EROSION, SEDIMENTATION & RURAL RUNOFF

A GROSS ASSESSMENT PROCESS

By

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A companion to EPA Region IV SAD
Urban Runoff Computations - 6/73

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ABSTRACT

A Wide Area Erosion, Sedimentation and Rural Runoff gross assessment process developed by the EPA Region IV Surveillance and Analysis Division, Southeast Environmental Research Laboratory, Athens, Georgia, is available for operational use. The system utilizes the USDA-ARS "Universal Soil Loss Equation", with probabilistic element tables, for time period erosion calculations for any size area; however, the well known small plot calculating accuracy is preserved intact. Variable Plot Size Blowup Theory, used so successfully for decades in the U.S. Forest Survey, is just one of many parasitic (hung on) extensions employed to track soil and certain constituent movements from inland mountains to the sea. distribution function. 20% – 50% H. True gets to stream SCS 25% of erosion ? ?

Consultations with and historical data from EPA R&D, USDA-ARS/SCS, Geological Survey, U.S. Army Corps of Engineers, State Agencies, Regional Planning Agencies and Universities bridged gaps in the total structure and partial validation of the process to date is attributable to their assistance. The source program is in standard FORTRAN 4, execution is rapid and it will run on any medium size computer. The program and user guide are available to all potential users.

x % of stream sediment migrates downstream

x f. (reservoir size)
(geometry, r.t.)

WIDE AREA EROSION LOSS, STREAM SEDIMENTATION AND RURAL RUNOFF PREDICTION PROCESS FOR GROSS ASSESSMENTS

A probabilistic model has been developed to encompass several major aspects of the wide area urban and rural runoff problem. The target was to provide EPA, state and regional planners with a tool for gross assessments of reasonable accuracy for multi-county areas and entire river basins without the requirement of excessive detail information. The process performs far beyond expectations due to very flexible data input requirements that allow small areas to be accurately assessed on a single storm basis or on a monthly group basis for one to twelve months. Comprehensive input data for small areas should produce results accurately within ±5%; broad generalized data for multi-million acre river basins should give results with ±20% accuracy. Poor input data can be expected to give poor results.

?

Forest Svc. accuracy of surveys
1 Sample pt → 10,000 Acres
usually 3-5000 Acres
±5%

The basic mechanism employed by the model is the "Universal Soil Loss Equation" developed at the Runoff and Soil-Loss Data Center, Purdue University, by the USDA Agricultural Research Service during the latter 1950's. This equation (A=RKLSCP) is based on nation-wide studies from 1930 on and is essentially free of geographic and climatic restrictions; however, associated tables restrict use to 37 states east of the Rocky Mountains at the present time. Briefly, the equation is directly applicable to a described unit plot with a slope length of

72.6 feet, a uniform slope gradient of 9% and the plot is in continuous fallow and maintained under special bare and tilled conditions with no erosion controls; under these qualifications, L,S,C, and P would be equal to 1 and A (annual tons/acre)=RK. The value R is a rainfall factor expressed as a number of erosion index units in a normal year's rain and K is the Soil Erodibility Factor or erosion rate per unit of erosion-index. The factors L (slope length in feet) and S (slope %) are used in the equation $LS=(L/75)^{0.6} \times (S/9)^{1.4}$ to calculate the soil loss ratio LS, C is the cropping management factor and P is a factor related to erosion control practice. All required tables and curves from USDA-ARS Handbook 282 "Rainfall Losses from Cropland East of the Rocky Mountains" 1965, are in the model to calculate how much and when soil moves in a prescribed area.

Many processes utilizing relational and loading factors have been integrated into the basic mechanism to provide the following information:

A. Soil movement (loss) and sediment actually reaching area water bodies by unit, state and wide area.

B. Litter reaching water bodies from land and forest areas.

C. Constituents from both soil and litter combined such as N, P, K, BOD, TOC, and mine acid.

D. Constituents from livestock and fowl populations composed of N, P, K, BOD, and TOC.

E. The listed constituents are combined for unit, state, and wide area totals.

F. Sediment deposition is calculated using sediment migration factors and allows a single total in tons at the wide area terminal point such as the most downstream reservoir or in an estuary. look at each one separately estimation

Sediment Moves thru reservoirs?

A simplified users guide and extensive documentation of information sources is available along with the source deck of 668 cards. The model requires 66K memory (IBM 370/158), no tapes or disks, 20 seconds to compile and link edit and problem execution is at the rate of 1000 iterations per second (example - Mobile Basin, 29,000,000 acres, 18000 iterations and 18 seconds).

The model was developed to provide reasonable assessments in the implementation of the following requirements of Public Law 92-500 "Federal Water Pollution Control Act Amendments of 1972":

Section 104(N) Sedimentation Effects in the Nation's Estuaries. (EPA)

Section 208(F,G) Identification of Agriculturally, Silviculturally and Mine Related Nonpoint Sources of Pollution. (State/local)

Section 305(B,1,E) Determine Nature and Extent of Nonpoint Sources of Pollutants. (State)

Section 404 Evaluation of Runoff Effects due to Fill of Wetlands. (EPA)

Methods and procedures such as the documented working model are in full accord with the "National Environmental Policy Act of 1969"

Paragraph 4332 A, B, C, and F. Other operational uses involve field studies and upgrading runoff sections of Environmental Impact Statements.

Documentation and source/run loan decks are available at the address below. O.S.I. users may punch the decks directly from Disk TSØ012 File CNMD01.HAT.WATAR1 or run with the compiled program on Disk TSØ012 File CNMD01.HAT.ROF using the program name WASRRHAT.

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THE UNIVERSAL SOIL-LOSS EQUATION - USLE

The USLE was developed at the Runoff and Soil-Loss Data Center of the Agricultural Research Service, Purdue University, during the latter 1950's. Basic runoff and soil-loss data collected from nation-wide studies from 1930 on was used to produce an equation essentially free of geographic and climatic restrictions. The form of the equation is:

$$A = R \times K \times L \times S \times C \times P$$

where:

A is the computed soil loss per unit area.

R is the rainfall factor expressed as the number of erosion-index units in a normal year's rain (see Note R).

K is the soil erodibility factor or erosion rate per unit of erosion-index for a special set of conditions (see Note K).

L is the slope-length factor (see Note SL).

S is the slope-gradient factor (see Note SL).

C is the cropping management factor (see Note C).

P is the erosion-control practice factor (see Note P).

The equation is directly applicable to a unit plot described as follows:

(a) length of slope 72.6 feet.

(b) uniform slope of 9%.

(c) continuous fallow, tilled up and down the slope and with no vegetation or crop residue.

(d) the plot is plowed and placed in conventional corn seedbed each spring (no planting) and is tilled as needed to prevent vegetal growth or serious surface crusting.

(e) under these conditions L, S, C, and P each have a value of 1.0 and K = A/R. How USDA found K's

(f) items (a) through (d) represent predominant characteristics exhibited by nation-wide erosion study data and a set of surface conditions least influenced by varying climatic and local cropping systems.

Agriculture Handbook No. 282 "Predicting Rainfall-Erosion Losses from Cropland East of the Rocky Mountains", May 1965, displays iso-erodent maps, curves, charts and tables for use in developing relative values for all USLE elements to predict erosion in any of the 33 sub-areas (37 states) covered.

Note R - The annual rainfall factor (EI) ranges from 50 to 600 and is selected from Figure 1 the iso-erodent map for the area involved.

Note K - The soil erodibility factor is obtained from Table 1 which contains the 23 major soil type K values relative to the unit plot reference soil.

Note SL - The slope gradient and slope length are used in Figure 2 to give a single value called the Soil-Loss Ratio.

Note C - The cropping management factor is essentially a time period modifier of the erosion-index unit for the area involved. This factor is obtained from the sub-area maps and curves, Figures 4 through 21 as applicable.

Note P - Erosion control such as contouring, terracing and contour strip-cropping and mechanical means of controlling erosion. Table 6 gives P values for contouring and 50% of these values are used for strip-cropping and 20% of these values apply when terracing is used.

STEP BY STEP PROCEDURE FOR PREPARING DATA FOR THE WIDE AREA EROSION, SEDIMENTATION AND RURAL RUNOFF PREDICTION PROCESS

1. Obtain a map covering the runoff area, segment the map in accord with Section 11 iso-erodent map and record the appropriate state region numbers. This limits the size of a unit generally because the program selects the erosion index number and the period values based on the state region number. A review of the Section 11 table of state data will indicate possibilities for coding an entire state as a single unit.

2. The run will require a 7-card area group with cards 1-6 being report headings and card 7 punched with overall run information such as time period, seed value for the random number generator, number of state groups involved and special print switches to obtain input table listings, probability table listings, random number table, LS table and a detail trace of the first unit. Section 5 "Key Punch Instructions and Run Card Formats" gives full information on formats for punching all data cards and the published test cases give data input illustrations.

3. Card 8 is a state control card preceding unit groups. This card is punched with the FIPS 5 (see Section 11) state code, the state name and number of unit groups for the state.

4. Cards 9 through 17 contain information covering the first unit, there must be a 9 card unit group for each unit in the state. There is no limit on the number of units within a state and no limit on the number of states. Control is based on unit group count in card 8 and state count in card 7; therefore, regionalization of totals within a state can be accomplished by having multiple state-unit groups within a state.

5. Unit group cards will be referred to hereafter as #1 through #9.

6. #1 is the unit control card and must contain the state region number referred to in item 1 above and the number of acres in the unit. The third value is optional and is calculated as the square root of the number of acres unless the plot size (blowup factor) is punched. The number of iterations performed on the unit is determined by dividing the plot size into the number of acres; therefore, the punched plot size should be a sub-multiple of an integer value since only a calculated value is adjusted in the program. The process calculates on a per acre basis and then applies the plot size as a blowup factor before accumulating.

7. #2 is the soil erodibility card carrying from 1 to 5 soil type factors with a percentage attached to each value for building a 100 value probability table of K values. This limits the size of a unit to an area containing no more than 5 different soil types unless

some soil types can be grouped with a weighted mean assigned. Representative K values are obtained from Table 1, page 5 of USDA-ARS Handbook 282 - See Section 11.

8. #3 is the slope gradient & slope length card with slope % S and slope % deviation required and slope length L and slope length deviation in feet optional. If L is not punched the program will supply an empirically determined L = 140.1 and L deviation = ±93.4 giving a slope length range for a one acre plot of 46.7 to 233.5 feet. Two 100 value equal interval probability tables will be built by the program independently for slope % and slope length. The program supplied maximum L is equal to the diameter of a one acre circle and the minimum L is equal to one fifth of the diameter.

9. #4 is the cropping management card carrying from 1 to 5 ground cover factors with a percentage attached to each value for building a 100 value probability table of C values. The values must be physically located in the card in this order: cropland, pasture land, forest, urban and other. If no values are punched in any field the program will put in the SMSA set given in the 1973 CEQ report to the President (24% .08, 19% .01, 32% .005, 10% .01, 15% 1.0). The percent of each type ground cover or type of utilization can be estimated from SCS County Soil Surveys, aerial photographs, special atlas maps or from local knowledge.

10. #5 is the erosion control practice card carrying from 1 to 5 erosion factors (low values imply good control and high values 1.0 and greater indicate no control or conditions aiding erosion) with a percentage attached to each value for building a 100 value probability table of P values. The values can be punched in any order, and if no values are punched in the card, the program will put in a set compatible with the C values supplied for a blank #4 card. These fill values (24% .50, 19% 1.0, 32% 1.0, 10% 1.0, 15% 1.3) are equivalent to (24% .50, 61% 1.0, 15% 1.3).

11. #6 sediment delivery, sediment migration and parameter card provides factors for translating erosion on land to sediment delivered to water bodies and further transport to some downstream terminal point such as a reservoir or estuary. A mean percent and deviation percent is punched for sediment delivery and sediment migration (in stream movement to a terminal point). The program produces two independent 100 value probability tables for random selection of applicable factors. This card is punched with sediment conversion factors to produce pounds of N, P, K, BOD, and TOC reaching local water bodies from the soil. The program will use zero for any unpunched percentages or factors; therefore, failure to provide data for sediment delivery will nulify effects of all other values since they calculate quantities based on sediment delivery calculated quantity.

not realistic

12. #7 livestock and fowl counts card provides information for application of daily loading factors for nutrients and organics. Dairy cows produce a larger load than other cows and must be separatable; broilers are marketed every 10 to 12 weeks and must be treated differently from other domestic poultry. Non-poultry domestic fowl (i.e. turkeys) can be put in as poultry equivalents on an annual basis.[20]

This is the definition of poultry.

13. #8 litter card provides information for litter calculations keyed to percentages given in #4 cropping management card. This card carries factors for calculating nutrients and organics contained in the transported litter for combining with sediment contained values and reported on the land line.[7]

14. #9 mining acid loading card provides simple information for calculating acid loads to water bodies from mining areas only. This value is valid for annual and monthly periods but not for a single storm event.[11]

KEY PUNCH INSTRUCTIONS AND RUN CARD FORMATS

AREA CARDS (7 required)

Card 1 All 80 Cols. - First part of Report Heading Line #1.
" 2 Cols. 1 - 40 - Remainder of Report Heading Line #1.
" 3 All 80 Cols. - First part of Report Heading Line #2.
" 4 Cols. 1 - 40 - Remainder of Report Heading Line #2.
" 5 All 80 Cols. - Report Line #3.
" 6 All 80 Cols. - Report Line #4.
" 7 See below:

Card Cols.	Var. Name	Format	(X)Req./Default	Identification
1 - 40	Unused	40X		-Anything desired
41 - 42	IPS	I2	X *See Note	-Starting Month (01-12)
43 - 45	IPF	I3	X *See Note	-Ending Month (01-12)
46	Unused	1X		
47 - 53	IRNS	I7	3451427	-Seed Value for RNG
54 - 56	ICTS	I3	X	-Number of States
57	Unused	1X		
58	LT	I1	0	-SW1 '1' causes print of STATE/PERIOD Tables
59	LP	I1	0	-SW2 '1' causes print of First Unit Input Probability Tables
60	LD	I1	0	-SW3 '1' causes print of First Unit Detail Calculations Trace
61 - 80	Unused			

*Note - If a Single Storm Event is to be run Cols. 41-42 must be blank and the Single Storm EI value is determined from USDA-ARS Handbook 282 and is punched into Cols. 43-45. SW3 should be used with caution because a lot of paper will print for a large unit having a small plot size.

******************** FIRST STATE GROUP ******************************

STATE CARD (1 required)

Card Cols.	Var. Name	Format	(X)Req./Default	Identification
1 - 40	Unused	40X		-Anything desired
41 - 42	ISC	I2	X	-State FIPS Number
43	Unused	1X		
44 - 63	ISN(1-5)	5A4	X	-State Name (Max.20 Ch.)
64 - 65	ICTSS	I2	X	-Number of Units
66 - 80	Unused			

Note - The State Card is a cover control card for one or more units within that state. The process controls unit processing based on the number of units specified at ICTSS and controls state processing based on the number of states at ICTS in Area card #7. Multiple State-Unit groups within the same State can be run in the same process run for regional results.

************ FIRST LAND UNIT FOR ANY STATE ****************************
LAND UNIT CARDS (9 required)

Card #1 Unit Control - See below.

Card Cols.	Var. Name	Format	(X)Req./Default	Identification
1 - 40	Unused	40X		-Anything desired
41 - 42	ISGN	I2	X	-State region from map S11
43	Unused	1X		
44 - 51	ACSG	F8.0	X	-Acres in this unit
52 - 55	SGPLS	F4.0	*See Note	-Plot size acres
56 - 80	Unused			

*Note - If the plot size is not punched the process will take the Square Root of the total unit acres and convert this to Integer form for division into total unit acres to get a reasonable plot size. The process then divides the plot size (punched or calculated) into total unit acres to get the number of iterations required. The plot size is a blowup (or down) factor since the process calculates on a one acre unit area basis. Judicious selection of plot size can save costly machine time while allowing random processes to operate properly. Test runs on the 29,000,000 acre Mobile River Basin with 100 acre plots, 290,000 iterations and 5 minutes machine time gave essentially the same results as 358.5 - 2004.7 acre plots, 18,000 iterations and 18 seconds machine time.

