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University Park PA 16802

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A Preliminary Model to Estimate the Strip Mine Reclamation Potential of Selected Land Uses

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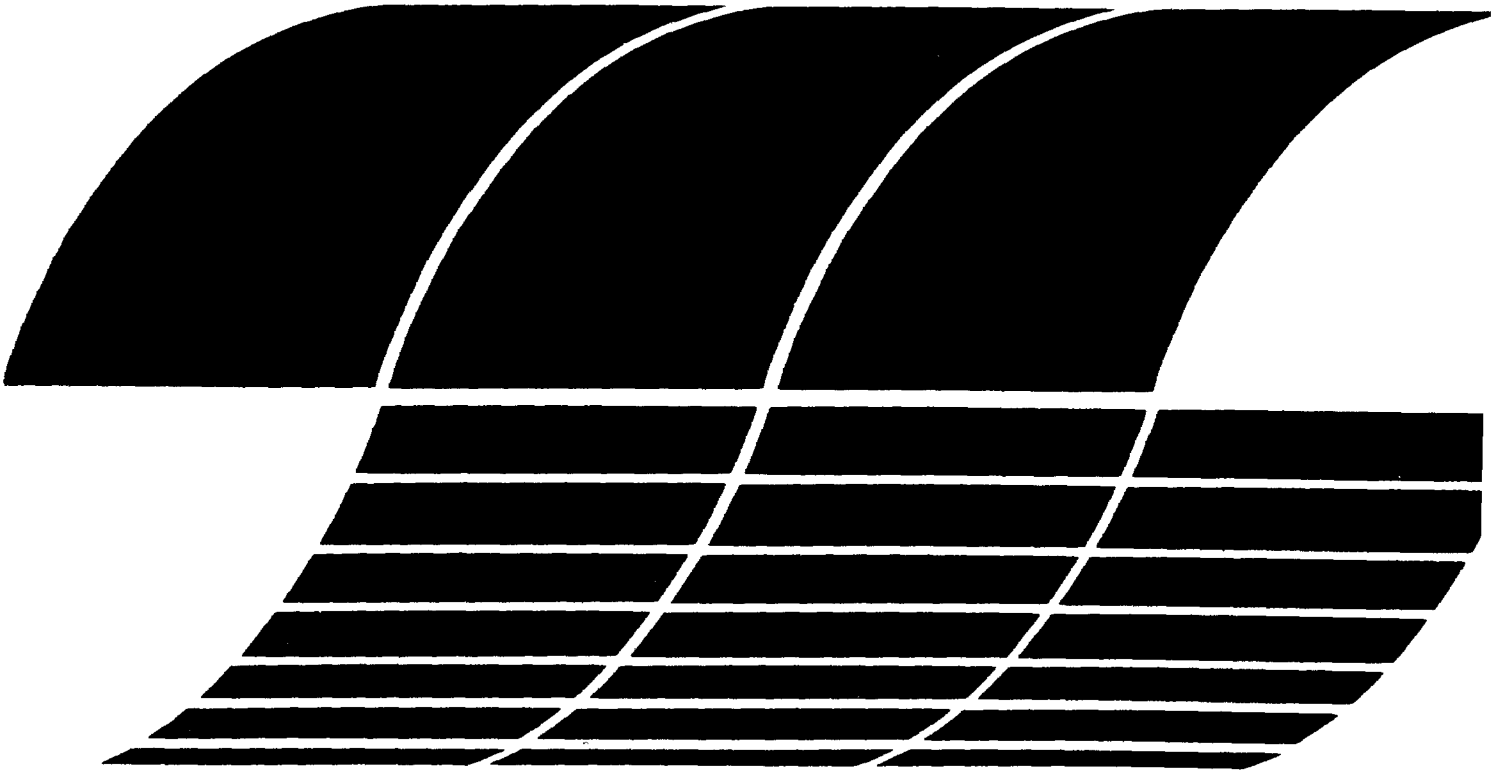

A PRELIMINARY MODEL TO ESTIMATE THE STRIP MINE RECLAMATION POTENTIAL OF SELECTED LAND USES

by

R. W. Elfstrom, Jr. and A. S. Rogowski
U.S. Department of Agriculture, ARS
Northeast Watershed Research Center
University Park, Pennsylvania 16802

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Project Officer

Clinton W. Hall
Office of Energy, Minerals and Industry
Washington, D.C. 20250

Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C. 20250

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FOREWORD

The Federal Water Pollution Control Act Amendments of 1972, in part, stress the control of nonpoint source pollution. Sections 102 (C-1), 208 (b-2,F) and 304(e) authorize basin scale development of water quality control plans and provide for area-wide waste treatment management. The act and the amendments include, when warranted, waters from agriculturally and silviculturally related nonpoint sources, and requires the issuance of guidelines for both identifying and evaluating the nature and extent of nonpoint source pollutants and the methods to control these sources. Research program at the Northeast Watershed Research Center contributes to the aforementioned goals. The major objectives of the Center are to:

- study the major hydrologic and water-quality associated problems of the Northeastern U.S. and
- develop hydrologic and water quality simulation capability useful for land-use planning.
  Initial emphasis is on the hydrologically most severe land uses of the Northeast.

Within the context of the Center's objectives, stripmining for coal ranks as a major and hydrologically severe land use. In addition, once the site is reclaimed and the conditions of the mining permit are met, stripmined areas revert legally from point to nonpoint sources. As a result, the hydrologic, physical, and chemical behavior of the reclaimed land needs to be understood directly and in terms of control practices before the goals of Sections 102, 208 and 304 can be fully met.

Signed:

Harry B Pionke

Harry B. Pionke
Director
Northeast Watershed
Research Center

ABSTRACT

Investigations were conducted to estimate land use reclamation potentials at two unmined sites in Bradford Township, Clearfield County (site 1) and Somerset/Brothers Valley Townships, Somerset County (site 2), Pennsylvania. The objective was to design a preliminary model which would enable a strip mine operator to determine a priori an optimum land use following reclamation.

Reclamation potentials were estimated for agriculture (corn and meadow), forestry (pine and wildlife habitat), and recreation (trails and multiuse) land uses. The magnitude of the change in the existing and anticipated physical and chemical properties of the site's soils as well as the change in related economic and aesthetic properties at the site were estimated. The significance of the anticipated property levels to the land use in question was also determined. For both property magnitude and significance a number scheme ranging from 1 to 5 was preassigned to various levels of each property, indicating optimum and least optimum property levels, respectively. The land use with the best reclamation potential would be the one which had the lowest significance value.

Physical property changes were greater and the anticipated property levels were more favorable for all land uses at site 2. Chemical magnitude values, although equal for all land uses at each site, were higher at site 1. However, anticipated chemical property levels also had more of an impact on land use establishment at site 2. Economic magnitude and significance values were higher at site 1.

Site 2 was much larger than site 1; consequently, aesthetic properties were more critical at site 2.

Economic properties had the greatest influence on magnitude values, while aesthetic and economic properties had the greatest influence on significance values.

At both sites, trails were least affected by the physical and chemical properties of the soil. Economic values favored pine at site 1 and wildlife habitat at site 2. Corn and meadow were the most aesthetically favored at sites 1 and 2.

Wildlife habitat had the best reclamation potential at site 1 and meadow had the best reclamation potential at site 2.

CONCLUSIONS

The reclamation potential preliminary model was tested at Bradford Township, Clearfield County (site 1) and Somerset/Brothers Valley Townships, Somerset County, Pennsylvania (site 2). At both sites reclamation potentials were estimated for corn, meadow, pine, wildlife habitat, trails, and multiuse by comparing existing (prior to mining) and anticipated (following reclamation) physical, chemical, economic, and aesthetic property levels (magnitude values) and noting the effects of the anticipated property levels on each land use (significance values).

Results showed that the economic properties had the greatest influence on the overall magnitude value for each of the land uses at both sites. Overall significance values were more influenced by the aesthetic and economic properties than by the physical and chemical properties.

Corn was the land use most affected by the physical and chemical properties at both sites, while trails were the least affected by these properties. Pine was economically favored at site 1, whereas wildlife habitat was favored at site 2. For both sites, trails received the lowest reclamation potential based on economic properties alone. Corn and meadow were the most aesthetically favored at both sites. Opposition from local residents could be expected if the sites are reclaimed to trails or multiuse.

Results indicate that wildlife habitat and meadow have the best reclamation potential at sites 1 and 2, respectively, and multiuse has the worst. Review and comparison of the property matrices for each land use at both sites prior to mining would enable the operator to note particularly high magnitude and significance values for specific properties. Thus, reclamation could be geared to amend these properties in order to improve the potential for reclaiming the area to a given land use.

A limiting factor in this study was the inadequate information available on the physical and chemical properties of minesoils. Properties were estimated from analyses on only 25 Pennsylvania minesoils. Three minesoil groups, with relatively the same amount of minesoils in each group, were established on the basis of pH. The sample size was small and the breakdown on the basis of pH questionable. Therefore, supplemental data sources for existing soil properties and anticipated minesoil properties are needed.

An expanded data source will enable this model to be applied to a multivariate regression program for analyzing property land use interactions. Different combinations of independent variables can then be tested to determine the suitability of a minesoil for a selected land use.

Furthermore, as related research progresses, it will be possible to minimize some of the arbitrary assignment of weights and perhaps elicit more objectivity in estimating significance values.

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SECTION 1

INTRODUCTION

It would be advantageous for the United States to become energy self-sufficient because of the rising costs of imported oil. Coal is by far the most abundant of the domestic fuels, and as of January 1, 1975, more than 30% of the coal reserves were recoverable by surface mining methods (Kleppe, 1977). Therefore, at present much emphasis is being placed on surface mining. At the same time, higher qualitative and quantitative demands are being made on the environment. Consequently, requirements have been imposed on the surface mining industry to reclaim the land in such a way as to maintain the environmental quality during and after mining (Surface Mining Control and Reclamation Act of 1977, PL 95-87).

The objective of this study was to design a preliminary model which would serve as a general framework for a reclamation potential model. The reclamation potential model will enable a strip mine operator to determine a priori an optimum land use following reclamation. The reclamation potential for a given land use will be based on the anticipated physical and chemical properties of the minesoil as well as the economics and the aesthetics associated with mining and reclamation at the chosen site. Once reclamation potentials are established using the proposed model, the strip mine operator can gear his reclamation plan towards the land use with the best potential. The operator may also decide to amend certain properties to improve the reclamation potential of a land use to conform with the local land use objectives.

The major goals of reclamation and related physical, chemical, and socio-economic properties of strip mining and reclamation are well documented (Zellmer and Carter, 1977; Brooks and Williams, 1973; and Falkie, 1971). Today, coal can only be mined if a detailed reclamation plan (Hill, 1977) has been reviewed and approved by the Office of Surface Mining Reclamation and Enforcement (Waldrop, 1977). McCormack (1974) already stressed the importance of reclaiming the land to its optimum use. However, definition of optimum use can be ambiguous, although it is generally agreed that unnecessary costs can be avoided if a land use is selected before mining. In this study optimum land use is defined as the land use having the best reclamation potential score. Only three land uses, agriculture, forestry, and recreation will be considered in this study.

At present, there is no single procedure available that provides an assessment of impact and long range effects of strip mining on an area (Rogowski et al., 1977). Recent evidence (Sendlein et al., 1977) suggests that concerted efforts in that direction are being initiated. The proposed model is a modification of the environmental impact matrix (Leopold et al., 1971). It relies on anticipated changes in the physical and chemical properties of the soil as a result of mining, on the economics and aesthetics associated with mining and reclamation processes, and on the effects of these changes on selected land uses.

Land use suitability classes had been suggested for minesoils predating recent Federal strip mine legislation (Smith et al., 1976), yet little work has been done with more recent minesoils (Ciolkosz et al., in press; and Pedersen, 1977). In general, minesoils are pedogenically young and reflect the properties of their parent material (Sobek et al., 1976), although little is known about the rate at which changes occur after the rock strata are mined and exposed to weathering (Davis, 1977). Except for the information on toxicities and nutrient deficiencies in spoil materials (Fleming et al., 1974), substantive data on chemical property changes are also scarce. Economic and aesthetic properties are more readily ascertained. Doyle (1974) and Boehlje and Libbin (1977) have described various economic indicators related to surface mining while aesthetic properties are most commonly determined through opinion surveys (Fischer, 1975; Krutella and Fisher, 1976; and Mann et al., 1976).

A related study in land use management is The Canada Land Inventory (Department of Regional Economic Expansion, 1970a). Portions of Canada have been assessed according to their land use capabilities for agriculture (Department of the Environment, 1972), forestry (McCormack, 1972), wildlife (Perret, 1973), and recreation (Department of Regional Economic Expansion, 1970b). The surveys were compared with present land use. The purposes of the land inventory, however, was different and broader in scope than this study.

EXPERIMENTAL SITES

The proposed model was tested at two geologically different unmined sites in Clearfield and Somerset Counties, Pennsylvania. The

Clearfield site is in the area where brackish water sediments predominate resulting in low pH values and high potential for acid drainage. The Somerset County site is on the fresh water sediments with overburden containing large quantities of limestone and dolomite.

Description of Site 1

Site 1 is located in the Pittsburgh Plateau section of the Appalachian Plateau Province approximately 3 km northwest of Bigler in the Bradford Township of Clearfield County (Figure 1). The existing land is a mixture of rolling to steeply sloping meadow, brush, and woodland (Figure 2). Seventy-seven acres are scheduled to be mined for the Upper, Middle, and Lower Kittannning coal (C', C, and B coal, respectively). A map of the soils present, including the Berks, Cookport, Gilpin, and Weikert soils and an old Minesoil, and their percent distribution are shown in Figure 3.

Description of Site 2

Site 2 is located in the Allegheny Mountain section of the Appalachian Plateau Province approximately 8 km west of Brotherton in Somerset/Brothers Valley Townships, Somerset County (Figure 1). The topographic features are similar to site 1, but the slope is less severe (Figure 4). Two-hundred and three acres are scheduled to be mined for the Upper Freeport coal (E coal). A map of the soils present, including the Cavode, Cookport, Hazleton, Nolo, and Wharton soils and their distribution are shown in Figure 5.

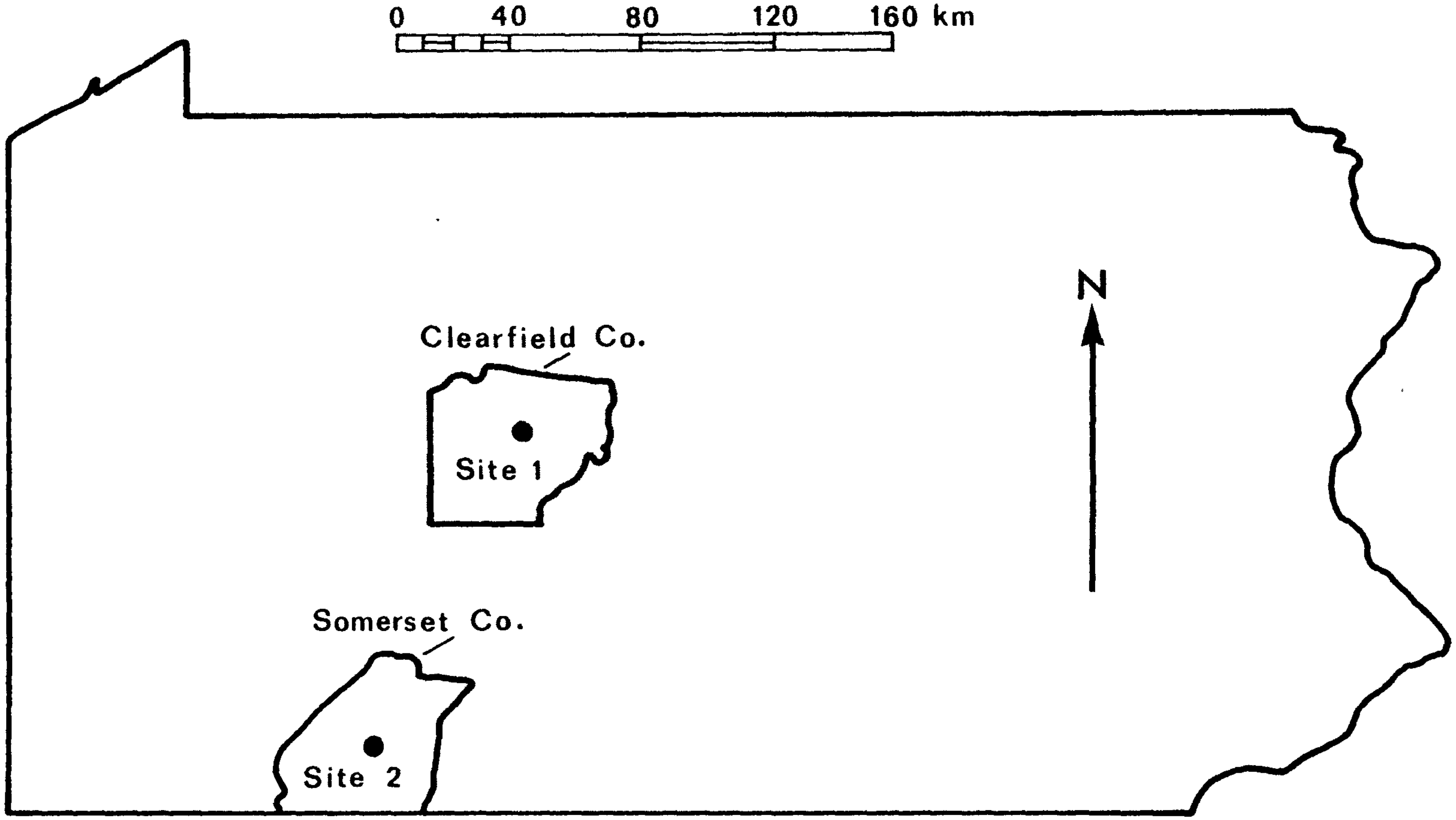


Figure 1. Location of experimental sites 1 and 2.

Figure 2. Site 1, Bradford Township, Clearfield County, Pennsylvania.

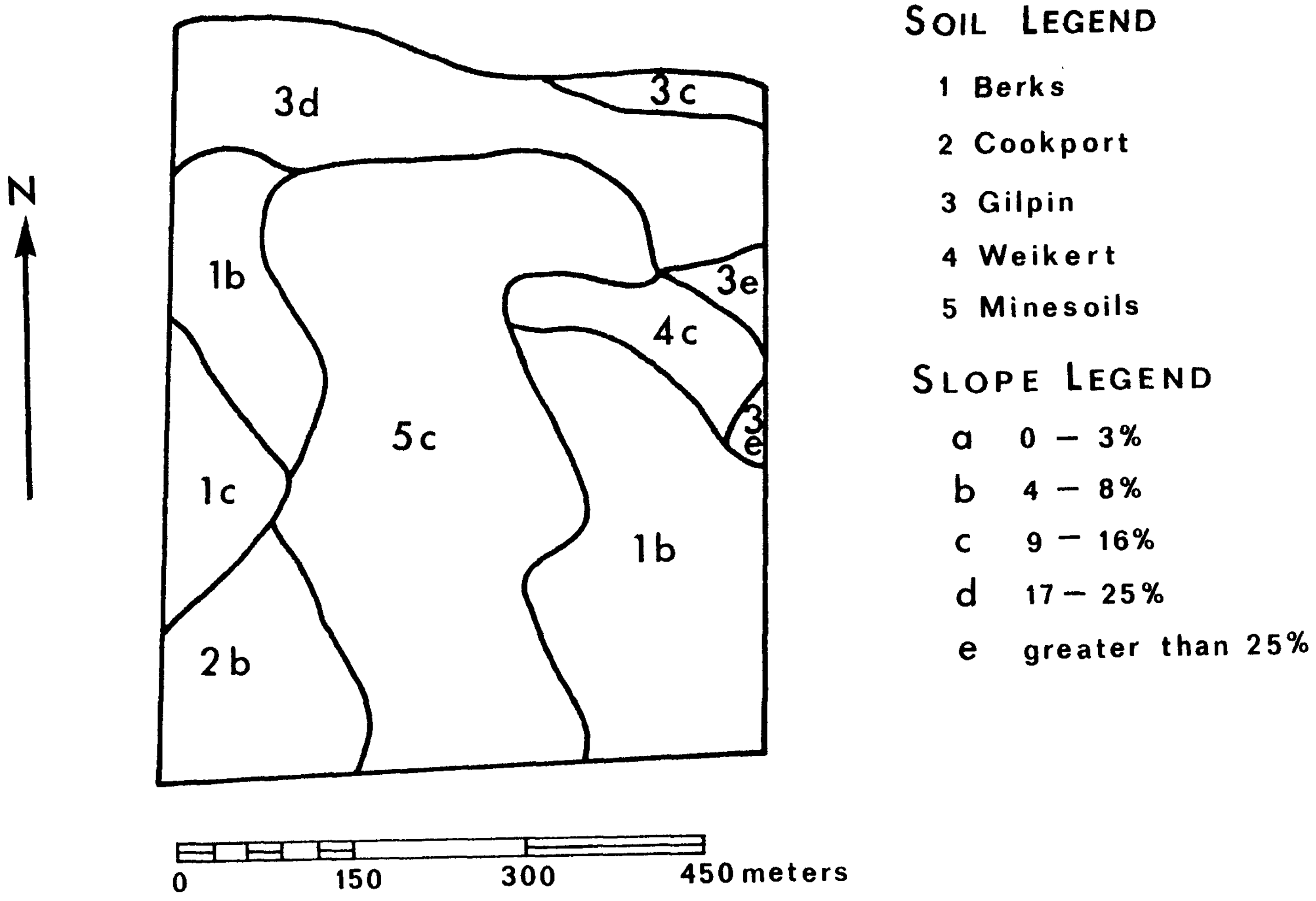
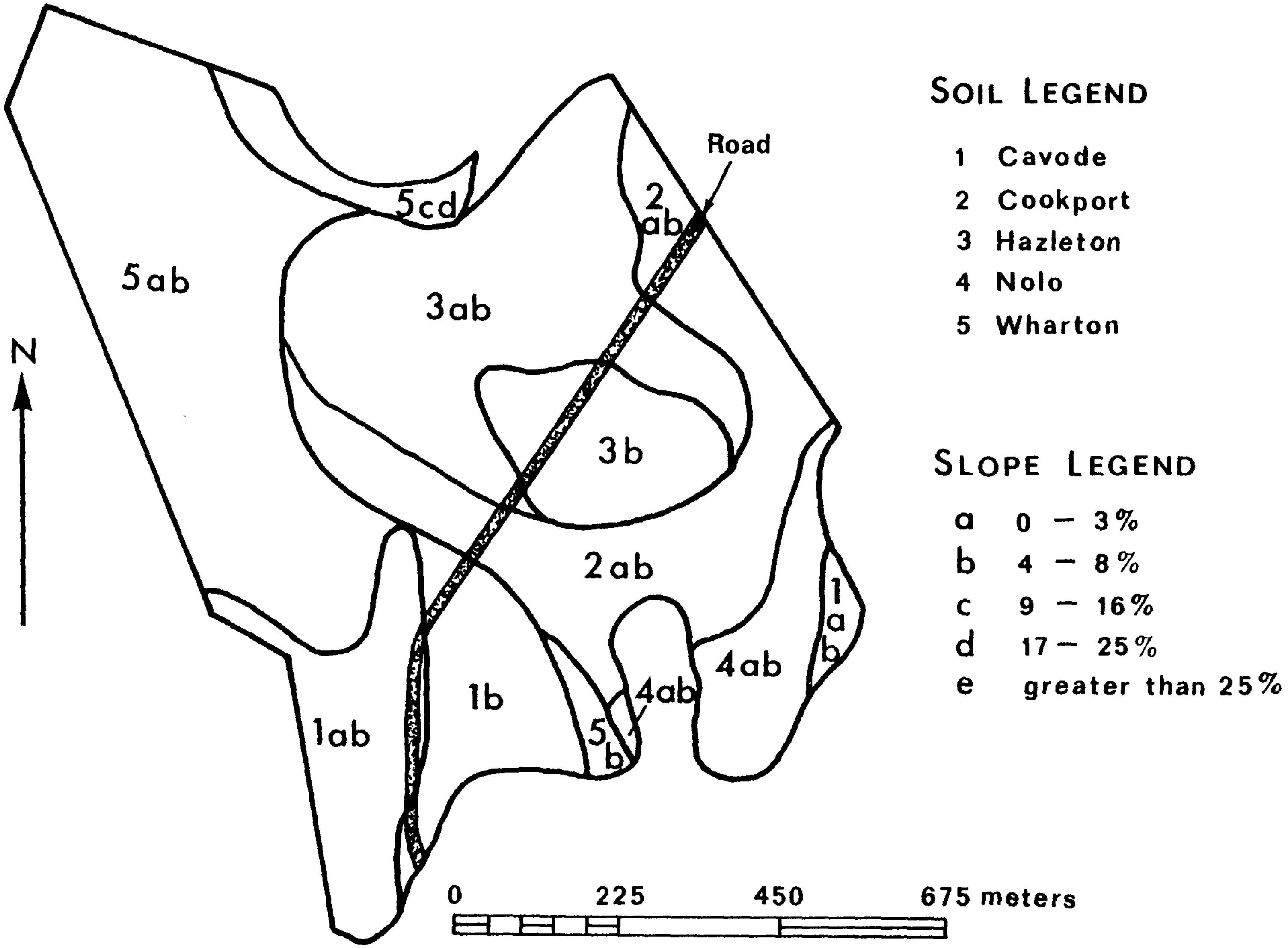


Figure 3. Soils present at site 1, Bradford Township, Clearfield County, Pennsylvania.

Figure 4. Site 2, Somerset/Brothers Valley Townships, Somerset County, Pennsylvania.

Figure 5. Soils present at site 2, Somerset/Brothers Valley Townships, Somerset County, Pennsylvania.


Road
5cd
2
ab
5ab
3ab
N
3b
2ab
1
a
b
4ab
1b
4ab
1ab
5
b
SOIL LEGEND
1 Cavode
2 Cookport
3 Hazleton
4 Nolo
5 Wharton
SLOPE LEGEND
a 0 – 3%
b 4 – 8%
c 9 – 16%
d 17 – 25%
e greater than 25%
0
225
450
675 meters

Detailed maps and discussions pertaining to the topography, stratigraphy, and coal and mineral statistics for the areas including sites 1 and 2 are provided by Glover (1970), Flint (1965), and Crentz et al. (1951 and 1952).

SECTION 2

MATERIALS AND METHODS

RECLAMATION POTENTIAL MODEL

Model Properties

The reclamation potential for a selected land use is based on the changes in the physical and chemical properties of the area's soils and on the changes in the economic and aesthetic properties of the site. The preliminary model can be written as,

$$RP = \Delta\ (P + C + E + A)$$

where RP = site reclamation potential

ΔP = change in physical properties of the area's soils
ΔC = change in chemical properties of the area's soils
ΔE = change in economic properties of the site
ΔA = change in aesthetic properties of the site

Generally speaking, a minesoil following reclamation will not have the same physical and chemical characteristics as the natural soil that existed there before mining (McCormack, 1974). However, some anticipated properties of the minesoil can be estimated prior to mining if the soil and overburden properties are known (Sobek et al., 1976). It is also unlikely that the same economic and aesthetic properties will prevail at the site for each land use following mining and reclamation. Therefore, reclamation potential is determined by estimating anticipated levels of the physical, chemical, economic, and aesthetic properties and comparing these with existing conditions.

Soil Coefficients

Usually a site to be mined is composed of several soils which have different physical and chemical properties. During mining the soils are removed and segregated into stockpiles. Consequently, horizons for each soil become mixed. Therefore, when the soil's physical and chemical properties are determined, they need to be multiplied by a coefficient based on the soils acreage at the site.

Land Uses

Agriculture Land Uses -- Three basic land uses will be considered, agriculture, forestry, and recreation. Briggs et al. (1977) have reviewed the soil requirements for successful agricultural reclamation. At both sites in this study reclamation potentials are established for the following agriculture land uses:

Corn - The land is planted to corn annually. Species selection is based on county crop statistics and related literature from the Soil Conservation Service and Agricultural Extension Services.

Meadow - The spoil is seeded with perennial grasses and/or legumes. A land reclaimed to meadow can be used for the production of hay and/or production of beef cattle.

Forest Land Uses. Approximately 80% of all areas that have been strip mined since 1945 have been reforested (Research Committee on

Coal Mine Spoil Revegetation in Pennsylvania, 1965). Reclamation potentials are derived for the following forest land uses:

Pine - Pine seedlings, suited to Pennsylvania soils and climate, are planted in the spoil so that a marketable pine stand will develop quickly.

Wildlife Habitat - A combination of trees, shrubs, and grasses are planted to establish a diverse natural setting for wildlife management.