++

Card #2 Soil Erodibility (K) Allows from 1 to 5 Soil Types.

Card Cols.	Var. Name	Format	(X)Req.	/Default	Identification
1 - 40	Unused	40X			-Anything desired
41 - 43	ISE1	I3	X	0	-% probability SET#1
44 - 48	SEF1	F5.0	X	.33	-K value SET#1
49 - 56	ISE2,SEF2	I3,F5.0		*See Note	-% & K SET#2
57 - 64	ISE3,SEF3	I3,F5.0		"	-% & K SET#3
65 - 72	ISE4,SEF4	I3,F5.0		"	-% & K SET#4
73 - 80	ISE5,SEF5	I3,F5.0		"	-% & K SET#5

*Note - A 100 element K probability table is constructed by the process; therefore the sum of all percentages should be 100. If a non-zero percent is punched and no corresponding K is punched then zero will go into that group of slots in the table; however if the percent sum is non-zero and is less than 100 then an average K=.33 will be put into the remainder of the table. A blank card will produce 100 values of .33 and is not a recommended procedure.

++

Card #3 Slope % and Slope Length - For LS Ratio Calculations.

Card Cols.	Var. Name	Format	(X)Req.	/Default	Identification
1 - 40	Unused	40X			-Anything desired
41 - 45	XPSL	F5.0	X		-Mean Slope %
46 - 50	XSLD	F5.0		0	-Slope % ± Deviation
51 - 55	XSLG	F5.0		140.1*	-Mean Slope Length in Ft.
56 - 60	XSLGD	F5.0		93.4*	-Slope L ± Deviation
61 - 80	Unused				

* XSLG & XSLGD is a combination that is effective only when XSLG=0.0

++

Card #4 Cropping Management (C).

Card Cols.	Var. Name	Format	(X)Req./Default		Identification
1 - 40	Unused	40X			-Anything desired
41 - 43	ICM1	I3		24	-Crop Land % SET#1
44 - 48	CMF1	F5.0		.08	-Crop Land C SET#1
49 - 56	ICM2,CMF2	I3,F5.0		19 .01	-Pasture % & C SET#2
57 - 64	ICM3,CMF3	I3,F5.0		32 .005	-Forest % & C SET#3
65 - 72	ICM4,CMF4	I3,F5.0		10 .01	-Urban % & C SET#4
73 - 80	ICM5,CMF5	I3,F5.0		15 1.0	-other % & C SET#5

Note: See Note under Card #2, the C value for filling is .174

++

Card #5 Erosion Control Practice (P).

Card Cols.	Var. Name	Format	(X)Req./Default		Identification
1 - 40	Unused	40X			-Anything desired
41 - 43	IEC1	I3		24	-Crop Land % SET#1
44 - 48	ECF1	F5.0		.50	-Crop Land P SET#1
49 - 56	IEC2,ECF2	I3,F5.0		19 1.0	-Pasture % & P SET#2
57 - 64	IEC3,ECF3	I3,F5.0		32 1.0	-Forest % & P SET#3
65 - 72	IEC4,ECF4	I3,F5.0		10 1.0	-Urban % & P SET#4
73 - 80	IEC5,ECF5	I3,F5.0		15 1.3	-other % & P SET#5

Note: See Note under Card #2, the P value for filling is .93

++

Card #6 Sediment Delivery, Sediment in-stream migration and factors for Constituent calculations.

Card Cols.	Var. Name	Format	(X)Req./Default		Identification
1 - 40	Unused	40X			-Anything desired
41 - 43	SDA	F3.0	X	0	-Mean Sed. Del. %
44 - 45	SDD	F2.0		0	-Sed.Del. % + Dev.
46 - 50	SDNF	F5.0		0	-% Nitrogen In Sed.
51 - 55	SDPF	F5.0		0	-% Phosphorus in Sed.
56 - 60	SDKF	F5.0		0	-% Potassium in Sed.
61 - 65	SDBOD	F5.0		0	-% BOD in Sed.
66 - 70	SDTOC	F5.0		0	-% TOC in Sed.
71 - 73	SRESP	F3.0		0	-Mean Sed. Mig. %
74 - 75	SRESD	F2.0		0	-Sed.Mig. % ± Dev.
76 - 80	Unused				

Note: The process will build two 100 value tables. The Sediment Migration table is independent of the Sediment Delivery table; however if Sediment Delivery is zero then all other card data is ineffective.

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Card #7 Livestock and Fowl counts.

Card Cols.	Var. Name	Format	(X)Req./Default		Identification
1 - 20	Unused	20X			-Anything desired
21 - 30	COWT	F10.0		0	-Total Cows
31 - 40	COWD	F10.0		0	-Dairy Cows
41 - 50	SWINE	F10.0		0	-Swine
51 - 60	POULT	F10.0		0	-Poultry except Broilers
61 - 70	WFOWL	F10.0		0	-Waterfowl
71 - 80	BROIL	F10.0		0	-Broilers (Annual Total)

Note: if this card is blank the Livestock/Fowl Report Line will be eliminated.

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Card #8 Litter from Plant Life.

Card Cols.	Var. Name	Format	(X)Req./Default	Identification
1 - 40	Unused			-Anything desired
41 - 45	XLPA	F5.0	0	-Litter/Forest Ac. (LBS)
46 - 50	XLNF	F5.0	0	-% Nitrogen in Litter
51 - 55	XLPF	F5.0	0	-% Phosphorus in Litter
56 - 60	XLKF	F5.0	0	-% Potassium in Litter
61 - 65	XLBOD	F5.0	0	-% BOD in Litter
66 - 70	XLTOC	F5.0	0	-% TOC in Litter
71 - 80	Unused			

Note: Litter constituents are combined with Sediment constituents on the Report Land Line.

Card #9 Acid Loading from Mining.

Card Cols.	Var. Name	Format	(X)Req./Default	Identification
1 - 40	Unused			-Anything desired
41 - 50	XMDA	F10.0	0	-Mining Acres
51 - 60	XMDAP	F10.0	0	-Acid Lbs/Acre/Year
61 - 80	Unused			

Note: Acid Loads are calculated for the period specified in Area Card #7. This card should be blank for Single Storm Events.

NEXT 9 CARD LAND UNIT FOR THIS STATE

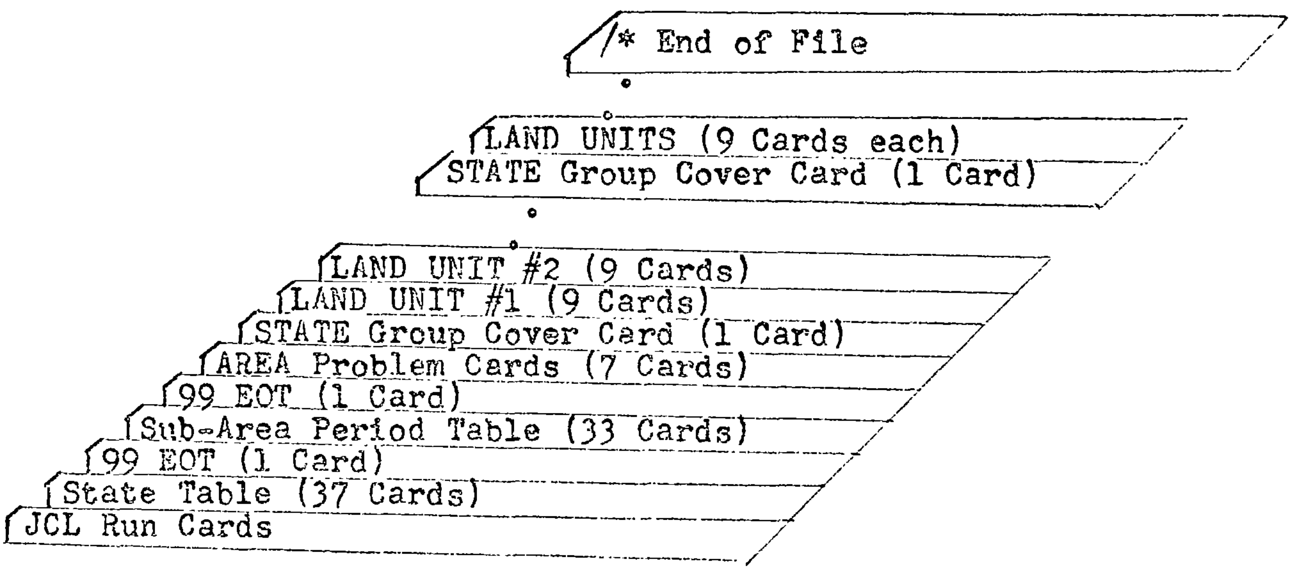
- or -

NEXT STATE GROUP

- or -

/* END OF FILE CARD

RUN DECK SEQUENCE

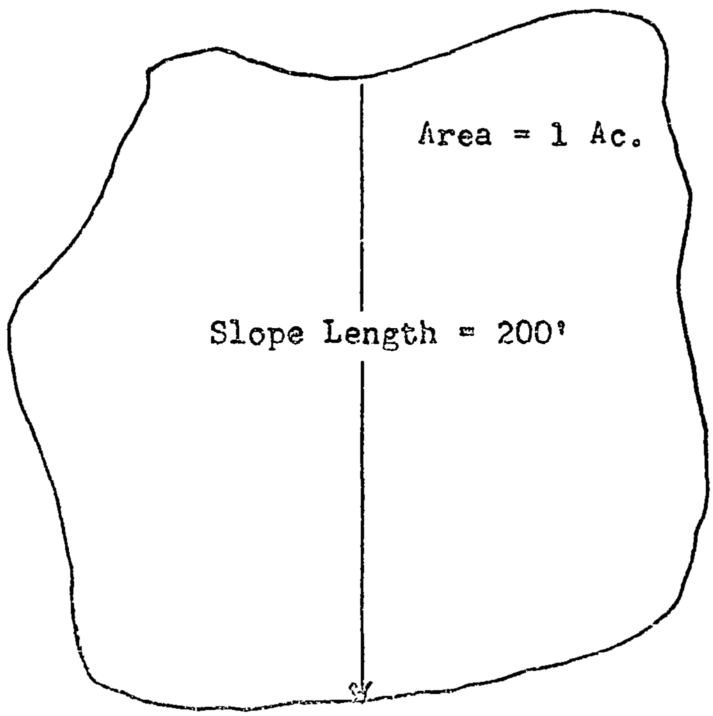


SINGLE STORM TEST CASE - SMALL AREA

Area Size	1 Acre
Erosion Index Units (EI)	175
Soil Erodibility (K)	.28
Slope % (S)	4.5 %
Slope Length (L)	200 Feet
Cropping Management (C)	1.0
Control (P)	1.0

Manual Solution for Erosion (A)	34.40 Tons
Process Solution for Erosion (A)	33.45 Tons*(Exhibit TC1)

* Difference due to more exact calculation of LS Ratio in Process Solution.



SINGLE STORM TEST PROBLEM
CALCULATING EROSION ONLY

EXHIBIT TC1

PROBLEM STATEMENT: 1 ACRE PLOT, EROSION-INDEX EI=175, SOIL ERODIBILITY K=.28
SLOPE %=4.5, SLOPE LENGTH =200 FT., C=1, P=1, EXPECTED ANSWER 34.4 TONS/YR.
**** SINGLE STORM WITH EI= 175.

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	* * * * * * * * * * * * * * * * * * TO WATER BODIES	* * * * * * * * * * * * * * * *						
				SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(1.0)	1.00	33.45	0.0	0.0	0.	0.	0.	0.	0.	0.
GEORGIA	TOTALS	1.00	33.45	0.0	0.0	0.	0.	0.	0.	0.	0.
GRAND TOTALS		1.00	33.45	0.0	0.0	0.	0.	0.	0.	0.	0.

TC1 (Single Storm Event) INPUT CARDS

```
NOTE - REMOVE ALL CARDS WITH * IN COL 80                                       *
*********  THIS IS SINGLE STORM EXHIBIT TC1 INPUT DATA  ************************
|---00---|----10---|----20---|----30---|----40---|----50---|----60---|----70---*
1234567890123456789012345678901234567890123456789012345678901234567890123456789*
-------------------------------------------------------------------------------*
                                                  SINGLE STORM TEST PROBLEM
                            EXHIBIT TC1
                                                   CALCULATING EROSION ONLY

PROBLEM STATEMENT: 1 ACRE PLOT, EROSION-INDEX EI=175, SOIL ERODIBILITY K=.28
 SLOPE %=4.5, SLOPE LENGTH =200 FT., C=1, P=1, EXPECTED ANSWER 34.4 TONS/YR.
AREA CONTROL CARD                         175 3451427  1 111
STATE CONTROL CARD                      13 GEORGIA                1
#1 UNIT CONTROL CARD                     6       1.0 1.0
#2 SOIL ERODIBILITY (K)                 100  .28
#3 SLOPE % & SLOPE LENGTH (LS)            4.5  0.0  200  0.0
#4 CROPPING MANAGEMENT (C)              100  1.0
#5 EROSION CONTROL PRACTICE (P)         100  1.0
#6 SEDIMENT DELIVERY,MIGRATION & FACTORS
#7 LIVESTOCK & FOWL
#8 LITTER & LITTER FACTORS
#9 MINE DRAINAGE ACRES & ACID LOADING
```

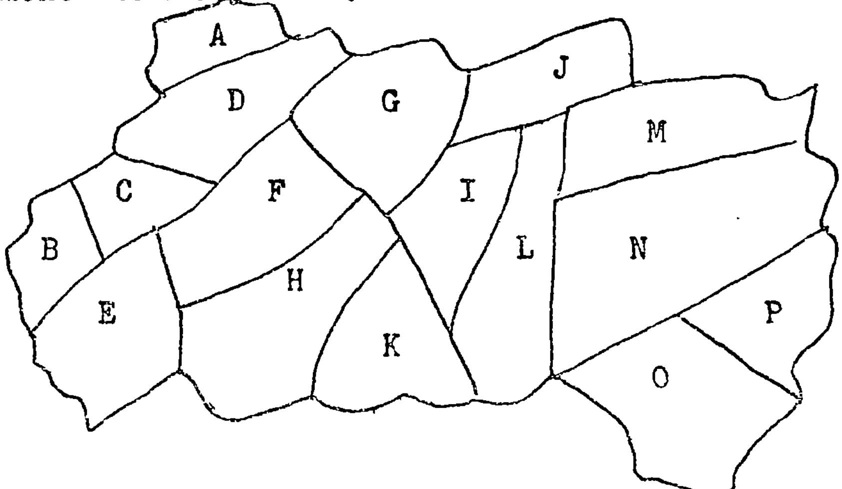
CLARKE COUNTY, GEORGIA - MEDIUM SIZE AREA

Unit	Soil Erodi-bility (K)	Slope % Range	Typical Areas from Map*	Unit Acres
1	.10	0 - 2	C	2,136
2	.10	2 - 6	A	209
3	.26	2 - 6	D	4,010
4	.26	6 - 15	B+F+H+K	18,165
5	.26	15 - 25	O	8,765
6	.36	0 - 2	P	5,180
7	.36	2 - 6	E+I+J	13,560
8	.36	6 - 15	L+N	17,599
9	.36	15 - 25	G+M	10,010
			Total	79,634

There are no known Manual Estimates of Annual Sediment Tons.