Recreation Land Uses-- Sawyer and Crowl (1968) state that much emphasis in the past ten years has been placed on developing areas for recreational purposes. The following recreation land uses are evaluated for their reclamation potentials:

Trails - A series of hiking and riding trails are routed through a forest-type setting.

Multiuse - The land is reclaimed in a similar manner as in trails, however, areas are established for camping, ballplaying, and other accommodations, such as registration and restroom facilities.

Property Land Use Interaction

Table 1 lists definitions of selected terminology of the reclamation potential equation. The magnitude of the changes in the physical, chemical, economic, and aesthetic property levels and the significance of the anticipated property levels to the reclamation potential of a given land use are recorded in matrix tables. In these tables the land uses form the vertical axis and the properties form the horizontal axis.

TABLE 1. DEFINITIONS OF SELECTED TERMINOLOGY

Physical properties	Slope, erosion, texture, permeability, coarse fragments content, depth to limiting layer, and bulk density.
Chemical properties	pH, cation exchange capacity, potassium content, magnesium content, calcium content, organic matter content, and sulfur content.
Economic properties	Land property value, reallocation of state income tax, effect of unemployment, and additional costs.
Aesthetic properties	Public attitude and area mined and visual conformity.
Existing property level	The estimated or observed property level prior to mining.
Anticipated property level	The estimated property level following reclamation.
Weight	A number ranging from 1 to 5 such that 1 indicates an optimum property level and 5 indicates the least optimum property level.
Magnitude[1]	Anticipated weight/existing weight.
Importance value	A subjective numerical evaluation describing numerically the importance of an anticipated property level to a given land use. Numbers range from 1 to 5 such that 1 indicates little importance and 5 indicates great importance.
Significance[2]	Anticipated weight + importance.
Interaction	Magnitude|significance. Slash line does not indicate a ratio.
Property matrix	A table showing the interaction of land uses and property levels.
Soil coefficient	A value which represents the soil's relative percentage at the site.

TABLE 1. (continued)

Weighted sum	Sum of magnitude X C|sum of significance X C for physical or chemical properties on a given land use where C is the soil coefficient.
Average sum	Sum of the magnitude and sum of significance values for the weighted physical sum, and weighted chemical sum and for the site economic, and aesthetic properties divided by the number of components (7, 7, 4, and 2, respectively).
Reclamation potential	Average sum (physical) + average sum (chemical) + average sum (economic) + average sum (aesthetic).

[1] Exceptions are sulfur, reallocation of state income tax, effect of unemployment, additional costs, and area mined and visual conformity properties.

[2] The exception is the sulfur property.

Magnitude-- The magnitude of the change in property levels, unless otherwise indicated, is represented by a ratio of the anticipated property level to the existing property level. Since each property has a different unit of measurement, which may be very small (as in a percent value) or very large (as in a cost estimate), it is necessary to assign numbers to various levels of each property. These numbers are referred to as weights and range from 1 to 5. A weight of 1 indicates an optimum property level, whereas a weight of 5 designates the least optimum property level. Magnitude ratio may be less than, equal to, or greater than 1 depending on the degree of change expected. Ideally, a value less than 1 is desirable because it suggests that the property level may improve following reclamation.

Significance-- The significance of the anticipated property level to a selected land use, unless otherwise specified, is represented by the sum of the weight assigned to the anticipated property level and an importance value. The importance value, also ranging from 1 to 5, is a subjective evaluation describing numerically the importance of an anticipated property level to a given land use. A value of 1 indicates little importance and a value of 5 represents great importance. The lower the significance value for a land use, the better the reclamation potential.

The magnitude value appears to the left of the slash line and the significance value appears to the right. The slash line does not indicate a ratio.

The reader is referred to the end of this chapter (page 51) for an example of how to use this preliminary reclamation potential model.

Sources of Data for Existing and Anticipated Property Levels

Estimated existing physical and chemical property values (Appendix A) are taken from readily available sources such as Characteristics, Interpretations, and Uses of Pennsylvania Soils; Soil Survey Reports; pertinent U.S. Geological Survey and State Geological Survey publications; and coal company data. Anticipated minesoil properties (Appendix B) are determined from recent physical and chemical analyses of 25 minesoils in Pennsylvania (Ciolkosz et al., in press). The 25 minesoils have been categorized into three groups according to pH. Group I minesoils have a pH greater than 5 (Tables B1 and B2), Group II minesoils have a pH between 4 and 5, inclusive (Tables B3 and B4), and Group III minesoils have a pH less than 4 (Tables B5 and B6). Anticipated physical and chemical properties of a minesoil are estimated by assigning the soil to minesoil group whose pH corresponds to the average pH (all horizons) for a given soil. A summary of the physical and chemical properties for Group I, II, and III are given in Table 2.

Some existing and anticipated economic and aesthetic properties can also be determined through discussions with coal company engineers and county courthouse personnel. Additional information is obtained from responses to opinion surveys (Appendix C). These surveys are designed to quantitatively approximate various environmental qualities.

TABLE 2. SUMMARY OF THE PHYSICAL AND CHEMICAL PROPERTIES FOR MINESOILS GROUP I,* GROUP II,† AND III‡

	Minesoil group		
	I	II	III
	Physical properties		
Texture (class)	Loamy sand	Sandy loam	Loamy sand
Permeability (mm/hr)	101.7	34.8	101.7
Coarse fragments content (% by weight)	77.7	75.5	78.8
Depth to limiting layer (meters)	.33	.43	.21
	Chemical properties		
pH	6.12	4.34	3.75
Cation exchange capacity (me/100 grams)	20.90	27.02	21.46
Potassium (% of CEC)	.94	.50	.54
Magnesium (% of CEC)	12.39	4.50	1.80
Calcium (% of CEC)	34.89	23.60	14.70
Organic matter (% nitrogen)	.12	.11	.10

*Group I consists of minesoils with a pH greater than 5.

†Group II consists of minesoils with a pH between 4 and 5, inclusive.

‡Group III consists of minesoils with a pH less than 4.

DESCRIPTION OF THE MODEL PROPERTIES

Physical Properties

Slope-- A decrease in slope is beneficial. Excessive slope inhibits seed start and the use of machinery and increases erosion and runoff. Weights have been assigned on the basis of a slope class system (Soil Survey Staff, 1951) such that a 0 to 3% slope represents no limitations and a slope greater than 25% represents severe limitations (Table 3).

Unless exceptions are granted (PL 95-87, Sec. 515 (c) 2, 3, and 4), the average slope for the site should remain unchanged. Therefore, the existing slope value equals the anticipated slope value. The importance of the anticipated slope level to each land use is found in Table 4.

Erosion-- No erosion is desirable. Potential adverse effects of erosion include breakdown of soil aggregates, crust formation, and channelized flow through rills and gullies. Wischmeier (1971) states that it is the policy of the Soil Conservation Service to plan cropland practices so that soil loss from a field averages less than 5 tons/acre/year (approximately 2 mm of soil). Considering this level of erosion to be optimum, weights have been assigned in increments of 4 tons/acre/year (Table 5).

The severity of erosion depends on the steepness and length of slope, extent of freezing and thawing, amount and intensity of precipitation, and how water is concentrated in the soil (USDA, 1968). The Universal Soil Loss Equation (Wischmeier and Smith, 1962 and 1965) is used to determine existing and anticipated soil loss. All equation parameters are available through the Soil Conservation

TABLE 3. WEIGHTS ASSIGNED TO SLOPE

Slope	Weight
%	
0 to 3	1
4 to 8	2
9 to 16	3
17 to 25	4
greater than 25	5

TABLE 4. IMPORTANCE VALUES ASSIGNED TO SLOPE WEIGHT

Land Use	Slope weight				
	1	2	3	4	5
Corn	1	2	3	4	5
Meadow	1	1	2	3	4
Pine	1	1	2	3	4
Wildlife habitat	1	1	2	3	4
Trails	1	1	1	2	3
Multiuse	1	1	2	3	4

TABLE 5. WEIGHTS ASSIGNED TO EROSION

Erosion Tons/acre/year	Weight
1 to 4	1
4.1 to 8	2
8.1 to 12	3
12.1 to 16	4
greater than 16	5

Service, however, it is necessary to make assumptions about the ground cover for each land use to develop a cropping management factor (Appendix A, Table A7). In Table 6, the importance of the anticipated erosion level to each land use is shown.

Texture-- In general, sands are well-aerated but are apt to be loose, structureless, and droughty; clays compact easily favoring puddle formation and crust over during dry periods; and loams and silts usually have enough fine material to hold moisture (USDA, 1968). Assuming loams are the most desirable and sands and clays are the least desirable, textural classes (Soil Survey Staff, 1951) have been assigned weights (Table 7).

The texture of a minesoil can be estimated if the rock types and overburden material are known (Sobek et al., 1976). Pedersen (1977) has found that minesoils typically have less silt and more sand in their fine earth fraction than do natural soils. To account for this anticipated texture change, the percent of silt and clay are calculated on the basis of field soil rather than just those fractions less

TABLE 6. IMPORTANCE VALUES ASSIGNED TO EROSION WEIGHTS

Land Use	Erosion weight 1	2	3	4	5
Corn	1	3	4	5	5
Meadow	1	2	3	4	5
Pine	1	2	3	4	5
Wildlife habitat	1	2	3	4	5
Trails	1	1	2	3	4
Multiuse	1	2	3	4	5

TABLE 7. WEIGHTS ASSIGNED TO TEXTURE

Texture Class	Weights
Loamy: medium textured	1
Loamy: medium coarse textured	2
Loamy: fine textured	3
Sandy - clayey	4
Sands - clays	5

than 2 mm. The importance of the anticipated texture to each land use is listed in Table 8.

Permeability-- Rapid permeability leaches the soil of nutrients and slow permeability encourages water accumulation. Weights have been assigned to the permeability classes outlined by the Soil Survey Staff (1951) assuming that rapid permeability is less damaging to plant growth and soil management than slow permeability (Table 9).

In Table 10 the relationship between soil horizon texture and hydraulic conductivity is shown (Mason et al., 1957). Anticipated permeabilities are established corresponding to anticipated texture. These conductivities are summed and averaged to yield the soil's anticipated permeability. Anticipated permeabilities for minesoil Group I and II (sands) and Group III (medium coarse textured) are summarized in Table 2. The importance of the anticipated permeability to each land use is given in Table 11.

Coarse Fragments Content -- A decrease in the amount of coarse fragments is beneficial. Coarse fragments may interfere with the use of machinery and obstruct plant growth. Furthermore, when fractions larger than 25 mm constitute more than 80% of the spoil, it is no longer analogous to soil (Rogowski and Weinrich, 1977). Minesoils usually contain from 40 to 70% coarse fragments by weight (Pedersen, 1977). Weights have been assigned spanning this range (Table 12). In Table 13, the importance of the anticipated coarse fragments content to each land use is listed.

Depth to Limiting Layer -- An increase in depth to a limiting layer is generally desirable. Shallow bedrock impeding root growth, a seasonally high water table contributing to flooding, or a toxic

TABLE 8. IMPORTANCE VALUES ASSIGNED TO TEXTURE WEIGHTS

Land Use	Texture weight				
	1	2	3	4	5
Corn	1	1	1	3	5
Meadow	1	1	1	2	4
Pine	1	1	1	2	4
Wildlife habitat	1	1	1	2	4
Trails	1	1	1	2	4
Multiuse	1	1	1	3	5

TABLE 9. WEIGHTS ASSIGNED TO PERMEABILITY

Permeability mm/hr	Weight
20.32 to 63.50	1
63.60 to 127.00	2
5.00 to 20.31	3
greater than 127.00	4
less than 5.00	5

TABLE 10. HYDRAULIC CONDUCTIVITY OF VARIOUS TEXTURES FOR DIFFERENT SOIL HORIZONS*

Texture	Hydraulic conductivity (mm/hr) by horizon			
	Horizon A	Horizon B	Horizon C	Arithmetic mean
Sands†	199.6	46.2	59.4	101.7
Medium coarse‡	51.1	29.5	23.9	34.8

*This table is abstracted from a report by D. D. Mason, J. F. Lutz, and R. G. Petersen (1957).

†Sands texture is indicative of Minesoil Group I and III (loamy sands).

‡Medium coarse texture is indicative of Minesoil Group II (sandy loams).

TABLE 11. IMPORTANCE VALUES ASSIGNED TO PERMEABILITY WEIGHTS

Land Use	Permeability weight				
	1	2	3	4	5
Corn	1	3	4	5	5
Meadow	1	2	3	4	5
Pine	1	2	3	4	5
Wildlife habitat	1	2	3	4	5
Trails	1	2	3	4	5
Multiuse	1	2	3	4	5

TABLE 12. WEIGHTS ASSIGNED TO COARSE FRAGMENTS CONTENT

% by weight	Coarse fragments content Weight
less than 40	1
41 to 50	2
51 to 60	3
61 to 70	4
greater than 70	5

TABLE 13. IMPORTANCE VALUES ASSIGNED TO COARSE FRAGMENTS CONTENT WEIGHTS

Land Use	Coarse fragments content weight				
	1	2	3	4	5
Corn	1	3	5	5	5
Meadow	1	2	3	4	5
Pine	1	1	2	3	4
Wildlife habitat	1	1	2	3	4
Trails	1	1	1	2	3
Multiuse	1	2	3	4	5

stratum adversely affecting plant growth, can be considered as limiting layers in land use establishment. In Table 14 weights have been assigned assuming that a depth of 1.2 meters will not affect most land uses.

Pedersen (1977) reported that the greatest amount of pedogenic development in minesoils occurs in the surface horizons. The C horizon is usually structureless and massive and unless the site is on prime agricultural land, it will not be segregated but will be mixed with the coal overburden containing pyrite. Therefore, the presence of pyritic sulfur, toxic to plant growth, throughout the C horizon of minesoils is likely. The anticipated depth to a limiting layer for a minesoil was taken as the sum of average depths of the A and B horizons of its respective Group (Tables B1, B3, and B5). The anticipated values for each minesoil group are summarized in Table 2. Table 15 shows the importance of the anticipated depth to limiting layer to each land use.

Bulk Density-- High and low bulk densities will adversely affect water and nutrient accumulation, the water to air ratio in the soil, root development, and consequently crop yields. Alekseyeva (1972) indicated that a favorable bulk density range for crops was 1.1 to 1.45 g/cc. Weights have been assigned reflecting this range (Table 16).

Pedersen (1977) lists some values of minesoil bulk density. A value of 1.78 g/cc, which is an average bulk density value determined by Pedersen (1977), was taken as the anticipated bulk density for all

TABLE 14. WEIGHTS ASSIGNED TO DEPTH TO LIMITING LAYER

m	Depth to limiting layer Weight
greater than 1.20	1
.91 to 1.20	2
.61 to .90	3
.30 to .60	4
less than .30	5

TABLE 15. IMPORTANCE VALUES ASSIGNED TO DEPTH TO LIMITING LAYER WEIGHTS

Land Use	Depth to limiting layer weight				
	1	2	3	4	5
Corn	1	2	3	4	5
Meadow	1	1	2	3	4
Pine	1	1	2	3	4
Wildlife habitat	1	1	1	2	3
Trails	1	1	2	3	4
Multiuse	1	2	3	4	5

TABLE 16. WEIGHTS ASSIGNED TO BULK DENSITY

	Bulk density
g/cc	Weight
1.25 to 1.30	1
1.20 to 1.24 and 1.31 to 1.35	2
1.15 to 1.19 and 1.36 to 1.40	3
1.10 to 1.14 and 1.41 to 1.45	4
less than 1.10 and greater than 1.45	5

minesoils. Table 17 gives the importance of the anticipated bulk density to each land use.

Chemical Properties

pH -- Low pH values inhibit the availability of nutrients and enhance the availability of minor elements, such as aluminum and magnesium, making them toxic to plant growth (Bennett et al., 1972). Martin et al. (1976) list optimum and tolerable pH ranges for major crops. Noting these ranges, weights have been assigned to various pH levels favoring a slightly acid to neutral pH (Table 18). Table 19 summarizes the importance of the anticipated pH level for each land use.

Cation Exchange Capacity -- The exchange capacity of Pennsylvania soils is essentially saturated with hydrogen, potassium, magnesium, and calcium (Hinish, 1969). Hinish (1969) states that a balanced soil will contain (as a percent of the cation exchange capacity) 2 to 5% potassium, 10 to 25% magnesium, and 60 to 80% calcium. Using the minimum values of these ranges, and the equations for determining the hydrogen concentration and the cation exchange capacity (Hinish, 1969), a minimum cation exchange capacity of approximately 8 me/100 g was calculated. Weights have been assigned such that any cation exchange capacity value at or above 8 me/100 g is acceptable and any value below this level is not acceptable (Table 20), while Table 21 shows the importance of the anticipated cation exchange capacity level for each land use.

Potassium Content -- Potassium is a constituent of plant protein, maintains cell permeability, keeps iron mobile in the plant, and

TABLE 17. IMPORTANCE VALUES ASSIGNED TO BULK DENSITY WEIGHT

Land Use	Bulk density weight				
	1	2	3	4	5
Corn	1	2	3	4	5
Meadow	1	1	2	3	4
Pine	1	1	2	3	4
Wildlife habitat	1	1	1	2	3
Trails	1	1	1	1	2
Multiuse	1	1	1	2	3

TABLE 18. WEIGHTS ASSIGNED TO pH

	pH Weight
6.1 to 7.3	1
5.6 to 6.0 and 7.4 to 7.8	2
5.1 to 5.5 and 7.9 to 8.4	3
4.5 to 5.0 and 8.5 to 9.0	4
less than 4.5 and greater than 9.0	5

TABLE 19. IMPORTANCE VALUES ASSIGNED TO pH WEIGHTS

Land Use	pH weight 1	2	3	4	5
Corn	1	2	3	4	5
Meadow	1	1	2	3	4
Pine	1	1	2	3	4
Wildlife habitat	1	1	2	3	4
Trails	1	1	1	2	3
Multiuse	1	1	2	3	4

TABLE 20. WEIGHTS ASSIGNED TO CATION EXCHANGE CAPACITY

me/100 g	Cation exchange capacity Weight
greater than or equal to 8.0	1
less than 8.0	5

TABLE 21. IMPORTANCE VALUES ASSIGNED TO CATION EXCHANGE CAPACITY WEIGHTS

Land Use	Cation exchange capacity weight 1	5
Corn	1	3
Meadow	1	2
Pine	1	2
Wildlife habitat	1	1
Trails	1	1
Multiuse	1	2

increases the resistance to disease (Donahue et al., 1971). Assuming these functions proceed normally in a balanced soil (Hinish, 1969), only soils with a potassium content in the range of 2 to 5% of the cation exchange capacity are acceptable and weights have been assigned accordingly (Table 22). Table 23 gives the importance of the anticipated potassium content for each land use.

Magnesium Content -- Donahue et al. (1971) state that magnesium aids in the uptake of phosphorus and is a necessary component of chlorophyll. In Table 24, weights have been assigned assuming that these properties are maintained in a magnesium balanced soil (Hinish, 1969). Table 25 lists the importance of the anticipated magnesium content to each land use.

Calcium Content -- Calcium makes cells more selective in absorption and is needed in large quantities for cell division (Donahue et al., 1971). Balanced and unbalanced soils, with respect to calcium content (Hinish, 1969), have been appropriately weighted in Table 26. In Table 27, the importance of the anticipated calcium content to each land use is given.

Organic Matter Content -- An increase in organic matter content is beneficial. Organic matter content can be estimated by the percent carbon; however, because of the occurrence of carboniferous shale and coal fragments in the soil, which can account for high organic carbon values (Pedersen, 1977), percent nitrogen is used. Soil organic matter is approximately 5% nitrogen (Donahue et al., 1971). Bremner (1965) states that the total-N content of soils ranges from 0.02% in subsoils to 2.5% in peats and that the surface layer of most cultivated soils contains between 0.06 and 0.5% N. Weights have been

TABLE 22. WEIGHTS ASSIGNED TO POTASSIUM CONTENT

% of CEC	Potassium content Weight
2 to 5	1
less than 2 and greater than 5	5

TABLE 23. IMPORTANCE VALUES ASSIGNED TO POTASSIUM CONTENT WEIGHTS

Land Use	Potassium content weight 1	 5
Corn	1	5
Meadow	1	3
Pine	1	2
Wildlife habitat	1	1
Trails	1	1
Multiuse	1	2

TABLE 24. WEIGHTS ASSIGNED TO MAGNESIUM CONTENT

% of CEC	Magnesium content Weight
10 to 25	1
less than 10 and greater than 25	5

TABLE 25. IMPORTANCE VALUES ASSIGNED TO MAGNESIUM CONTENT WEIGHTS

Land Use	Magnesium content weight 1	 5
Corn	1	4
Meadow	1	4
Pine	1	3
Wildlife habitat	1	2
Trails	1	2
Multiuse	1	3

TABLE 26. WEIGHTS ASSIGNED TO CALCIUM CONTENT

% of CEC	Calcium content Weight
60 to 80	1
less than 60 and greater than 80	5

TABLE 27. IMPORTANCE VALUES ASSIGNED TO CALCIUM CONTENT WEIGHTS

Land Use	Calcium content weight 1	 5
Corn	1	3
Meadow	1	2
Pine	1	2
Wildlife habitat	1	1
Trails	1	1
Multiuse	1	1

assigned on the basis of percent N in the soil (Table 28). The importance of the anticipated organic matter content to each land use is reported in Table 29.

Sulfur Content-- A decrease in sulfur content is desirable. Although sulfur is required for synthesis of certain vitamins in plants, and averages 0.15% in a typical soil (Donahue et al., 1971), its pyritic form, especially framboidal pyrite (Caruccio, 1975), poses an environmental problem. Acid producing materials, such as pyrite, often become mixed and distributed throughout the spoil and topsoil during strip mining and reclamation (Rogowski and Jacoby, 1977). A weight is assigned to sulfur content such that any value less than or equal to .05% is considered environmentally safe (Table 30).

The Freeport and Upper Kittanning coals occur in fresh water sediments and the Middle and Lower Kittanning coals occur in marine-brackish water sediments (Degens et al., 1957). Because the deposition of pyrite is favored in reducing environments (marine-brackish environments as opposed to an oxidized continental fresh water environment), the lower formations in the Allegheny Group contain higher pyritic sulfur than the upper formations (Caruccio and Parizek, 1967). Also, younger coals have more alkaline drainage (Degens et al., 1957; and Emrich et al., 1968). Thus, a second series of weights have been assigned to coal seams indicating the potential for acid drainage (Table 31).

We recall that magnitude is represented by the ratio of the anticipated property level to the existing property level. For this property, magnitude is represented by the sum of two weights (one for sulfur content, Table 30, and one for the lowest coal seam being

TABLE 28. WEIGHTS ASSIGNED TO ORGANIC MATTER CONTENT

% N	Organic matter content Weight
greater than 1.0	1
.50 to 1.00	2
.06 to .49	3
.02 to .05	4
less than .02	5

TABLE 29. IMPORTANCE VALUES ASSIGNED TO ORGANIC MATTER CONTENT WEIGHTS

Land Use	Organic matter content weight				
	1	2	3	4	5
Corn	1	1	2	2	3
Meadow	1	1	1	1	2
Pine	1	1	1	1	1
Wildlife habitat	1	1	1	1	1
Trails	1	1	1	1	1
Multiuse	1	1	1	1	1

TABLE 30. WEIGHTS ASSIGNED TO SULFUR CONTENT

% Sulfur	Sulfur content Weight
less than or equal to .05	1
greater than .05	5

TABLE 31. WEIGHTS ASSIGNED TO COAL SEAM

	Coal seam Weight
Upper Freeport	1
Lower Freeport	2
Upper Kittanning	3
Middle Kittanning	4
Lower Kittanning	5

mined, Table 31). Also, significance is normally represented by the sum of the weight for the anticipated property level and the importance of that level to the land use in question; however, for this property, it is determined by the sum of the weight assigned to the lowest coal seam to be mined at the site (Table 31) and the importance of sulfur content (reflecting the affects of acid drainage) for a given land use (Table 32).

TABLE 32. IMPORTANCE VALUES ASSIGNED TO SULFUR CONTENT WEIGHTS

Land Use	Sulfur content weight	
	1	5
Corn	1	5
Meadow	1	3
Pine	1	3
Wildlife habitat	1	4
Trails	1	1
Multiuse	1	2

Economic Properties

Land Property Value -- Individual property assessments are available at county and township tax assessment offices. However, site property values are estimated because a mining site is usually composed of more than one person's property and often only portions of these properties are involved. Somerset's tax assessment scheme for agricultural land was modified to provide a land property value for each land use at both sites (Table 33). Land uses were assigned to land groups I through IV (Table 33) on the basis of group description.

Economic returns expected from the land use are considered when determining land property value. In Table 33, importance values have been assigned to each land use indicating how important it is for that land use to have an economic return.

Reallocation of State Income Tax-- This property was designed to quantify by a mail survey (Appendix C, questions 5, 6, 7, and 12 and Table C2) the visual ammenities related to agriculture, forest, and recreation land uses. In the same manner, the value of not stripping the land was quantified. The survey respondents ranked the land uses according to preference (Appendix C, question 5) and then designated the portion of his state income tax he would be willing to reallocate in order to reclaim the land to his most preferred use (Appendix C, question 6) or to prevent strip mining in the township (Appendix C, question 7). These responses were indexed with income levels (Appendix C, question 12). Average reallocation quantities were expressed in units of dollars/family/year. Weights have been assigned in $45.00/family/year increments for both land use preference (Table 34) and the no strip mining option (Table 35).

For this property, magnitude is represented by the sum of the reallocation amount and the amount assigned for preventing strip mining. Significance values are represented by the sum of the weight assigned to the reallocation amount for the land use and the importance value. Since expected public involvement with the land use affects the amount of state income tax reallocated, importance values

TABLE 33. WEIGHTS AND IMPORTANCE VALUES ASSIGNED TO THE PROPERTY VALUE FOR SELECTED LAND USES*

Group	Group description	Land uses that apply to group	Property value Dollars	Weight	Importance value
I	Ideal cropland, level to nearly level, deep well-drained soils	Corn	500	1	5
II	Good to fair cropland, gentle to moderate slopes, medium depth soils, slight crop limitations	Multiuse	250 to 450	2	3
III	Marginal cropland, gentle to moderate slopes, light shallow soils, subject to erosion	Pine Trails	80 to 150	3	4 2
IV	Pasture, rolling to steep slopes, shallow soils, woodland and brush, subject to strong erosion	Meadow Wildlife habitat	40 to 60	4	3 1
V	Rugged steep slopes, mountainous, limited woodland, barren, waste	-	20	5	-

*Based on Somerset County, Pennsylvania tax assessment scheme for agricultural land.

TABLE 34. WEIGHTS ASSIGNED TO LAND USE PREFERENCE

Dollars/family/year	Land use preference Weight
greater than 180	1
136-180	2
91-135	3
45-90	4
less than 45	5

TABLE 35. WEIGHTS ASSIGNED TO THE NO STRIP MINING OPTION

Dollars/family/year	No strip mining option Weight
less than 45	1
45-90	2
91-135	3
136-180	4
greater than 180	5

have been assigned indicating the importance of public involvement in each land use (Table 36).

Effect of Unemployment-- It is economically desirable to reclaim a land to a use which provides more employment opportunities for the immediate area, especially in areas of high unemployment. General skills are required for maintaining each of the six land uses and weights have been assigned on the basis of the potential number of persons that may be required (Table 37). In Table 38, weights are also assigned to unemployment levels. In general, unemployment figures are usually available at the county level.

For this property, magnitude is represented by the ratio of the anticipated number of persons (Table 37) to the percent unemployment in the county (Table 38). Significance values were determined by the sum of the weight for the anticipated number of jobs (Table 37) and the importance value (Table 37), which indicates the importance of employment availability for each land use.

Additional Costs --General summary costs for mining and strip mine reclamation (Sendlein et al., 1977), factors affecting costs (Brooks and Williams, 1973), and methods for estimating costs (Otte and Boehlje, 1976; and Pundari and Coates, 1975) are available. However, the additional costs of reclaiming a land to a selected land use are highly variable. Relative costs estimates, expressed in dollars/acre, based on Soil Conservation Service cost figures for grading and planting, have been made for each of the six land uses (Appendix D). Weights have been assigned to each land use based on these estimates (Table 39).