Process Solutions - Exhibits TC2(1,2 & 3):

Best Case (20% Sediment/Erosion Ratio) 90,189 Tons
Author's best estimate (40% Sediment/Erosion Ratio) 180,571 "
Probable worst case (50% Sediment/Erosion Ratio) 225,761 "
Note - These are Annual Sediment Tons reaching all types of water bodies such as streams, creeks, rivers, lakes, ponds and reservoirs. Nutrients are keyed to the Sediment Delivery rate.



* Clarke County, Georgia Map (not to scale). For illustrative purposes only to show how scattered parcels can be grouped into units of like characteristics.

CLARKE COUNTY, GEORGIA (20% SED.) EXHIBIT TC2

TOTAL AREA ANNUAL EROSION AND CONTRIBUTION OF SEDIMENT & CONTAMINANTS TO WATER BODIES

EACH UNIT HAS A DIFFERENT LAND TYPE AND SLOPE % COMBINATION.
UNITS HAVE 3 SOIL TYPES (K=.1,.26,.36) & 4 SLOPE RANGES (%=0-2,2-6,6-15,15-25)
**** PERIOD MONTHS 1 - 12

UNIT/TYPE (PLOT AC.)	ACRES	S.L. TONS	* * * * * * * * * * * * * * * * * * TO WATER BODIES	* * * * * * * * * * * * * * * *						
			SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND (46.4)	2136.00	74.25	16.21	520.18	5234.	1482.	7271.	780266.	936320.	0.
LIVESTOCK/FOWL					5.	2.	0.	19.	34.	
UNIT TOTALS	2136.00	74.25	16.21	520.18	5239.	1484.	7271.	780286.	936354.	0.
2 LAND (14.9)	209.00	41.20	9.48	57.64	595.	177.	998.	86463.	103756.	0.
LIVESTOCK/FOWL					0.	0.	0.	0.	1.	
UNIT TOTALS	209.00	41.20	9.48	57.64	595.	177.	998.	86464.	103757.	0.
3 LAND (63.7)	4010.00	4952.54	1278.14	990.83	12465.	4819.	45033.	1486243.	1783493.	0.
LIVESTOCK/FOWL					12.	4.	0.	45.	79.	
UNIT TOTALS	4010.00	4952.54	1278.14	990.83	12476.	4823.	45033.	1486288.	1783571.	0.
4 LAND (135.6)	18165.00	67575.87	12177.48	4658.78	70942.	32529.	365930.	6988174.	8385820.	0.
LIVESTOCK/FOWL					36.	11.	0.	137.	240.	
UNIT TOTALS	18165.00	67575.87	12177.48	4658.78	70978.	32540.	365930.	6988310.	8386059.	0.
5 LAND (94.2)	8765.00	89816.81	24871.60	2313.96	72882.	46274.	652333.	3470935.	4165127.	0.
LIVESTOCK/FOWL					27.	8.	0.	102.	179.	
UNIT TOTALS	8765.00	89816.81	24871.60	2313.96	72909.	46282.	652333.	3471036.	4165305.	0.
6 LAND (73.0)	5180.00	1412.65	159.93	1235.83	12678.	3716.	20311.	1853743.	2224492.	0.
LIVESTOCK/FOWL					6.	2.	0.	24.	43.	
UNIT TOTALS	5180.00	1412.65	159.93	1235.83	12685.	3718.	20311.	1853767.	2224535.	0.
7 LAND (116.9)	13560.00	18136.80	4755.41	3498.46	44495.	17404.	165062.	5247655.	6297194.	0.
LIVESTOCK/FOWL					39.	12.	0.	149.	262.	
UNIT TOTALS	13560.00	18136.80	4755.41	3498.46	44534.	17416.	165062.	5247803.	6297455.	0.
8 LAND (133.3)	17599.00	112815.50	20559.87	4254.36	83663.	44808.	570153.	6381522.	7657841.	0.
LIVESTOCK/FOWL					35.	11.	0.	134.	237.	
UNIT TOTALS	17599.00	112815.50	20559.87	4254.36	83698.	44819.	570153.	6381656.	7658077.	0.
9 LAND (100.1)	10010.00	137974.62	26361.10	2530.86	78030.	49264.	692434.	3796268.	4555526.	0.
LIVESTOCK/FOWL					21.	7.	0.	81.	142.	
UNIT TOTALS	10010.00	137974.62	26361.10	2530.86	78052.	49271.	692434.	3796348.	4555667.	0.
STATE LAND	79634.00	432800.12	90189.19	20060.89	380985.	200473.	2519522.	30091248.	36109536.	0.
LIVESTOCK/FOWL					182.	57.	0.	692.	1216.	
GEORGIA TOTALS	79634.00	432800.12	90189.19	20060.89	381167.	200529.	2519522.	30091936.	36110736.	0.
AREA LAND	79634.00	432800.12	90189.19	20060.89	380985.	200473.	2519522.	30091248.	36109536.	0.
LIVESTOCK/FOWL					182.	57.	0.	692.	1216.	
GRAND TOTALS	79634.00	432800.12	90189.19	20060.89	381167.	200529.	2519522.	30091936.	36110736.	0.

(SEDIMENT MIGRATION TO A TERMINAL POINT= 46980.82 SHORT TONS OR 59590.04 CUBIC YARDS OR 45561.63 CUBIC METERS)

CLARKE COUNTY, GEORGIA (50% SED.) EXHIBIT TC2

TOTAL AREA ANNUAL EROSION AND CONTRIBUTION OF SEDIMENT & CONTAMINANTS TO WATER BODIES

EACH UNIT HAS A DIFFERENT LAND TYPE AND SLOPE % COMBINATION.
UNITS HAVE 3 SOIL TYPES (K=.1,.26,.36) & 4 SLOPE RANGES (%=0-2,2-6,6-15,15-25)
**** PERIOD MONTHS 1 - 12

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	* * * * * * * * TO WATER BODIES * * * * * * * *							
				SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(46.4)	2136.00	74.25	40.62	1298.93	13070.	3702.	18161.	1948390.	2338070.	0.
LIVESTOCK/FOWL						13.	4.	0.	49.	86.	
UNIT TOTALS		2136.00	74.25	40.62	1298.93	13083.	3706.	18161.	1948438.	2338155.	0.
2 LAND	(14.9)	209.00	41.20	23.79	144.49	1492.	443.	2502.	216735.	260082.	0.
LIVESTOCK/FOWL						0.	0.	0.	1.	1.	
UNIT TOTALS		209.00	41.20	23.79	144.49	1493.	443.	2502.	216736.	260084.	0.
3 LAND	(63.7)	4010.00	4952.54	3218.07	2475.38	31190.	12080.	113125.	3713051.	4455669.	0.
LIVESTOCK/FOWL						30.	9.	0.	114.	199.	
UNIT TOTALS		4010.00	4952.54	3218.07	2475.38	31219.	12089.	113125.	3713165.	4455867.	0.
4 LAND	(135.6)	18165.00	67575.87	30338.46	11652.57	177199.	81167.	912276.	17479024.	20974720.	0.
LIVESTOCK/FOWL						90.	28.	0.	340.	598.	
UNIT TOTALS		18165.00	67575.87	30338.46	11652.57	177289.	81194.	912276.	17479360.	20975312.	0.
5 LAND	(94.2)	8765.00	89816.81	62724.65	5792.85	183374.	116577.	1644546.	8689323.	10427193.	0.
LIVESTOCK/FOWL						68.	21.	0.	256.	451.	
UNIT TOTALS		8765.00	89816.81	62724.65	5792.85	183442.	116598.	1644546.	8689579.	10427643.	0.
6 LAND	(73.0)	5180.00	1412.65	390.15	3083.90	31619.	9259.	50461.	4625834.	5551005.	0.
LIVESTOCK/FOWL						16.	5.	0.	60.	105.	
UNIT TOTALS		5180.00	1412.65	390.15	3083.90	31635.	9264.	50461.	4625893.	5551110.	0.
7 LAND	(116.9)	13560.00	18136.80	11977.55	8751.95	111473.	43670.	414965.	13128041.	15753661.	0.
LIVESTOCK/FOWL						99.	31.	0.	375.	659.	
UNIT TOTALS		13560.00	18136.80	11977.55	8751.95	111572.	43700.	414965.	13128415.	15754320.	0.
8 LAND	(133.3)	17599.00	112815.50	51241.88	10620.87	208689.	111725.	1421225.	15931501.	19117664.	0.
LIVESTOCK/FOWL						88.	27.	0.	335.	591.	
UNIT TOTALS		17599.00	112815.50	51241.88	10620.87	208777.	111752.	1421225.	15931835.	19118240.	0.
9 LAND	(100.1)	10010.00	137974.62	65805.56	6327.37	194881.	123003.	1728615.	9491127.	11389365.	0.
LIVESTOCK/FOWL						53.	17.	0.	201.	354.	
UNIT TOTALS		10010.00	137974.62	65805.56	6327.37	194934.	123019.	1728615.	9491328.	11389718.	0.
STATE LAND		79634.00	432800.12	225760.62	50148.30	952988.	501625.	6305875.	75222976.	90267376.	0.
LIVESTOCK/FOWL						456.	142.	0.	1731.	3043.	
GEORGIA	TOTALS	79634.00	432800.12	225760.62	50148.30	953444.	501766.	6305875.	75224704.	90270416.	0.
AREA LAND		79634.00	432800.12	225760.62	50148.30	952988.	501625.	6305875.	75222976.	90267376.	0.
LIVESTOCK/FOWL						456.	142.	0.	1731.	3043.	
GRAND TOTALS		79634.00	432800.12	225760.62	50148.30	953444.	501766.	6305875.	75224704.	90270416.	0.

(SEDIMENT MIGRATION TO A TERMINAL POINT= 117939.50 SHORT TONS OR 149593.37 CUBIC YARDS OR 114376.81 CUBIC METERS)

CLARKE COUNTY, GEORGIA (40% SED.) EXHIBIT TC2

TOTAL AREA ANNUAL EROSION AND CONTRIBUTION OF SEDIMENT & CONTAMINANTS TO WATER BODIES

EACH UNIT HAS A DIFFERENT LAND TYPE AND SLOPE % COMBINATION.
UNITS HAVE 3 SOIL TYPES (K=.1,.26,.36) & 4 SLOPE RANGES (%=0-2,2-6,6-15,15-25)
**** PERIOD MONTHS 1 - 12

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
				* * * * * *	* * * * * *	TO WATER	BODIES	* * * * *	* * * * *	* * * * *	* * *
1 LAND	(46.4)	2136.00	74.25	32.48	1039.35	10458.	2962.	14531.	1559020.	1870818.	0.
LIVESTOCK/FOWL						10.	3.	0.	39.	69.	
UNIT TOTALS		2136.00	74.25	32.48	1039.35	10469.	2965.	14531.	1559058.	1870886.	0.
2 LAND	(14.9)	209.00	41.20	19.02	115.54	1193.	354.	2001.	173312.	207974.	0.
LIVESTOCK/FOWL						0.	0.	0.	0.	1.	
UNIT TOTALS		209.00	41.20	19.02	115.54	1194.	354.	2001.	173312.	207975.	0.
3 LAND	(63.7)	4010.00	4952.54	2571.43	1980.53	24948.	9660.	90427.	2970786.	3564947.	0.
LIVESTOCK/FOWL						24.	8.	0.	91.	159.	
UNIT TOTALS		4010.00	4952.54	2571.43	1980.53	24972.	9667.	90427.	2970877.	3565105.	0.
4 LAND	(135.6)	18165.00	67575.87	24284.83	9321.31	141779.	64956.	730162.	13982143.	16778576.	0.
LIVESTOCK/FOWL						72.	22.	0.	272.	478.	
UNIT TOTALS		18165.00	67575.87	24284.83	9321.31	141851.	64978.	730162.	13982415.	16779040.	0.
5 LAND	(94.2)	8765.00	89816.81	50107.09	4633.25	146543.	93142.	1313799.	6949880.	8339857.	0.
LIVESTOCK/FOWL						54.	17.	0.	205.	360.	
UNIT TOTALS		8765.00	89816.81	50107.09	4633.25	146597.	93159.	1313799.	6950084.	8340216.	0.
6 LAND	(73.0)	5180.00	1412.65	313.41	2467.89	25305.	7411.	40411.	3701809.	4442177.	0.
LIVESTOCK/FOWL						13.	4.	0.	48.	84.	
UNIT TOTALS		5180.00	1412.65	313.41	2467.89	25318.	7415.	40411.	3701857.	4442261.	0.
7 LAND	(116.9)	13560.00	18136.80	9570.18	7000.80	89147.	34915.	331664.	10501276.	12601532.	0.
LIVESTOCK/FOWL						79.	25.	0.	299.	527.	
UNIT TOTALS		13560.00	18136.80	9570.18	7000.80	89226.	34939.	331664.	10501575.	12602058.	0.
8 LAND	(133.3)	17599.00	112815.50	41014.65	8498.72	167014.	89419.	1137535.	12748199.	15297849.	0.
LIVESTOCK/FOWL						71.	22.	0.	268.	473.	
UNIT TOTALS		17599.00	112815.50	41014.65	8498.72	167084.	89441.	1137535.	12748466.	15298321.	0.
9 LAND	(100.1)	10010.00	137974.62	52657.58	5061.88	155931.	98423.	1383227.	7592863.	9111438.	0.
LIVESTOCK/FOWL						42.	13.	0.	161.	283.	
UNIT TOTALS		10010.00	137974.62	52657.58	5061.88	155973.	98436.	1383227.	7593024.	9111721.	0.
STATE LAND		79634.00	432800.12	180570.50	40119.27	762319.	401241.	5043757.	60179232.	72215120.	0.
LIVESTOCK/FOWL						365.	114.	0.	1384.	2434.	
GEORGIA TOTALS		79634.00	432800.12	180570.50	40119.27	762684.	401355.	5043757.	60180640.	72217536.	0.
AREA LAND		79634.00	432800.12	180570.50	40119.27	762319.	401241.	5043757.	60179232.	72215120.	0.
LIVESTOCK/FOWL						365.	114.	0.	1384.	2434.	
GRAND TOTALS		79634.00	432800.12	180570.50	40119.27	762684.	401355.	5043757.	60180640.	72217536.	0.

(SEDIMENT MIGRATION TO A TERMINAL POINT= 94286.69 SHORT TONS OR 119592.37 CUBIC YARDS OR 91438.50 CUBIC METERS)

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NOTE - REMOVE ALL CARDS WITH * IN COL 80                                       *
*********  THIS IS CLARKE COUNTY, GA. EXHIBIT TC2 INPUT DATA  *****************
|---00---|----10---|----20---|----30---|----40---|----50---|----60---|----70---*
12345678901234567890123456789012345678901234567890123456789012345678901234567890*
-------------------------------------------------------------------------------*
                                                  CLARKE COUNTY, GEORGIA
                                 EXHIBIT TC2
                        TOTAL AREA ANNUAL EROSION AND CONTRIBUTION OF SEDIMENT & CONTAM
INANTS TO WATER BODIES
EACH UNIT HAS A DIFFERENT LAND TYPE AND SLOPE % COMBINATION.
UNITS HAVE 3 SOIL TYPES (K=.1,.26,.36) & 4 SLOPE RANGES (%=0-2,2-6,6-15,15-25)
PERIOD CARD                                 01 12 3451427 01 111
STATE CARD                                  13 GEORGIA           09
A11                                         05     2136
A12                                         100 0.10
A13                                           1.0  .99
A14                                           26  .08 20  .01 34 .005 19  .01  1  1.0
A15                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
A16                                           4039   .1  .08 1.25  0.0  0.0 4039
A17                              116      14      14      2570        0     32100
A18                                           5000   .5  .14  .66 75.0 90.0
A19
A21                                         05     209
A22                                         100 0.10
A23                                           4.0  2.0
A24                                           26  .08 20  .01 34 .005 19  .01  1  1.0
A25                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
A26                                           4039   .1  .08 1.25  0.0  0.0 4039
A27                                2       0       0        43        0       540
A28                                           5000   .5  .14  .66 75.0 90.0
A29
B21                                         05     4010
B22                                         100 0.26
B23                                           4.0  2.0
B24                                           26  .08 20  .01 34 .005 19  .01  1  1.0
B25                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
B26                                           4039   .1  .08 1.25  0.0  0.0 4039
B27                              225      29      29      4731        0     61595
B28                                           5000   .5  .14  .66 75.0 90.0
B29
B31                                         05    18165
B32                                         100 0.26
B33                                           11.0  4.0
B34                                           26  .08 20  .01 34 .005 19  .01  1  1.0
B35                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
B36                                           4039   .1  .08 1.25  0.0  0.0 4039
B37                              980     119     120     21900        0    274000
B38                                           5000   .5  .14  .66 75.0 90.0
B39
B41                                         05     8765
B42                                         100 0.26
B43                                           20.0  5.0
B44                                           26  .08 20  .01 34 .005 19  .01  1  1.0
B45                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
B46                                           4039   .1  .08 1.25  0.0  0.0 4039
B47                              477      58      58     10500        0    132000
B48                                           5000   .5  .14  .66 75.0 90.0
B49
C11                                         05     5180
C12                                         100 0.36
C13                                           1.0  .99
C14                                           26  .08 20  .01 34 .005 19  .01  1  1.0
C15                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
C16                                           4039   .1  .08 1.25  0.0  0.0 4039
C17                              282      34      34      6210        0     78000
C18                                           5000   .5  .14  .66 75.0 90.0
C19
C21                                         05    13560
C22                                         100 0.36
C23                                           4.0  2.0
C24                                           26  .08 20  .01 34 .005 19  .01  1  1.0
C25                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
C26                                           4039   .1  .08 1.25  0.0  0.0 4039
C27                              738      89      90     16300        0    204200
C28                                           5000   .5  .14  .66 75.0 90.0
C29
C31                                         05    17599
C32                                         100 0.36
C33                                           11.0  4.0
C34                                           26  .08 20  .01 34 .005 19  .01  1  1.0
C35                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
C36                                           4039   .1  .08 1.25  0.0  0.0 4039
C37                              967     115     116     21150        0    265000
C38                                           5000   .5  .14  .66 75.0 90.0
C39
C41                                         05    10010
C42                                         100 0.36
C43                                           20.0  5.0
C44                                           26  .08 20  .01 34 .005 19  .01  1  1.0
C45                                           26  .50 20  1.0 34  1.0 19  1.0  1  1.3
C46                                           4039   .1  .08 1.25  0.0  0.0 4039
C47                              548      66      67     12200        0    152000
C48                                           5000   .5  .14  .66 75.0 90.0
C49
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TABLE OF STATE DATA

1	22	24	23	24	23	23	23	23	23	325	300	350	350	375	375	500	450	600
5	18	18	22	18	22	22	9	22	22	275	275	275	325	325	325	365	365	365
9	33	33	0	0	0	0	0	0	0	175	150	0	0	0	0	0	0	0
10	30	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0
11	30	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0
12	23	25	25	29	25	0	0	0	0	600	550	450	450	500	0	0	0	0
13	24	24	24	24	26	26	26	26	29	300	275	275	325	275	275	375	375	400
17	14	14	14	16	16	16	16	19	19	175	160	165	190	185	175	200	225	220
18	15	15	15	16	16	16	19	19	16	165	160	150	180	175	160	220	185	180
19	2	2	12	2	13	14	13	13	14	150	155	165	155	160	175	170	175	180
21	20	20	19	20	20	20	19	19	20	180	175	240	200	225	150	250	200	180
22	9	22	22	22	22	22	22	22	23	400	400	400	525	525	525	600	600	600
23	32	32	32	32	0	0	0	0	0	75	75	100	100	0	0	0	0	0
24	30	30	30	30	0	0	0	0	0	125	200	200	200	0	0	0	0	0
25	32	33	33	0	0	0	0	0	0	140	125	135	0	0	0	0	0	0
26	12	12	12	15	15	15	15	15	15	85	80	75	75	75	90	80	125	115
27	1	1	1	1	1	1	12	12	12	75	80	85	100	115	120	120	135	145
28	22	22	22	22	22	23	22	23	23	325	325	350	350	390	400	500	550	600
29	13	16	16	16	16	16	18	18	19	200	200	200	220	215	215	245	240	240
31	2	2	2	2	2	2	2	3	13	60	85	125	75	100	140	100	125	150
33	32	33	0	0	0	0	0	0	0	100	120	0	0	0	0	0	0	0
34	30	30	0	0	0	0	0	0	0	175	200	0	0	0	0	0	0	0
36	31	31	31	31	31	31	31	31	31	85	85	100	100	90	85	95	130	150
37	28	28	28	29	21	28	28	29	29	225	225	275	350	225	250	270	350	400
38	1	1	1	1	1	1	1	1	1	50	50	60	50	55	65	50	60	75
39	16	16	17	16	16	17	16	16	20	125	125	125	150	140	150	165	150	150
40	6	4	5	4	4	5	4	5	5	120	175	255	175	225	290	190	260	320
42	17	30	30	17	30	30	17	30	30	115	100	115	120	120	150	125	125	155
44	33	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0
45	28	27	27	27	27	27	29	29	29	300	250	250	275	275	300	375	350	340
46	1	1	1	1	2	2	2	2	2	50	65	85	50	65	85	60	75	100
47	19	22	22	22	21	22	22	22	21	250	215	210	180	150	300	250	240	225
48	7	10	11	7	10	11	7	10	11	125	250	400	120	225	375	90	160	250
50	32	32	32	0	0	0	0	0	0	85	100	125	0	0	0	0	0	0
51	30	30	30	30	28	28	28	30	30	175	155	165	220	150	150	185	210	250
54	17	17	17	17	30	17	17	17	17	150	150	150	140	125	150	150	150	150
55	1	12	12	12	12	14	14	14	14	110	100	90	150	125	95	165	140	115

TABLE OF PERIOD FACTORS

1.	0.0	0.0	0.0	0.01	0.03	0.11	0.37	0.63	0.89	0.97	1.00	1.00	1.00
2.	0.0	0.0	0.01	0.02	0.06	0.18	0.42	0.67	0.85	0.95	0.99	1.00	1.00
3.	0.0	0.0	0.01	0.02	0.06	0.22	0.52	0.69	0.85	0.93	0.98	1.00	1.00
4.	0.0	0.01	0.03	0.05	0.12	0.27	0.47	0.62	0.75	0.89	0.97	0.99	1.00
5.	0.0	0.02	0.04	0.09	0.21	0.37	0.53	0.64	0.73	0.87	0.94	0.98	1.00
6.	0.0	0.0	0.0	0.02	0.07	0.27	0.45	0.60	0.74	0.87	0.98	1.00	1.00
7.	0.0	0.01	0.03	0.06	0.13	0.40	0.56	0.67	0.75	0.85	0.98	0.99	1.00
8.	0.0	0.02	0.07	0.14	0.27	0.47	0.60	0.67	0.77	0.85	0.92	0.98	1.00
9.	0.0	0.04	0.09	0.17	0.28	0.42	0.54	0.62	0.69	0.77	0.85	0.93	1.00
0.	0.0	0.02	0.06	0.12	0.21	0.39	0.52	0.61	0.70	0.82	0.91	0.96	1.00
1.	0.0	0.03	0.07	0.10	0.17	0.34	0.45	0.56	0.68	0.79	0.89	0.96	1.00
2.	0.0	0.0	0.01	0.02	0.05	0.15	0.38	0.62	0.85	0.95	0.98	0.99	1.00
3.	0.0	0.0	0.01	0.03	0.07	0.18	0.47	0.65	0.81	0.93	0.98	0.99	1.00
4.	0.0	0.0	0.02	0.05	0.10	0.20	0.38	0.62	0.79	0.90	0.96	0.98	1.00
5.	0.0	0.01	0.02	0.05	0.11	0.22	0.40	0.60	0.79	0.90	0.95	0.98	1.00
6.	0.0	0.01	0.04	0.08	0.14	0.25	0.44	0.64	0.78	0.88	0.94	0.98	1.00
7.	0.0	0.02	0.04	0.06	0.10	0.19	0.39	0.62	0.82	0.91	0.95	0.98	1.00
8.	0.0	0.03	0.06	0.11	0.20	0.34	0.50	0.63	0.74	0.83	0.92	0.97	1.00
9.	0.0	0.03	0.09	0.16	0.25	0.37	0.50	0.63	0.77	0.83	0.90	0.95	1.00
0.	0.0	0.03	0.07	0.13	0.19	0.26	0.40	0.62	0.80	0.88	0.92	0.95	1.00
1.	0.0	0.07	0.13	0.19	0.26	0.33	0.47	0.68	0.80	0.86	0.90	0.95	1.00
2.	0.0	0.07	0.13	0.22	0.33	0.44	0.55	0.67	0.74	0.81	0.86	0.93	1.00
3.	0.0	0.05	0.11	0.18	0.27	0.35	0.45	0.60	0.74	0.83	0.88	0.93	1.00
4.	0.0	0.06	0.13	0.20	0.29	0.37	0.51	0.68	0.80	0.86	0.92	0.97	1.00
5.	0.0	0.03	0.07	0.13	0.19	0.28	0.40	0.53	0.69	0.88	0.94	0.96	1.00
6.	0.0	0.04	0.09	0.16	0.25	0.36	0.47	0.68	0.81	0.87	0.91	0.95	1.00
7.	0.0	0.02	0.05	0.10	0.17	0.26	0.37	0.57	0.80	0.92	0.95	0.97	1.00
8.	0.0	0.03	0.07	0.12	0.17	0.24	0.35	0.55	0.77	0.87	0.92	0.97	1.00
9.	0.0	0.02	0.04	0.07	0.11	0.17	0.30	0.54	0.75	0.89	0.95	0.98	1.00
0.	0.0	0.02	0.03	0.06	0.10	0.19	0.35	0.55	0.75	0.85	0.92	0.97	1.00
1.	0.0	0.01	0.02	0.04	0.07	0.17	0.32	0.55	0.77	0.88	0.94	0.98	1.00
2.	0.0	0.02	0.03	0.06	0.10	0.17	0.32	0.52	0.68	0.80	0.88	0.96	1.00
3.	0.0	0.02	0.06	0.11	0.15	0.20	0.32	0.46	0.64	0.77	0.85	0.94	1.00

ABLE OF RANDOM NUMBERS - READ DOWN COL BY COL - ZERO IS CONVERTED TO 100 FOR SUBSCRIPTING 100 VALUE TABLES

33	52	73	8	35	67	70	31	79	51	66	14	66	67	50	61	90	85	93	8	27	52	39	72	28	23	28	52	70	67	99	55	94	8	13	22	16	35	92	25
93	40	37	96	64	4	44	6	65	20	29	12	66	50	35	44	69	52	49	80	42	10	79	8	39	63	8	69	28	66	15	83	60	89	87	22	67	10	43	32
21	79	34	87	94	64	84	52	26	28	23	28	52	70	67	99	55	94	8	13	22	16	35	92	25	2	3	25	70	28	76	53	95	93	89	78	87	66	49	64
18	13	62	84	70	26	8	79	70	39	63	8	69	28	66	15	83	60	89	87	22	67	10	43	32	55	0	46	64	36	69	27	13	93	71	0	2	18	74	36
65	7	14	83	79	60	96	17	95	25	2	3	25	70	28	76	53	95	93	89	78	87	66	49	64	98	0	30	60	86	47	10	12	71	10	16	67	90	31	42
65	43	73	75	2	28	22	47	38	32	55	0	46	64	36	69	27	13	93	71	0	2	18	74	36	65	80	51	34	13	61	92	86	64	2	50	30	56	1	43
33	15	65	44	55	98	86	3	3	64	98	0	30	60	86	47	10	12	71	10	16	67	90	31	42	52	84	44	39	44	65	58	78	66	21	24	1	39	26	74
84	42	8	52	97	27	12	44	54	36	65	80	51	34	13	61	92	86	64	2	50	30	56	1	48	90	52	80	3	93	56	97	21	1	26	2	50	87	10	81
81	75	28	43	81	99	84	39	85	42	52	84	44	39	44	65	58	78	66	21	24	1	39	26	74	67	15	91	71	51	52	42	12	93	44	93	21	56	64	12
26	18	14	10	11	81	63	22	17	48	90	52	80	3	93	56	97	21	1	26	2	50	87	10	81	83	99	80	1	75	11	49	61	94	3	51	66	14	66	67
54	58	28	34	82	37	30	0	26	74	67	15	91	71	51	52	42	12	93	44	93	21	56	64	12	40	99	42	48	21	60	38	98	19	16	20	29	12	66	50
84	48	97	72	24	41	21	79	10	81	83	99	80	1	75	11	49	61	94	3	51	66	14	66	67	50	61	90	85	93	8	27	52	39	72	28	23	28	52	70
69	81	7	39	22	75	65	37	64	12	40	99	42	48	21	60	38	98	19	16	20	29	12	66	50	35	44	69	52	49	80	42	10	79	8	39	63	8	69	28
14	92	15	9	62	43	42	19	66	67	50	61	90	85	93	8	27	52	39	72	28	23	28	52	70	67	99	55	94	8	13	22	16	35	92	25	2	3	25	70
69	58	18	12	25	74	90	14	66	50	35	44	69	52	49	80	42	10	79	8	39	63	8	69	28	66	15	83	60	89	87	22	67	10	43	32	55	0	46	64
66	28	6	76	53	47	71	45	52	70	67	99	55	94	8	13	22	16	35	92	25	2	3	25	70	28	76	53	95	93	89	78	87	66	49	64	98	0	30	60
53	8	34	55	20	33	24	56	69	28	66	15	83	60	89	87	22	67	10	43	32	55	0	46	64	36	69	27	13	93	71	0	2	18	74	36	65	80	51	34
11	77	99	37	44	37	66	95	25	70	28	76	53	95	93	89	78	87	66	49	64	98	0	30	60	86	47	10	12	71	10	16	67	90	31	42	52	84	44	39
79	40	43	88	71	20	48	26	46	64	36	69	27	13	93	71	0	2	18	74	36	65	80	51	34	13	61	92	86	64	2	50	30	56	1	48	90	52	80	3
70	5	24	28	35	1	54	27	30	60	86	47	10	12	71	10	16	67	90	31	42	52	84	44	39	44	65	58	78	66	21	24	1	39	26	74	67	15	91	71
91	90	33	60	56	40	46	75	51	34	13	61	92	86	64	2	50	30	56	1	48	90	52	80	3	93	56	97	21	1	26	2	50	87	10	81	83	99	80	1
97	15	40	78	76	71	71	94	44	39	44	65	58	78	66	21	24	1	39	26	74	67	15	91	71	51	52	42	12	93	44	93	21	56	64	12	40	99	42	48
1	32	58	6	95	1	81	6	80	3	93	56	97	21	1	26	2	50	87	10	81	83	99	80	1	75	11	49	61	94	3	51	66	14	66	67	50	61	90	85
78	68	53	58	65	39	88	99	91	71	51	52	42	12	93	44	93	21	56	64	12	40	99	42	48	21	60	38	98	19	16	20	29	12	66	50	35	44	69	52
64	32	40	44	66	50	97	92	80	1	75	11	49	61	94	3	51	66	14	66	67	50	61	90	85	93	8	27	52	39	72	28	23	28	52	70	67	99	55	94
28	7	95	3	12	85	57	11	42	48	21	60	38	98	19	16	20	29	12	66	50	35	44	69	52	49	80	42	10	79	8	39	63	8	69	28	66	15	83	60
88	45	22	36	3	40	60	13	90	85	93	8	27	52	39	72	28	23	28	52	70	67	99	55	94	8	13	22	16	35	92	25	2	3	25	70	28	76	53	95
3	24	92	45	76	94	33	86	69	52	49	80	42	10	79	8	39	63	8	69	28	66	15	83	60	89	87	22	67	10	43	32	55	0	46	64	36	69	27	13
30	29	94	43	5	60	16	9	55	94	8	13	22	16	35	92	25	2	3	25	70	28	76	53	95	93	89	78	87	66	49	64	98	0	30	60	86	47	10	12
30	99	44	15	93	91	65	33	83	60	89	87	22	67	10	43	32	55	0	46	64	36	69	27	13	93	71	0	2	18	74	36	65	80	51	34	13	61	92	86
72	33	56	40	30	38	16	4	53	95	93	69	78	87	66	49	64	98	0	30	60	86	47	10	12	71	10	16	67	90	31	42	52	84	44	39	44	65	58	78
2	56	76	6	85	52	47	76	27	13	93	71	0	2	18	74	36	65	80	51	34	13	61	92	86	64	2	50	30	56	1	48	90	52	80	3	93	56	97	21
39	5	18	17	78	14	71	20	10	12	71	10	16	67	90	31	42	52	84	44	39	44	65	58	78	66	21	24	1	39	26	74	67	15	91	71	51	52	42	12
61	58	72	54	88	80	34	78	92	86	64	2	50	30	56	1	48	90	52	80	3	93	56	97	21	1	26	2	50	87	10	81	83	99	80	1	75	11	49	61
96	7	52	38	17	98	30	92	58	78	66	21	24	1	39	26	74	67	15	91	71	51	52	42	12	93	44	93	21	56	64	12	40	99	42	48	21	60	38	98
41	75	71	61	26	57	63	55	97	21	1	26	2	50	87	10	81	83	99	80	1	75	11	49	61	94	3	51	66	14	66	67	50	61	90	85	93	8	27	52
71	58	20	20	6	28	62	40	42	12	93	44	93	21	56	64	12	40	99	42	48	21	60	38	98	19	16	20	29	12	66	50	35	44	69	52	49	80	42	10
68	59	31	54	87	49	32	79	49	61	94	3	51	66	14	66	67	50	61	90	85	93	8	27	52	39	72	28	23	28	52	70	67	99	55	94	8	13	22	16
51	86	33	37	36	69	76	49	38	98	19	16	20	29	12	66	50	35	44	69	52	49	80	42	10	79	8	39	63	8	69	28	66	15	83	60	89	87	22	67
67	65	38	73	7	73	48	12	27	52	39	72	28	23	28	52	70	67	99	55	94	8	13	22	16	35	92	25	2	3	25	70	28	76	53	95	93	89	78	87
87	46	5	3	26	83	51	88	42	10	79	8	39	63	8	69	28	66	15	83	60	89	87	22	67	10	43	32	55	0	46	64	36	69	27	13	93	71	0	2
42	43	27	0	71	6	89	64	22	16	35	92	25	2	3	25	70	28	76	53	95	93	89	78	87	66	49	64	98	0	30	60	86	47	10	12	71	10	16	67
86	44	88	77	40	66	87	70	22	67	10	43	32	55	0	46	64	36	69	27	13	93	71	0	2	18	74	36	65	80	51	34	13	61	92	86	64	2	50	30
33	16	38	27	44	44	90	83	78	87	66	49	64	98	0	30	60	86	47	10	12	71	10	16	67	90	31	42	52	84	44	39	44	65	58	78	66	21	24	1
72	94	28	48	49	49	28	41	0	2	18	74	36	65	80	51	34	13	61	92	86	64	2	50	30	56	1	48	90	52	80	3	93	56	97	21	1	26	2	50
84	89	8	48	50	6	87	93	16	67	90	31	42	52	84	44	39	44	65	58	78	66	21	24	1	39	26	74	67	15	91	71	51	52	42	12	93	44	93	21
15	47	37	42	83	42	98	6	50	30	56	1	48	90	52	80	3	93	56	97	21	1	26	2	50	87	10	81	83	99	80	1	75	11	49	61	94	3	51	66
87	38	36	89	5	94	90	93	24	1	39	26	74	67	15	91	71	51	52	42	12	93	44	93	21	56	64	12	40	99	42	48	21	60	38	98	19	16	20	29
20	96	78	25	30	46	18	41	2	50	87	10	81	83	99	80	1	75	11	49	61	94	3	51	66	14	66	67	50	61	90	85	93	8	27	52	39	72	28	23
9	41	90	61	16	32	63	96	93	21	56	64	12	40	99	42	48	21	60	38	98	19	16	20	29	12	66	50	35	44	69	52	49	80	42	10	79	8	39	63