TABLE 36. IMPORTANCE VALUES ASSIGNED TO LAND USE PREFERENCE WEIGHTS

Land Use	Land use preference weight				
	1	2	3	4	5
Corn	1	1	1	1	2
Meadow	1	1	2	2	3
Pine	1	1	2	2	3
Wildlife habitat	1	1	2	2	3
Trails	1	2	3	4	5
Multiuse	1	2	3	4	5

TABLE 37. WEIGHTS AND IMPORTANCE VALUES ASSIGNED TO THE POTENTIAL NUMBER OF JOBS FOR EACH LAND USE

Land Use	Description of job duties	Number of persons	Weight	Importance
Corn	Plowing, planting, maintenance, harvesting	2	3	2
Meadow	Planting, maintenance	1	5	1
Pine	Planting, maintenance, clearing/ thinning, harvesting	3	2	3
Wildlife habitat	Planting, maintenance, enforcement,	2	3	2
Trails	Planting, maintenance, enforcement, cleanup	3	2	4
Multiuse	Planting, maintenance, enforcement, cleanup	5	1	5

TABLE 38. WEIGHTS ASSIGNED TO UNEMPLOYMENT

	Unemployment Weight
%	
less than 1	1
1 to 3	2
3.1 to 5	3
5.1 to 7	4
greater than 7	5

TABLE 39. WEIGHTS AND IMPORTANCE VALUES ASSIGNED TO ADDITIONAL COSTS*

Land Use	Additional costs dollars/acre	Weight	Importance
Corn	3630	5	1
Meadow	50	1	3
Pine	75	2	2
Wildlife habitat	225	3	4
Trails	200	3	4
Multiuse	130	2	3

*Explanations and calculations for each of these values are given in Appendix C.

Thus, magnitude is represented by the weighted additional cost values (Table 39). It is assumed that additional costs can be offset by expected monetary returns from the land use. In Table 39, importance values have been assigned to each land use indicating the anticipated profits.

Aesthetic Properties

Public Attitude--Community acceptance with land use selection is critical (Research Committee on Coal Mine Spoil Revegetation in Pennsylvania, 1965). In order to determine the public's preference for each of the land uses, such as agriculture, forestry, or recreation, survey techniques were used (Appendix C, question 5). From the responses it was possible to estimate what percent of the population favored the existing and anticipated land uses. In Table 40, weights have been assigned to percentage ranges. The importance of the anticipated public attitude for each land use is shown in Table 41.

Area Mined and Visual Conformity--Aesthetically speaking, a decrease in the amount of acres disturbed during mining is beneficial. For this property, the magnitude is represented by the weight for the amount of acres mined (Table 42). Ideally, the intended land use should aesthetically blend with the rest of the landscape. This degree of visual conformity of the land use to the surrounding area is a subjective appraisal based on the onsite inspection and aerial photographs (if available). The significance value is determined by the sum of the weight for the acres to be mined and the importance value, which indicates the degree of conformity. Importance values

TABLE 40. WEIGHTS ASSIGNED TO PUBLIC ATTITUDE

% of the population in favor of the land use	Public attitude Weight
greater than 80	1
61 to 80	2
41 to 60	3
21 to 40	4
less than 20	5

TABLE 41. IMPORTANCE VALUES ASSIGNED TO PUBLIC ATTITUDE WEIGHTS

	Public attitude weight				
Land Use	1	2	3	4	5
Corn	1	1	1	1	2
Meadow	1	1	2	2	3
Pine	1	1	2	2	3
Wildlife habitat	1	1	2	2	3
Trails	1	2	3	4	5
Multiuse	1	2	3	4	5

TABLE 42. WEIGHTS ASSIGNED TO AREA MINED

Acres	Area mined Weight
less than 25	1
25 to 50	2
51 to 75	3
76 to 100	4
greater than 100	5

range from aesthetically conforming (1), to moderately conforming (3), and to non-conforming (5).

INTERPRETATION OF THE CALCULATIONS TO DETERMINE THE RECLAMATION POTENTIAL OF A SELECTED LAND USE

We recall that the reclamation potential for a site is determined by the sum of the changes in the physical and chemical properties of the area's soils and the economics and aesthetics associated with strip mining and reclamation. The values for property magnitude and significance are listed in the four property matrices for each land use. These values were summed and averaged, the results are reported in the summary tables. Differences can be interpreted by reviewing the four property matrices and noting unusually high and low values. This review process can serve as a guide to select those properties, if amended, that would improve the reclamation potential of a given land use.

The reclamation potential for a given land use is determined by the sum of the four property average significance values alone, with the optimum land use having the lowest total significance value. Low magnitude values are beneficial; however, the values by themselves do not indicate the severity of the property level with respect to the land use in question (i.e., a magnitude of 1 may be the result of a 1/1 or a 4/4 ratio of anticipated to existing values). Magnitude values are included in the determination of reclamation potentials if significance values for two or more land uses are identical. In this situation, the land use with the lower magnitude value, indicating a more overall improvement in site characteristics following reclamation, would have the better reclamation potential.

AN EXAMPLE

To illustrate the use of this model, the influence of four properties, one physical (coarse fragments content), one chemical (pH), one economic (effect of unemployment), and one aesthetic (area mined and visual conformity) and their effect on the reclamation potential of corn at a hypothetical site (Y) will be examined.

Site Y is 45% soil A and 55% soil B. Therefore, the soil coefficients for A and B are .45 and .55, respectively. Existing property values are as follows:

coarse fragments content: Soil A = 29%
Soil B = 49%

pH: Soil A = 5.3
Soil B = 4.9

effect of unemployment: 5% unemployment in the county

area mined and visual conformity: 90 acres to be mined

Anticipated physical and chemical values for each soil are based on its pH value. Soil A corresponds to minesoil group I (Table B1 and B2), the anticipated coarse fragments content and pH are 77.8% and 6.1 units, respectively. Soil B corresponds to minesoil group II (Table B3 and B4), and the anticipated coarse fragments content and pH are 75.5% and 4.3 units, respectively.

The physical property matrix for soil A is given in Table 43. Magnitude and significance values are taken from Tables 12 and 13. The existing coarse fragments content of 29% has a weight of 1 (Table 12) and the anticipated coarse fragments content of 77.8% has a weight of 5 (Table 12). Therefore, the magnitude (the ratio of anticipated value weight to existing value weight) is 5/1 or 5 (Table 43). The importance value of the anticipated coarse fragments content with respect to corn, is 5 (Table 13). Therefore, the significance value which is the sum of the weighted anticipated value and the importance value is 5 + 5 or 10 (Table 43). The weighted sum for coarse fragments content for soil A is the sum of the soil coefficient (.45) times the magnitude and times the significance values above.

Physical property matrix for soil B (Table 44) and chemical property matrix for soil A (Table 43) and soil B (Table 44) are determined in the same manner.

The economic and aesthetic properties matrix at site Y is shown in Table 45. Anticipated economic and aesthetic properties are independent of the site's soils. For the effect of unemployment property (economic), magnitude is represented by the ratio of the weight associated with anticipated number of persons required to do the work (Table 37) and the weight associated with the total

TABLE 43. PHYSICAL AND CHEMICAL PROPERTIES MATRIX FOR SOIL A AT SITE Y

	Properties	
	Physical	Chemical
Land Use	Coarse fragments content	pH
Corn	5|10	.33|2

TABLE 44. PHYSICAL AND CHEMICAL PROPERTIES MATRIX FOR SOIL B AT SITE Y

	Properties	
	Physical	Chemical
Land Use	Coarse fragments content	pH
Corn	2.5|70	1.25|10

TABLE 45. ECONOMIC AND AESTHETIC PROPERTIES MATRIX AT SITE Y

	Properties	
	Economic	Aesthetic
Land Use	Effect of unemployment	Area mined and visual conformity
Corn	1|5	4|5

unemployment in the area (Table 38). The magnitude is 3/3 or 1 (Table 45). The significance again represented by the weights associated with the anticipated number of people needed to do the work (Table 37) plus the importance value (Table 37). The economic significance value is therefore 3 + 2 or 5 (Table 45).

For the visual conformity property matrix for the area mined the magnitude is given by a weighted value which represents the amount of acres being mined (Table 42). Since ninety acres are being mined at site Y, the magnitude is 4 (Table 45). Significance, given by the sum of weighted value and the importance value, represents the degree to which the proposed land use will conform to the surrounding landscape (see page 50). At site Y, corn should be aesthetically conforming, so the significance value is 4 + 1 or 5 (Table 45).

The physical and chemical properties and the weighted sums for corn are given in Table 46. The average sums calculated (Appendix F, Tables F1 through F12 and Tables F25 through F36) by dividing the sum of weighted sums for individual physical and chemical properties by the number of components (7 for physical, 7 for chemical, 4 for economic, and 2 for aesthetic). In this example since only one physical and chemical property each were chosen, the average sum equals the weighted sum. Similar inferences can be made for the economic and aesthetic properties for corn (Tables F13 through F24 and Tables F37 through F48). The average sums for the economic and aesthetic properties equal the site values found in Table 45.

The reclamation potential for corn at site Y, is the sum of the four average sums:

$$3.37|10.00 + .84|6.40 + 1.00|5.00 + 4.00|5.00 = 9.21|26.4$$

TABLE 46. PHYSICAL AND CHEMICAL PROPERTIES FOR CORN AT SITE Y*

	Properties	
	Physical	Chemical
Soil Type†	Coarse fragments content	pH
A	$5|10$	$.33|2$
B	$2.5|10$	$1.25|10$
Weighted sum	$3.37|10.00$	$.84|6.40$

*Component values are taken from Tables 43 and 44.

†Soil coefficients for soils A and B are .45 and .55, respectively.

SECTION 3

RESULTS AND DISCUSSION

ANALYSIS OF SELECTED SITE PROPERTIES AT SITE 1

Physical Properties

Slope-- Existing values of slope in the Bradford Township site 1 are found in Appendix A (Table A1). The slope for the Gilpin soil (17 to 25%) will most likely create soil management problems related to the use of machinery, seed emergence, runoff, and erosion. Management problems are less likely to occur on the Weikert soil and on the old Minesoil because the slope is less severe. The Berks and Cookport soils have the least slope which should not inhibit management practices. In Appendix E, Tables E1, E2, E3, E4 and E5 show separately for each soil the component values and the physical properties matrix for different land uses. We recall that values on the left of the slash line represent the magnitude of the property, and the values on the right of the slash line represent the significance of the property. Reclamation on this site will probably restore the land to its original contour, therefore, no change in the magnitude of slope is expected. Consequently, the matrix values of the property slope will be determined by the values of significance, the lower the significance the smaller the impact. The significance values for the Berks (Table E1) and Cookport soils (Table E2) are identical. They are lower than those for the Weikert soil (Table E4) and the Minesoil (Table E5) which also have identical significance values. The highest significance values occur on Gilpin soil (Table E3). Regardless of the soil, corn has the highest and trails have the lowest significance values.

Erosion -- Existing values for erosion are reported in Appendix A (Table A1). The composite erosion for the site preceding reclamation is relatively low, the anticipated erosion values being dependent on land use C factors (Table A2). No change in magnitude occurs with the Berks soil (Table E1), and the highest magnitude is found for pine on the Minesoil (Table E5). Erosion increases or remains the same for all land uses except meadow. A decrease in erosion occurs if the land is reclaimed in meadow on Gilpin (Table E3) and on Weikert soils (Table E4). The anticipated erosion value of significance was maximum (10) for pine, corn, and multiuse on the Gilpin soil (Table E3) and for pine on the Weikert soil (Table E4) and on the Minesoil (Table E5). In general, it is desirable to have low magnitude and significance values. On all soils significance values for meadow were consistently low.

Texture -- Existing values of texture are given in Appendix A (Table A1). Since in this study texture is correlated with permeability the loamy texture of the Berks, Cookport, and Weikert soils should enhance permeability, while the finer texture of Gilpin soil may inhibit permeability. The loamy sand texture of the Minesoil may induce excessive permeability rates leaving the profile dry. The anticipated texture value (Table B1) indicates that a loamy sand texture will exist after mining. Although no change in magnitude occurs with the Minesoil (Table E5), the change in magnitude for the Berks (Table E1), Cookport (Table E2), and Weikert soils

(Table E4) shows that texture will degrade to a greater extent than it will for the Gilpin soil (Table E3). For all soils, the significance of the anticipated texture for corn and multiuse is slightly higher than the significance for the other land uses.

Permeability -- Existing values for permeability are found in Appendix A (Table A1). With the exception of the Minesoil (101.7 mm/hr), all soils at site 1 are within the optimum range (20.32 mm/hr to 63.50 mm/hr) making them ideal for air and water movement. The anticipated permeability value (Table B1) is based on the hydraulic conductivity of the anticipated texture class. No change in magnitude occurs with the Minesoil (Table E5), while the magnitude is twice as large but remains the same for each land use for the Berks (Table E1), Cookport (Table E2), Gilpin (Table E3), and Weikert soils (Table E4). For all soils, the value of property significance for corn is slightly higher than it is for the other land uses.

Coarse Fragments Content -- Existing values for coarse fragments content are summarized in Appendix A (Table A1). In existing profiles the coarse fragments content is quite low in the Cookport soil, but higher in the Berks, Gilpin, and Weikert soils and the Minesoil. The anticipated values are to be found in Appendix B (Table B1). No change in magnitude occurs with the Minesoil (Table E5). Changes occur in the Berks (Table E1), Cookport (Table E2), Gilpin (Table E3), and Weikert soils (Table E4). The significance value of the anticipated coarse fragments content is maximum for corn, meadow, and multiuse. The other land uses appear less affected.

Depth to Limiting Layer -- Depth to a limiting layer may be a seasonally high water table (as for the Cookport soil) or bedrock (as for the Berks, Gilpin, and Weikert soils). Existing values are shown in Appendix A (Table A1). For most land uses the Berks, Cookport, and Gilpin soils extend to adequate depths. The Weikert soil and the Minesoil are more shallow and may encourage flooding and adversely affect plant growth. The anticipated values following reclamation are estimated in Appendix B, Table B1. Although no change in magnitude occurs with the Weikert soil (Table E4) or Minesoil (Table E5), the increase in magnitude for the Berks (Table E1), Cookport (Table E2), and Gilpin soils (Table E3) suggests that the depth to the limiting layer will decrease. The significance values are again highest for corn and multiuse and lowest for wildlife habitat.

Bulk Density-- Existing values for bulk density are reported in Appendix A (Table A1). Prior to reclamation the bulk density of the Berks soil (1.38 g/cc) is the only acceptable value. The values for the Cookport, Gilpin, and Weikert soils and the Minesoil are larger and will likely affect the water and nutrient contents, the water to air ratio, the development of the root system, and crop yields. The value of 1.78 g/cc is used for the anticipated bulk density (Pedersen, 1977). No change in magnitude occurs with the Cookport (Table E2), Gilpin (Table E3), Weikert soils (Table E4) and Minesoil (Table E5) although the magnitude increased slightly for the Berks soil (Table E1). The significance value of the anticipated bulk density is again maximum for corn. The other land uses appear less affected.

Chemical Properties

pH -- Existing values of pH in the Bradford Township site 1 are found in Appendix A (Table A3). Prior to reclamation, the pH values for the Berks and Weikert soils and the Minesoil are favorable for plant growth (slightly acid to neutral). The more acidic Gilpin soil is less favorable and the strongly acidic Cookport soil is the least favorable. On this soil pH will most likely inhibit nutrient availability, contribute to toxicity, and adversely affect plant growth. In Appendix E, Tables E6, E7, E8, E9 and E10 show separately for each soil the component values and the chemical properties matrix for different land uses. The anticipated pH values are given in Appendix B, Table B2. No change in magnitude occurs with the Berks (Table E6) and Weikert soils (Table E9) and the Minesoil (Table E10). However, the decrease in magnitude for the Cookport (Table E7) and Gilpin soils (Table E8) may indicate an improvement in pH value following reclamation. The significance values for all soils are identical and at a minimum (2). We recall that a low significance value suggests a good potential for establishing a given land use after reclamation.

Cation Exchange Capacity -- Existing values of cation exchange capacity are reported in Appendix A (Table A3). The anticipated cation exchange capacity values (Table B2) appear adequate. Therefore, the magnitude remains the same for the Berks (Table E6), Cookport (Table E7), Gilpin (Table E8), and Weikert soils (Table E9) as well as the Minesoil (Table E10). The significance values for all soils are identical and at a minimum.

Potassium Content-- Existing values for potassium content are summarized in Appendix A (Table A3). The existing value for the Weikert soil (2.8% of the cation exchange capacity) is the only acceptable one. The values for the Berks, Cookport, and Gilpin soils and the Minesoil are less than 2% and may affect the protein balance, cell permeability, translocation of carbohydrates, iron mobility, and resistance to disease in plants. Anticipated potassium content values are found in Appendix B, Table B2. The magnitude remains the same for the Berks (Table E6), Cookport (Table E7), and Gilpin soils (Table E8) and the Minesoil (Table E10), while the magnitude increases for the Weikert soil (Table E9) indicating a decrease in potassium content. The significance values of the anticipated potassium content is maximum for corn. The other land uses seem less affected.

Magnesium Content-- Existing values for magnesium content are shown in Appendix A (Table A3). In Berks and Gilpin soils and the Minesoil magnesium contents are greater than 10% of the cation exchange capacity value and will probably not affect the uptake of phosphorus and the chlorophyll balance; however, the values for the Cookport and Weikert soils are less and may present a problem. The anticipated magnesium content values following reclamation are estimated in Appendix B, Table B2. No change in magnitude occurs with the Berks (Table E6) and Gilpin soils (Table E8) and the Minesoil (Table E10). An increase in magnesium content is anticipated in the Cookport (Table E7) and Weikert soils (Table E9). As before, the significance values for all soils are identical and at a minimum.

Calcium Content-- Existing values of calcium content are listed in Appendix A (Table A3). The Berks and Weikert soils are in the minimum range (60 to 80% of the cation exchange capacity) of a balanced soil. The calcium content values for the other soils are much less and will most likely affect cell absorption and division. The anticipated values following reclamation are also very low (Table B2). The magnitude of this property for the Cookport (Table E7) and Gilpin soils (Table E8) and the Minesoil (Table E10) will experience a decrease in calcium content. The significance value of the anticipated calcium content appears higher for corn than the other land uses.

Organic Matter Content-- Existing values of organic matter content are found in Appendix A (Table A3). The premining organic matter content for the Cookport soil (.03% nitrogen) is quite low. The values for the Berks, Gilpin, and Weikert soils and the Minesoil are higher and are likely to increase the availability of carbohydrates and nutrients. The anticipated value (Table B2) is comparable to the calcium content of the Berks (Table E6), Gilpin (Table E8), and Weikert soils (Table E9) and the Minesoil (Table E10) and no change in magnitude is expected for these soils. The decrease in magnitude for the Cookport soil (Table E7) shows that reclamation may improve the organic matter content for that soil. As before, significance values are highest for corn.

Sulfur -- We recall that the magnitude is represented by the ratio of the anticipated property value to the existing property value. Also, the significance is represented by the sum of the weight of anticipated property level and the importance of that property level to the land use. A modification of this procedure is employed to evaluate the effect of sulfur content on the land uses. Existing values for sulfur content are greater than .05% for all soils and have received a weight of 5. The magnitude is represented by the sum of this weight and the weight assigned to the lowest coal seam being mined at the site (Table 31). For site 1, the lowest coal seam being mined is the Lower Kittanning (5) which has high potential for increasing acid mine drainage. Therefore, the magnitude for all land uses for Berks (Table E6), Cookport (Table E7), Gilpin (Table E8), and Weikert soils (Table E9) and the Minesoil (Table E10) are at a maximum (10). The significance is represented by the weight of the lowest coal seam being mined and the importance of the sulfur content to the land use (Table 32). Corn seems to be most affected, while the effect on trails appears to be least.

Economic Properties

Land Property Value-- The existing and anticipated land property values for the Bradford Township site 1 are found in Table 33 (Group IV). The existing land is a mixture of rolling to steeply sloping meadow, brush, and woodland. The magnitude and significance values are given in Appendix E, Table E11. In general, low magnitude and significance values are desirable. No change in magnitude should occur if this land is reclaimed to a meadow or wildlife habitat. The other land uses will decrease the magnitude enhancing the property values with corn having the greatest influence. Low significance land property values occur with corn, wildlife habitat, trails, and multiuse. Meadow has the highest significance value, suggesting that this land use would not be economically favored at this site.

Reallocation of State Income Tax -- Values for the amount of state income tax the people would be willing to reallocate to prevent strip mining and the amount of state income tax the people would be willing to reallocate in order to reclaim the land to a selected land use are reported in Table 47. Values are estimated from responses to opinion surveys (Appendix C, questions 5, 6, 7, and 12 and Table C2). We recall that the magnitude value is typically the ratio of the anticipated property value to the existing property value. For this property, the magnitude is represented by the sum of the reallocation values for preventing strip mining and reclaiming the land to a selected land use. The significance value is represented by the sum of the amount of state income tax the people would be willing to reallocate to reclaim the land to a selected land use and the importance value (Table 36). Magnitude and significance values are reported in Table E11. For site 1, the magnitude increases more for trails and multiuse, indicating that people would be likely to reallocate more for the other land uses. The significance reallocation of state income tax values are lowest for corn and highest for trails and multiuse.

Effect of Unemployment -- The existing township unemployment figure is not available for Bradford Township, so the unemployment figure for Clearfield County (8.0%), available through the county courthouse, was used. The anticipated value is represented by the potential number of men that would be needed to maintain a selected land use (Table 37). Magnitude and significance values are shown in Table E11. The magnitude for meadow remains the same. However, decreases in magnitude for the other land uses (especially multiuse)

TABLE 47. THE AMOUNT OF STATE INCOME TAX WILLING TO BE REALLOCATED PER FAMILY PER YEAR TO PREVENT STRIP MINING AND TO RECLAIM THE LAND TO A SELECTED LAND USE AT SITE 1*

Land Use	Amount of state income tax willing to be reallocated
	dollars/family/year
Prevent strip mining	49.40
Corn	121.33
Meadow	121.33
Pine	118.22
Wildlife habitat	118.22
Trails	80.60
Multiuse	80.60

*Explanations and calculations for each of these values are reported in Appendix C.

suggest that employment for the township could be improved. The significance of the effect of unemployment is less for corn, pine, and wildlife habitat than it is for the other land uses.

Additional Costs--Additional costs of reclaiming a land to a given land use are summarized in Table 39. The magnitude (Table E11) is represented by the value found in Table 39 which indicates that corn will be the most expensive to establish while meadow will cost the least. The significance of additional costs is low for meadow and pine and high for wildlife habitat and trails (Table E11).

Aesthetic Properties

Public Attitude--Public attitude values for Bradford Township for the existing and selected land uses are found in Table 48. Values were estimated based on opinion surveys (Appendix C, question 5). Pine and wildlife habitat are slightly favored over corn and meadow. Trails and multiuse are favored by only a small portion (3%) of the population. Magnitude and significance values are found in Appendix E, Table E12. No change in magnitude is likely to occur if the land is reclaimed to corn, meadow, pine, or wildlife habitat; however, a slight increase in magnitude indicates that some public disapproval could be anticipated if the land is reclaimed to trails or multiuse. The lowest significance public attitude value occurs with corn. Maximum significance values (10) occur with trails and multiuse.

Area Mined and Visual Conformity--Magnitude and significance values are given in Table E12. We recall that magnitude is represented by the ratio of the anticipated property value to the

TABLE 48. PUBLIC ATTITUDE VALUES FOR SELECTED LAND USES BASED ON THE PERCENT OF THE POPULATION THAT WOULD RANK THAT LAND USE ABOVE THE OTHER LAND USES AT SITE 1

Land Use	Public attitude
	% of population
Corn	45
Meadow	45
Pine	54
Wildlife habitat	54
Trails	3
Multiuse	3

existing property value. For this property, magnitude is represented by a value which indicates the amount of acres being mined (Table 42). Approximately 77 acres are being mined in Bradford Township. We recall that significance is represented by the sum of the anticipated property value and the importance of the anticipated property value. For this property significance is the sum of a subjective numerical representation of the degree to which the selected land use conforms with the rest of the landscape and the importance value. All land uses appear to be aesthetically conforming, with the exception of multiuse. The higher significance value for multiuse indicates that multiuse at this site would probably be somewhat out of place.

ESTIMATION OF RECLAMATION POTENTIAL FOR EACH LAND USE AT SITE 1

The average sums of the physical properties for corn, meadow, pine, wildlife habitat, trails, and multiuse are found in Appendix F, Tables F1, F2, F3, F4, F5 and F6, respectively. We note that only the physical property magnitude values for erosion vary between land uses. We recall that low magnitude and significance values are beneficial. No change in magnitude occurs with slope. Generally, magnitude progressively increases with depth to limiting layer, bulk density, permeability, coarse fragments content, texture, and erosion; however, the magnitude value for erosion for meadow (Table F2) is slightly less than the depth to limiting layer. Typically, low significance values occur with slope, where high values occur with coarse fragments content and bulk density.

In Appendix F, Tables F7, F8, F9, F10, F11 and F12 the average sums of the chemical properties for corn, meadow, pine, wildlife habitat, trails, and multiuse are shown, respectively. There is no variation in the chemical property magnitude values between land uses. A decrease in magnitude with pH, magnesium content, and organic matter content indicates an improvement in these chemical properties after reclamation. No change in magnitude occurs with cation exchange capacity. There is a slight increase in magnitude with potassium content and calcium content, but the largest increase occurs with sulfur. Significance values are lowest for pH, cation exchange capacity, and magnesium content, where the highest significance values occur with sulfur.

The average sums of the economic properties for corn, meadow, pine, wildlife habitat, trails, and multisue are given in Appendix F, Tables F13, F14, F15, F16, F17 and F18, respectively. For the land property value, a decrease in magnitude occurs with corn (Table F13), pine (Table F15), trails (Table F17), and multiuse (Table F18) indicating that the property value will likely improve if the land is reclaimed to one of these uses. No change in property value magnitude occurs with meadow (Table F14) or wildlife habitat (Table F16). The significance land property values for wildlife habitat (Table F16) is less than the significance values for the other land uses. For the effect of the reallocation of state income tax property, somewhat higher magnitude and significance values occur with trails (Table F17) and multiuse (Table F18) than with the other land uses. The lowest significance reallocation of state income tax value occurs with corn (Table F13). For the effect of the unemployment property, a decrease in magnitude (suggesting a potential increase in employment) occurs for all land uses except meadow (Table F14) where no change is anticipated. The significance effect of unemployment values are slightly higher for meadow (Table F14), trails (Table F17), and multiuse (Table F18). For the additional costs property, no change in magnitude is expected for meadow (Table F14), and the largest increase in magnitude is expected for corn (Table F13) indicating that corn will probably be the most expensive land use to establish. Significance additional cost values are lowest for meadow (Table F14) and pine (Table F15), and highest for wildlife habitat (Table F16) and trails (Table F17).

In Appendix F, Tables F19, F20, F21, F22, F23 and F24 the average sums of the aesthetic properties for corn, meadow, pine, wildlife habitat, trails, and multiuse are reported, respectively. For the public attitude property value, an increase in magnitude is anticipated for trails (Table F23) and multiuse (Table F24). The significance public attitude value is lowest for corn (Table F19) and highest for trails (Table F23) and multiuse (Table F24). For the area mined and visual conformity property, the increase in magnitude (4) is the same for all land uses. Significance values are also the same (5) except for multiuse (Table F24), which is slightly higher than the other land uses.

The reclamation potentials for corn, meadow, pine, wildlife habitat, trails, and multiuse at site 1 are summarized in Table 49. We recall that land use reclamation potentials are determined by the significance values alone. Low magnitude values are beneficial; however, they are only considered in the estimation of reclamation potentials if significance values for two or more land uses are identical. Although meadow has the lowest magnitude value (8.39),

TABLE 49. RECLAMATION POTENTIALS FOR EACH LAND USE AT SITE 1

Land Use	Property average sums									
	Physical		Chemical		Economic		Aesthetic		Sum	
Corn*	1.68	7.70	2.45	6.29	2.71	5.25	2.50	4.50	9.34	23.74
Meadow†	1.44	6.19	2.45	5.43	2.00	5.50	2.50	5.00	8.39	22.12
Pine‡	1.77	6.83	2.45	5.29	2.04	5.00	2.50	5.00	8.76	22.12
Wildlife habitat§	1.61	6.42	2.45	5.14	2.77	5.50	2.50	5.00	8.88	22.06
Trails#	1.69	5.99	2.45	4.71	2.54	6.75	2.84	7.50	9.52	24.95
Multiuse**	1.61	6.78	2.45	5.00	2.18	6.25	2.84	8.50	9.08	26.53

*Component values are taken from Appendix F (Tables F1, F7, F13, and F19).

†Component values are taken from Appendix F (Tables F2, F8, F14, and F20).

‡Component values are taken from Appendix F (Tables F3, F9, F15, and F21).

§Component values are taken from Appendix F (Tables F4, F10, F16, and F22).

#Component values are taken from Appendix F (Tables F5, F11, F17, and F23).