TABLE OF LS FACTORS FOR PROBABLE SLOPE % & SLOPE LENGTH COMBINATIONS

SLOPE FT.>>	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
1 %SLOPE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2 %SLOPE	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
3 %SLOPE	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
4 %SLOPE	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7
5 %SLOPE	0.1	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0
6 %SLOPE	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.3	1.3
7 %SLOPE	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6
8 %SLOPE	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.9	1.9	1.9
9 %SLOPE	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3
10 %SLOPE	0.3	0.5	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7
11 %SLOPE	0.4	0.6	0.8	0.9	1.0	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.0
12 %SLOPE	0.4	0.7	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.8	2.9	2.9	3.0	3.1	3.2	3.2	3.3	3.4	3.4
13 %SLOPE	0.5	0.8	1.0	1.1	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.4	3.5	3.6	3.7	3.8	3.8
14 %SLOPE	0.6	0.8	1.1	1.3	1.5	1.6	1.8	1.9	2.1	2.2	2.3	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3
15 %SLOPE	0.6	0.9	1.2	1.4	1.6	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.8	3.0	3.1	3.2	3.3	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7
16 %SLOPE	0.7	1.0	1.3	1.5	1.8	2.0	2.1	2.3	2.5	2.7	2.8	3.0	3.1	3.3	3.4	3.5	3.7	3.8	3.9	4.0	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1
17 %SLOPE	0.7	1.1	1.4	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.2	3.4	3.5	3.7	3.8	4.0	4.1	4.3	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.3	5.4	5.5	5.6
18 %SLOPE	0.8	1.2	1.5	1.8	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.8	4.0	4.2	4.3	4.5	4.6	4.8	4.9	5.0	5.2	5.3	5.4	5.6	5.7	5.8	5.9	6.1
19 %SLOPE	0.8	1.3	1.6	2.0	2.2	2.5	2.7	3.0	3.2	3.4	3.6	3.8	4.0	4.1	4.3	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.1	6.3	6.4	6.5
20 %SLOPE	0.9	1.4	1.8	2.1	2.4	2.7	2.9	3.2	3.4	3.6	3.8	4.1	4.3	4.4	4.6	4.8	5.0	5.2	5.3	5.5	5.7	5.8	6.0	6.1	6.3	6.4	6.6	6.7	6.9	7.0
21 %SLOPE	1.0	1.5	1.9	2.2	2.6	2.9	3.1	3.4	3.7	3.9	4.1	4.3	4.6	4.8	5.0	5.2	5.4	5.5	5.7	5.9	6.1	6.2	6.4	6.6	6.7	6.9	7.1	7.2	7.4	7.5
22 %SLOPE	1.0	1.6	2.0	2.4	2.7	3.1	3.4	3.6	3.9	4.2	4.4	4.6	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3	6.5	6.7	6.8	7.0	7.2	7.4	7.5	7.7	7.9	8.0
23 %SLOPE	1.1	1.7	2.1	2.6	2.9	3.3	3.6	3.9	4.1	4.4	4.7	4.9	5.2	5.4	5.6	5.9	6.1	6.3	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.8	8.0	8.2	8.4	8.5
24 %SLOPE	1.2	1.8	2.3	2.7	3.1	3.5	3.8	4.1	4.4	4.7	5.0	5.2	5.5	5.7	6.0	6.2	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.1	8.3	8.5	8.7	8.9	9.1
25 %SLOPE	1.2	1.9	2.4	2.9	3.3	3.7	4.0	4.3	4.7	5.0	5.3	5.5	5.8	6.1	6.3	6.6	6.8	7.1	7.3	7.5	7.8	8.0	8.2	8.4	8.6	8.8	9.0	9.2	9.4	9.6

PROB.TBLS.STATE= 13 UNIT= 1 UNIT AC.= 2136.00 PLOT SZ. AC.= 46.4 N-(%)= 0.10 P-(%)= 0.08 K-(%)= 1.25
BOD%= 0.0 TOC%= 0.0 SED.MIG.%= 40.00

S.E. FACTORS(SEF)	SLOPE %(SLP)	SLOPE LGTH.(SLL)	CROPPING MGT.(CM)	EROSION CTL.(EC)	SED. DEL. (SD)
100 %= 0.100	AVG= 1.000	AVG= 140.	26 %= 0.080	26 %= 0.500	AVG. % = 40.00
0 %= 0.0	DEV= 0.990	DEV= 93.	20 %= 0.010	20 %= 1.000	DEV= 39.00
0 %= 0.0			34 %= 0.005	34 %= 1.000	
0 %= 0.0			19 %= 0.010	19 %= 1.000	
0 %= 0.0			1 %= 1.000	1 %= 1.300	

# FACTOR	# FACTOR	#	PCT.	#	PCT.	#	FEET	#	FEET	# FACTOR	# FACTOR	#	PCT.	#	PCT.	# FACTOR	# FACTOR
10.1000	510.1000	1	0.01	51	1.00	1	47.	51	140.	10.0800	510.0050	1	0.50	51	1.00	10.0100	510.4000
20.1000	520.1000	2	0.03	52	1.02	2	49.	52	142.	20.0800	520.0050	2	0.50	52	1.00	20.0178	520.4078
30.1000	530.1000	3	0.05	53	1.04	3	50.	53	144.	30.0800	530.0050	3	0.50	53	1.00	30.0256	530.4156
40.1000	540.1000	4	0.07	54	1.06	4	52.	54	146.	40.0800	540.0050	4	0.50	54	1.00	40.0334	540.4234
50.1000	550.1000	5	0.09	55	1.08	5	54.	55	148.	50.0800	550.0050	5	0.50	55	1.00	50.0412	550.4312
60.1000	560.1000	6	0.11	56	1.10	6	56.	56	149.	60.0800	560.0050	6	0.50	56	1.00	60.0490	560.4390
70.1000	570.1000	7	0.13	57	1.12	7	58.	57	151.	70.0800	570.0050	7	0.50	57	1.00	70.0568	570.4468
80.1000	580.1000	8	0.15	58	1.14	8	60.	58	153.	80.0800	580.0050	8	0.50	58	1.00	80.0646	580.4546
90.1000	590.1000	9	0.17	59	1.16	9	62.	59	155.	90.0800	590.0050	9	0.50	59	1.00	90.0724	590.4624
100.1000	600.1000	10	0.19	60	1.18	10	64.	60	157.	100.0800	600.0050	10	0.50	60	1.00	100.0802	600.4702
110.1000	610.1000	11	0.21	61	1.20	11	65.	61	159.	110.0800	610.0050	11	0.50	61	1.00	110.0880	610.4780
120.1000	620.1000	12	0.23	62	1.22	12	67.	62	161.	120.0800	620.0050	12	0.50	62	1.00	120.0958	620.4858
130.1000	630.1000	13	0.25	63	1.24	13	69.	63	163.	130.0800	630.0050	13	0.50	63	1.00	130.1036	630.4936
140.1000	640.1000	14	0.27	64	1.26	14	71.	64	164.	140.0800	640.0050	14	0.50	64	1.00	140.1114	640.5014
150.1000	650.1000	15	0.29	65	1.28	15	73.	65	166.	150.0800	650.0050	15	0.50	65	1.00	150.1192	650.5092
160.1000	660.1000	16	0.31	66	1.30	16	75.	66	168.	160.0800	660.0050	16	0.50	66	1.00	160.1270	660.5170
170.1000	670.1000	17	0.33	67	1.32	17	77.	67	170.	170.0800	670.0050	17	0.50	67	1.00	170.1348	670.5248
180.1000	680.1000	18	0.35	68	1.34	18	78.	68	172.	180.0800	680.0050	18	0.50	68	1.00	180.1426	680.5326
190.1000	690.1000	19	0.37	69	1.36	19	80.	69	174.	190.0800	690.0050	19	0.50	69	1.00	190.1504	690.5404
200.1000	700.1000	20	0.39	70	1.38	20	82.	70	176.	200.0800	700.0050	20	0.50	70	1.00	200.1582	700.5482
210.1000	710.1000	21	0.41	71	1.40	21	84.	71	177.	210.0800	710.0050	21	0.50	71	1.00	210.1660	710.5560
220.1000	720.1000	22	0.43	72	1.42	22	86.	72	179.	220.0800	720.0050	22	0.50	72	1.00	220.1738	720.5638
230.1000	730.1000	23	0.45	73	1.44	23	88.	73	181.	230.0800	730.0050	23	0.50	73	1.00	230.1816	730.5716
240.1000	740.1000	24	0.47	74	1.46	24	90.	74	183.	240.0800	740.0050	24	0.50	74	1.00	240.1894	740.5794
250.1000	750.1000	25	0.49	75	1.48	25	92.	75	185.	250.0800	750.0050	25	0.50	75	1.00	250.1972	750.5872
260.1000	760.1000	26	0.50	76	1.49	26	93.	76	187.	260.0800	760.0050	26	0.50	76	1.00	260.2050	760.5950
270.1000	770.1000	27	0.52	77	1.51	27	95.	77	189.	270.0100	770.0050	27	1.00	77	1.00	270.2128	770.6028
280.1000	780.1000	28	0.54	78	1.53	28	97.	78	191.	280.0100	780.0050	28	1.00	78	1.00	280.2206	780.6106
290.1000	790.1000	29	0.56	79	1.55	29	99.	79	192.	290.0100	790.0050	29	1.00	79	1.00	290.2284	790.6184
300.1000	800.1000	30	0.58	80	1.57	30	101.	80	194.	300.0100	800.0050	30	1.00	80	1.00	300.2362	800.6262
310.1000	810.1000	31	0.60	81	1.59	31	103.	81	196.	310.0100	810.0100	31	1.00	81	1.00	310.2440	810.6340
320.1000	820.1000	32	0.62	82	1.61	32	105.	82	198.	320.0100	820.0100	32	1.00	82	1.00	320.2518	820.6418
330.1000	830.1000	33	0.64	83	1.63	33	106.	83	200.	330.0100	830.0100	33	1.00	83	1.00	330.2596	830.6496
340.1000	840.1000	34	0.66	84	1.65	34	108.	84	202.	340.0100	840.0100	34	1.00	84	1.00	340.2674	840.6574
350.1000	850.1000	35	0.68	85	1.67	35	110.	85	204.	350.0100	850.0100	35	1.00	85	1.00	350.2752	850.6652
360.1000	860.1000	36	0.70	86	1.69	36	112.	86	205.	360.0100	860.0100	36	1.00	86	1.00	360.2830	860.6730
370.1000	870.1000	37	0.72	87	1.71	37	114.	87	207.	370.0100	870.0100	37	1.00	87	1.00	370.2908	870.6808
380.1000	880.1000	38	0.74	88	1.73	38	116.	88	209.	380.0100	880.0100	38	1.00	88	1.00	380.2986	880.6886
390.1000	890.1000	39	0.76	89	1.75	39	118.	89	211.	390.0100	890.0100	39	1.00	89	1.00	390.3064	890.6964
400.1000	900.1000	40	0.78	90	1.77	40	120.	90	213.	400.0100	900.0100	40	1.00	90	1.00	400.3142	900.7042
410.1000	910.1000	41	0.80	91	1.79	41	121.	91	215.	410.0100	910.0100	41	1.00	91	1.00	410.3220	910.7120
420.1000	920.1000	42	0.82	92	1.81	42	123.	92	217.	420.0100	920.0100	42	1.00	92	1.00	420.3298	920.7198
430.1000	930.1000	43	0.84	93	1.83	43	125.	93	219.	430.0100	930.0100	43	1.00	93	1.00	430.3376	930.7276
440.1000	940.1000	44	0.86	94	1.85	44	127.	94	220.	440.0100	940.0100	44	1.00	94	1.00	440.3454	940.7354
450.1000	950.1000	45	0.88	95	1.87	45	129.	95	222.	450.0100	950.0100	45	1.00	95	1.00	450.3532	950.7432
460.1000	960.1000	46	0.90	96	1.89	46	131.	96	224.	460.0100	960.0100	46	1.00	96	1.00	460.3610	960.7510
470.1000	970.1000	47	0.92	97	1.91	47	133.	97	226.	470.0050	970.0100	47	1.00	97	1.00	470.3688	970.7588
480.1000	980.1000	48	0.94	98	1.93	48	134.	98	228.	480.0050	980.0100	48	1.00	98	1.00	480.3766	980.7666
490.1000	990.1000	49	0.96	99	1.95	49	136.	99	230.	490.0050	990.0100	49	1.00	99	1.00	490.3844	990.7744
500.1[illegible]0	1000.1000	50	0.98	10	1.97	50	8.	100	232	500.0050	1[illegible]1.0000	50	[illegible].00	100	1[illegible]	500.3922	100.7822

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DETAIL CALCULATIONS FOR EACH SMALL PLOT

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R-EROSION INDEX UNITS (IRF) =   275.  EI-NO. =     26
K-SOIL ERODIBILITY RNO=  93 (VK) = 0.1000
SLOPE% RNO= 18  SLOPE %=   0.35  LGTH RNO= 21  LGTH=     84.  LS=   0.01
C-CROPPING MGT. RNO=  65 VC =    0.0050
P-EROSION CONTROL RNO=  65 VP =       1.00
SED. RNO=  65 SED. YIELD FACTOR=    0.50920 SED. YIELD TONS=     0.03644
NO.OF PLOTS =          46 ACRES/PLOT =     46.43 PERIOD =  1 TO 12 UNLESS SINGLE STORM INDICATED
PERIOD FACTOR =   1.00 TONS/ACRE =      0.00 ACCUMULATED TONS FOR SEG.& PERIOD =          0.07
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R-EROSION INDEX UNITS (IRF) =   275.  EI-NO. =     26
K-SOIL ERODIBILITY RNO=  84 (VK) = 0.1000
SLOPE% RNO= 26  SLOPE %=   0.50  LGTH RNO= 81  LGTH=    196.  LS=   0.03
C-CROPPING MGT. RNO=  54 VC =    0.0050
P-EROSION CONTROL RNO=  54 VP =       1.00
SED. RNO=  84 SED. YIELD FACTOR=    0.65740 SED. YIELD TONS=     0.13248
NO.OF PLOTS =          46 ACRES/PLOT =     46.43 PERIOD =  1 TO 12 UNLESS SINGLE STORM INDICATED
PERIOD FACTOR =   1.00 TONS/ACRE =      0.00 ACCUMULATED TONS FOR SEG.& PERIOD =          0.20
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R-EROSION INDEX UNITS (IRF) =   275.  EI-NO. =     26
K-SOIL ERODIBILITY RNO=  14 (VK) = 0.1000
SLOPE% RNO= 66  SLOPE %=   1.30  LGTH RNO= 69  LGTH=    174.  LS=   0.11
C-CROPPING MGT. RNO=  53 VC =    0.0050
P-EROSION CONTROL RNO=  53 VP =       1.00
SED. RNO=  11 SED. YIELD FACTOR=    0.08800 SED. YIELD TONS=     0.06176
NO.OF PLOTS =          46 ACRES/PLOT =     46.43 PERIOD =  1 TO 12 UNLESS SINGLE STORM INDICATED
PERIOD FACTOR =   1.00 TONS/ACRE =      0.02 ACCUMULATED TONS FOR SEG.& PERIOD =          0.70
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R-EROSION INDEX UNITS (IRF) =   275.  EI-NO. =     26
K-SOIL ERODIBILITY RNO=  70 (VK) = 0.1000
SLOPE% RNO= 97  SLOPE %=   1.91  LGTH RNO= 91  LGTH=    215.  LS=   0.21
C-CROPPING MGT. RNO=   1 VC =    0.0800
P-EROSION CONTROL RNO=   1 VP =       0.50
SED. RNO=  78 SED. YIELD FACTOR=    0.61060 SED. YIELD TONS=     6.69807
NO.OF PLOTS =          46 ACRES/PLOT =     46.43 PERIOD =  1 TO 12 UNLESS SINGLE STORM INDICATED
PERIOD FACTOR =   1.00 TONS/ACRE =      0.24 ACCUMULATED TONS FOR SEG.& PERIOD =         10.97
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R-EROSION INDEX UNITS (IRF) =   275.  EI-NO. =     26
K-SOIL ERODIBILITY RNO=  28 (VK) = 0.1000
SLOPE% RNO=  3  SLOPE %=   0.05  LGTH RNO= 88  LGTH=    209.  LS=   0.00
C-CROPPING MGT. RNO=  30 VC =    0.0100
P-EROSION CONTROL RNO=  30 VP =       1.00
SED. RNO=  30 SED. YIELD FACTOR=    0.23620 SED. YIELD TONS=     0.00384
NO.OF PLOTS =          46 ACRES/PLOT =     46.43 PERIOD =  1 TO 12 UNLESS SINGLE STORM INDICATED
PERIOD FACTOR =   1.00 TONS/ACRE =      0.00 ACCUMULATED TONS FOR SEG.& PERIOD =          0.02
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R-EROSION INDEX UNITS (IRF) =   275.  EI-NO. =     26
K-SOIL ERODIBILITY RNO=   2 (VK) = 0.1000
SLOPE% RNO= 61  SLOPE %=   1.20  LGTH RNO= 39  LGTH=    118.  LS=   0.08
C-CROPPING MGT. RNO=  96 VC =    0.0100
P-EROSION CONTROL RNO=  96 VP =       1.00
SED. RNO=  41 SED. YIELD FACTOR=    0.32200 SED. YIELD TONS=     0.32013
NO.OF PLOTS =          46 ACRES/PLOT =     46.43 PERIOD =  1 TO 12 UNLESS SINGLE STORM INDICATED
PERIOD FACTOR =   1.00 TONS/ACRE =      0.02 ACCUMULATED TONS FOR SEG.& PERIOD =          0.99
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TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Clarke County		Oconee County		Total
	Acres	Percent	Acres	Percent	
Appling coarse sandy loam, 2 to 6 percent slopes, eroded	1,125	1.4	2,070	1.7	3,195
Appling coarse sandy loam, 6 to 10 percent slopes, eroded	750	.9	910	.8	1,660
Appling sandy clay loam, 6 to 10 percent slopes, severely eroded	185	.2	300	.3	485
Buncombe loamy sand	250	.3	375	.3	625
Cecil sandy loam, 2 to 6 percent slopes, eroded	8,670	10.8	14,8[illegible]	12.5	2[illegible],5[illegible]5
Cecil sandy loam, 6 to 10 percent slopes, eroded	6,650	8.3	11,325	9.5	1[illegible],[illegible]
Cecil sandy clay loam, 2 to 6 percent slopes, severely eroded	3,010	3.8	4,100	3.4	7,110
Cecil soils, 0 to 2 percent slopes, overwash	580	.7	680	.6	1,260
Chewacla soils and Alluvial land	1,400	1.8	910	.8	2,310
Colfax sandy loam, 2 to 6 percent slopes	200	.3	570	.5	8[illegible]0
Congaree soils and Alluvial land	2,950	3.7	3,8[illegible]5	3.3	6,8[illegible]5
Davidson sandy loam, 2 to 6 percent slopes, eroded	1,080	1.4	1,620	1.4	2,700
Davidson sandy loam, 6 to 10 percent slopes, eroded	1,255	1.6	2,070	1.7	3,325
Davidson sandy loam, 15 to 25 percent slopes, eroded	1,000	1.3	1,320	1.1	2,320
Davidson clay loam, 2 to 6 percent slopes, severely eroded	700	.9	1,150	.9	1,850
Davidson clay loam, 6 to 10 percent slopes, severely eroded	1,220	1.5	1,750	1.6	2,970
Davidson clay loam, 10 to 15 percent slopes, severely eroded	1,040	1.3	1,500	1.3	2,540
Davidson clay loam, 15 to 25 percent slopes, severely eroded	710	.9	900	.7	1,610
Louisburg loamy sand, 6 to 10 percent slopes	115	.1	235	.2	350
Louisburg loamy sand, 10 to 25 percent slopes	430	.5	765	.6	1,195
Louisburg stony loamy sand, 10 to 25 percent slopes	400	.5	635	.5	1,035
Madison sandy loam, 2 to 6 percent slopes, eroded	2,425	3.0	3,140	2.6	5,565
Madison sandy loam, 6 to 10 percent slopes, eroded	1,360	1.7	2,070	1.7	3,430
Madison sandy loam, 10 to 15 percent slopes, eroded	1,550	1.9	2,170	1.8	3,720
Madison sandy loam, 15 to 25 percent slopes, eroded	5,050	6.3	6,900	5.8	11,950
Madison sandy clay loam, 2 to 6 percent slopes, severely eroded	300	.4	330	.3	630
Madison sandy clay loam, 6 to 10 percent slopes, severely eroded	1,050	1.3	2,170	1.8	3,220
Madison sandy clay loam, 10 to 25 percent slopes, severely eroded	5,700	7.2	8,275	6.9	13,975
Madison-Louisa complex, 6 to 10 percent slopes, eroded	60	[1]	430	.4	490
Madison-Louisa complex, 10 to 15 percent slopes, eroded	190	.2	750	.6	940
Madison-Louisa complex, 15 to 25 percent slopes, eroded	1,550	1.9	2,545	2.1	4,095
Musella clay loam, 15 to 25 percent slopes, eroded	425	.5	855	.7	1,280
Pacolet sandy loam, 10 to 15 percent slopes, eroded	3,960	5.0	5,150	4.3	9,110
Pacolet sandy clay loam, 6 to 10 percent slopes, severely eroded	7,030	8.8	9,620	8.1	16,650
Pacolet stony sandy loam, 6 to 15 percent slopes, eroded	270	.3	260	.2	530
Pacolet stony sandy loam, 15 to 25 percent slopes, eroded	260	.3	475	.4	735
Pacolet sandy clay loam, 10 to 15 percent slopes, severely eroded	7,160	8.9	8,470	7.1	15,630
Pacolet-Gullied land complex, 6 to 10 percent slopes	1,970	2.5	3,530	3.0	5,500
Pacolet-Gullied land complex, 10 to 25 percent slopes	3,130	3.9	5,890	4.9	9,020
Rock outcrop	6	[1]	75	[1]	81
Wehadkee and Alluvial land, wet	2,120	2.7	3,195	2.7	5,315
Worsham sandy loam, 2 to 6 percent slopes	410	.5	530	.4	940
Total	80,000	100	119,040	100	199,040

[1] Less than 0.1 percent.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. The capability unit, woodland group, and wildlife group in which the mapping unit has been placed, and the pages on which each of these groupings is described, can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Alluvial Land

Alluvial land is a nearly level miscellaneous land type consisting of sediments recently deposited by water on the flood plains of streams. It is subject to varying intensities of flooding. From the surface downward, the sediments vary greatly in thickness, color, and texture. Internal drainage ranges from good to poor.

Alluvial land is not mapped separately in this survey area but is mapped in undifferentiated units with Chewacla, Congaree, and Wehadkee soils. It is described in more detail under mapping units of the Chewacla, Congaree, and Wehadkee series.

Appling Series

The Appling series consists of well drained soils on uplands. These soils have formed over weathered material derived from granite and granite-gneiss, in many places mixed with some material from mica schist. The slopes range from 2 to 10 percent but are mostly between 3 and 7 percent.

In many areas where no erosion or only moderate erosion has taken place, the surface layer is grayish-brown coarse sandy loam about 4 to 11 inches thick. The subsoil is generally sandy clay loam to clay or clay loam. Distinct mottles begin at some depth between 12 and 20 inches. Bedrock is at a depth of 6 to 10 feet. The profile of these soils is strongly acid throughout.

Appling soils are commonly adjacent to Madison, Cecil, and Davidson soils, but they have a predominantly coarser textured surface layer than do those soils. Also, their subsoil is less micaceous than that of the Madison soils and less reddish than those of the Cecil and Davidson soils.

Originally, the Appling soils had a cover of hardwoods. The trees were mainly oaks and hickories, but yellow-poplars grew in places. Most of the acreage has been cleared, but many of the fields that were formerly cleared and cultivated have reverted to forests of loblolly and shortleaf pines. Now, a large part of the acreage is in trees, although many areas are still cultivated or used for pasture. Cotton, corn, small grains, and lespedeza are commonly grown in the less sloping areas. The steeper and eroded areas are commonly used for pasture.

Representative profile of Appling coarse sandy loam, 2 to 6 percent slopes, eroded (three-fourths of a mile south of the railroad station at Farmington and 100 yards east of U.S. Highway No. 441, Oconee County):

Ap—0 to 6 inches, grayish-brown (2.5Y 5/2) coarse sandy loam; weak, fine, granular structure; very friable; numerous fine roots; strongly acid; abrupt, smooth boundary.

B1t—6 to 9 inches, strong-brown (7.5YR 5/6) sandy clay loam; moderate, medium and coarse, subangular blocky structure; friable to slightly firm; [illegible] common; slight mixing with material from the Ap horizon; strongly acid; clear, smooth boundary.

B21t—9 to 12 inches, strong-brown (7.5YR 5/6) clay; moderate, medium and coarse, subangular blocky structure; firm; a few clay films on ped faces; some fine mica flakes; strongly acid; clear, smooth boundary.

B22t—12 to 25 inches, yellowish-red (5YR 5/6) clay; a few, fine, distinct, red (10R 4/6) mottles; moderate, medium and coarse, subangular blocky structure; firm; a few clay films on ped faces; common fine mica flakes; strongly acid; diffuse, wavy boundary.

B3—25 to 36 inches, prominently mottled red (10R 4/6) and yellowish-brown (10YR 5/6) clay loam; mottles are many and coarse; weak, coarse, subangular blocky structure; very friable; many fine and medium mica flakes and a few lumps of soft, nearly white feldspar; strongly acid; diffuse, wavy boundary.

C—36 to 58 inches, yellowish-brown (10YR 5/6), micaceous, loamy material; coarse, red (10R 4/6) mottles; lumps of nearly white feldspar; massive; very friable; contains some mica.

In the less eroded areas of these soils, the A horizon ranges from 4 to 11 inches in thickness and from brown or light yellowish brown to dark brown, dark grayish brown, or grayish brown in color. The dominant texture of the A horizon is coarse sandy loam, but the texture ranges to sandy clay loam. Where severely eroded areas of these soils have been cultivated, the surface layer ranges from less than 2 inches to about 4 inches in thickness. In these areas remnants of the A horizon are mixed with material from the B1t horizon in many fields, and the present surface layer is yellowish-brown sandy clay loam.

The B1t horizon ranges from strong brown to reddish yellow or yellowish red in color and from 3 to 6 inches in thickness. The B2 horizons range from strong brown to yellowish red in color and from sandy clay or clay to clay loam in texture. They have distinct or prominent, red, yellowish-brown, or brownish-yellow mottles in the lower part.