**Component values are taken from Appendix F (Tables F6, F12, F18, and F24).

wildlife habitat has been estimated to have the best reclamation potential at site 1, because it has the lowest significance value (22.06) of the six land uses under consideration in this study. Pine and meadow land uses have equal significance values; however, the magnitude value for meadow is less making reclamation to pine less favorable. Trails, corn, and multiuse had higher significance values and consequently worse reclamation potentials. Multiuse had the highest significance value (26.53), while trails had the highest magnitude value (9.52).

INFLUENCE OF EACH PROPERTY ON RECLAMATION POTENTIAL AT SITE 1

In Figures 6 and 7 magnitude and significance of the physical, chemical, economic, and aesthetic properties for each land use are displayed. Tables 50 and 51 show separately for each property the range of values, mean, standard deviation, and coefficient of variation for property magnitude and significance values for the land uses, respectively.

Of the four properties, the physical properties have the lowest mean magnitude value (1.63), but the standard deviation is also low which indicates that the magnitude of this property varies little between land uses (Table 50). The mean magnitude values for the chemical, economic, and aesthetic properties are higher; however, there is no variation in mean values between land uses for the chemical properties. The mean values for the economic properties show the greatest variation between land uses (.34). Therefore, the variation in the overall magnitude value for each of the land uses appears to be most influenced by the economic properties.

Figure 6. Variation in property magnitude at site 1, Bradford Township, Clearfield County, Pennsylvania.

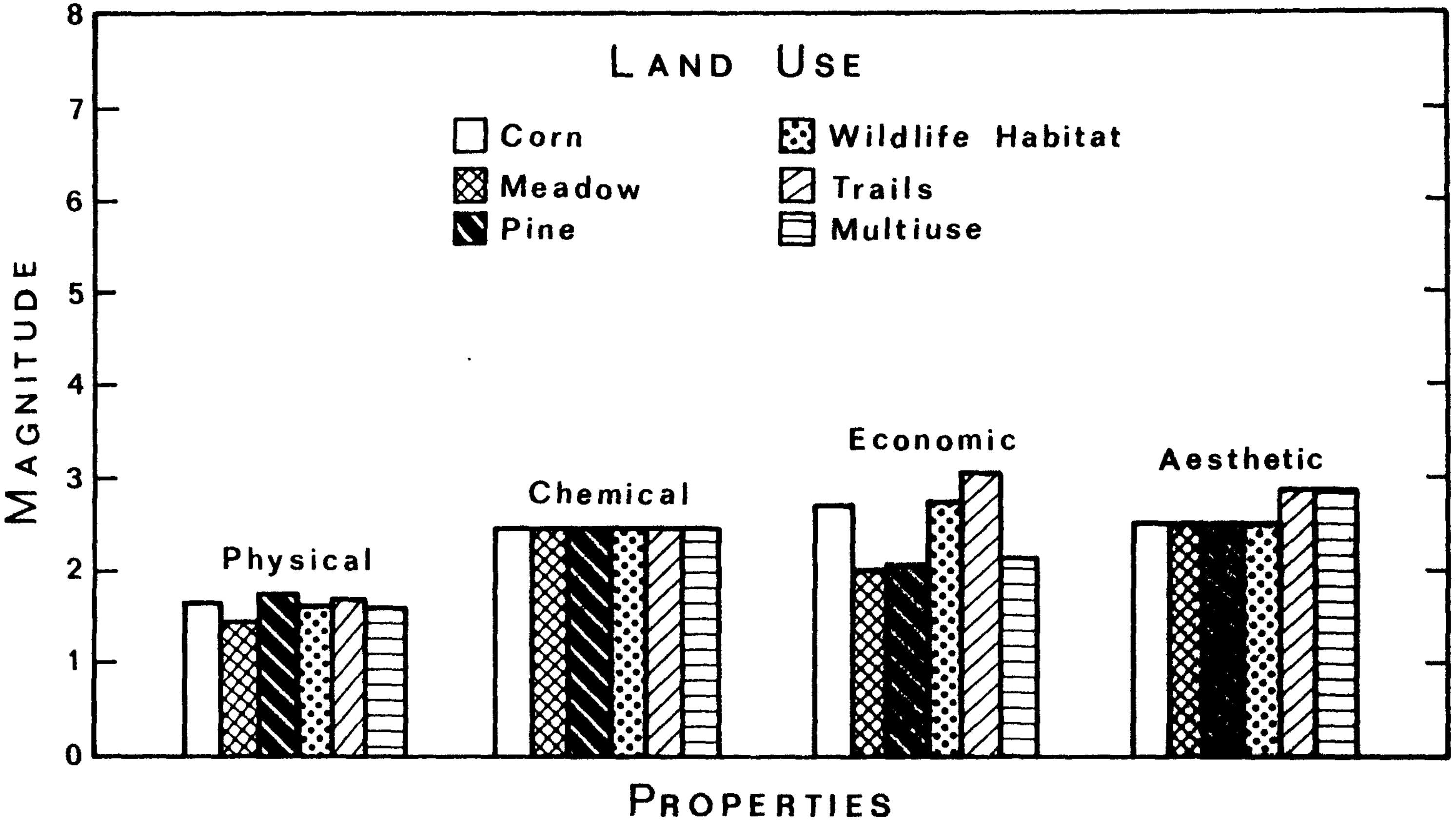

LAND USE
Corn
Meadow
Pine
Wildlife Habitat
Trails
Multiuse
MAGNITUDE
0
1
2
3
4
5
6
7
8
Physical
Chemical
Economic
Aesthetic
PROPERTIES

Figure 7. Variation in property significance at site 1, Bradford Township, Clearfield County, Pennsylvania.

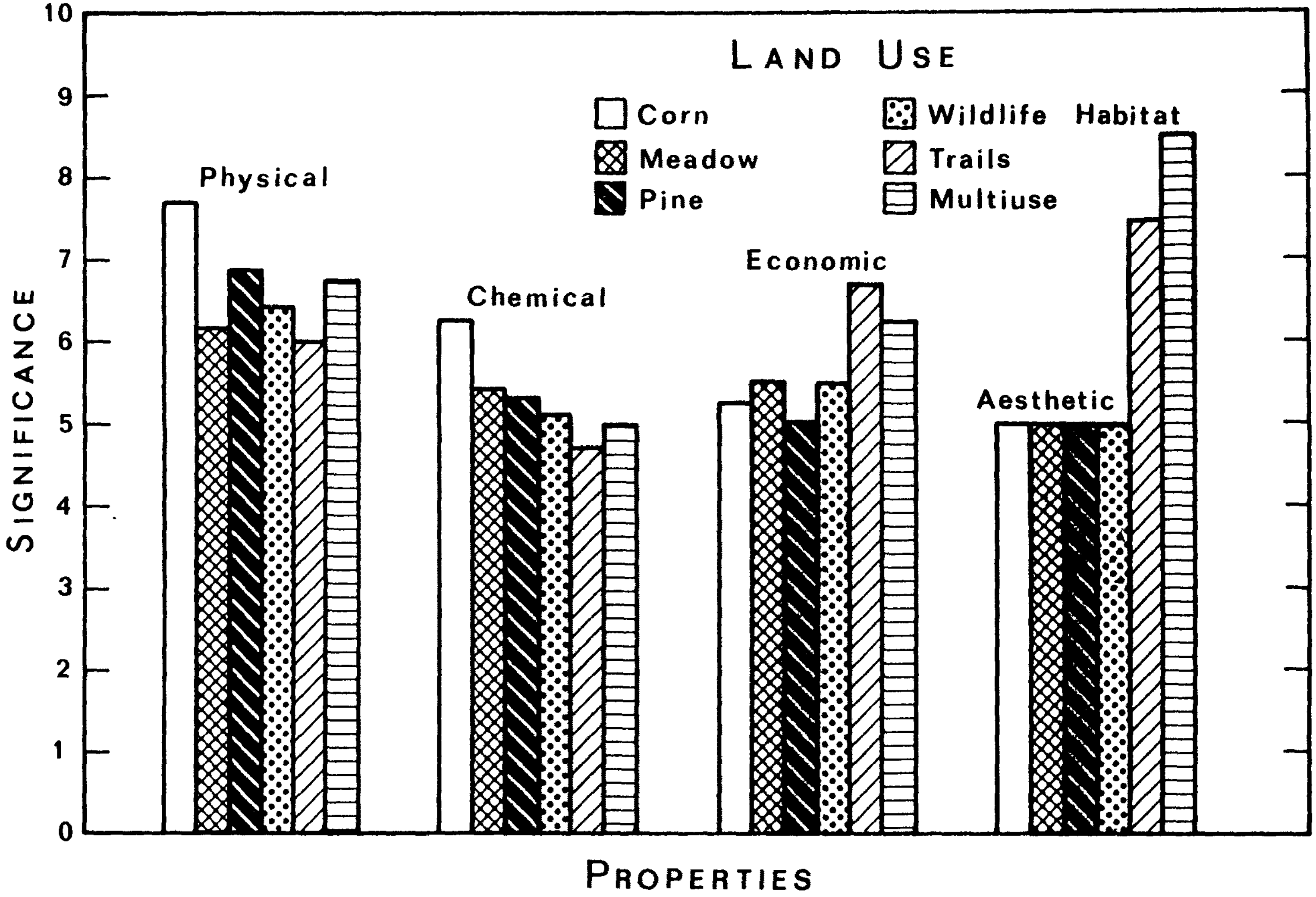

LAND USE
Corn
Meadow
Pine
Wildlife Habitat
Trails
Multiuse
SIGNIFICANCE
0
1
2
3
4
5
6
7
8
9
10
Physical
Chemical
Economic
Aesthetic
PROPERTIES

TABLE 50. STATISTICAL COMPARISON OF THE MAGNITUDE VALUES FOR THE LAND USES BY PROPERTY AT SITE 1

	Statistical comparison			
Property	Range	Mean	Standard deviation	Coefficient of variation
				%
Physical	1.44 to 1.77	1.63	.11	7
Chemical	2.45	2.45	.0	0
Economic	2.00 to 2.77	2.37	.34	14
Aesthetics	2.50 to 2.84	2.61	.18	7

TABLE 51. STATISTICAL COMPARISON OF THE SIGNIFICANCE VALUES FOR THE LAND USES BY PROPERTY AT SITE 1

	Statistical comparison			
Property	Range	Mean	Standard deviation	Coefficient of variation
				%
Physical	5.99 to 7.70	6.65	.61	9
Chemical	4.71 to 6.29	5.31	.54	10
Economic	5.00 to 6.75	5.71	.66	12
Aesthetics	4.50 to 8.50	5.42	2.31	43

As shown in Table 51, the physical properties mean significance value is the highest (6.65), but the variation between land uses is greatest with the aesthetic properties indicated by its standard deviation (2.31). Therefore, the variation in the overall significance value for each land use seems to be most influenced by the aesthetic properties.

COMPARISON OF CHANGES IN PROPERTY LEVELS AND THE EFFECT OF THESE CHANGES ON EACH LAND USE AT SITE 1

We recall that land use reclamation potentials are determined by the significance values which are represented by the sum of the weight assigned to an anticipated property level and the importance of that level to the land use in question. The assignment of higher physical and chemical importance values to corn placed corn at a disadvantage over meadow, pine, wildlife habitat, trails, and multiuse (Figure 7). Trails appear to be least affected by the physical and chemical properties. Soil amendments that improve the reclamation potential for one land use will most likely improve the reclamation potentials for the other land uses.

At site 1, when considering the significance values of the economic properties, pine has been estimated to have the highest potential and trails the lowest (Figure 7). Reclamation potentials can improve for corn (Table F13), meadow (Table F14), pine (Table F15), trails (Table F17), and multiuse (Table F18) if the property values are increased; for meadow (Table F14), trails (Table F17), and multiuse (Table F18) if the effects of unemployment are minimized; and for corn (Table F13), wildlife habitat (Table F16), trails (Table F17), and multiuse (Table F18) if additional costs can be reduced. Due to the nature of the questions used to determine the data for the reallocation of state income tax, public attitude, and the area mined and visual conformity properties (Appendix C, questions 5, 6, 7, and 12), no improvement in these properties for any land use is likely to occur. Corn and meadow are the two land uses most aesthetically favored in Bradford Township, whereas much opposition may arise if the land is reclaimed to multiuse (Figure 7).

ANALYSIS OF SELECTED SITE PROPERTIES AT SITE 2

Physical Properties

Slope -- Existing values of slope in the Somerset/Brothers Valley site 2 are found in Appendix A (Table A4). No slope for any soil exceeds 8%. In Appendix E, Tables E13, E14, E15, E16 and E17 show separately for each soil the component values and the physical properties matrix for different land uses. As with the Bradford site, no change in magnitude of slope is expected, so the matrix values of the property slope will be determined by the values of significance. The significance values for the Cookport (Table E14) and the Nolo soils (Table E16) are identical and all land uses appear to be affected in the same way. The significance values for the Cavode (Table E13), Hazleton (Table E15), and Wharton soils (Table E17) are larger and indicate that corn is more affected by the degree of slope than the other land uses.

Erosion -- Existing values for erosion are given in Appendix A (Table A4). Prior to reclamation, erosion values for the Hazleton and Nolo soils were quite low. Erosion is somewhat greater on the Wharton soil and much greater on the Cavode and Cookport soils, which may affect the breakdown of soil aggregates, crust formation, and channelized flow through rills and gullies. Anticipated erosion values are dependent on land use C factors (Table A5). Magnitude values for the Cavode (Table E13), and the Cookport soils (Table E14) indicate that if the land is reclaimed and topsoiled with either the Cavode or Cookport soil, erosion will likely remain the same or decrease depending on the land uses, while on the Hazleton (Table E15) and Nolo soils erosion is expected to increase. Erosion magnitude for the Wharton soil (Table E17) increases for all land uses with the exception of meadow. The anticipated significance value of erosion was minimum (2) for meadow on all soils and maximum (10) for pine on the Wharton soil (Table E17).

Texture-- Existing values of texture are reported in Appendix A (Table A4). Since texture is correlated with permeability, the loamy texture of the Cookport, Hazleton, and Nolo soils should enhance permeability, while the finer texture of the Cavode and Wharton soils may inhibit permeability. The anticipated values for the Cookport and Wharton soils (Table B1) indicate that a loamy sand texture will exist after mining. For the Cavode, Hazleton, and Nolo soils (Table B3) sandy loam texture should prevail. The only decrease in magnitude occurs with the Cavode soil (Table E13), which suggests that texture may improve after reclamation. The magnitude increases for the Cookport (Table E14), Hazleton (Table E15), Nolo (Table E16), and Wharton soils (Table E17). The largest increase occurs with the Cookport soil (Table E14). The anticipated significance value of texture is much higher with the Cookport (Table E14) and Wharton soils (Table E17). Corn and multiuse have the highest significance values.

Permeability-- Existing values of permeability are summarized in Appendix A (Table A4). Only the Cookport and Hazleton soils have adequate permeabilities. The permeabilities for the Nolo soil (moderately slow) and the Cavode and Wharton soils (very slow) may prevent air and water movement. Anticipated permeability values are based on the hydraulic conductivity of the anticipated texture class. The anticipated values are found in Appendix B, Tables B1 and B3. No change in magnitude occurs with the Hazleton soil (Table E15). Although an increase in magnitude does occur with the Cookport soil (Table E14), the magnitude decreases for the Cavode (Table E13), Nolo (Table E16), and Wharton soils (Table E17). Property significance values are higher with the Cookport (Table E14) and Wharton soils (Table E17). Again, the highest significance values occur with corn.

Coarse Fragments Content-- Existing values for coarse fragments content are listed in Appendix A (Table A4). The coarse fragments content prior to mining was very low for all soils, except for the Hazleton (57.5%). The anticipated values are given in Appendix B, Tables B1 and B3. Magnitude increases for the Cavode (Table E13), Cookport (Table E14), Hazleton (Table E15), Nolo (Table E16), and Wharton soils (Table E17), which indicate that the coarse fragments content of the soil column will likely increase after reclamation. The significance value of the anticipated coarse fragments content is maximum for corn, meadow, and multiuse. The other land uses seem less affected.

Depth to Limiting Layer-- Existing values for the depth to limiting layer are found in Appendix A (Table A4). A seasonally high water table is the limiting layer for all soils. The water table for the

Cookport, Hazleton, and Wharton soils is low enough to support most land uses. The Cavode and Nolo water tables are closer to the surface which may prevent reclaiming the land to any land use. The anticipated values are reported in Appendix B, Tables B1 and B3. The only decrease in magnitude occurs with the Cavode soil (Table E13). The magnitude increases for the Cookport (Table E14), Hazleton (Table E15), Nolo (Table E16), and Wharton soils (Table E17). The significance value of the depth to limiting layer is highest for corn and multiuse and lowest for wildlife habitat.

Bulk Density -- Existing values of bulk density are shown in Appendix A (Table A4). For all soils, bulk density values are high (>1.45 g/cc). The value of 1.78 g/cc is used for the anticipated bulk density (Pedersen, 1977). No change in magnitude occurs with the Cavode (Table E13), Cookport (Table E14), Hazleton (Table E15), Nolo (Table E16), and Wharton soils (Table E17). The significance value of the anticipated bulk density is again maximum for corn. The other land uses appear less affected.

Chemical Properties

pH -- Existing values of pH in the Somerset/Brothers Valley Townships site 2 are listed in Appendix A (Table A6). The pH values range from strongly acid for the Cookport and Wharton soils to very strongly acid for the Cavode, Hazleton, and Nolo soils. Appendix E, Tables E7, E18, E19, E20 and E21 show the chemical properties matrix for each soil and each land use. The anticipated pH values for the Cookport and Wharton soils are taken from Appendix B, Table B2, and for the Cavode, Hazleton, and Nolo soils from Appendix B, Table B4.

A decrease in magnitude value for pH on the Cookport (Table E7) and Wharton soils (Table E21) indicates that reclamation will likely improve the pH for these two soils. The magnitude values for the Cavode (Table E18), Hazleton (Table E19), and Nolo soils (Table E20) increase the same amount. Significance values are at a minimum (2) for all land uses on the Cookport (Table E7) and Wharton soils (Table E21). Maximum significance values (10) occur with pine on the Cavode (Table E18), Hazleton (Table E19), and the Nolo soils (Table E20). The other land uses appear less affected.

Cation Exchange Capacity -- Existing values of cation exchange capacity are given in Appendix A (Table A6). As with the Bradford site, existing and anticipated cation exchange capacity values (Appendix B, Tables B2 and B4) appear adequate. The magnitude remains unchanged for the Cavode (Table E18), Cookport (Table E7), Hazleton (Table E19), Nolo (Table E20), and Wharton soils (Table E21). Significance values of the anticipated cation exchange capacity for all soils are identical and at a minimum.

Potassium Content -- Existing values of potassium content are found in Appendix A (Table A6). Prior to and following reclamation (Appendix B, Tables B2 and B4), all soils fall below the minimum value for a balanced soil (<2%). Therefore, the magnitude remains the same for the Cavode (Table E18), Cookport (Table E7), Hazleton (Table E19), Nolo (Table E20), and Wharton soils (Table E21). Again, significance values of the anticipated potassium content is maximum for corn.

Magnesium Content -- Existing values of magnesium content are summarized in Appendix A (Table A6). The existing value for the

Wharton soil (12.5% of the cation exchange capacity) is the only acceptable one. No change in magnitude occurs with the Cavode (Table E18), Hazleton (Table E19), Nolo (Table E20), and Wharton soils (Table E21); however, a decrease in magnitude for the Cookport soil (Table E7) indicates that magnesium content will likely increase in the soil following reclamation. Significance values of the anticipated magnesium content are minimum for the Cookport (Table E7) and Wharton soils (Table E21) for all land uses. The significance values for the other soils are higher and suggest that corn and meadow will probably be more affected by anticipated magnesium levels than the other land uses.

Calcium Content-- Existing values for calcium content are reported in Appendix A (Table A6). All soils fall below the minimum value for a balanced soil (<60%). No change in magnitude occurs with the Cavode (Table E18), Cookport (Table E7), Hazleton (Table E19), Nolo (Table E20) and Wharton soils (Table E21). Because of the higher significance value of the anticipated calcium content for corn on all soils, this land use is again at a disadvantage.

Organic Matter Content-- Existing values for organic matter content are shown in Appendix A (Table A6). The initial organic matter content for the Cookport soil is quite low. The magnitude remains the same for the Cavode (Table E18), Hazleton (Table E19), Nolo (Table E20) and Wharton soils (Table E21). The magnitude for the Cookport soil (Table E7) decreases which implies that organic matter content in this soil may increase following reclamation. As before, the significance value of the anticipated organic matter content is greatest for corn.

Sulfur Content--Existing values for sulfur content are greater than .05% for all soils and have received a weight of 5. The magnitude for this property is represented by the sum of this weight and the weight assigned to the lowest coal seam being mined at the site (Table 31). For site 2, the lowest coal seam being mined is the Upper Freeport which has a much lower potential for creating acid mine drainage than the Lower Kittanning seam being mined at site 1. The magnitude change for the Cavode (Table E18), Cookport (Table E7), Hazleton (Table E19), Nolo (Table E20), and Wharton soils (Table E21) increased the same amount (6). We recall that the significance for this property is represented by the weight of the lowest coal seam being mined and the importance of the sulfur content to the land use (Table 32). As with site 1, corn appears to be most affected while the effect on trails seems to be least.

Economic Properties

Land Property Value--Existing and anticipated land property values for the Somerset/Brothers Valley site 2 are found in Table 33 (Group II). The topography is similar to site 1, but the land is gently to moderately sloping. The magnitude and significance values are given in Appendix E, Table E22. No change in magnitude should occur if the land is reclaimed to multiuse. An increase in magnitude for meadow, pine, wildlife habitat, and trails indicates that property values may decrease if the land is reclaimed to any of these uses. As with site 1, corn will likely enhance land property values the most. Significance of the anticipated land property values is higher for meadow and pine than for the other land uses.

Reallocation of State Income Tax--Values for the amount of state income tax the people would be willing to reallocate to prevent strip mining and the amount of state income tax the people would be willing to reallocate in order to reclaim the land to a given land use are listed in Table 52. Values were estimated from opinion surveys (Appendix C, questions 5, 6, 7, and 12 and Table A2). The magnitude for this property is represented by the sum of the reallocation values for preventing strip mining and reclaiming the land to a selected land use. Furthermore, the significance is represented by the sum of the amount of state income tax the people would be willing to reallocate to reclaim the land to a selected land use and the importance value (Table 36). Magnitude and significance values are summarized in Table E22. As with site 1, the magnitude increased the most for trails and multiuse suggesting that people would be willing to reallocate more for the other land uses. The significance values are lowest for corn and meadow and highest for trails and multiuse.

Effect of Unemployment--The existing township unemployment figure is not available for Somerset/Brothers Valley Townships, so the unemployment figure for Somerset County (8.5%) was used. The anticipated value is represented by the potential numer of men that would be needed to maintain a selected land use (Table 37). Magnitude and significance values are listed in Table E22. The same inferences that apply to site 1 regarding magnitude and significance values also apply to site 2. The magnitude increases more for trails and multiuse indicating that people would probably reallocate more for the other

TABLE 52. THE AMOUNT OF STATE INCOME TAX WILLING TO BE REALLOCATED PER FAMILY PER YEAR TO PREVENT STRIP MINING AND TO RECLAIM THE LAND TO A SELECTED LAND USE AT SITE 2*

Land Use	Amount of state income tax willing to be reallocated
	dollars/family/year
Prevent strip mining	37
Corn	195
Meadow	195
Pine	126
Wildlife habitat	126
Trails	78
Multiuse	78

*Explanations and calculations for each of these values are in Appendix C.

land uses. The significance reallocation of state income tax values are lowest for corn and highest for trails and multiuse.

Additional Costs--Additional costs of reclaiming a land to a selected land use are found in Table 39. The magnitude for this property is represented by the value found in Table 39. Magnitude and significance values are reported in Table E22. The magnitude values indicate that corn will be the most expensive to establish while meadow will cost the least. As with site 1, the significance of additional costs is low for meadow and pine and high for wildlife habitat and trails.

Aesthetic Properties

Public Attitude--Public attitude values for Somerset/Brothers Valley Townships for the existing and selected land uses are reported in Table 53. Values are estimated from opinion surveys (Appendix C, question 5). Corn and meadow are greatly favored over the other land uses. Magnitude and significance values are given in Appendix E, Table E23. Magnitude values for corn and meadow indicate that the public will probably be satisfied if the land is reclaimed to either of these uses. Higher magnitude values for the other land uses suggests that some unfavorable public reaction may occur if the land is reclaimed to these uses. The lowest significance public attitude value occurs with corn and meadow. As with site 1, maximum significance values (10) occur with trails and multiuse.

Area Mined and Visual Conformity--Magnitude and significance values are listed in Table E23. The magnitude for this property is represented by a value which indicates the amount of

TABLE 53. PUBLIC ATTITUDE VALUES FOR SELECTED LAND USES BASED ON THE PERCENT OF THE POPULATION THAT WOULD RANK THAT LAND USE ABOVE THE OTHER LAND USES AT SITE 2

Land Use	Public attitude
	% of population
Corn	70
Meadow	70
Pine	25
Wildlife habitat	25
Trails	5
Multiuse	5

acres being mined (203 acres at site 2). Significance for this property is the sum of a subjective numerical representation of the degree to which the selected land use conforms with the rest of the landscape and the importance value. All land uses seem to be aesthetically conforming.

ESTIMATION OF RECLAMATION POTENTIAL FOR EACH LAND USE AT SITE 2

The average sum of the physical properties for corn, meadow, pine, wildlife habitat, trails, and multiuse are given in Appendix F, Tables F25, F26, F27, F28, F29 and F30, respectively. As with site 1, only the physical property magnitude values for erosion vary between land uses. Low magnitude and significance values are desirable. No change in magnitude occurs with slope or bulk density. Although magnitude values of erosion are less than 1 if the land is reclaimed to meadow (Table F26) or wildlife habitat (Table F28), generally, magnitude progressively increases with permeability, slope and bulk density, erosion, texture, depth to limiting layer, and coarse fragments content. Low significance values are common with slope and permeability and higher values are found with coarse fragments content and bulk density.

In Appendix F, Tables F31, F32, F33, F34 and F35 the average sum of the chemical properties for corn, meadow, pine, wildlife habitat, trails, and multiuse are found, respectively. There is no variation in the chemical property magnitude values between land uses. A decrease in magnitude with pH and magnesium content suggests that these chemical properties may improve following reclamation. The magnitude remains unchanged for cation exchange capacity, potassium content, and organic matter content. The only increase in magnitude occurs with sulfur. For all land uses, significance values are at a minimum (2) for cation exchange capacity. Significance values progressively increase with cation exchange capacity, organic matter content, magnesium content, pH, calcium content, potassium content, and sulfur content.

The average sum of the economic properties for corn, meadow, pine, wildlife habitat, trails, and multiuse are listed in Appendix F, Tables F37, F38, F39, F40, F41 and F42, respectively. For the land property value, reclaiming the land to corn (Table F37) will be beneficial as indicated by the decrease in magnitude. No change in property value magnitude occurs with multiuse (Table F42), while an increase in magnitude is expected if the land is reclaimed to meadow (Table F38), pine (Table F39), wildlife habitat (Table F40), and trails (Table F41). The significance of the land property values are lowest for wildlife habitat (Table F40), trails (Table F41), and multiuse (Table F42) and highest for corn (Table F37) and meadow (Table F38). As with site 1, the magnitude and significance values for the reallocation of state income tax property appear higher if the land is reclaimed to trails (Table F41) and multiuse (Table F42). For corn (Table F37) and meadow (Table F38), the reallocation of state income tax magnitude value remains unchanged and the significance values are at a minimum. If the land is reclaimed to any land use except meadow (Table F38), employment may increase as suggested by the decrease in magnitude for the effect of unemployment property. Meadow (Table F38), trails (Table F41), and multiuse (Table F42) have higher significance values for this property. For the additional costs property, the magnitude remained unchanged for meadow (Table F38) and increased the most for corn (Table F37). This increase implies that reclaiming the land to corn will cost the most.

In Appendix F, Tables F43, F44, F45, F46, F47, and F48 the average sum of the aesthetic properties for corn, meadow, pine, wildlife habitat, trails, and multiuse are summarized, respectively. For the public attitude property, a decrease in magnitude is expected if the land is reclaimed to corn (Table F43) or meadow (Table F44). Magnitude increases in the remaining land uses reflect the public's dissatisfaction for reclaiming the land to these land uses. The significance value of the anticipated public attitude is maximum (10) for trails (Table F47) and multiuse (Table F48). For the area mined and visual conformity property, the magnitude (5) and the significance (6) are the same for all land uses.

The reclamation potentials for corn, meadow, pine, wildlife habitat, trails, and multiuse are listed in Table 54 and are graphically compared in Figure 9. We recall that unless values for two or more land uses are identical (which would then require the evaluation of magnitude values) land use reclamation potentials are determined by the significance values alone. Reclamation at site 2 favors meadow because of its low significance value (20.55). Again, meadow also has the lowest magnitude value (7.62). Significance values become progressively higher with wildlife habitat, corn, pine, trails, and multiuse. Therefore, multiuse, with a significance value of 25.11, has the worse reclamation potential at site 2. Trails has the highest magnitude value (9.20).

TABLE 54. RECLAMATION POTENTIALS FOR EACH LAND USE AT SITE 2

Land Use	Property average sums								Sum	
	Physical		Chemical		Economic		Aesthetic			
Corn*	1.77	6.58	1.66	6.72	2.02	4.75	2.83	4.50	8.32	22.66
Meadow†	1.63	5.50	1.66	5.80	1.50	4.75	2.83	4.50	7.62	20.55
Pine‡	1.81	6.08	1.66	5.59	1.97	5.25	3.16	6.00	8.60	22.92
Wildlife habitat§	1.69	5.31	1.66	5.38	2.40	5.50	3.16	6.00	8.91	22.19
Trails#	1.74	5.31	1.66	4.88	2.47	6.50	3.33	8.00	9.20	24.69
Multiuse**	1.70	5.81	1.66	5.30	2.05	6.00	3.33	8.00	8.74	25.22

*Component values are taken from Appendix F (Tables F25, F31, F37, and F43).

†Component values are taken from Appendix F (Tables F26, F32, F38, and F44).

‡Component values are taken from Appendix F (Tables F27, F33, F39, and F45).

§Component values are taken from Appendix F (Tables F28, F34, F40, and F46).

#Component values are taken from Appendix F (Tables F29, F35, F41, and F47).

**Component values are taken from Appendix F (Tables F30, F36, F42, and F48).

INFLUENCE OF EACH PROPERTY ON RECLAMATION POTENTIAL AT SITE 2

Magnitude and significance values of the physical, chemical, economic, and aesthetic properties for each land use are shown in Figures 8 and 9, respectively. For each property, the range of values, mean, standard deviation, and coefficient of variation for property magnitude and significance values are reported in Tables 55 and 56.

The chemical properties have the lowest mean magnitude value (1.66) and exhibit no variation between land uses (Table 55). The mean magnitude value for the physical properties is higher and shows a slight variation between land uses. Although the aesthetic properties have the highest mean magnitude value, the economic properties have the highest standard deviation (.35). As with site 1, the economic properties seem to be the greatest influence on the overall magnitude values for each of the land uses.

Mean significance values of the economic, chemical, physical, and aesthetic properties (listed is ascending order with respect to mean significance values) are given in Table 56. The aesthetic mean significance value also has the largest standard deviation (1.57) which indicates that this property has the greatest effect on the overall significance values for each land use.

COMPARISON OF CHANGES IN PROPERTY LEVELS AND THE EFFECT OF THESE CHANGES ON EACH LAND USE AT SITE 2

We recall that the significance (Figure 9) and not the magnitude values (Figure 8) usually determine the reclamation potential for each land use. Corn is again at a physical and chemical disadvantage

Figure 8. Variation in property magnitude at site 2,
Somerset/Brothers Valley Townships,
Somerset County, Pennsylvania.

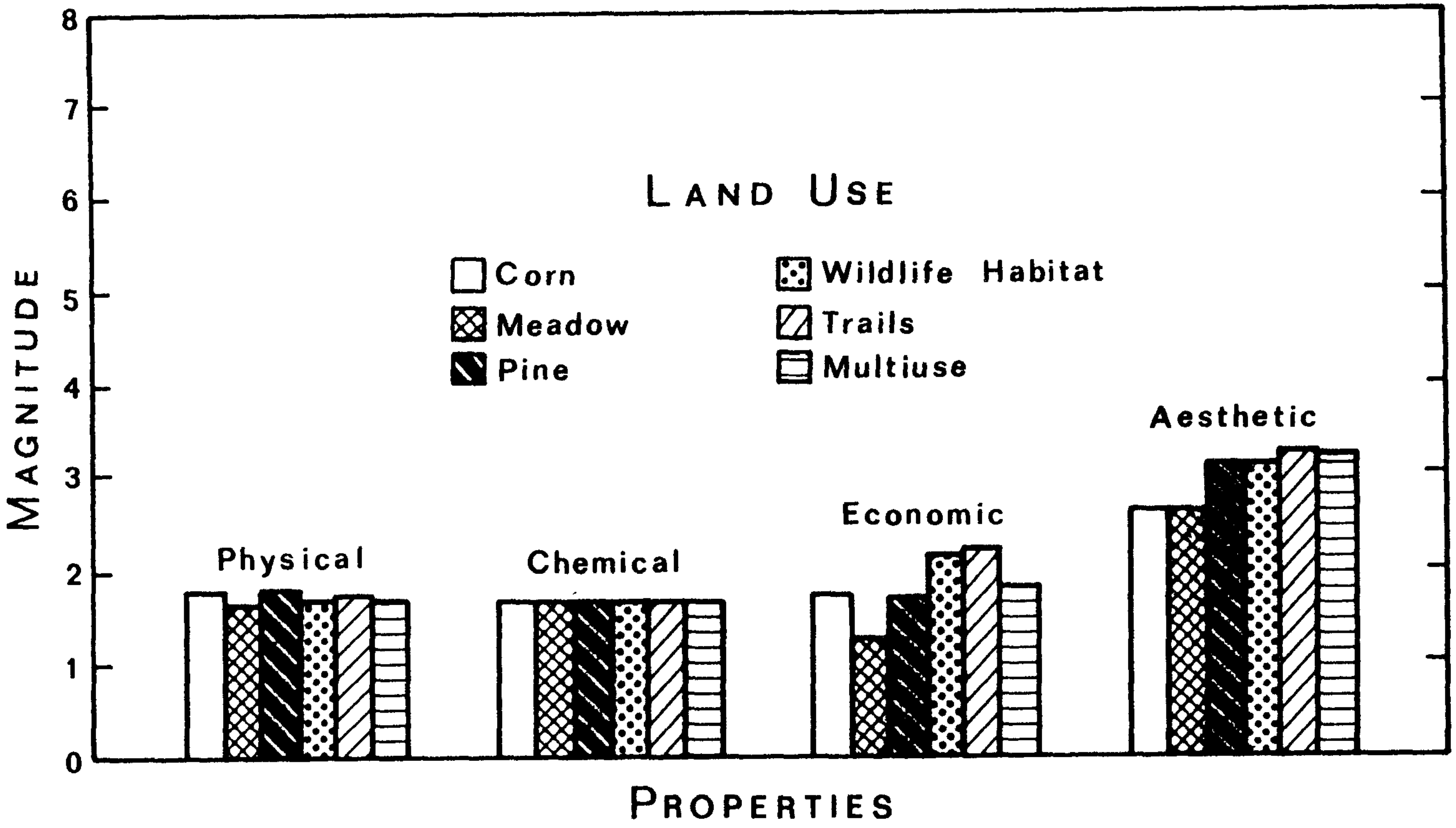

LAND USE
Corn
Meadow
Pine
Wildlife Habitat
Trails
Multiuse
MAGNITUDE
0
1
2
3
4
5
6
7
8
Physical
Chemical
Economic
Aesthetic
PROPERTIES

Figure 9. Variation in property significance at site 2, Somerset/Brothers Valley Townships, Somerset County, Pennsylvania.

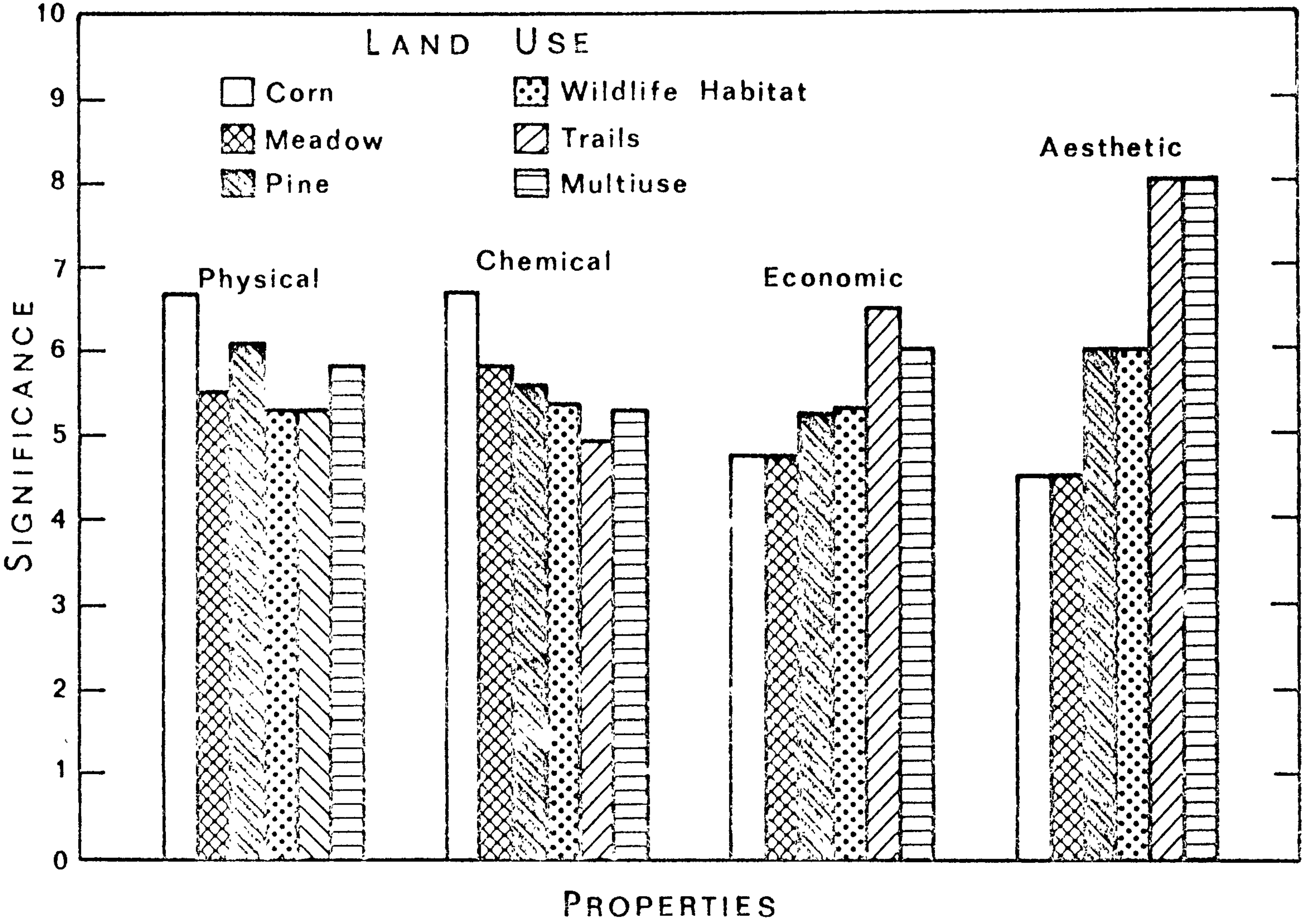

LAND USE
Corn
Meadow
Pine
Wildlife Habitat
Trails
Multiuse
Physical
Chemical
Economic
Aesthetic
SIGNIFICANCE
0
1
2
3
4
5
6
7
8
9
10
PROPERTIES

TABLE 55. STATISTICAL COMPARISON OF THE MAGNITUDE VALUES FOR THE LAND USES BY PROPERTY AT SITE 2

Property	Statistical comparison Range	Mean	Standard deviation	Coefficient of variation
				%
Physical	1.63 to 1.81	1.73	.07	4
Chemical	1.66	1.66	0	0
Economic	1.50 to 2.47	2.07	.35	17
Aesthetics	2.83 to 3.33	3.12	.23	7

TABLE 56. STATISTICAL COMPARISON OF THE SIGNIFICANCE VALUES FOR THE LAND USES BY PROPERTY AT SITE 2

Property	Statistical comparison Range	Mean	Standard deviation	Coefficient of variation
				%
Physical	5.26 to 6.71	5.78	.55	10
Chemical	4.88 to 6.72	5.61	.62	11
Economic	4.50 to 6.00	5.29	.80	15
Aesthetics	4.50 to 8.00	6.17	1.57	25

because high importance values were assigned to this land use (Figure 9). Wildlife habitat and trails seem to be less affected by the physical properties than corn, meadow, pine, and multiuse (Figure 7). Trails also appears to be the least affected by the chemical properties (Figure 9).

In terms of the significance values of the economic properties for site 2, wildlife habitat has received the highest reclamation potential and trails the lowest (Figure 9). Improvements in reclamation potential are possible for corn (Table F37), meadow (Table F38), and pine (Table F39) if the property values are raised; for meadow (Table F38), trails (Table F41), and multiuse (Table F42) if the effects of unemployment are reduced; and for corn (Table F37), wildlife habitat (Table F40), trails (Table F41), and multiuse (Table F42) if additional costs are minimized. As before, due to the data source for the reallocation of state income tax, public attitude, and the area mined and visual conformity properties (Appendix C, questions 5, 6, 7, and 12), changes in these properties are not likely to occur. Corn and meadow (Figure 9) have a substantial aesthetic advantage in Somerset/Brothers Valley Townships. Reclaiming the land to either trails or multiuse seems to be unacceptable (Figure 9).

SUMMARY COMPARISON OF LAND USE RECLAMATION POTENTIALS AT SITES 1 AND 2

Tables 57 and 58 show separately for each land use at Bradford Township site 1 and Somerset/Brothers Valley Townships site 2, respectively, the magnitude and significance values for the physical, chemical, economic, and aesthetic properties. At site 1, anticipated erosion values were higher (due to steeper slopes) and the anticipated

TABLE 57. SUMMARY OF PROPERTY MAGNITUDE AND SIGNIFICANCE VALUES AT SITE 1

Property	Land use					
	Corn	Meadow	Pine	Wildlife habitat	Trails	Multiuse
Physical						
slope	1.00 | 5.68	1.00 | 4.68	1.00 | 4.68	1.00 | 4.68	1.00 | 4.02	1.00 | 4.68
erosion	2.86 | 7.72	1.14 | 2.52	3.48 | 8.12	2.39 | 5.24	2.92 | 5.90	2.39 | 5.78
texture	2.22 | 7.00	2.22 | 6.15	2.22 | 6.00	2.22 | 7.00	2.22 | 6.00	2.22 | 7.00
permeability	1.57 | 5.00	1.57 | 4.00	1.57 | 4.00	1.57 | 4.00	1.57 | 4.00	1.57 | 4.00
coarse fragments content	1.77 | 10.00	1.77 | 10.00	1.77 | 9.00	1.77 | 10.00	1.77 | 8.00	1.77 | 10.00
depth to limiting layer	1.15 | 8.51	1.16 | 7.00	1.15 | 7.00	1.15 | 6.00	1.15 | 7.00	1.15 | 8.00
bulk density	1.17 | 10.00	1.20 | 9.00	1.17 | 9.00	1.17 | 8.00	1.17 | 7.00	1.17 | 8.00
Chemical						
pH	.86 | 2.00	.86 | 2.00	.86 | 2.00	.86 | 2.00	.86 | 2.00	.86 | 2.00
cation exchange capacity	1.00 | 2.00	1.00 | 2.00	1.00 | 2.00	1.00 | 2.00	1.00 | 2.00	1.00 | 2.00
potassium content	1.20 | 10.00	1.20 | 8.00	1.20 | 7.00	1.20 | 6.00	1.20 | 6.00	1.20 | 7.00
magnesium content	.90 | 2.00	.90 | 2.00	.90 | 2.00	.90 | 2.00	.90 | 2.00	.90 | 2.00
calcium content	2.24 | 8.00	2.24 | 7.00	2.24 | 7.00	2.24 | 6.00	2.24 | 6.00	2.24 | 6.00

TABLE 57. (continued)

Property	Corn	Meadow	Pine	Wildlife habitat	Trails	Multiuse
	Land use					
organic matter content	.98 | 5.00	.98 | 4.00	.98 | 4.00	.98 | 4.00	.98 | 4.00	.98 | 4.00
sulfur content	10.00 | 15.00	10.00 | 13.00	10.00 | 13.00	10.00 | 14.00	10.00 | 11.00	10.00 | 12.00
Economic						
land property value	.25 | 6.00	1.00 | 7.00	.75 | 6.00	1.00 | 5.00	.75 | 6.00	.50 | 6.00
reallocation of state income tax	5.00 | 4.00	5.00 | 5.00	5.00 | 5.00	5.00 | 5.00	6.00 | 8.00	6.00 | 8.00
effect of unemployment	.60 | 5.00	1.00 | 6.00	.40 | 5.00	.60 | 5.00	.40 | 6.00	.20 | 6.00
additional costs	5.00 | 6.00	1.00 | 4.00	2.00 | 4.00	3.00 | 7.00	3.00 | 7.00	2.00 | 5.00
Aesthetic						
public attitude	1.00 | 4.00	1.00 | 5.00	1.00 | 5.00	1.00 | 5.00	1.67 | 10.00	1.67 | 10.00
area mined and visual conformity	4.00 | 5.00	4.00 | 5.00	4.00 | 5.00	4.00 | 5.00	4.00 | 5.00	4.00 | 7.00
Reclamation potential	9.34 | 23.74	8.39 | 22.12	8.76 | 22.12	8.88 | 22.06	9.52 | 24.95	9.08 | 26.53

TABLE 58. SUMMARY OF PROPERTY MAGNITUDE AND SIGNIFICANCE VALUES AT SITE 2

	Land use											
Property	Corn		Meadow		Pine		Wildlife habitat		Trails		Multiuse	
Physical												
slope	1.00	3.54	1.00	2.77	1.00	2.77	1.00	2.77	1.00	2.77	1.00	2.77
erosion	1.84	6.66	.59	2.00	1.83	7.02	.96	3.66	1.35	4.66	1.04	3.66
texture	1.95	5.12	1.95	4.59	1.95	4.59	1.95	4.59	1.95	4.59	1.95	5.12
permeability	.84	3.59	.84	3.06	.84	3.06	.84	3.06	.84	3.06	.84	3.06
coarse fragments content	4.07	10.00	4.07	10.00	4.07	9.00	4.07	9.00	4.07	8.00	4.07	10.00
depth to limiting layer	1.99	8.08	1.99	7.08	1.98	7.10	1.98	6.08	1.98	7.08	1.98	8.08
bulk density	1.00	10.00	1.00	9.00	1.00	9.00	1.00	8.00	1.00	7.00	1.00	8.00
Chemical												
pH	.76	5.76	.76	5.29	.76	5.29	.76	5.29	.76	4.82	.76	5.29
cation exchange capacity	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00
potassium content	1.00	10.00	1.00	8.00	1.00	7.00	1.00	6.00	1.00	6.00	1.00	7.00
magnesium content	.85	5.29	.85	5.29	.85	4.82	.85	4.35	.85	4.35	.85	4.82
calcium content	1.00	8.00	1.00	7.00	1.00	7.00	1.00	6.00	1.00	6.00	1.00	6.00

TABLE 58. (continued)

Property	Land use Corn	Meadow	Pine	Wildlife habitat	Trails	Multiuse
organic matter content	1.00 | 5.00	1.00 | 4.00	1.00 | 4.00	1.00 | 4.00	1.00 | 4.00	1.00 | 4.00
sulfur content	6.00 | 11.00	6.00 | 9.00	6.00 | 9.00	6.00 | 10.00	6.00 | 7.00	6.00 | 8.00
Economic						
land property value	.50 | 6.00	2.00 | 7.00	1.50 | 7.00	2.00 | 5.00	1.50 | 5.00	1.00 | 5.00
reallocation of state income tax	2.00 | 2.00	2.00 | 2.00	4.00 | 5.00	4.00 | 5.00	5.00 | 8.00	5.00 | 8.00
effect of unemployment	.60 | 5.00	1.00 | 6.00	.40 | 5.00	.60 | 5.00	.40 | 6.00	.20 | 6.00
additional costs	5.00 | 6.00	1.00 | 4.00	2.00 | 4.00	3.00 | 7.00	3.00 | 7.00	2.00 | 5.00
Aesthetic						
public attitude	.67 | 3.00	.67 | 3.00	1.33 | 6.00	1.33 | 6.00	1.67 | 10.00	1.67 | 10.00
area mined and visual conformity	5.00 | 6.00	5.00 | 6.00	5.00 | 6.00	5.00 | 6.00	5.00 | 6.00	5.00 | 6.00
Reclamation potential	8.32 | 22.68	7.62 | 20.55	8.60 | 22.92	8.91 | 22.19	9.20 | 24.69	8.74 | 25.11

texture less favorable; however, higher magnitude values were experienced at site 2, because the anticipated and existing depths to limiting layers and the coarse fragments content showed substantially greater variation at site 2 than site 1. Although the change in physical properties was greater at site 2, the anticipated physical property levels were more favorable for all land uses at site 2 which is indicated by the lower significance values.

Chemical magnitude values, equal for all land uses at a particular site, were higher at site 2. Primarily, this difference is due to the sites' geologies. Site 1 is more likely to produce acid mine drainage because of the older coal seams being mined, compounded by the lack of neutralizing strata to offset potential acidity. Thus, there was a larger ratio of anticipated to existing sulfur content at site 1. The chemical properties were to change more at site 1, but the significance of the anticipated chemical property levels were more severe at site 2.

Magnitude values for the economic properties were higher at site 1 than site 2. However, the land property values were higher for all land uses at site 2, which indicates that the original property value of site 1 (Table 33, Group IV) was lower than that of site 2 (Table 33, Group II). Consequently, more improvement could be anticipated at site 1 if any of the land uses are established. With the exception of pine, significance values were lower at site 2 than site 1. The reallocation of state income tax was responsible for the higher significance values at site 1. The dollars/family/year for preventing strip mining at site 2 (Table 52) was lower than the value estimated for site 1 (Table 47). Also, with the exception of trails and multiuse, the dollars/family/year for reclaiming a land to a selected land use was higher at site 2 (Table 52) than at site 1 (Table 47).

Aesthetic magnitude values were noticeably higher at site 2, because the amount of acres disturbed was nearly threefold that of site 1. Significance values at site 2 were generally greater than those at site 1, suggesting that the public's attitude and the degree to which the land use conformed with the surrounding landscape were more critical in contributing to land use reclamation potential at site 2.

Reclamation potentials for each land use at sites 1 and 2 are also shown in Tables 57 and 58, respectively. For all land uses, except wildlife habitat, magnitude values at site 1 were higher than those at site 2 indicating that the average change in the physical, chemical, economic, and aesthetic property levels were greater at site 1. Significance values at site 1 were also greater than those at site 2 for corn, meadow, trails, and multiuse. The higher significance values that occurred with pine and wildlife habitat at site 2 were primarily due to the aesthetic property-land use interactions and partially due to the chemical property land-use interactions. Based on significance values, the following land uses (listed in order of preference) would be: wildlife habitat, meadow, pine, corn, trails, and multiuse at site 1; and meadow, wildlife habitat, corn, pine, trails, and multiuse at site 2. Wildlife habitat proved to be the land use with the best reclamation potential at site 1 while meadow was favored at site 2. The significance value for multiuse, the land use with the worst reclamation potential at both sites, was higher at site 1 (26.53) than at site 2 (25.11). At sites 1 and 2 trails had the highest magnitude value (9.52 and 9.20, respectively). However, it was not necessary to consider the magnitude values for the estimation of reclamation potential at either site, because significance values for each land use were different.

REFERENCES

1. Alekseyeva, YU. S. 1972. Change in the water-physical properties of soil on reclaimed land used as a pasture (in Russian). Pochvovedeniye 1972 (11):74-78.

2. Bennett, O. L., J. N. Jones, Jr., W. H. Armiger, and P. E. Lunberg. 1972. New techniques for revegetating strip-mined areas. In Proc. 27th Ann. Mtg. SCSA, Portland, Oregon. p. 50-55.

3. Boehlje, M. and J. D. Libbin. 1977. Economics of mining coal in Iowa. IS-ICP-46. Energy and Mineral Resources Institute, Ames, Iowa. 32 p.

4. Bremner, J. M. 1965. In C. A. Black (ed.) Methods of soil analysis, part II. Agronomy 9:1149-1178. Amer. Soc. of Agron., Madison, Wisconsin.

5. Briggs, J. M. and T. S. Covin. 1977. Reclamation planning at the Iowa coal project demonstration mine. Paper No. 77-2517. Presented at 1977 Winter Mtg. ASAE, Palmer House Hotel, Chicago, Illinois. Dec. 13-16. 18 p.

6. Brooks, D. B. and R. L. Williams. 1973. Planning and designing for mining conservation. In R. B. Cummins and I. A. Given (ed.) SME mining engineering handbook. Vol. 2, Chpt. 19. The American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Port City Press, Baltimore, Maryland.

7. Caruccio, F. T. 1975. Estimating the acid potential of coal mine refuse. In M. J. Chadwick and G. T. Goodman (ed.) The ecology of resource degradation and renewal. p. 197-205.

8. ________ and R. Parizek. 1967. An evaluation of factors influencing acid mine drainage production from various strata of the Allegheny group and the ground water interactions in selected areas of western Pennsylvania: special research report SR-65. Coal Research Section, The Pennsylvania State University, University Park, Pennsylvania. 213 p.

9. Ciolkosz, E. J., R. L. Cunningham, and G. W. Petersen. In press. Characteristics, interpretations, and uses of Pennsylvania minesoils. Progress report. The Pennsylvania State University Agric. Exp. Stat., University Park, Pennsylvania.

10. Crentz, W. L., A. L. Bailey, and J. W. Miller. 1951. Preparation characteristics of coal from Somerset County, Pennsylvania. In Bureau of mine report of investigations, 4834, U.S. Dept. of Int. 23 p.

11. Crentz, W. L., A. L. Bailey, and J. W. Miller. 1952. Preparation characteristics of coal from Clearfield County, Pennsylvania. In Bureau of mine report of investigations, 4894, U.S. Dept. of Int. 27 p.

12. Davis, G. 1977. Forest service mining reclamation research. In Energy environment II. EPA decision series. EPA 600/9-77-012. p. 191-193.

13. Degens, E. T., E. G. Williams, and M. L. Keith. 1957. Environmental studies of carboniferous sediments. Part I. Bulletin of the American Assn. of Petroleum Geologists, 41:2427-2455.

14. Department of the Environment. 1972. The Canada land inventory: soil capability classification for agriculture. Report No. 2. Cat. No. Fo 63-2/1972. Information Canada, Ottawa. 16 p.

15. Department of Regional Economic Expansion. 1970a. A guide for resource planning: the Canada land inventory. Pamphlet. Cat. No. RE 63-7/1970. Queens Printer for Canada, Ottawa. 8 p.

16. ________. 1970b. The Canada land inventory: land capability classification for outdoor recreation. Report No. 6. Cat. No. RE 63-6/1969. Queens Printer for Canada, Ottawa. 114 p.

17. Donahue, R. L., J. C. Shickluna, and L. S. Robertson. 1971. Soils and plant nutrition, chpt. 11. In Soils: an introduction to soils and plant growth. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

18. Doyle, F. J. 1974. Variables affecting grading costs for strip mine and refuse bank reclamation. In First symposium on mine and preparation plant refuse disposal. National Coal Assn. p. 212-227.

19. Emrich, G. H. and D. R. Thompson. 1968. Some characteristics of drainage from deep bituminous mines in western Pennsylvania. In Proc. of the 2nd symposium on coal mine drainage research, Pittsburgh, Pennsylvania. p. 190-222.

20. Falkie, T. V. 1971. Land reclamation for the mining industry. Paper No. EQC 32. Presented at the 1971 AIME Environmental Quality Conference, Washington, D. C. June 7-9. 8 p.

21. Fischer, D. W. 1975. Willingness to pay as a behaviourial criterion for environmental decision making. J. of Env. Mgt. 3:29-41.

22. Fleming, A. L., J. W. Schwartx, and C. D. Foy. 1974. Chemical factors controlling the adaptation of weeping lovegrass and tall fescue to acid mine spoisl. Agron. J. 66:715-719.

23. Flint, N. K. 1965. Geology and mineral resources of southern Somerset County, Pennsylvania. Pa. Geol. Survey, 4th Series. County Report C56A, Harrisburg, Pennsylvania.

24. Glover, A. C. 1970. Geology and mineral resources of the southern half of the Clearfield 15-minute quadrangle, Pennsylvania. Pa. Geol. Survey, 4th Series. Bulletin A84cd. Harrisburg, Pennsylvania.

25. Hill, R. D. 1977. Premining planning: the key to environmental acceptable surface mining. Paper No. 77-2216, ASAE. Dec. 13-16. 7 p.