The solum ranges from about 2[illegible] to 57 inches in thickness. Depth to hard rock ranges from 6 to 10 feet.

Appling coarse sandy loam, 2 to 6 percent slopes, eroded (AaB2).—This deep soil has the profile described for the series. In most of the acreage, so much material has been removed by erosion that the plow layer now extends into the subsoil.

Included in some areas mapped as this soil are a few small areas of an uneroded soil that has a thicker surface layer. Also included are small galled spots, areas where there are a few shallow gullies, and areas of a soil that has a red or micaceous subsoil. The surface layer in the galled spots and gullied areas is reddish-yellow light sandy clay loam. In other small included areas near Watkinsville and south of Eastville, the profile is lighter colored than typical for Appling soils.

Appling coarse sandy loam, 2 to 6 percent slopes, eroded, is generally in good tilth and has a thick root zone. It is moderately permeable. The available water capacity is moderate but slightly lower than that of an uneroded Appling soil.

This soil is well suited to farming. It responds well to good management and is suited to a wide range of crops. Further erosion is a moderate hazard, however, if this soil is used for cultivated crops and is not protected.

Appling coarse sandy loam, 6 to 10 percent slopes, eroded (AaC2).—This soil has a surface layer that is 3 to 8 inches thick over a clay loam or sandy clay subsoil. It is a deep soil. In most of the acreage, however, enough soil material has been removed by erosion that the plow layer now extends into the subsoil.

Included in some areas mapped as this soil are small areas of a soil that has a thicker surface layer. Also included are small galled spots, areas where there are a few shallow gullies, and small areas of a soil that has a red subsoil. The surface layer in the galled spots and gullied areas is reddish-yellow light sandy clay loam.

This Appling soil is in good tilth and has a thick root zone. The rate of infiltration is slightly slower, and the available water capacity is lower than in a less sloping Appling soil. Permeability and the available water capacity are moderate.

This soil is suitable for farming. It responds well to good management and is suited to a wide range of crops. The hazard of further erosion is moderate to severe, however, if cultivated crops are grown and the soils are not protected. Nearly half of the acreage is in [illegible] or in volunteer loblolly pines, part is in pasture, and the rest is tilled.

Appling sandy clay loam, 6 to 10 percent slopes, severely eroded (AnC3).—Erosion has removed most of the original surface layer of this soil, and in places the upper part of the subsoil. The areas have been cut by shallow gullies and by a few deep ones. The present surface layer is yellowish-brown sandy clay loam about 3 inches thick. In most cultivated areas, it is a mixture of the remnants of the original surface layer and the upper part of the subsoil. The subsoil is sandy clay or clay and has distinct or prominent, yellowish-red and red mottles in the lower part.

Surface runoff is rapid, and the hazard of further erosion is severe if this soil is cultivated and is not protected. Tilth is poor because of the high content of clay in the surface layer.

This soil is better suited to close-growing crops, pasture, and trees than to cultivated crops. It can be cultivated only within a narrow range of moisture content. Because of the slopes and hazard of erosion, the soil is not suited to intensive cultivation. Cultivated crops are grown to some extent, but many areas, formerly cultivated, are reverting to trees.

Time

A long period of time is generally required for the formation of a soil. Differences in the length of time the parent material has been in place are reflected in the characteristics of the soil profile. The soils of the two counties range widely in development of their genetic horizons. Where the soil material has been in place for a long time, the soils generally have more distinct horizons than where the soil material has been deposited fairly recently. Cecil and Davidson soils are examples of ones formed in material that has been in place for a long period of time. They are considered to be old soils.

Most soils in the survey area have distinct horizons. The surface soil contains an accumulation of organic matter, and silicate clay minerals have formed and moved downward to produce horizons that are relatively high in content of clay. Also, oxidation or reduction of iron has had its effect on such soils. The extent to which the soils are affected depends on the natural drainage. Many of the soils are well enough drained that they have a red or dark red subsoil and contain highly oxidized iron. A few have impaired drainage, and consequently, have a gray subsoil that contains reduced iron. In addition, leaching of soluble calcium, magnesium, potassium, and other weatherable products has caused a resulting increase in exchangeable hydrogen.

Buncombe, Congaree, and Chewacla soils of the flood plains are examples of young soils. Their parent material has not been in place long enough for a distinct profile to have formed. Their profile shows little development other than darkening of the surface layer with organic matter. Many of the soils of uplands, on the other hand, have strongly contrasting horizons of an ABC sequence, indicating relative maturity.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First, through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands, in developing rural areas; in performing engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as counties and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (3) and later revised (5). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study (4, 7). Therefore, readers interested in developments of this system should search the latest literature available.

New soil series must be established, and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at State, regional, and national levels of responsibility for soil classification result in a judgment that the new series should be established. All but one of the soil series described in this publication have been established earlier. The Pacolet series had tentative status when the survey was sent to the printer.

In table 7 some of the classes in the current system (7) are given for each soil series. The classes in the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates.

Table 7 shows the three soil orders in Clarke and Oconee Counties—Entisols, Inceptisols, and Ultisols. Entisols are recent mineral soils that do not have genetic horizons or have only the beginnings of such horizons. Because Inceptisols generally form on young but not recent land surfaces, their name is derived from the Latin *inceptum*, for beginning. Ultisols have a clay-enriched B horizon that has less than 35 percent base saturation. In these soils the base saturation decreases with increasing depth.

TABLE 7.—*Classification of soil series in Clarke and Oconee Counties, Ga.*

Series	Family	Subgroup	Order
Appling	Clayey, kaolinitic, thermic	Typic Hapludults	Ultisols.
Buncombe	Mixed, thermic	Typic Udipsamments	Entisols.
Cecil	Clayey, kaolinitic, thermic	Typic Hapludults	Ultisols.
Chewacla	Fine-loamy, mixed, thermic	Aquic Fluventic Dystrochrepts	Inceptisols.
Colfax	Fine-loamy, mixed, thermic	Aquic Fragiudults	Ultisols.
Congaree	Fine-loamy, mixed, nonacid, thermic	Typic Udifluvents	Entisols.
Davidson	Clayey, kaolinitic, thermic	Rhodic Paleudults	Ultisols.
Louisa	Loamy, micaceous, thermic, shallow	Ruptic-Ultic Dystrochrepts	Inceptisols.
Louisburg	Coarse-loamy, mixed, mesic	Typic Dystrochrepts	Inceptisols.
Madison	Clayey, kaolinitic, thermic	Typic Hapludults	Ultisols.
Musella	Fine-loamy, mixed, thermic	Typic Rhodudults	Ultisols.
Pacolet	Clayey, kaolinitic, thermic	Typic Hapludults	Ultisols.
Wehadkee	Fine-loamy, mixed, nonacid, thermic	Fluventic Haplaquepts	Inceptisols.
Worsham	Clayey, mixed, thermic	Typic Ochraquults	Ultisols.

SUBORDER. Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes having the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have a pan interfering with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 7, because it is the last word in the name of the subgroup.

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Fluventic Haplaquepts.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils where used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. An example is the fine-loamy, mixed, nonacid, thermic family of Fluventic Haplaquepts.

Additional Facts About Clarke and Oconee Counties

This section tells about the climate, physiography, drainage, and water supply in the survey area. It also gives facts about the industries, transportation, and markets, and briefly describes the agriculture. The agricultural statistics used are mainly from records of the U.S. Bureau of the Census.

Originally, Clarke County was somewhat larger than it is today, but part of it was used to form Oconee County in 1875. Clarke County was named for General Elijah Clarke, a leader in the Revolutionary War. Oconee County was named for the Oconee River, which forms most of its eastern boundary. Athens, the home of the University of Georgia, is the county seat of Clarke County. Watkinsville is the county seat of Oconee County.

The total population of the two counties was about 53,000 in 1960. Athens had a population of [illegible] in 1960, exclusive of college students.

Climate*

The climate of Clarke and Oconee Counties is influenced by the Atlantic Ocean 200 miles to the southeast and by the Gulf of Mexico 275 miles to the south. It is also influenced, to some extent, by the [illegible] mountains to the north and northwest. These mountains serve as a partial barrier to the masses of cold air that move in from the north and northwest. [illegible] gives data about temperature and [illegible] for the two counties. Tables 9, 10, and 11 provide supplementary information about the amount and distribution of rainfall, and table 12 gives the probabilities of the last freezing temperatures in spring and the first in fall.

* By HORACE S. CARTER, State climatologist, U.S. Weather Bureau, Athens, Ga.

TABLE 8.—*Temperature and precipitation data for Clarke and Oconee Counties, Ga.*

[Based on records for 10-year period 1954 through 1963]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Temperature: 2 years in 10 will have at least 4 days with—: Maximum temperature equal to or higher than—	Temperature: 2 years in 10 will have at least 4 days with—: Minimum temperature equal to or lower than—	Precipitation: Average	Precipitation: 1 year in 10 will have—: Less than—	Precipitation: 1 year in 10 will have—: More than—
	°F.	°F.	°F.	°F.	Inches	Inches	Inches
January	51.6	31.5	70	20	4.80	2.5	[illegible]
February	57.0	35.1	73	20	4.70	1.7	[illegible]
March	63.4	[illegible]	79	25	5.16	[illegible]	[illegible]
April	73.3	45.6	86	35	[illegible]	1.5	[illegible]
May	82.2	57.0	92	46	3.61	[illegible]	[illegible]
June	89.2	65.0	96	50	[illegible]	1.4	[illegible]
July	90.2	69.2	96	61	[illegible]	1.2	[illegible]
August	89.6	68.4	96	62	[illegible]	1.0	[illegible]
September	84.4	62.8	94	51	3.02	.8	[illegible]
October	75.1	50.8	85	30	2.80	.3	[illegible]
November	63.3	39.6	76	20	[illegible]	[illegible]	[illegible]
December	54.8	34.4	69	20	4.53	1.2	[illegible]
Year	73.1	50.6	99	15	48.53	40.6	[illegible]

TABLE 9.—*Average number of days per year (by months) that have rainfall equal to or greater than the stated amounts*

[Based on records for 10-year period 1954 through 1963]

Rainfall equal to or greater than—	Average number of days in—												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Inches													
0.10	7	8	6	6	6	6	8	5	4	4	6	6	74
.25	5	5	6	5	4	4	6	3	3	2	4	4	51
.50	3	4	4	4	3	3	4	2	2	2	3	3	37

TABLE 10.—*Total number of days in 10 years (by months) that have rainfall equal to or greater than the stated amounts*

[Based on records for 10-year period 1954 through 1963]

Rainfall equal to or greater than—	Total number of days in—												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	10-year period
Inches													
1	16	17	11	13	12	10	16	7	12	5	9	9	137
2	1	3	2	3	3	1	5	3	6	2	1	1	31
3	0	0	0	0	1	1	1	0	2	0	0	0	5
4	0	0	0	0	0	1	0	0	1	0	0	0	2

TABLE 11.—*Total number of 2-week, 4-week, and 6-week periods in 10 years (by months) with no day having 0.25 inch or more of precipitation*

[Based on records for 10-year period 1954 through 1963]

Periods equal to or greater than—[1]	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total in 10-year period
2 weeks	3	5	1	3	5	10	3	8	10	8	7	10	73
4 weeks	1	0	0	0	3	2	0	3	0	5	0	1	15
6 weeks	0	0	0	0	0	1	0	0	0	2	0	0	3

[1] Periods are listed in the month during which the greater part of the precipitation occurred.

TABLE 12.—*Probabilities of the last freezing temperatures in spring and the first in fall*

Probability	Dates for given probability and temperature		
	24° F. or lower	28° F. or lower	32° F. or lower
Spring:			
1 year in 10 later than	March 16	March 30	April 15
2 years in 10 later than	March 7	March 22	April 10
5 years in 10 later than	February 21	March 11	March 26
Fall:			
1 year in 10 earlier than	November 20	November 5	October 25
2 years in 10 earlier than	November 25	November 10	November 3
5 years in 10 earlier than	December 2	November 20	November 10

Summers are moderately warm and somewhat humid, but there is a noticeable absence of extended periods of hot weather. A temperature of 90° F. or higher can be expected on about half the days during June, July, and August, but a temperature of 100° or higher occurs only about 1 year in 3. The hottest weather usually occurs in several short spells rather than in one long, continuous period. In summer, the nights are mild, but the temperature usually drops to the sixties by early morning.

Winters are generally rather mild. The cold spells that do occur usually persist for only a few days, even in midwinter. A temperature of 32° or below occurs on an average of about 50 days each winter. In more than half the months in winter, the temperature drops below 20° at least once, and it drops as low as 10° about 1 year in 4.

The rolling hills and valleys are conducive to large local variations in winter temperatures. On clear, calm mornings in winter, temperatures are likely to be several degrees colder in low areas than on adjacent slopes. A knowledge of the variations in temperature in different areas can be useful in selecting crops for a specific area and in planning a schedule for planting in spring.

The average freeze-free season is about 225 days in length. Normally, it extends from near the end of March to about November 10. Differences in terrain may cause rather large local variations, however, in the length of the growing season.

Spring is usually wetter than fall in these two counties. It is normally more windy and slightly cooler than fall, although both seasons are generally mild. Several periods of stormy weather can be expected in most springs, and the frequency of thunderstorms gradually increases as summer approaches. Fall is characterized by long periods of fine weather, when the days are mild and sunny and the nights are crisp and clear.

Precipitation is well distributed. The average amount received annually is nearly 49 inches (see table 8). March and July are normally the wettest months, and October and November are the driest. Much of the cool season precipitation occurs as rainfall that lasts for several hours and covers a large area. Most of the precipitation in cool seasons results from the interaction between masses of warm, moist air from the south and masses of cold air from the north. The low-pressure systems and weather fronts associated with these masses of air are generally extensive and may result in rainfall that covers a large area and lasts for several hours. In summer, rainfall occurs primarily as local showers, normally of short duration. During these brief showers, rainfall is sometimes very intensive.

The total amounts of monthly and annual rainfall vary greatly from year to year. The total annual rainfall in Athens, for example, has ranged from 75.50 inches, received in 1929, to only 28.61 inches, received in 1951. Also the total monthly precipitation has ranged from 15.07 inches in June 1963 to none in October 1963. The annual total is between 40 and 60 inches in about 4 out of 5 years. Thunderstorms are to be expected on about 50 days each year. About half of this number of days occurs in June, July, and August. Occasionally, the more intense storms are accompanied by damaging winds and hail. Tornadoes are infrequent, but three or four have been reported in the two counties.

Traces of snow occur nearly every year, but a measurable amount has been reported in less than half the total number of years of record. In about 1 year out of [illegible] accumulation of snow is to be expected. The heaviest snowfall of record occurred in March [illegible], when 10 inches was measured.

The average relative humidity ranges from [illegible] to [illegible] percent early in the morning and [illegible] early in the afternoon. Dense fog [illegible] about 30 days each year. Fog generally occurs early in the morning but normally lasts for only a few hours.

The average hourly windspeed ranges from about 6.5 miles per hour in August to slightly more than 10 miles per hour in February and March. [illegible] of the prevailing winds is southwesterly. During [illegible] months, the prevailing [illegible] from west [illegible], through north, to east northeast.

Physiography, Drainage, and Water Supply

Clarke and Oconee Counties are entirely within the Piedmont Plateau. Formerly, the area appears to have been a broad, fairly smooth plain. During a long period of erosion, however, the larger streams cut valleys having strongly sloping walls. The smaller streams have not dissected the area nearly so deeply, [illegible] smooth plains.

A large part of the survey area is drained by the Oconee River and its tributaries. Sandy Creek is the main tributary that drains the northern part of Clarke County. [illegible] and McNutt Creeks are the main [illegible] western part [illegible] River, which forms the southwestern [illegible] County. In these two counties the [illegible] high in April and May and low in October and November.