26. Hinish, W. W. 1969. Interpreting soil tests for agronomic crops. College of Agric. Ext. Service, The Pennsylvania State University, University Park, Pennsylvania. 4 p.

27. Kleppe, T. S. 1977. Mining and mineral policy: 1977 annual report of the Secretary of the Interior under the Mining and Minerals Policy Act of 1970. U.S. Govt. Print. Off., Washington, D. C. p. 15.

28. Krutella, J. V. and A. C. Fisher. 1976. Studies in the valuation of commodity and amenity resources. In The economics of natural environments: Chpt. 2. John Hopkins University Press, Washington, D. C.

29. Leopold, L. B., F. E. Clarke, B. B. Hanshaw, and J. R. Balsley. 1971. A procedure for evaluating environmental impact. Geol. Survey Cir. 645. 13 p.

30. Mann, S. H., T. J. Douglas, J. L. Nasar, and F. R. Tellefsen. 1977. The determination of the economic effect of pesticide use on human health: a gaming approach to willingness-to-pay. Working Paper No. 32. Center for the Study of Environmental Policy, The Pennsylvania State University, University Park, Pennsylvania.

31. Mason, D. D., J. F. Lutz, and R. G. Petersen. 1957. Hydraulic conductivity as related to certain soil properties in a number of great soil groups--sampling errors involved. Soil Sci. Soc. Proc. 21:554-560.

32. Martin, J. H., H. Leonard, and D. L. Stemp. 1976. p. 56. In Principle of field crop production, 3rd ed. Macmillan Publishing Co., Inc., New York.

33. McCormack, D. E. 1974. Soil reconstruction: for the best soil after mining. In Second research and applied technology on mined land reclamation. National Coal Assn. p. 159-161.

34. McCormack, R. J. 1972. The Canada land inventory: land capability classification for forestry. Report No. 4. Cat. No. RE 63-4/1970. Information Canada, Ottawa. 72 p.

35. Otte, J. A. and M. Boehlje. 1976. A model to analyze the costs of strip mining and reclamation IS-ICP-3. Energy and Mineral Resources Research Institute, Iowa State University, Ames, Iowa. 19 p.

36. Pedersen, T. A. 1977. Comparison of some morphological, chemical, and physical characteristics of minesoils and contiguous natural soils. M.S. Thesis, 206 p. The Pennsylvania State University (Micro 4 PSUm 1977). Univ. Microfilms, University Park, Pennsylvania.

37. Perret, N. B. 1973. The Canada land inventory: land capability classification for wildlife. Report No. 7. Information Canada, Ottawa. 30 p.

38. Pundari, N. B. and J. A. Coates. 1975. Estimate of reclamation costs resulting from federal law. Coal Age 80(April):127-131.

39. Research Committee on Coal Mine Spoil Revegetation in Pennsylvania. 1965. G. Davis, et al. (ed.). Northeast Forest Experiment Station, Forest Service, U.S. Dept. of Agric. 46 p.

40. Rogowski, A. S. and E. L. Jacoby, Jr. 1977. Water movement through Kylertown strip mine spoil. Paper No. 77-2057. Presented at 1977 Ann. Mtg. ASAE, North Carolina State University, Raleigh, North Carolina. June 26-29. 24 p.

41. ________, H. B. Pionke, and J. G. Broyan. 1977. Modeling the impact of strip mining and reclamation processes on quality and quantity of water in mined areas: a review. J. of Environ. Qual. 6:273-244.

42. ________ and B. E. Weinrich. 1977. Modeling water flux on strip-mined land. Paper No. 77-2061. Presented at 1977 Ann. Mtg. ASAE, North Carolina State University, Raleigh, North Carolina. June 26-29. 17 p.

43. Sawyer, L. E. and J. M. Crowl. 1968. Land reclamation. In E. P. Pfleider (ed.) Surface mining. p. 247-266. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Maple Press Co., York, Pennsylvania.

44. Sendlein, L. V. A., C. E. Anderson, and J. B. Gulliford. 1977. Land restoration: the Iowa experiment. In Fifth symposium on surface mining and reclamation. National Coal Assn. p. 283-297.

45. Smith, R. M., A. A. Sobek, T. Arkle, Jr., J. C. Sencindiver, and J. R. Freeman. 1976. Extensive overburden potentials for soil and water quality. Environmental Protection Technology Series, EPA-600/2-76-184. p. 31-34.

46. Sobek, A. A., R. M. Smith, W. A. Schuller, and J. R. Freeman. 1976. Overburden properties that influence minesoils. In Fourth symposium of surface mining and reclamation. National Coal Assn. p. 153-159.

47. Soil Survey Staff. 1951. Soil survey manual. U.S. Dept. Agric. Hdbk. No. 18. U.S. Govt. Print. Off., Washington, D. C.

Surface Mining Control and Reclamation Act of 1977. 30 U.S.C. Chpt. 1201-1328; Publ. L. 95-87, Aug, 3, 1977, 91 Stat. 445.

48. U.S. Department of Agriculture. 1968. Restoring surface mined lands. Misc. Publ. No. 1082. 18 p.

Waldrop, M. 1977. Strict law challenges strip mine operators. C & EN, Augs. p. 18-19.

49. Wischmeier, W. H. 1971. The erosion equation--a tool for conservation planning. In Proc. 26th Ann. Mtg. Soil Cons. Soc. Am., Ankeny, Iowa. p. 73-78.

50. ________ and D. D. Smith. 1962. Soil loss estimation as a tool in soil and water management planning. Publ. No. 59, Int. Assoc. Sci. Hydrology, Belgrade, Yugoslavia. p. 148-159.

51. ________ and ________. 1965. Predicting rainfall erosion losses from cropland east of the Rocky Mountains. Agric. Hdbk. No. 282. U.S. Dept. Agric., Washington, D. C. 47 p.

52. Zellmer, S. D. and R. P. Carter. 1977. Abandoned coal mine refuse areas: their reclamation and use. Paper No. 77-2515. Presented at 1977 Winter Mtg. ASAE, Palmer House Hotel, Chicago, Illinois. Dec. 13-16. 17 p.

APPENDIX A

EXISTING PHYSICAL AND CHEMICAL PROPERTIES AT SITES 1 AND 2

TABLE A1. EXISTING PHYSICAL PROPERTY DATA AT SITE 1

Soil Type	Soil coefficient	Physical properties						
		Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
		%	t/ac/yr	class	mm/hr	% by wt	m	g/cc
Berks	.26	4 to 8	1.1	SIL	34.80	57.0	.76	1.39
Cookport	.08	4 to 8	3.5	L	34.80	17.7	.68	1.48
Gilpin	.18	17 to 25	6.8	SCL	58.42	49.1	.76	1.72
Weikert	.05	9 to 16	4.2	SIL	34.80	62.5	.38	1.46
Minesoil*	.43	9 to 16	1.6	LS	101.70	77.8	.33	1.78

*Existing physical properties for the Minesoil are the anticipated physical properties for Group I Minesoils (Appendix B, Table B1).

TABLE A2. ANTICIPATED LAND USE EROSION VALUES FOR EACH SOIL AT SITE 1

		Erosion values				
		Soil type				
Land Use	C factor[*]	Berks[†]	Cookport[‡]	Gilpin[§]	Weikert[#]	Minesoil[**]
		t/ac/yr				
Corn	.29	5.4	5.1	39.3	11.0	15.5
Meadow	.01	.2	.2	1.4	.4	.5
Pine	.52	9.6	9.1	70.5	19.7	27.8
Wildlife habitat	.18	3.3	3.2	24.4	6.8	9.6
Trails	.25	4.6	4.4	33.9	9.5	13.4
Multiuse	.20	3.7	3.5	27.1	7.6	10.7

[*] See Table A7 for C factor calculation.

[†] The RKSLP product for the Berks soil is 18.48 t/ac/yr.

[‡] The RKSLP product for the Cookport soil is 17.60 t/ac/yr.

[§] The RKSLP product for the Gilpin soil is 135.52 t/ac/yr.

[#] The RKSLP product for the Weikert soil is 37.88 t/ac/yr.

[**] The RKSLP product for the Minesoil is 53.46 t/ac/yr.

TABLE A3. EXISTING CHEMICAL PROPERTIES AT SITE 1

Soil Type	Soil coefficient	Chemical properties					
		pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content
			me/100 g	——— % of CEC me/100 g		———	% N
Berks	.26	6.49	10.7	1.8	10.8	63.4	.11*
Cookport	.08	5.06	20.0	.6	9.7	29.4	.03
Gilpin	.18	5.68	14.9	1.1	10.5	27.2	.19
Weikert	.05	6.22	10.8	2.8	6.5	59.7	.11
Minesoil†	.43	6.12	18.1	.9	12.4	29.4	.12

*Organic matter content for the Berks and Weikert soils are based on the mean average of the organic matter content for the Cookport and Gilpin soils.

†Existing chemical properties for the Minesoil and the anticipated chemical properties for Group I Minesoil (Appendix B, Table B2).

TABLE A4. EXISTING PHYSICAL PROPERTY DATA AT SITE 2

Soil Type	Soil coefficient	Physical properties						
		Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
		%	t/ac/yr	class	mm/hr	% by wt	m	g/cc
Cavode	.15	4 to 8	12.4	SiCL	2.54	18.9	.30	1.54
Cookport	.19	0 to 8	11.7	L	34.80	17.7	.68	1.48
Hazleton	.28	4 to 8	3.4	L	44.45	57.5	1.21	1.86
Nolo	.04	0 to 8	3.6	SiL	8.12	13.8	.08	1.66
Wharton	.34	4 to 8	7.1	SiCL	2.54	8.2	.69	1.62

TABLE A5 ANTICIPATED LAND USE EROSION VALUES FOR EACH SOIL AT SITE 2

		Erosion values				
		Soil type				
Land Use	C factor*	Cavode†	Cookport‡	Hazleton§	Nolo#	Wharton**
		t/ac/yr				
Corn	.29	8.2	5.2	5.1	5.8	13.6
Meadow	.01	.3	.2	.2	.2	.5
Pine	.52	14.7	9.4	9.2	10.5	24.5
Wildlife habitat	.18	5.1	3.2	3.2	3.6	8.5
Trails	.25	7.1	4.5	4.4	5.0	11.8
Multiuse	.20	5.6	3.6	3.5	4.0	9.4

*See Table A7 for C factor calculation.

†The RKSLP product for the Cavode soil is 28.22 t/ac/yr

‡The RKSLP product for the Cookport soil is 18.00 t/ac/yr.

§The RKSLP product for the Hazleton soil is 17.7 t/ac/yr.

#The RKSLP product for the Nolo soil is 20.16 t/ac/yr.

**The RKSLP product for the Wharton soil is 47.03 t/ac/yr.

TABLE A6. EXISTING CHEMICAL PROPERTIES AT SITE 2

		Chemical properties					
Soil Type	Soil coefficient	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content
			me/100 g	——— % of CEC me/100 g ———			% N
Cavode	.15	4.66	16.1	.9	3.7	6.8	.18
Cookport	.19	5.06	20.0	.6	9.7	29.4	.03
Hazleton	.28	4.90	20.2	.2	1.2	2.6	.15
Nolo	.04	4.90	27.2	.9	4.0	6.2	.14
Wharton	.34	5.2	16.8	1.0	12.5	18.5	.20

Calculation of C, the Cropping Management Factor

Land use C factors were based on a composite of crop stage periods that were estimated from Agricultural Handbook 282 (Wischmeier and Smith, 1965). These include Period F (rough fallow, 1/2 month), 1 (seedling, 1 month), 2 (establishment, 1 month), 3 (growing and maturing crop, 1 month), and 4 (residue or stubble, 1/2 month). Wischmeier and Smith (1965) provide further descriptions of these crop stage periods.

In order to use the handbook for land uses evaluated in this study, it was necessary to make certain assumptions for ground cover following reclamation. For corn, ground cover was compared to first year corn after sweet clover (Table 2, line 52, Wischmeier and Smith, 1965); for meadow, a grass and legume mix (Table 2, line 122, Wischmeier and Smith, 1965); for pine, continuous cotton (Table 2, Wischmeier and Smith, 1962); and for wildlife habitat, first year corn after grass and legume hay (Table 2, line 61, Wischmeier and Smith, 1965). Trails and multiuse were assumed to be generally composed of a combination of bare, meadow-like, pine-like, and wildlife habitat-like areas. Therefore, the C factors for these land uses were based on a composite sum of the C factors estimated for meadow, pine, and wildlife habitat (with bare areas having a C value of 1).

In Table A7 calculations were made for the composite C factors (as a function of time) for corn, pine, and wildlife habitat. The C value for meadow (.01) was taken directly from the handbook. Trails were assumed to be 5% bare, 85% meadow, and 10% pine. A composite C value

TABLE A7. CALCULATIONS OF COMPOSITE C VALUES BY CROP STATE PERIOD (AS A FUNCTION OF TIME AND SOIL LOSS RATIOS*) FOR CORN, PINE, AND WILDLIFE HABITAT

Land Use	C values by crop stage period as a function of time and soil loss ratios					Sum (C)
	F	1	2	3	4	
Corn	.5 month(.23)	1 month(.45)	1 month(.38)	1 month(.28)	.5 month(.44)	.29
Pine	.5 month(.45)	1 month(.80)	1 month(.80)	1 month(.52)	.5 month(.48)	.52
Wildlife habitat	.5 month(.08)	1 month(.25)	1 month(.30)	1 month(.20)	.5 month(.22)	.18

*Soil loss ratios were taken from Table 2, Wischmeier and Smith (1965).

for trails based on these percentages was estimated to be .25. For multiuse, the percentage breakdown was 5% bare, 40% meadow, 15% pine, and 40% wildlife habitat which were proportionately combined to derive a cropping management factor of .20.

APPENDIX B

ANTICIPATED MINESOIL PROPERTIES

TABLE B1. MINESOIL: GROUP I PHYSICAL DATA BASED ON EXISTING pH VALUES GREATER THAN 5

	Physical properties						
	Texture			Coarse fragments	Soil horizon depth		
Soil No*	Sand	Silt	Clay	content	A	B	C
	%			% by weight	cm		
317	5.8	9.8	4.4	80.0	10.2	0.0	162.6
318	7.5	9.2	4.3	78.7	45.7	0.0	139.7
1042	5.9	8.0	3.1	82.7	40.6	0.0	129.5
1044	7.6	10.0	5.3	76.9	12.7	66.0	73.7
1045	7.2	10.3	3.5	79.0	35.6	0.0	134.6
1723	5.9	5.2	2.9	86.1	7.6	0.0	165.1
5436	16.0	13.2	5.8	64.7	5.1	0.0	177.8
6350	5.8	13.3	6.9	74.4	10.2	30.5	132.1
Mean	7.7	9.9	4.5	77.8	21.1	12.1	139.4
SD	3.4	2.6	1.4	6.4	16.8	24.3	32.0
CV%	44	26	31	8	80	200	23

*These are sample numbers used in analysis of minesoils (Ciolkosz et al., in press).

TABLE B2. MINESOIL: GROUP I CHEMICAL DATA BASED ON EXISTING pH VALUES GREATER THAN 5

	Chemical properties					
Soil No*	pH	Cation exchange capacity†	Potassium	Magnesium	Calcium	Organic matter
		me/100 g	% of CEC me/100 g			% N
317	7.33	18.82	1.41	14.88	57.01	.087
318	7.57	19.07	.95	13.97	54.69	.058
1042	6.30	16.70	.92	13.17	34.07	.107
1044	5.64	17.68	.94	14.59	19.34	.130
1045	5.28	14.47	.99	8.09	24.88	.113
1723	5.15	17.25	.89	14.38	11.48	.09
5436	5.04	22.73	.47	7.66	4.70	.175
6350	6.67	40.52	1.13	3.75	73.00	.165
Mean	6.12	20.90	.94	12.39	34.89	.12
SD	.10	8.27	.27	3.13	24.31	.04
CV%	2	40	29	25	70	.33

*These are sample numbers used in analysis of minesoils (Ciolkosz et al., in press).

†me/100 g of material less than 2 mm.

TABLE B3. MINESOIL: GROUP II PHYSICAL DATA BASED ON EXISTING pH VALUES BETWEEN 4 AND 5, INCLUSIVE

	Physical properties						
	Texture			Coarse fragments content	Soil horizon depth		
Soil No*	Sand	Silt	Clay		A	B	C
	%			% by weight	cm		
1041	11.2	10.9	4.9	73.4	10.2	61.0	116.8
1602	4.3	10.7	6.0	79.0	38.1	0.0	160.0
1720	8.1	6.6	2.3	82.5	10.2	27.9	139.7
1722	5.7	3.2	1.1	90.0	7.6	30.5	119.4
2407	7.3	10.2	4.5	77.5	7.6	12.7	215.9
3317	3.9	11.0	10.1	75.2	10.2	No data	No data
5435	21.9	13.4	6.5	59.1	5.1	68.6	154.9
5437	17.2	7.2	2.6	73.4	10.2	27.9	190.5
6348	No data	No data	No data	69.0	33.0	0.0	119.4
Mean	9.9	9.2	4.8	75.5	14.7	28.6	152.1
SD	6.3	3.2	2.9	8.6	12.0	25.5	36.2
CV%	64	35	<0	11	82	89	24

*These are sample numbers used in analysis of minesoils (Ciolkosz et al., in press).

TABLE B4. MINESOIL: GROUP II CHEMICAL DATA BASED ON EXISTING pH VALUES BETWEEN 4 AND 5, INCLUSIVE

	Chemical properties					
Soil No*	pH	Cation exchange capacity†	Potassium	Magnesium	Calcium	Organic matter
		me/100 g	% of CEC me/100 g			% N
1041	4.22	23.00	.52	.74	10.78	.14
1602	4.27	38.35	.42	4.38	52.23	.10
1720	4.38	17.15	.54	3.38	6.00	.07
1722	4.70	15.55	.56	5.14	6.30	.06
2407	4.52	39.04	.43	7.99	53.18	.07
3317	4.01	27.24	.45	4.19	8.44	.10
5435	4.62	19.13	.59	8.57	19.39	.13
5437	4.30	16.26	.44	No data	No data	.15
6348	4.07	47.47	.53	1.62	32.51	.15
Mean	4.34	27.02	.50	4.50	23.60	.11
SD	.24	11.80	.06	2.75	19.98	.04
CV%	6	44	<1	<1	85	36

*These are number samples used in analysis of minesoils (Ciolkosz et al., in press).

†me/100 g of material less than 2 mm.

TABLE B5. MINESOIL: GROUP III PHYSICAL DATA BASED ON EXISTING pH VALUES LESS THAN 4

	Physical properties						
	Texture			Coarse fragments	Soil horizon depth		
Soil No*	Sand	Silt	Clay	content	A	B	C
	%			% by weight	cm		
315	4.5	8.0	5.5	82.3	10.2	40.6	121.9
316	16.0	10.4	6.6	66.7	0.0	0.0	152.4
1601	12.9	7.7	3.4	76.1	10.2	25.4	147.3
1721	6.3	2.5	1.2	89.8	7.6	0.0	208.3
1724	5.5	2.3	1.2	90.7	7.6	0.0	208.3
1725	7.8	10.0	5.2	76.9	22.9	0.0	241.3
2408	12.2	9.6	5.2	73.4	7.6	0.0	218.4
6349	6.6	13.0	5.4	74.8	38.1	0.0	149.9
Mean	9.0	7.9	4.2	78.8	13.0	8.2	181.0
SD	4.2	3.8	2.1	8.3	12.0	15.8	43.0
CV%	47	48	<1	10	92	193	24

*These are sample numbers used in analysis of minesoils (Ciolkosz et al., in press).

TABLE B6. MINESOIL: GROUP III CHEMICAL DATA BASED ON EXISTING pH VALUES LESS THAN 4

	Chemical properties					
Soil No*	pH	Cation exchange capacity†	Potassium	Magnesium	Calcium	Organic matter
		me/100 g	% of CEC me/100 g			% N
315	3.67	18.82	.74	.11	.27	.11
316	3.48	13.32	.68	2.70	9.01	.06
1601	3.87	10.48	.93	.29	No data	.06
1721	3.96	19.67	.05	1.73	4.07	.06
1724	3.68	27.78	.32	2.73	4.37	.17
1725	3.89	19.47	.65	1.90	4.67	.12
2408	3.92	27.23	.52	3.97	33.42	.07
6349	3.52	35.92	.40	.97	32.66	.20
Mean	3.75	21.46	.54	1.80	12.64	.10
SD	.19	8.21	.28	1.32	14.17	.07
CV%	5	38	52	73	112	<1

*These are number samples used in analysis of minesoils (Ciolkosz et al., in press).

†me/100 g of material less than 2 mm.

APPENDIX C

Opinion Survey

Mail questionnaires, with enclosed pre-stamped self-addressed return envelopes, were sent to families in the immediate localities of Bradford Township site 1 and Somerset/Brothers Valley Townships site 2. The families were randomly selected from applicable voter registration lists. A cover letter (page 134) also accompanied each survey and served to introduce the author and his research. The survey (pages 135 and 136) was developed to attempt to quantify the environmental qualities related to agriculture, forestry, and recreation land uses as well as strip mining and reclamation.

Survey responses from site 1 (29% return) and site 2 (42% return) are summarized in Table C1. Responses to question 5, 6, 7, and 12 (assumed to be representative of site population responses) were used to estimate the reallocation of state income tax property. For each land use including the no strip mining option this property was calculated by summing the products for each income group of the average land use dollar value (Table C1, questions 6 and 7), the median income level of the given income group, and the percent of the population which that income group represents (Table C2). Responses to question 5 (Table C1) were used to evaluate the public attitude property by establishing a ranking of the land uses according to preference.

Bob Elfstrom
600 N. Allen Street
State College, Pa. 16801

Phone: (814) 238-4976

To The Family,

I am currently doing research for my graduate thesis at Penn State I believe that it's possible to develop a ranking of land use alternatives for strip mine reclamation based on certain costs. The costs of establishing certain environments involving the chemical and physical properties of the soil can be determined from books and other printed information. However, the costs of the value that people place on these different land uses cannot similarly be found. This is why I am asking for your help.

Although anonymous, your responses will be of great value to me. I hope you realize, as a selected representative family of your township, that your responses could have some implication in the selection of environmental land uses for strip mine reclamation in your township.

If you have any question or comments, please feel free to contact me at any time. Please complete this survey at your leisure and return it within the enclosed, pre-stamped envelope.

Thank you for your time, consideration, and advice.

Sincerely,

Bob Elfstrom

Enclosures

LAND RECLAMATION SURVEY

1. How many people are in your family? _____

2. To be answered by the respondent:

   a. Your age _____
   b. Your sex ○ Male ○ Female
   c. Education ○ Grammar School ○ Senior High ○ 4 Years College
      ○ Junior High ○ 2 Years College ○ More
   d. Your occupation ______________________________

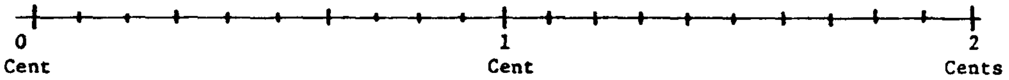
3. How many years has your family lived in the township? _________

4. Can you see any mining activity from your home or way to work? ○ Yes ○ No

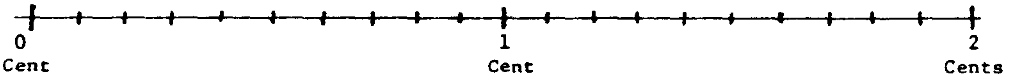
5. If a portion of your township was to be strip mined, one of three land uses have the chance of becoming established: Environment A - an economic crop field (Agricultural Use); Environment B - a wildlife habitat (Woodland or Forest); or Environment C - camping, hiking, and picnic areas (Recreation). In order of preference, how would your family rank the environments with 1 = favorite, 2 = less favorite, and 3 = least favorite?

   Environment A _____ Environment B _____ Environment C _____

6. If your family was given a choice of how your State tax (which is 2 cents for every dollar) was to be distributed, how much of this 2 cents would your family say should be spent for your favorite Environment?



7. How much of this 2 cents would your family say should be spent in order to prevent any stripping?



8. In your township, should more, less, or an equal amount of money be spent on local government when compared to environmental improvement?

   ○ More ○ Less ○ Equal Amount

9. In your township, would your family favor or oppose the idea of the stripped land being converted into a residential development or shopping center complex?

   ○ Favor ○ Oppose

(PLEASE TURN OVER)

10. On a scale of 0 to 10, with 10 representing a beautiful place to live and 0 an ugly place to live, how would your family rate your township?

0 1 2 3 4 5 6 7 8 9 10

11. In your township, should more, less, or an equal amount of money be spent on education and medical services when compared to environmental improvement?

○ More ○ Less ○ Equal Amount

12. What is your approximate total family income?

○ $0-5,999 ○ $6,000-10,999 ○ $11,000-19,999 ○ $20,000 and over

13. Place an X in any box which corresponds to any activity that a member of your family does for that season.

Outdoor Activity	Winter	Spring	Summer	Fall
Hunting				
Fishing				
Skiing or snowmobiling				
Camping				
Hiking or picnicking				
Boating or swimming				
Individual or team sports (golf, tennis, softball)				

14. Any comments?

THANK YOU

TABLE C1. SUMMARY OF SURVEY RESPONSES FROM SITES 1 AND 2*

Question number and description	Site responses Site 1	 Site 2
1. Average number of people per family	3.46	4.07
2. Average age (years)	44.4	39.2
Number of male respondents	20	21
Number of female respondents	8	19
Education†	2.9	3.8
3. Average number of years in township	25.9	24.6
4. Can see any mining activity		
Number of respondents answering yes	27	36
Number of respondents answering no	1	4
5. Agriculture		
Number of respondents answering most favorite	12	28
Number of respondents answering less favorite	7	8
Number of respondents answering least favorite	5	4
Forestry		
Number of respondents answering most favorite	15	10
Number of respondents answering less favorite	8	23
Number of respondents answering least favorite	2	3
Recreation		
Number of respondents answering most favorite	1	2
Number of respondents answering less favorite	5	5
Number of respondents answering least favorite	14	27
6. & 7. Average agriculture dollar value per income level		
$0 to 5,999	.009	.010
$6,000 to 10,999	.010	.009
$11,000 to 19,999	.008	.014
$20,000 and over	.010	.010

TABLE C1 (CONTINUED)

Question number and description	Site responses	
	Site 1	Site 2
Average forestry dollar value per income level		
$0 to 5,999	.020	.010
$6,000 to 10,999	.010	no response
$11,000 to 19,999	.007	.006
$20,000 and over	.010	.009
Average recreation dollar value per income level		
$0 to 5,999	no response	no response
$6,000 to 10,999	no response	no response
$11,000 to 19,999	.010	no response
$20,000 and over	no response	.008
Average prevent strip mining dollar value per income level		
$0 to 5,999	.006	.005
$6,000 to 10,999	.007	.006
$11,000 to 19,999	.004	.008
$20,000 and over	.001	.003
8. Local government vs environmental improvement		
Number of respondents answering more	6	8
Number of respondents answering less	5	8
Number of respondents answering equal amount	17	21
9. Reclaimed as residential development or shopping center complex		
Number of respondents that favored	19	20
Number of respondents that opposed	8	20
10. Average township rating	4.8	8.3
11. Education and medical service vs environmental improvement		
Number of respondents answering more	8	13
Number of respondents answering less	2	1
Number of respondents answering equal amount	18	24

TABLE C1 (CONTINUED)

Question number and description	Site responses Site 1	 Site 2
12. Percent of respondents per income level		
$0 to 5,999	15	8
$6,000 to 10,999	18	14
$11,000 to 19,999	52	39
$20,000 and over	15	39
13. Average number of activities	7.5	7.2

*Some questions were left unanswered by some of the respondents.

†Education was coded in the following manner: grammar school = 1, junior high = 2, senior high = 3, two years of college = 4, four years of college = 5, and more than four years of college = 6.

TABLE C2. CALCULATION OF THE REALLOCATION OF STATE INCOME TAX PROPERTY (EXPRESSED AS DOLLARS/FAMILY/YEAR) BY INCOME GROUP FOR THE LAND USES AND THE NO STRIP MINING OPTION AT SITES 1 AND 2

Land Use	Calculation/income group				Sum
	$0 to 5,999	$6,000 to 10,999	$11,000 to 19,999	$20,000 and over	
					dollars/ family/year
Agriculture					
Site 1	.009($3,000)(15%)	.010($8,500)(18%)	.008($15,500)(52%)	.010($25,000)(15%)	121.33
Site 2	.010($3,000)(8%)	.009($8,500)(14%)	.014($15,500)(39%)	.010($25,000)(39%)	195.24
Forestry					
Site 1	.020($3,000)(15%)	.010($8,500)(18%)	.007($15,500)(52%)	.010($25,000)(15%)	118.22
Site 2	.010($3,000)(8%)	no response	.006($15,500)(39%)	.009($25,000)(39%)	126.42
Recreation					
Site 1	no response	no response	.010($15,500)(52%)	no response	80.60
Site 2	no response	no response	no response	.008($25,000)(39%)	78.00
No strip mining option					
Site 1	.006($3,000)(15%)	.007($8,500)(18%)	.004($15,500)(52%)	.001($25,000)(15%)	49.40
Site 2	.005($3,000)(8%)	.006($8,500)(14%)	.008($15,500)(39%)	.003($25,000)(39%)	37.59

APPENDIX D

EXPLANATION OF ADDITIONAL COSTS REQUIRED TO ESTABLISH EACH LAND USE

Explanation of Additional Costs Required to Establish Each Land Use[1]

Additional costs for corn include grading to some degree (perhaps terracing), fertilizer and other soil amendments, seed cost, and planting. Of the land uses evaluated in this study, corn would likely require the most extensive grading. The cost of grading to change the slope of one acre of land by 1% requires the movement of 7260 cubic yards of soil. With a Soil Conservation Service figure of $.50/cubic yard, this amount of grading costs $3630.00/acre (Table 39). It was not necessary to estimate the other additional costs of establishing corn, because corn grading costs far exceed the anticipated costs for establishing the other land uses.

The costs of seed and fertilizer should be considered with meadow and the remaining land uses. However, because fertilizer additions are highly variable (depending on post-mining soil chemical analyses), they have been left out of cost estimations. A combination of trefoil at $4.40/pound and fescue at $.80/pound may be used to establish a meadow. In terms of economics, a larger proportion should be allotted to fescue. Meadow, for this study, was composed of 67% fescue and 33% trefoil, costing approximately $50.00/acre on a moderately steep terrain (Table 39).

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[1] All cost estimates for grading, seed, stock, and planting costs as well as the quantities of seed or stock required per acre were obtained from the Soil Conservation Office, Bellefonte, Pennsylvania.

Pine seedling ($10.00/1000 trees) and planting costs ($70.00/acre) were evaluated in estimating the additional costs for establishing pine. Approximately 670 trees are needed to sufficiently cover an acre. Therefore, the total additional cost for pine was $76.50/acre (Table 39).

An area suited to wildlife may be composed of a combination of poplar $35.00/1000 trees), locust and alder ($10.00/1000 trees), and bush and shrubbery ($150.00/1000 plants). An economic 1 acre planting scheme may include 500 poplar, 250 locust, and 250 alder relying on voluntary growth to provide for ground cover. Total costs, including planting (which is about three times as expensive as pine due to the greater degree of bulk handling of larger stock with protectively bagged roots) approached $225.00/acre (Table 39).

To estimate the additional costs of establishing trails, it was necessary to employ a composite of land use costs for pine and wildlife habitat. The percentage of land use composition for trails is described in Appendix B. Costs were estimated to be $200.00/acre (Table 39).

As with trails, the percentage of land uses for multiuse, including meadow, pine, wildlife habitat (as reported in Appendix A), was used to develop a composite cost for multiuse. The cost was $130.00/ acre (Table 39); however, additional costs would be incurred if sanitary and camping facilities were constructed.

APPENDIX E

PROPERTY MATRICES FOR SITES 1 AND 2

TABLE E1. PHYSICAL PROPERTIES MATRIX FOR BERKS SOIL AT SITE 1

	Physical properties						
Land Use	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1|4	2|5	4|7	2|5	1.67|10	1.33|8	1.67|10
Meadow	1|3	2|4	4|6	2|4	1.67|10	1.33|7	1.67|9
Pine	1|3	2|4	4|6	2|4	1.67|9	1.33|7	1.67|9
Wildlife habitat	1|3	2|4	4|6	2|4	1.67|9	1.33|6	1.67|8
Trails	1|3	2|3	4|6	2|4	1.67|8	1.33|7	1.67|7
Multiuse	1|3	2|4	4|7	2|4	1.67|10	1.33|8	1.67|8

TABLE E2. PHYSICAL PROPERTIES MATRIX FOR COOKPORT SOIL AT SITE 1

Land Use	Physical properties						
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1 | 4	1 | 5	4 | 7	2 | 5	5 | 10	1.33 | 8	1 | 10
Meadow	1 | 3	1 | 2	4 | 6	2 | 4	5 | 10	1.33 | 7	1 | 9
Pine	1 | 3	3 | 6	4 | 6	2 | 4	5 | 9	1.33 | 7	1 | 9
Wildlife habitat	1 | 3	1 | 2	4 | 6	2 | 4	5 | 9	1.33 | 6	1 | 8
Trails	1 | 3	2 | 3	4 | 6	2 | 4	5 | 8	1.33 | 7	1 | 7
Multiuse	1 | 3	1 | 2	4 | 7	2 | 4	5 | 10	1.33 | 8	1 | 8

TABLE E3. PHYSICAL PROPERTIES MATRIX FOR GILPIN SOIL AT SITE 1

	Physical properties						
Land Use	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1|8	2.50|10	1.33|7	2|5	2.50|10	1.33|8	1|10
Meadow	1|7	.50|2	1.33|6	2|4	2.50|10	1.33|7	1|9
Pine	1|7	2.50|10	1.33|6	2|4	2.50|9	1.33|7	1|9
Wildlife habitat	1|7	2.50|7	1.33|6	2|4	2.50|9	1.33|6	1|8
Trails	1|6	2.50|9	1.33|6	2|4	2.50|8	1.33|7	1|7
Multiuse	1|7	2.50|10	1.33|7	2|4	2.50|10	1.33|8	1|8

TABLE E4. PHYSICAL PROPERTIES MATRIX FOR WEIKERT SOIL AT SITE 1

<table>
<tr><th rowspan="2">Land Use</th><th colspan="7">Physical properties</th></tr>
<tr><th>Slope</th><th>Erosion</th><th>Texture</th><th>Permeability</th><th>Coarse fragments content</th><th>Depth to limiting layer</th><th>Bulk density</th></tr>
<tr><td>Corn</td><td>1 | 6</td><td>1.50 | 7</td><td>4 | 7</td><td>2 | 5</td><td>1.25 | 10</td><td>1 | 8</td><td>1 | 10</td></tr>
<tr><td>Meadow</td><td>1 | 5</td><td>.50 | 2</td><td>4 | 6</td><td>2 | 4</td><td>1.25 | 10</td><td>1 | 7</td><td>1 | 9</td></tr>
<tr><td>Pine</td><td>1 | 5</td><td>2.50 | 10</td><td>4 | 6</td><td>2 | 4</td><td>1.25 | 9</td><td>1 | 7</td><td>1 | 9</td></tr>
<tr><td>Wildlife habitat</td><td>1 | 5</td><td>1 | 4</td><td>4 | 6</td><td>2 | 4</td><td>1.25 | 9</td><td>1 | 6</td><td>1 | 8</td></tr>
<tr><td>Trails</td><td>1 | 4</td><td>1.50 | 5</td><td>4 | 6</td><td>2 | 4</td><td>1.25 | 8</td><td>1 | 7</td><td>1 | 7</td></tr>
<tr><td>Multiuse</td><td>1 | 5</td><td>1 | 4</td><td>4 | 7</td><td>2 | 4</td><td>1.25 | 10</td><td>1 | 8</td><td>1 | 8</td></tr>
</table>

TABLE E5. PHYSICAL PROPERTIES MATRIX FOR MINESOIL AT SITE 1

Land Use	Physical properties						
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1 | 6	4 | 9	1 | 7	1 | 5	1 | 10	1 | 8	1 | 10
Meadow	1 | 5	1 | 2	1 | 6	1 | 4	1 | 10	1 | 7	1 | 9
Pine	1 | 5	5 | 10	1 | 6	1 | 4	1 | 9	1 | 7	1 | 9
Wildlife habitat	1 | 5	3 | 6	1 | 6	1 | 4	1 | 9	1 | 6	1 | 8
Trails	1 | 4	4 | 7	1 | 6	1 | 4	1 | 8	1 | 7	1 | 7
Multiuse	1 | 5	3 | 6	1 | 7	1 | 4	1 | 10	1 | 8	1 | 8

TABLE E6. CHEMICAL PROPERTIES MATRIX FOR BERKS SOIL AT SITE 1

	Chemical properties						
Land Use	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content
Corn	1|2	1|2	1|10	1|2	5|8	1|5	10|15
Meadow	1|2	1|2	1|8	1|2	5|7	1|4	10|13
Pine	1|2	1|2	1|7	1|2	5|7	1|4	10|13
Wildlife habitat	1|2	1|2	1|6	1|2	5|6	1|4	10|14
Trails	1|2	1|2	1|6	1|2	5|6	1|4	10|11
Multiuse	1|2	1|2	1|7	1|2	5|6	1|4	10|12

TABLE E7. CHEMICAL PROPERTIES MATRIX FOR COOKPORT SOIL AT SITE 1

<table>
<tr><th rowspan="2">Land Use</th><th colspan="14">Chemical properties</th></tr>
<tr><th colspan="2">pH</th><th colspan="2">Cation exchange capacity</th><th colspan="2">Potassium content</th><th colspan="2">Magnesium content</th><th colspan="2">Calcium content</th><th colspan="2">Organic matter content</th><th colspan="2">Sulfur content</th></tr>
<tr><td>Corn</td><td>.33</td><td>2</td><td>1</td><td>2</td><td>1</td><td>10</td><td>.20</td><td>2</td><td>1</td><td>8</td><td>.75</td><td>5</td><td>10</td><td>15</td></tr>
<tr><td>Meadow</td><td>.33</td><td>2</td><td>1</td><td>2</td><td>1</td><td>8</td><td>.20</td><td>2</td><td>1</td><td>7</td><td>.75</td><td>4</td><td>10</td><td>13</td></tr>
<tr><td>Pine</td><td>.33</td><td>2</td><td>1</td><td>2</td><td>1</td><td>7</td><td>.20</td><td>2</td><td>1</td><td>7</td><td>.75</td><td>4</td><td>10</td><td>13</td></tr>
<tr><td>Wildlife habitat</td><td>.33</td><td>2</td><td>1</td><td>2</td><td>1</td><td>6</td><td>.20</td><td>2</td><td>1</td><td>6</td><td>.75</td><td>4</td><td>10</td><td>14</td></tr>
<tr><td>Trails</td><td>.33</td><td>2</td><td>1</td><td>2</td><td>1</td><td>6</td><td>.20</td><td>2</td><td>1</td><td>6</td><td>.75</td><td>4</td><td>10</td><td>11</td></tr>
<tr><td>Multiuse</td><td>.33</td><td>2</td><td>1</td><td>2</td><td>1</td><td>7</td><td>.20</td><td>2</td><td>1</td><td>6</td><td>.75</td><td>4</td><td>10</td><td>12</td></tr>
</table>

TABLE E8. CHEMICAL PROPERTIES MATRIX FOR GILPIN SOIL AT SITE 1

<table>
<tr><th></th><th colspan="7">Chemical properties</th></tr>
<tr><th>Land Use</th><th>pH</th><th>Cation exchange capacity</th><th>Potassium content</th><th>Magnesium content</th><th>Calcium content</th><th>Organic matter content</th><th>Sulfur content</th></tr>
<tr><td>Corn</td><td>.50 | 2</td><td>1 | 2</td><td>1 | 10</td><td>1 | 2</td><td>1 | 8</td><td>1 | 5</td><td>10 | 15</td></tr>
<tr><td>Meadow</td><td>.50 | 2</td><td>1 | 2</td><td>1 | 8</td><td>1 | 2</td><td>1 | 7</td><td>1 | 4</td><td>10 | 13</td></tr>
<tr><td>Pine</td><td>.50 | 2</td><td>1 | 2</td><td>1 | 7</td><td>1 | 2</td><td>1 | 7</td><td>1 | 4</td><td>10 | 13</td></tr>
<tr><td>Wildlife habitat</td><td>.50 | 2</td><td>1 | 2</td><td>1 | 6</td><td>1 | 2</td><td>1 | 6</td><td>1 | 4</td><td>10 | 14</td></tr>
<tr><td>Trails</td><td>.50 | 2</td><td>1 | 2</td><td>1 | 6</td><td>1 | 2</td><td>1 | 6</td><td>1 | 4</td><td>10 | 11</td></tr>
<tr><td>Multiuse</td><td>.50 | 2</td><td>1 | 2</td><td>1 | 7</td><td>1 | 2</td><td>1 | 6</td><td>1 | 4</td><td>10 | 12</td></tr>
</table>

TABLE E9. CHEMICAL PROPERTIES MATRIX FOR WEIKERT SOIL AT SITE 1

Land Use	Chemical properties						
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content
Corn	1 | 2	1 | 2	5 | 10	.20 | 2	5 | 8	1 | 5	10 | 15
Meadow	1 | 2	1 | 2	5 | 8	.20 | 2	5 | 7	1 | 4	10 | 13
Pine	1 | 2	1 | 2	5 | 7	.20 | 2	5 | 7	1 | 4	10 | 13
Wildlife habitat	1 | 2	1 | 2	5 | 6	.20 | 2	5 | 6	1 | 4	10 | 14
Trails	1 | 2	1 | 2	5 | 6	.20 | 2	5 | 6	1 | 4	10 | 11
Multiuse	1 | 2	1 | 2	5 | 7	.20 | 2	5 | 6	1 | 4	10 | 12

TABLE E10. CHEMICAL PROPERTIES MATRIX FOR MINESOIL AT SITE 1

	Chemical properties						
Land Use	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content
Corn	1 | 2	1 | 2	1 | 10	1 | 2	1 | 8	1 | 5	10 | 15
Meadow	1 | 2	1 | 2	1 | 8	1 | 2	1 | 7	1 | 4	10 | 13
Pine	1 | 2	1 | 2	1 | 7	1 | 2	1 | 7	1 | 4	10 | 13
Wildlife habitat	1 | 2	1 | 2	1 | 6	1 | 2	1 | 6	1 | 4	10 | 14
Trails	1 | 2	1 | 2	1 | 6	1 | 2	1 | 6	1 | 4	10 | 11
Multiuse	1 | 2	1 | 2	1 | 7	1 | 2	1 | 6	1 | 4	10 | 12

TABLE E11. ECONOMIC PROPERTIES MATRIX AT SITE 1

Land Use	Economic properties							
	Land property value		Reallocation of state income tax		Effect of unemployment		Additional costs	
Corn	.25	6.00	5.00	4.00	.60	5.00	5.00	6.00
Meadow	1.00	7.00	5.00	5.00	1.00	6.00	1.00	4.00
Pine	.75	6.00	5.00	5.00	.40	5.00	2.00	4.00
Wildlife habitat	1.00	5.00	5.00	5.00	.60	5.00	3.00	7.00
Trails	.75	5.00	6.00	8.00	.40	6.00	3.00	7.00
Multiuse	.50	5.00	6.00	8.00	.20	6.00	2.00	5.00

TABLE E12. AESTHETIC PROPERTIES MATRIX AT SITE 1

Land Use	Aesthetic properties			
	Public attitude		Area mined and visual conformity	
Corn	1.00	4.00	4.00	5.00
Meadow	1.00	5.00	4.00	5.00
Pine	1.00	5.00	4.00	5.00
Wildlife habitat	1.00	5.00	4.00	5.00
Trails	1.67	10.00	4.00	5.00
Multiuse	1.67	10.00	4.00	7.00

TABLE E13. PHYSICAL PROPERTIES MATRIX FOR CAVODE SOIL AT SITE 2

	Physical properties						
Land Use	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1 | 4	.75 | 7	.67 | 3	.20 | 2	5 | 10	.80 | 8	1 | 10
Meadow	1 | 3	.25 | 2	.67 | 3	.20 | 2	5 | 10	.80 | 7	1 | 9
Pine	1 | 3	1 | 8	.67 | 3	.20 | 2	5 | 9	.80 | 7	1 | 9
Wildlife habitat	1 | 3	.50 | 4	.67 | 3	.20 | 2	5 | 9	.80 | 6	1 | 8
Trails	1 | 3	.50 | 3	.67 | 3	.20 | 2	5 | 8	.80 | 7	1 | 7
Multiuse	1 | 3	1 | 4	.67 | 3	.20 | 2	5 | 10	.80 | 8	1 | 8

TABLE E14. PHYSICAL PROPERTIES MATRIX FOR COOKPORT SOIL AT SITE 2

Land Use	Physical properties						
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1 | 2	.67 | 5	4 | 7	2 | 5	5 | 10	1.33 | 8	1 | 10
Meadow	1 | 2	.33 | 2	4 | 6	2 | 4	5 | 10	1.33 | 7	1 | 9
Pine	1 | 2	1 | 6	4 | 6	2 | 4	5 | 9	1.33 | 7	1 | 9
Wildlife habitat	1 | 2	.33 | 2	4 | 6	2 | 4	5 | 9	1.33 | 6	1 | 8
Trails	1 | 2	.67 | 3	4 | 6	2 | 4	5 | 8	1.33 | 7	1 | 7
Multiuse	1 | 2	.33 | 2	4 | 7	2 | 4	5 | 10	1.33 | 8	1 | 8

TABLE E15. PHYSICAL PROPERTIES MATRIX FOR HAZLETON SOIL AT SITE 2

Land Use	Physical properties Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1 | 4	2 | 5	2 | 3	1 | 2	1.67 | 10	4 | 8	1 | 10
Meadow	1 | 3	1 | 2	2 | 3	1 | 2	1.67 | 10	4 | 7	1 | 9
Pine	1 | 3	3 | 6	2 | 3	1 | 2	1.67 | 9	4 | 7	1 | 9
Wildlife habitat	1 | 3	1 | 2	2 | 3	1 | 2	1.67 | 9	4 | 6	1 | 8
Trails	1 | 3	2 | 3	2 | 3	1 | 2	1.67 | 8	4 | 7	1 | 7
Multiuse	1 | 3	1 | 2	2 | 3	1 | 2	1.67 | 10	4 | 8	1 | 8

TABLE E16. PHYSICAL PROPERTIES MATRIX FOR NOLO SOIL AT SITE 2

Land Use	Physical properties						
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1 | 2	2 | 5	2 | 3	.25 | 2	5 | 10	1.25 | 10	1 | 10
Meadow	1 | 2	1 | 2	2 | 3	.25 | 2	5 | 10	1.25 | 9	1 | 10
Pine	1 | 2	3 | 6	2 | 3	.25 | 2	5 | 9	1.25 | 9	1 | 9
Wildlife habitat	1 | 2	1 | 2	2 | 3	.25 | 2	5 | 9	1.25 | 8	1 | 8
Trails	1 | 2	2 | 3	2 | 3	.25 | 2	5 | 8	1.25 | 9	1 | 7
Multiuse	1 | 2	1 | 2	2 | 3	.25 | 2	5 | 10	1.25 | 10	1 | 8

TABLE E17. PHYSICAL PROPERTIES MATRIX FOR WHARTON SOIL AT SITE 2

Land Use	Physical properties						
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density
Corn	1 │ 4	2 │ 9	1.33 │ 7	.40 │ 5	5 │ 10	1.33 │ 8	1 │ 10
Meadow	1 │ 3	.50 │ 2	1.33 │ 6	.40 │ 4	5 │ 10	1.33 │ 7	1 │ 9
Pine	1 │ 3	2.50 │ 10	1.33 │ 6	.40 │ 4	5 │ 9	1.33 │ 7	1 │ 9
Wildlife habitat	1 │ 3	1.50 │ 6	1.33 │ 6	.40 │ 4	5 │ 9	1.33 │ 6	1 │ 8
Trails	1 │ 3	1.50 │ 6	1.33 │ 6	.40 │ 4	5 │ 8	1.33 │ 7	1 │ 7
Multiuse	1 │ 3	1.50 │ 6	1.33 │ 7	.40 │ 4	5 │ 10	1.33 │ 8	1 │ 8

TABLE E18. CHEMICAL PROPERTIES MATRIX FOR CAVODE SOIL AT SITE 2

	Chemical properties						
Land Use	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content
Corn	1.25 | 10	1 | 2	1 | 10	1 | 9	1 | 8	1 | 5	6 | 11
Meadow	1.25 | 9	1 | 2	1 | 8	1 | 9	1 | 7	1 | 4	6 | 9
Pine	1.25 | 9	1 | 2	1 | 7	1 | 8	1 | 7	1 | 4	6 | 9
Wildlife habitat	1.25 | 9	1 | 2	1 | 6	1 | 7	1 | 6	1 | 4	6 | 10
Trails	1.25 | 8	1 | 2	1 | 6	1 | 7	1 | 6	1 | 4	6 | 7
Multiuse	1.25 | 9	1 | 2	1 | 7	1 | 8	1 | 6	1 | 4	6 | 8

TABLE E19. CHEMICAL PROPERTIES MATRIX FOR HAZLETON SOIL AT SITE 2

	Chemical properties						
Land Use	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content
Corn	1.25 | 10	1 | 2	1 | 10	1 | 9	1 | 8	1 | 5	6 | 11
Meadow	1.25 | 9	1 | 2	1 | 8	1 | 9	1 | 7	1 | 4	6 | 9
Pine	1.25 | 9	1 | 2	1 | 7	1 | 8	1 | 7	1 | 4	6 | 9
Wildlife habitat	1.25 | 9	1 | 2	1 | 6	1 | 7	1 | 6	1 | 4	6 | 10
Trails	1.25 | 8	1 | 2	1 | 6	1 | 7	1 | 6	1 | 4	6 | 7
Multiuse	1.25 | 9	1 | 2	1 | 7	1 | 8	1 | 6	1 | 4	6 | 8

TABLE E20. CHEMICAL PROPERTIES MATRIX FOR NOLO SOIL AT SITE 2

	Chemical properties						
Land Use	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content
Corn	1.25|10	1|2	1|10	1|9	1|8	1|5	6|11
Meadow	1.25|9	1|2	1|8	1|9	1|7	1|4	6|9
Pine	1.25|9	1|2	1|7	1|8	1|7	1|4	6|9
Wildlife habitat	1.25|9	1|2	1|6	1|7	1|6	1|4	6|10
Trails	1.25|8	1|2	1|6	1|7	1|6	1|4	6|7
Multiuse	1.25|9	1|2	1|7	1|8	1|6	1|4	6|8

TABLE E21. CHEMICAL PROPERTIES MATRIX FOR WHARTON SOIL AT SITE 2

	Chemical properties						
Land Use	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content
Corn	.33 | 2	1 | 2	1 | 10	1 | 2	1 | 8	1 | 5	6 | 11
Meadow	.33 | 2	1 | 2	1 | 8	1 | 2	1 | 7	1 | 4	6 | 9
Pine	.33 | 2	1 | 2	1 | 7	1 | 2	1 | 7	1 | 4	6 | 9
Wildlife habitat	.33 | 2	1 | 2	1 | 6	1 | 2	1 | 6	1 | 4	6 | 10
Trails	.33 | 2	1 | 2	1 | 6	1 | 2	1 | 6	1 | 4	6 | 7
Multiuse	.33 | 2	1 | 2	1 | 7	1 | 2	1 | 6	1 | 4	6 | 8

TABLE E22. ECONOMIC PROPERTIES MATRIX AT SITE 2

	Economic properties			
Land Use	Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs
Corn	.50 | 6.00	1.00 | 2.00	.60 | 5.00	5.00 | 6.00
Meadow	2.00 | 7.00	1.00 | 2.00	1.00 | 6.00	1.00 | 4.00
Pine	1.50 | 7.00	3.00 | 5.00	.40 | 5.00	2.00 | 4.00
Wildlife habitat	2.00 | 5.00	3.00 | 5.00	.60 | 5.00	3.00 | 7.00
Trails	1.50 | 5.00	4.00 | 8.00	.40 | 6.00	3.00 | 7.00
Multiuse	1.00 | 5.00	4.00 | 8.00	.20 | 6.00	2.00 | 5.00

TABLE E23. AESTHETIC PROPERTIES MATRIX AT SITE 2

<table>
<tr><th rowspan="2">Land Use</th><th colspan="2">Aesthetic properties</th></tr>
<tr><th>Public attitude</th><th>Area mined and visual conformity</th></tr>
<tr><td>Corn</td><td>.67 | 3.00</td><td>5.00 | 6.00</td></tr>
<tr><td>Meadow</td><td>.67 | 3.00</td><td>5.00 | 6.00</td></tr>
<tr><td>Pine</td><td>1.33 | 6.00</td><td>5.00 | 6.00</td></tr>
<tr><td>Wildlife habitat</td><td>1.33 | 6.00</td><td>5.00 | 6.00</td></tr>
<tr><td>Trails</td><td>1.67 | 10.00</td><td>5.00 | 6.00</td></tr>
<tr><td>Multiuse</td><td>1.67 | 10.00</td><td>5.00 | 6.00</td></tr>
</table>

APPENDIX F

COMPUTATION OF WEIGHTED AND AVERAGE SUMS

TABLE F1. PHYSICAL PROPERTIES FOR CORN AT SITE 1*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permea-bility	Coarse fragments content	Depth to limiting layer	Bulk density	
Berks	1|4	2|5	4|7	2|5	1.67|10	1.30|8	1.67|10	
Cookport	1|4	2|5	4|7	2|5	5|10	1.30|8	1|10	
Gilpin	1|8	2.50|10	1.30|7	2|5	2.50|10	1.30|8	1|10	
Weikert	1|6	1.50|7	4|7	2|5	1.25|10	1|8	1|10	
Minesoil	1|6	4|9	1|7	1|5	1|10	1|10	1|10	
Weighted sum	1.00|5.68	2.86|7.72	2.22|7.00	1.57|5.00	1.77|10.00	1.15|8.51	1.17|10.00	1.68|7.70

*Component values are taken from Appendix E (Tables E1, E2, E3, E4, and E5).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 11.74/53.91.

TABLE F2. PHYSICAL PROPERTIES FOR MEADOW AT SITE 1*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permea-bility	Coarse fragments content	Depth to limiting layer	Bulk density	
Berks	1 | 3	2 | 4	4 | 6	2 | 4	1.67 | 10	1.30 | 7	1.67 | 9	
Cookport	1 | 3	1 | 2	4 | 6	2 | 4	5 | 10	1.30 | 7	1 | 9	
Gilpin	1 | 7	.50 | 2	1.30 | 6	2 | 4	2.50 | 10	1.30 | 7	1 | 9	
Weikert	1 | 5	.50 | 2	4 | 9	2 | 4	1.25 | 10	1.30 | 7	1.67 | 9	
Minesoil	1 | 5	1 | 2	1 | 6	1 | 4	1 | 10	1 | 7	1 | 9	
Weighted sum	1.00 | 4.68	1.14 | 2.52	2.22 | 6.15	1.57 | 4.00	1.77 | 10.00	1.16 | 7.00	1.20 | 9.00	1.44 | 6.19

*Component values are taken from Appendix E (Tables E1, E2, E3, E4, and E5).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and 43, respectively.

‡Sum = 10.06/43.35.

TABLE F3. PHYSICAL PROPERTIES FOR PINE AT SITE 1*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density	
Berks	1 | 3	2 | 4	4 | 6	2 | 4	1.67 | 9	1.30 | 7	1.67 | 9	
Cookport	1 | 3	3 | 6	4 | 6	2 | 4	5 | 9	1.30 | 7	1 | 9	
Gilpin	1 | 7	2.50 | 10	1.30 | 6	2 | 4	2.50 | 9	1.30 | 7	1 | 9	
Weikert	1 | 5	2.50 | 10	4 | 6	2 | 4	1.25 | 9	1 | 7	1 | 9	
Minsoil	1 | 5	5 | 10	1 | 6	1 | 4	1 | 9	1 | 7	1 | 9	
Weighted sum	1.00 | 4.68	3.48 | 8.12	2.22 | 6.00	1.57 | 4.00	1.77 | 9.00	1.15 | 7.00	1.17 | 9.00	1.77 | 6.83

*Component values are taken from Appendix E (Tables E1 , E2 , E3 , E4 , and E5).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 12.36/47.80.

TABLE F4. PHYSICAL PROPERTIES FOR WILDLIFE HABITAT AT SITE 1*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permea-bility	Coarse fragments content	Depth to limiting layer	Bulk density	
Berks	1 | 3	2 | 4	4 | 6	2 | 4	1.67 | 9	1.30 | 6	1.67 | 8	
Cookport	1 | 3	1 | 2	4 | 6	2 | 4	5 | 9	1.30 | 6	1 | 8	
Gilpin	1 | 7	2.50 | 7	1.30 | 6	2 | 4	2.50 | 9	1.30 | 6	1 | 8	
Weikert	1 | 5	1 | 4	4 | 6	2 | 4	1.25 | 9	1 | 6	1 | 8	
Minesoil	1 | 5	3 | 6	1 | 6	1 | 4	1 | 9	1 | 6	1 | 8	
Weighted sum	1.00 | 4.68	2.39 | 5.24	2.22 | 7.00	1.57 | 4.00	1.77 | 10.00	1.15 | 6.00	1.17 | 8.00	1.61 | 6.42

*Component values are taken from Appendix E (Tables E1 , E2 , E3 , E4 , and E5).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 11.27/44.92.

TABLE F5. PHYSICAL PROPERTIES FOR TRAILS AT SITE 1*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permea-bility	Coarse fragments content	Depth to limiting layer	Bulk density	
Berks	1|3	2|3	4|6	2|4	1.67|8	1.30|7	1.67|7	
Cookport	1|3	2|3	4|6	2|4	5|8	1.30|7	1|7	
Gilpin	1|6	2.50|9	1.30|6	2|4	2.50|8	1.30|7	1|7	
Weikert	1|4	1.50|5	4|6	2|4	1|8	1|7	1|7	
Minesoil	1|4	4|7	1|6	1|4	1.25|8	1|7	1|7	
Weighted sum	1.00|4.02	2.92|5.90	2.22|6.00	1.57|4.00	1.77|8.00	1.15|7.00	1.17|7.00	1.69|5.39

*Component values are taken from Appendix E (Tables E1, E2, E3, E4, and E5).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 11.80/41.92.

TABLE F6. PHYSICAL PROPERTIES FOR MULTIUSE AT SITE 1*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permea-bility	Coarse fragments content	Depth to limiting layer	Bulk density	
Berks	1|3	2|4	4|7	2|4	1.67|10	1.30|8	1.67|8	
Cookport	1|3	1|2	4|7	2|4	5|10	1.30|8	1|8	
Gilpin	1|7	2.50|10	1.30|7	2|4	2.50|10	1.30|8	1|8	
Weikert	1|5	1|4	4|7	2|4	1.25|10	1|8	1|8	
Minesoil	1|5	3|6	1|7	1|4	1|10	1|8	1|8	
Weighted sum	1.00|4.68	2.39|5.78	2.22|7.00	1.57|4.00	1.77|10.00	1.15|8.00	1.17|8.00	1.61|6.78

*Component values are taken from Appendix E (Tables E1, E2, E3, E4, and E5).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 11.27/47.46.

TABLE F7. CHEMICAL PROPERTIES FOR CORN AT SITE 1*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Berks	1 | 2	1 | 2	1 | 10	1 | 2	5 | 8	1 | 5	10 | 15	
Cookport	.33 | 2	1 | 2	1 | 10	.20 | 2	1 | 8	.75 | 5	10 | 15	
Gilpin	.50 | 2	1 | 2	1 | 10	1 | 2	1 | 8	1 | 5	10 | 15	
Weikert	1 | 2	1 | 2	5 | 10	.20 | 2	5 | 8	1 | 5	10 | 15	
Minesoil	1 | 2	1 | 2	1 | 10	1 | 2	1 | 8	1 | 5	10 | 15	
Weighted sum	.86 | 2.00	1.00 | 2.00	1.20 | 10.00	.90 | 2.00	2.24 | 8.00	.98 | 5.00	10.00 | 15.00	2.45 | 6.29

*Component values are taken from Appendix E (Tables E6, E7, E8, E9, and E10).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 17.18/44.00.

TABLE F8. CHEMICAL PROPERTIES FOR MEADOW AT SITE 1*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Berks	1|2	1|2	1|8	1|2	5|7	1|4	10|13	
Cookport	.33|2	1|2	1|8	.20|2	1|7	.75|4	10|13	
Gilpin	.50|2	1|2	1|8	1|2	1|7	1|4	10|13	
Weikert	1|2	1|2	5|8	.20|2	5|7	1|4	10|13	
Minesoil	1|2	1|2	1|8	1|2	1|7	1|4	10|13	
Weighted sum	.86|2.00	1.00|1.00	1.20|8.00	.90|2.00	2.24|7.00	.98|4.00	10.00|13.00	2.45|5.43

*Component values are taken from Appendix E (Tables E6, E7, E8, E9, and E10).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 17.18/38.00

TABLE F9. CHEMICAL PROPERTIES FOR PINE AT SITE 1[*]

Soil Type[†]	Chemical properties							Average sum[‡]
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Berks	1|2	1|2	1|7	1|2	5|7	1|4	10|13	
Cookport	.33|2	1|2	1|7	.20|2	1|7	.75|4	10|13	
Gilpin	.50|2	1|2	1|7	1|2	1|7	1|4	10|13	
Weikert	1|2	1|2	5|7	.20|2	5|7	1|4	10|13	
Minesoil	1|2	1|2	1|7	1|2	1|7	1|4	10|13	
Weighted sum	.86|2.00	1.00|2.00	1.20|7.00	.90|2.00	2.24|7.00	.98|4.00	10.00|13.00	2.45|5.29

[*] Component values are taken from Appendix E (Tables E6, E7, E8, E9, and E10).

[†] Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

[‡] Sum = 17.18/37.00.

TABLE F10. CHEMICAL PROPERTIES FOR WILDLIFE HABITAT AT SITE 1*

	Chemical properties							
Soil Type†	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	Average sum‡
Berks	1|2	1|2	1|6	1|2	5|6	1|4	10|14	
Cookport	.33|2	1|2	1|6	.20|2	1|6	.75|4	10|14	
Gilpin	.50|2	1|2	1|6	1|2	1|6	1|4	10|14	
Weikert	1|2	1|2	5|6	.20|2	5|6	1|4	10|14	
Minesoil	1|2	1|2	1|6	1|2	1|6	1|4	10|14	
Weighted sum	.86|2.00	1.00|2.00	1.20|6.00	.90|2.00	2.24|6.00	.98|4.00	10.00|14.00	2.45|5.14

*Component values are taken from Appendix E (Tables E6 , E7 , E8 , E9 , and E10).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 17.18/36.00.

TABLE F11. CHEMICAL PROPERTIES FOR TRAILS AT SITE 1*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Berks	1|2	1|2	1|6	1|2	5|6	1|4	10|11	
Cookport	.33|2	1|2	1|6	.20|2	1|6	.75|4	10|11	
Gilpin	.50|2	1|2	1|6	1|2	1|6	1|4	10|11	
Weikert	1|2	1|2	5|6	.20|2	5|6	1|4	10|11	
Minesoil	1|2	1|2	1|6	1|2	1|6	1|4	10|11	
Weighted sum	.86|2.00	1.00|2.00	1.20|6.00	.90|2.00	2.24|6.00	.98|4.00	10.00|11.00	2.45|4.71

*Component values are taken from Appendix E (Tables E6, E7, E8, E9, and E10).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 17.18/33.00.

TABLE F12. CHEMICAL PROPERTIES FOR MULTIUSE AT SITE 1*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Berks	1 | 2	1 | 2	1 | 7	1 | 2	5 | 6	1 | 4	10 | 12	
Cookport	.33 | 2	1 | 2	1 | 7	.20 | 2	1 | 6	.75 | 4	10 | 12	
Gilpin	.50 | 2	1 | 2	1 | 7	1 | 2	1 | 6	1 | 4	10 | 12	
Weikert	1 | 2	1 | 2	5 | 7	.20 | 2	5 | 6	1 | 4	10 | 12	
Minesoil	1 | 2	1 | 2	1 | 7	1 | 2	1 | 6	1 | 4	10 | 12	
Weighted sum	.86 | 2.00	1.00 | 2.00	1.20 | 7.00	.90 | 2.00	2.24 | 6.00	.98 | 4.00	10.00 | 12.00	2.45 | 5.00

*Component values are taken from Appendix E (Tables E6, E7, E8, E9, and E10).

†Soil coefficient for Berks, Cookport, Gilpin, Weikert, and the Minesoil are .26, .08, .18, .05 and .43, respectively.

‡Sum = 17.18/35.00.

TABLE F13. ECONOMIC PROPERTIES FOR CORN AT SITE 1*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
.25|6.00	5.00|4.00	.60|5.00	5.00|6.00	2.71|5.25

*Component values are taken from Appendix E (Table E11).

†Sum = 10.85/21.00.

TABLE F14. ECONOMIC PROPERTIES FOR MEADOW AT SITE 1*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
1.00|7.00	5.00|5.00	1.00|6.00	1.00|4.00	2.00|5.50

*Component values are taken from Appendix E (Table E11).

†Sum = 8.00/22.00.

TABLE F15. ECONOMIC PROPERTIES FOR PINE AT SITE 1*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
.75|6.00	5.00|5.00	.40|5.00	2.00|4.00	2.04|5.00

*Component values are taken from Appendix E (Table E11).

†Sum = 8.15/20.00

TABLE F16. ECONOMIC PROPERTIES FOR WILDLIFE HABITAT AT SITE 1*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
1.00|5.00	5.00|5.00	.60|5.00	3.00|7.00	2.77|5.50

*Component values are taken from Appendix E (Table E11).

†Sum = 11.10/22.00.

TABLE F17. ECONOMIC PROPERTIES FOR TRAILS AT SITE 1*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
.75 | 6.00	6.00 | 8.00	.40 | 6.00	3.00 | 7.00	2.54 | 6.75

*Component values are taken from Appendix E (Table E11).

†Sum = 10.15/27.00.

TABLE F18. ECONOMIC PROPERTIES FOR MULTIUSE AT SITE 1*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
.50 | 6.00	6.00 | 8.00	.20 | 6.00	2.00 | 5.00	2.18 | 6.25

*Component values are taken from Appendix E (Table E11).

†Sum = 8.70/25.00.

TABLE F19. AESTHETIC PROPERTIES FOR CORN AT SITE 1*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
1.00 | 5.00	4.00 | 5.00	2.50 | 5.00

*Component values are taken from Appendix E (Table E12).

†Sum = 5.00/10.00.

TABLE F20. AESTHETIC PROPERTIES FOR MEADOW AT SITE 1*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
1.00 | 5.00	4.00 | 5.00	2.50 | 5.00

*Component values are taken from Appendix E (Table E12).

†Sum = 5.00/10.00.

TABLE F21. AESTHETIC PROPERTIES FOR PINE AT SITE 1*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
1.00|5.00	4.00|5.00	2.50|5.00

*Component values are taken from Appendix E (Table E12).

†Sum = 5.00/10.00

TABLE F22. AESTHETIC PROPERTIES FOR WILDLIFE HABITAT AT SITE 1*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
1.00|5.00	4.00|5.00	2.50|5.00

*Component values are taken from Appendix E (Table E12).

†Sum = 5.00/10.00.

TABLE F23. AESTHETIC PROPERTIES FOR TRAILS AT SITE 1*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
1.67|10.00	4.00|5.00	2.84|7.50

*Component values are taken from Appendix E (Table E12).

†Sum = 5.67/15.00

TABLE F24. AESTHETIC PROPERTIES FOR MULTIUSE AT SITE 1*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
1.67|10.00	4.00|7.00	2.84|8.50

*Component values are taken from Appendix E (Table E12).

†Sum = 5.67/17.00.

TABLE F25. PHYSICAL PROPERTIES FOR CORN AT SITE 2*

Soil Type†	Physical properties														Average sum‡	
	Slope		Erosion		Texture		Permeability		Coarse fragments content		Depth to limiting layer		Bulk density			
Cavode	1	4	.75	7	.67	3	.20	2	5	10	80	8	1	10		
Cookport	1	2	.67	5	4	7	2	5	5	10	1.33	8	1	10		
Hazleton	1	4	2	5	2	3	1	2	1.67	10	4	8	1	10		
Nolo	1	2	2	5	2	3	.25	2	5	10	1.25	10	1	10		
Wharton	1	4	2	9	1.33	7	.40	5	5	10	1.33	8	1	10		
Weighted sum	1.00	3.54	1.84	6.66	1.95	5.12	.84	3.59	4.07	10.00	1.99	8.08	1.00	10.00	1.81	6.71

*Component values are taken from Appendix E (Tables E13, E14, E15, E16, and E17).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 12.69/46.99.

TABLE F26. PHYSICAL PROPERTIES FOR MEADOW AT SITE 2*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density	
Cavode	1|3	.25|2	.67|3	.20|2	5|10	.80|7	1|9	
Cookport	1|2	.33|2	4|6	2|4	5|10	1.33|7	1|9	
Hazleton	1|3	1|2	2|3	1|2	1.67|10	4|7	1|9	
Nolo	1|2	1|2	2|3	.25|2	5|10	1.25|9	1|9	
Wharton	1|3	.50|2	1.33|6	.40|4	5|10	1.33|7	1|9	
Weighted sum	1.00|2.77	.59|2.00	1.95|4.59	.84|3.06	4.07|10.00	1.99|7.08	1.00|9.00	1.63|5.50

*Component values are taken from Appendix E (Tables E13, E14, E15, E16, and E17).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.44/38.50.

TABLE F27. PHYSICAL PROPERTIES FOR PINE AT SITE 2*

	Physical properties															
Soil Type†	Slope		Erosion		Texture		Permeability		Coarse fragments content		Depth to limiting layer		Bulk density		Average sum‡	
Cavode	1	3	1	8	.67	3	.20	2	5	9	.80	7	1	9		
Cookport	1	2	1	6	4	6	2	4	5	9	1.33	7	1	9		
Hazleton	1	3	2	5	2	3	1	2	1.67	9	4	7	1	9		
Nolo	1	2	2	5	2	3	.25	2	5	9	1	9	1	9		
Wharton	1	3	2.50	10	1.33	6	.40	4	5	9	1.33	7	1	9		
Weighted sum	1.00	2.77	1.83	7.02	1.95	4.59	.84	3.06	4.07	9.00	1.98	7.10	1.00	9.00	1.81	6.08

*Component values are taken from Appendix E (Tables E13, E14, E15, E16, and E17).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 12.67/42.54.

TABLE F28. PHYSICAL PROPERTIES FOR WILDLIFE HABITAT AT SITE 2*

	Physical properties															
Soil Type†	Slope		Erosion		Texture		Permeability		Coarse fragments content		Depth to limiting layer		Bulk density		Average sum‡	
Cavode	1	3	.50	4	.67	3	.20	2	5	9	.80	6	1	8		
Cookport	1	2	.33	2	4	6	2	4	5	9	1.33	6	1	8		
Hazleton	1	3	1	2	2	3	1	2	1.67	9	4	6	1	8		
Nolo	1	2	1	2	2	3	.25	2	5	9	1	8	1	8		
Wharton	1	3	1.50	6	1.33	6	.40	4	5	9	1.33	6	1	8		
Weighted sum	1.00	2.77	.96	3.66	1.95	4.59	.84	3.06	4.07	9.00	1.98	6.08	1.00	8.00	1.69	5.31

*Component values are taken from Appendix E (Tables E13, E14, E15, E16, and E17).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.80/37.16

TABLE F29. PHYSICAL PROPERTIES FOR TRAILS AT SITE 2*

Soil Type†	Physical properties							Average sum‡
	Slope	Erosion	Texture	Permeability	Coarse fragments content	Depth to limiting layer	Bulk density	
Cavode	1 | 3	.50 | 3	.67 | 3	.20 | 2	5 | 8	.80 | 7	1 | 7	
Cookport	1 | 2	.67 | 3	4 | 6	2 | 4	5 | 8	1.33 | 7	1 | 7	
Hazleton	1 | 3	2 | 5	2 | 3	1 | 2	1.67 | 8	4 | 7	1 | 7	
Nolo	1 | 2	2 | 5	2 | 3	.25 | 2	5 | 8	1 | 9	1 | 7	
Wharton	1 | 3	1.50 | 6	1.33 | 6	40 | 4	5 | 8	1.33 | 7	1 | 7	
Weighted sum	1.00 | 2.77	1.35 | 4.66	1.95 | 4.59	.84 | 3.06	4.07 | 8.00	1.98 | 7.08	1.00 | 7.00	1.74 | 5.31

*Component values are taken from Appendix E (Tables E13, E14, E15, E16, and E17).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 12.19/37.16.

TABLE F30. PHYSICAL PROPERTIES FOR MULTIUSE AT SITE 2*

Soil Type†	Physical properties														Average sum‡	
	Slope		Erosion		Texture		Permeability		Coarse fragments content		Depth to limiting layer		Bulk density			
Cavode	1	3	1	4	.67	3	.20	2	5	10	.80	8	1	8		
Cookport	1	2	.33	2	4	7	2	4	5	10	1.33	8	1	8		
Hazleton	1	3	1	2	2	3	1	2	1.67	10	4	8	1	8		
Nolo	1	2	1	2	2	3	.25	2	5	10	1	10	1	8		
Wharton	1	3	1.50	6	1.33	7	.40	4	5	10	1.33	8	1	8		
Weighted sum	1.00	2.77	1.04	3.66	1.95	5.12	.84	3.06	4.07	10.00	1.98	8.08	1.00	8.00	1.70	5.81

*Component values are taken from Appendix E (Tables E13, E14, E15, E16, and E17).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.88/40.69.

TABLE F31. CHEMICAL PROPERTIES FOR CORN AT SITE 2*

	Chemical properties															
Soil Type†	pH		Cation exchange capacity		Potassium content		Magnesium content		Calcium content		Organic matter content		Sulfur content		Average sum‡	
Cavode	1.25	10	1	2	1	10	1	9	1	8	1	5	6	11		
Cookport	.33	2	1	2	1	10	.20	2	1	8	1	5	6	11		
Hazleton	1.25	10	1	2	1	10	1	9	1	8	1	5	6	11		
Nolo	1.25	10	1	2	1	10	1	9	1	8	1	5	6	11		
Wharton	.33	2	1	2	1	10	1	2	1	8	1	5	6	11		
Weighted sum	.76	5.76	1.00	2.00	1.00	10.00	.85	5.29	1.00	8.00	1.00	5.00	6.00	11.00	1.66	6.72

*Component values are taken from Appendix E (Tables E18, E7, E19, E20, and E21).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.61/47.05.

TABLE F32. CHEMICAL PROPERTIES FOR MEADOW AT SITE 2*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Cavode	1.25 | 9	1 | 2	1 | 8	1 | 9	1 | 7	1 | 4	6 | 9	
Cookport	.33 | 2	1 | 2	1 | 8	.20 | 2	1 | 7	1 | 4	6 | 9	
Hazleton	1.25 | 9	1 | 2	1 | 8	1 | 9	1 | 7	1 | 4	6 | 9	
Nolo	1.25 | 9	1 | 2	1 | 8	1 | 9	1 | 7	1 | 4	6 | 9	
Wharton	.33 | 2	1 | 2	1 | 8	1 | 2	1 | 7	1 | 4	6 | 9	
Weighted sum	.76 | 5.29	1.00 | 2.00	1.00 | 8.00	.85 | 5.29	1.00 | 7.00	1.00 | 4.00	6.00 | 9.00	1.66 | 5.80

*Component values are taken from Appendix E (Tables E18, E7, E19, E20, and E21).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.61/40.58.

TABLE F33. CHEMICAL PROPERTIES FOR PINE AT SITE 2*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Cavode	1.25|9	1|2	1|7	1|8	1|7	1|4	6|9	
Cookport	.33|2	1|2	1|7	.20|2	1|7	1|4	6|9	
Hazleton	1.25|9	1|2	1|7	1|8	1|7	1|4	6|9	
Nolo	1.25|9	1|2	1|7	1|8	1|7	1|4	6|9	
Wharton	.33|2	1|2	1|7	1|2	1|7	1|4	6|9	
Weighted sum	.76|5.29	1.00|2.00	1.00|7.00	.85|4.82	1.00|7.00	1.00|4.00	6.00|9.00	1.66|5.59

*Component values are taken from Appendix E (Tables E18, E7, E19, E20, and E21).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.61/39.11.

TABLE F34. CHEMICAL PROPERTIES FOR WILDLIFE HABITAT AT SITE 2*

	Chemical properties							
Soil Type†	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	Average sum‡
Cavode	1.25|9	1|2	1|6	1|7	1|6	1|4	6|10	
Cookport	.33|2	1|2	1|6	.20|2	1|6	1|4	6|10	
Hazleton	1.25|9	1|2	1|6	1|7	1|6	1|4	6|10	
Nolo	1.25|9	1|2	1|6	1|7	1|6	1|4	6|10	
Wharton	.33|2	1|2	1|6	1|2	1|6	1|4	6|10	
Weighted sum	.76|5.29	1.00|2.00	1.00|6.00	.85|4.35	1.00|6.00	1.00|4.00	6.00|10.00	1.66|5.38

*Component values are taken from Appendix E (Tables E18, E7, E19, E20, and E21).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.61/37.64.

TABLE F35. CHEMICAL PROPERTIES FOR TRAILS AT SITE 2*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Cavode	1.25|8	1|2	1|6	1|7	1|6	1|4	6|7	
Cookport	.33|2	1|2	1|6	.20|2	1|6	1|4	6|7	
Hazleton	1.25|8	1|2	1|6	1|7	1|6	1|4	6|7	
Nolo	1.25|8	1|2	1|6	1|7	1|6	1|4	6|7	
Wharton	.33|2	1|1	1|6	1|2	1|6	1|4	6|7	
Weighted sum	.76|4.82	1.00|2.00	1.00|6.00	.85|4.35	1.00|6.00	1.00|4.00	6.00|7.00	1.66|4.88

*Component values are taken from Appendix E (Tables E18, E7, E19, E20, and E21).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.61/34.17.

TABLE F36. CHEMICAL PROPERTIES FOR MULTIUSE AT SITE 2*

Soil Type†	Chemical properties							Average sum‡
	pH	Cation exchange capacity	Potassium content	Magnesium content	Calcium content	Organic matter content	Sulfur content	
Cavode	1.25 | 9	1 | 2	1 | 7	1 | 8	1 | 6	1 | 4	6 | 8	
Cookport	.33 | 2	1 | 2	1 | 7	.20 | 2	1 | 6	1 | 4	6 | 8	
Hazleton	1.25 | 9	1 | 2	1 | 7	1 | 8	1 | 6	1 | 4	6 | 8	
Nolo	1.25 | 9	1 | 2	1 | 7	1 | 8	1 | 6	1 | 4	6 | 8	
Wharton	.33 | 2	1 | 2	1 | 7	1 | 2	1 | 6	1 | 4	6 | 8	
Weighted sum	.76 | 5.29	1.00 | 2.00	1.00 | 7.00	.85 | 4.82	1.00 | 6.00	1.00 | 4.00	6.00 | 8.00	1.66 | 5.30

*Component values are taken from Appendix E (Tables E18, E7, E19, E20, and E21).

†Soil coefficient for Cavode, Cookport, Hazleton, Nolo, and Wharton are .15, .19, .28, .04 and .34, respectively.

‡Sum = 11.61/37.11.

TABLE F37. ECONOMIC PROPERTIES FOR CORN AT SITE 2*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
.50 | 6.00	2.00 | 2.00	.60 | 5.00	5.00 | 6.00	2.02 | 4.75

*Component values are taken from Appendix E (Table E22).

†Sum = 8.10/19.00.

TABLE F38. ECONOMIC PROPERTIES FOR MEADOW AT SITE 2*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
2.00 | 7.00	2.00 | 2.00	1.00 | 6.00	1.00 | 4.00	1.50 | 4.75

*Component values are taken from Appendix E (Table E22).

†Sum = 6.00/19.00.

TABLE F39. ECONOMIC PROPERTIES FOR PINE AT SITE 2*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
1.50 | 7.00	4.00 | 5.00	.40 | 5.00	2.00 | 4.00	1.97 | 5.25

*Component values are taken from Appendix E (Table E22).

†Sum = 7.90/21.00.

TABLE F40. ECONOMIC PROPERTIES FOR WILDLIFE HABITAT AT SITE 2*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
2.00 | 5.00	4.00 | 5.00	.60 | 5.00	3.00 | 7.00	2.40 | 5.50

*Component values are taken from Appendix E (Table E22).

†Sum = 9.60/22.00.

TABLE F41. ECONOMIC PROPERTIES FOR TRAILS AT SITE 2*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
1.50|5.00	5.00|8.00	.40|6.00	3.00|7.00	2.47|6.50

*Component values are taken from Appendix E (Table E22).

†Sum = 9.90/26.00.

TABLE F42. ECONOMIC PROPERTIES FOR MULTIUSE AT SITE 2*

Economic properties				
Land property value	Reallocation of state income tax	Effect of unemployment	Additional costs	Average sum†
1.00|5.00	5.00|8.00	.20|6.00	2.00|5.00	2.05|6.00

*Component values are taken from Appendix E (Table E22).

†Sum = 8.20/24.00.

TABLE F43. AESTHETIC PROPERTIES FOR CORN AT SITE 2*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
.67|3.00	5.00|6.00	2.83|4.50

*Component values are taken from Appendix E (Table E23).

†Sum = 5.67/9.00.

TABLE F44. AESTHETIC PROPERTIES FOR MEADOW AT SITE 2*

Aesthetic properties		
Public attitude	Area mined and visual conformity	Average sum†
.67|3.00	5.00|6.00	2.83|4.50

*Component values are taken from Appendix E (Table E23).

†Sum = 5.67/9.00.

TABLE F45. AESTHETIC PROPERTIES FOR PINE AT SITE 2*

<table>
<tr><th colspan="2">Aesthetic properties</th><th></th></tr>
<tr><th>Public attitude</th><th>Area mined and visual conformity</th><th>Average sum†</th></tr>
<tr><td>1.33|6.00</td><td>5.00|6.00</td><td>3.16|6.00</td></tr>
</table>

*Component values are taken from Appendix E (Table E23).

†Sum = 6.33/12.00.

TABLE F46. AESTHETIC PROPERTIES FOR WILDLIFE HABITAT AT SITE 2*

<table>
<tr><th colspan="2">Aesthetic properties</th><th></th></tr>
<tr><th>Public attitude</th><th>Area mined and visual conformity</th><th>Average sum†</th></tr>
<tr><td>1.33|6.00</td><td>5.00|6.00</td><td>3.16|6.00</td></tr>
</table>

*Component values are taken from Appendix E (Table E23).

†Sum = 6.33/12.00.

TABLE F47. AESTHETIC PROPERTIES FOR TRAILS AT SITE 2*

<table>
<tr><th colspan="2">Aesthetic properties</th><th></th></tr>
<tr><th>Public attitude</th><th>Area mined and visual conformity</th><th>Average sum†</th></tr>
<tr><td>1.67|10.00</td><td>5.00|6.00</td><td>3.33|8.00</td></tr>
</table>

*Component values are taken from Appendix E (Table E23).

†Sum = 6.67/16.00.

TABLE F48. AESTHETIC PROPERTIES FOR MULTIUSE AT SITE 2*

<table>
<tr><th colspan="2">Aesthetic properties</th><th></th></tr>
<tr><th>Public attitude</th><th>Area mined and visual conformity</th><th>Average sum†</th></tr>
<tr><td>1.67|10.00</td><td>5.00|6.00</td><td>3.33|8.00</td></tr>
</table>

*Component values are taken from Appendix E (Table E23).

†Sum = 6.67/16.00.

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2.

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5. REPORT DATE

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16. ABSTRACT

Investigations were conducted to estimate land use reclamation potentials at two unmined sites, one in Clearfield and one in Somerset County, Pennsylvania. The objective was to design a preliminary model which would enable a strip mine operator to determine a priori an optimum land use following reclamation. Reclamation potentials were determined for agriculture, forestry, and recreation. The magnitude of the change in the existing and anticipated physical and chemical properties of the site's soils as well as the change in related economic and aesthetic properties at the site were estimated and the significances of the property levels to the land use were determined.

Physical property changes were greater and the anticipated property levels were more favorable for all land uses at the Somerset County site. Chemical property levels were higher at Clearfield site but had more impact on land use establishment at the Somerset site. Economic property levels were higher at the Clearfield site and the aesthetic property levels were more critical at the Somerset site. At both sites, trails were least affected by the physical and chemical properties of the soil. Economic values favored pine at site 1 and wildlife habitat at site 2, while corn and meadow were the preferred aesthetically at both sites by the responders. Wildlife habitat had the best reclamation potential at site 1 and meadow had the best reclamation potential at site 2.

17. (Circle One or More) KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS

Ecology
[✓ Environments]
Earth Atmosphere
[✓ Environmental Engineering]
Geography
Other

Hydrology, Limnology
Biochemistry
Earth Hydrosphere
Combustion
Refining

Energy Conversion
Physical Chemistry
Materials Handling
Inorganic Chemistry
Organic Chemistry
Chemical Engineering

b. IDENTIFIERS/OPEN ENDED TERMS

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Flue Gas Cleaning
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Synthetic Fuels
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Thermal
Improved Efficiency
Advanced Systems
Other

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Charac. Meas. & Mon.
Health Effects
Integrated Assessment
Energy Cycle
Extraction
Processing
Conversion
Utilization

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Waste as Fuel
Environmental
Multi-fuel 2 or more

c. COSATI Field/Group

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