Water for the city of Athens is taken from Sandy Creek. Water is also piped to other towns in Clarke County and to towns in the northern part of Oconee County. Water for Watkinsville is [illegible] feet deep and yields about 120 gallons per minute. On many farms water for kitchen use is pumped from dug or drilled wells that yield about 4 gallons per minute. [illegible] wells are generally 40 to 60 feet deep, but a few are more than 100 feet deep. Streams and farm ponds supply most of the water for livestock.

Industries, Transportation, and Markets

Many small industries and other enterprises of moderate size are located in Clarke and Oconee Counties. [illegible] include several sewing plants, two [illegible] where paper [illegible] are manufactured, a factory where electrical transformers are fabricated, and [illegible] shops. Families on almost every farm have at least one member who is employed at a factory or plant.

The two counties are served by U.S. Highways Nos. 29, 78, 441, and 129, and State Highways Nos. 8, 10, 15, 24, 53, and 106. All of these highways and most of the county roads are paved. In addition, two railways and several motor freight lines pass through the area.

Cotton and other farm products are marketed at Athens. Chickens and other kinds of livestock are also marketed there.

Agriculture

Before white settlers arrived in the area that is now Clarke and Oconee Counties, Indians grew corn, beans, and potatoes on some of the bottom lands. After the settlers came, the land was cleared for farms, and by 1900 most of the acreage was cultivated. Since that time, however, much of the land that was formerly used for cultivated crops has reverted to woodland. Cotton, corn, and small grains are the crops now grown the most extensively.

Clarke County had a total of 279 farms in 1959, a much smaller number than were in the county in 1910. Oconee County had a total of 478, also a considerably smaller number than were in the county in 1910. The reduction in the number of farms has resulted partly because a large acreage has been taken out of production for use for residences and industries, and partly because the size of farms has increased. The average size of farms in the two counties increased from about 75 acres in 1900 to about 157 acres in 1959.

The total amount of harvested cropland declined from 53,116 acres in 1949 to 26,764 acres in 1959. The amount of acreage in wheat did not change greatly in the years between 1949 and 1959, but the acreage in cotton and corn declined somewhat during that period.

In 1959 income from the sale of poultry and poultry products in Clarke County accounted for more than half the total income derived from the sale of farm products. In the same year, income from the sale of field crops in Oconee County accounted for more than half the farm income.

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Glossary

Acidity, soil. See Reaction, soil.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of a soil to hold water in a form available to plants. The amount of moisture held in a soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, fragments of rock, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.
Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, is readily deformed by moderate pressure but can be pressed into a lump; will form a wire when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart, rather than pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard and brittle; little affected by moistening.

Drainage, soil. The rapidity and extent of the removal of water from the soil, in relation to additions, especially by runoff, by flow through the soil to underground spaces, or by a combination of both processes.

Felsic rock. A term applied to light-colored rocks containing an abundance of feldspars, quartz, or feldspathoids, and silica, or any one of these rocks alone. Contrasted with mafic rock.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residue.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active, and it is therefore marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused by (1) accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. The combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this layer is presumed to be like that from which the overlying horizons were formed. If the underlying material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or soil material.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Mafic rock. A term applied to rocks composed dominantly of the magnesian rock-forming silicates; applied to some dark-colored igneous rocks and their constituent minerals. Contrasted with felsic rock.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *Fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material. The disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See also Horizon, soil.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction, because it is neither acid nor alkaline. In words the degrees of acidity or alkalinity are expressed thus:

	pH		pH
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Residual material. Unconsolidated, partly weathered mineral material that accumulates over disintegrating solid rock. Residual material is not soil but is frequently the material in which a soil has formed.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.5 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. [illegible] In mature soil [illegible] the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have, together with the aggregates, [illegible] mass of [illegible]. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. Structureless soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are [illegible].

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt.) The basic textural classes, in order of increasing proportion of fine particles, are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geomorphology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

7-5d

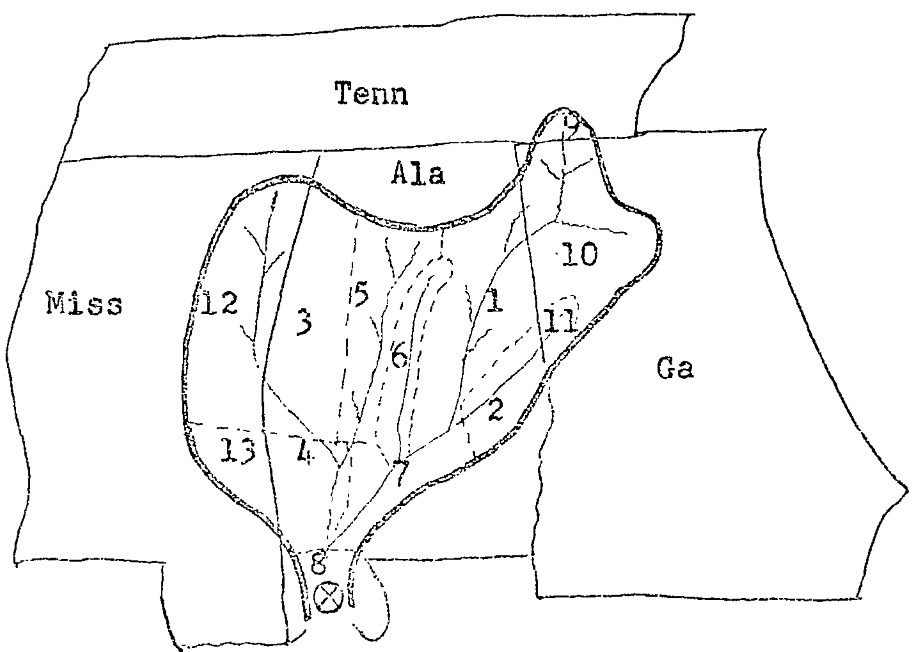
ENTIRE MOBILE RIVER MAJOR BASIN - LARGE AREA

Unit	Minor Basin #	Basin Name	Slope % Range	Unit Acres
1	35	Ala-Coosa R.	1 - 25	3,460,480
2	34	Ala-Tallapoosa R.	1 - 13	2,584,080
3	38	Ala-U. Tombigbee R.	1 - 25	2,408,960
4	40	Ala-L. Tombigbee R.	1 - 9	2,506,880
5	39	Ala-Warrior R.	1 - 25	4,015,360
6	36	Ala-Cahaba R.	1 - 25	1,196,800
7	37	Ala-Alabama R.	1 - 9	3,696,000
8	41	Ala-Mobile R.	1 - 5	1,317,760
9	35	Tenn-Coosa R.	1 - 25	128,000 E
10	35	Ga-Coosa R.	1 - 25	3,520,000 E
11	34	Ga-Tallapoosa R.	1 - 13	320,000 E
12	38	Miss-U. Tombigbee R.	1 - 25	3,584,000 E
13	40	Miss-L. Tombigbee R.	1 - 9	256,000 E
			Total	28,994,320

E - indicates estimates as a percentage of total state area.

Literature derived Solutions:
U.S. Army Corps of Engineers 12 year annual average 4.7 Million tons of suspended sediment (1952-1963).
100 year total sediment estimate 331 Million tons (1871-1971).

Process Solutions - Exhibits TC3(1 & 2):
Best Case (Lowest Sediment/Erosion Ratio) 3.34 Million tons.
Worst Case (Highest Sediment/Erosion Ratio) 7.38 Million tons.
Note - Same Sediment in-stream migration factors used in both.



Units are bounded by State Lines, Minor River Basin Lines and heavy Major River Basin lines.

MOBILE RIVER BASIN - SEDIMENTATION & RURAL RUNOFF — EXHIBIT TC3 (20 % SED.)

INVOLVING MINOR RIVER BASINS IN ALABAMA, GEORGIA, MISSISSIPPI AND TENNESSEE — PLOT SIZE = 100 ACRES

UNITS 1=AL35C,2=AL34T,3=AL38UT,4=AL40LT,5=AL39W,6=AL36CAH,7=AL37A,8=AL41M
UNITS TENN. 1=TN35C, GA. 1=GA35C,2=GA34T, MISS. 1=MS38UT,2=MS40LT (ST-RB#-RN)
**** PERIOD MONTHS 1 - 12

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	TO WATER BODIES: SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(100.0)	3460480.00	19969504.0	3562402.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(100.0)	2584080.00	6659744.00	1204265.00	0.0	0.	0.	0.	0.	0.	0.
3 LAND	(100.0)	2408960.00	14756906.0	5269725.00	0.0	0.	0.	0.	0.	0.	0.
4 LAND	(100.0)	2506880.00	5232227.00	1892488.00	0.0	0.	0.	0.	0.	0.	0.
5 LAND	(100.0)	4015360.00	24574112.0	4421305.00	0.0	0.	0.	0.	0.	0.	0.
6 LAND	(100.0)	1196800.00	7343132.00	2635201.00	0.0	0.	0.	0.	0.	0.	0.
7 LAND	(100.0)	3696000.00	5862596.00	1069163.00	0.0	0.	0.	0.	0.	0.	0.
8 LAND	(100.0)	1317760.00	7938359.00	1567205.00	0.0	0.	0.	0.	0.	0.	0.
ALABAMA	TOTALS	21186320.0	92336544.0	21621728.0	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(100.0)	128000.00	950762.00	219187.69	0.0	0.	0.	0.	0.	0.	0.
TENNESSEE	TOTALS	128000.00	950762.00	219187.69	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(100.0)	3520000.00	17159760.0	3057301.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(100.0)	320000.00	726079.94	130153.06	0.0	0.	0.	0.	0.	0.	0.
GEORGIA	TOTALS	3840000.00	17885824.0	3187454.00	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(100.0)	3584000.00	19844576.0	7063868.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(100.0)	256000.00	428314.06	76940.31	0.0	0.	0.	0.	0.	0.	0.
MISSISSIPPI	TOTALS	3840000.00	20272880.0	7140808.00	0.0	0.	0.	0.	0.	0.	0.
GRAND TOTALS		28994320.0	131446000.	32169152.0	0.0	0.	0.	0.	0.	0.	0.

(SEDIMENT MIGRATION TO A TERMINAL POINT= 3299574.00 SHORT TONS OR 4185150.00 CUBIC YARDS OR 3199901.00 CUBIC METERS)

MOBILE RIVER BASIN - SEDIMENTATION & RURAL RUNOFF
INVOLVING MINOR RIVER BASINS IN ALABAMA, GEORGIA, MISSISSIPPI AND TENNESSEE

EXHIBIT TC3 (20% SED.)
PLOT SIZE = [illegible]

UNITS 1=AL35C,2=AL34T,3=AL38UT,4=AL40LT,5=AL39W,6=AL36CAH,7=AL37A,8=AL41M
UNITS TENN. 1=TN35C, GA. 1=GA35C,2=GA34T, MISS. 1=MS38UT,2=MS40LT (S1-RB#-RN)
**** PERIOD MONTHS 1 - 12

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	* * * * TO WATER BODIES * * * *							
				SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(1860.5)	3460480.00	19584896.0	3580353.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(1608.0)	2584080.00	6790993.00	1222446.00	0.0	0.	0.	0.	0.	0.	0.
3 LAND	(1552.2)	2408960.00	14522497.0	5222879.00	0.0	0.	0.	0.	0.	0.	0.
4 LAND	(1583.6)	2305880.00	5289397.00	1889788.00	0.0	0.	0.	0.	0.	0.	0.
5 LAND	(2004.7)	4015360.00	24411608.0	4452590.00	0.0	0.	0.	0.	0.	0.	0.
6 LAND	(1995.0)	1196800.00	7394310.00	2655605.00	0.0	0.	0.	0.	0.	0.	0.
7 LAND	(1923.0)	3695000.00	5973051.00	1071746.00	0.0	0.	0.	0.	0.	0.	0.
8 LAND	(1148.9)	1317760.00	7789159.00	1535127.00	0.0	0.	0.	0.	0.	0.	0.
ALABAMA	TOTALS	21186320.0	91756080.0	21624512.0	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(358.5)	128000.00	975871.75	226849.87	0.0	0.	0.	0.	0.	0.	0.
TENNESSEE	TOTALS	128000.00	975871.75	226849.87	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(1876.3)	3520000.00	17195600.0	3063775.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(566.4)	320000.00	713225.00	129023.25	0.0	0.	0.	0.	0.	0.	0.
GEORGIA	TOTALS	3840000.60	17908816.0	3192798.00	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(1893.3)	3584000.00	19756848.0	7021163.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(506.9)	256000.00	407465.31	78728.37	0.0	0.	0.	0.	0.	0.	0.
MISSISSIPPI	TOTALS	3840000.00	20164304.0	7099891.00	0.0	0.	0.	0.	0.	0.	0.
GRAND TOTALS		28994320.0	130805056.	32144032.0	0.0	0.	0.	0.	0.	0.	0.

(SEDIMENT MIGRATION TO A TERMINAL POINT= 3340452.00 SHORT TONS OR 4237000.00 CUBIC YARDS OR 3239545.00 CUBIC METERS)

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EXHIBIT TC3 (40% SED.)

MOBILE RIVER BASIN - SEDIMENTATION & RURAL RUNOFF
INVOLVING MINOR RIVER BASINS IN ALABAMA, GEORGIA, MISSISSIPPI AND TENNESSEE

UNITS 1=AL35C,2=AL34T,3=AL38UT,4=AL40LT,5=AL39W,6=AL36CAH,7=AL37A,8=AL41M
UNITS TENN. 1=TN35C, GA. 1=GA35C,2=GA34T, MISS. 1=MS38UT,2=MS40LT (ST-RB#-RN)
**** PERIOD MONTHS 1 - 12

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	* * * * * * * * * TO WATER BODIES * * * * * * * * *							
				SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(1860.5)	3460480.00	19584896.0	7329479.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(1608.0)	2584080.00	6790993.00	2512539.00	0.0	0.	0.	0.	0.	0.	0.
3 LAND	(1552.2)	2408960.00	14522497.0	5369372.00	0.0	0.	0.	0.	0.	0.	0.
4 LAND	(1583.6)	2506880.00	5289397.00	1939481.00	0.0	0.	0.	0.	0.	0.	0.
5 LAND	(2004.7)	4015360.00	24411808.0	9120960.00	0.0	0.	0.	0.	0.	0.	0.
6 LAND	(1095.0)	1196800.00	7394310.00	2733326.00	0.0	0.	0.	0.	0.	0.	0.
7 LAND	(1923.0)	3696000.00	5973051.00	2204593.00	0.0	0.	0.	0.	0.	0.	0.
8 LAND	(1148.9)	1317760.00	7789159.00	3081611.00	0.0	0.	0.	0.	0.	0.	0.
ALABAMA	TOTALS	21186320.0	91756080.0	34291328.0	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(358.5)	128000.00	975871.75	437867.12	0.0	0.	0.	0.	0.	0.	0.
TENNESSEE	TOTALS	128000.00	975871.75	437867.12	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(1876.3)	3520000.00	17195600.0	6315445.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(566.4)	320000.00	713225.00	264860.19	0.0	0.	0.	0.	0.	0.	0.
GEORGIA	TOTALS	3840000.00	17908816.0	6580305.00	0.0	0.	0.	0.	0.	0.	0.
1 LAND	(1893.3)	3584000.00	19756848.0	7241576.00	0.0	0.	0.	0.	0.	0.	0.
2 LAND	(506.9)	256000.00	407465.31	158837.06	0.0	0.	0.	0.	0.	0.	0.
MISSISSIPPI	TOTALS	3840000.00	20164304.0	7400413.00	0.0	0.	0.	0.	0.	0.	0.
GRAND TOTALS		28994320.0	130805056.	48709888.0	0.0	0.	0.	0.	0.	0.	0.

(SEDIMENT MIGRATION TO A TERMINAL POINT= 7378743.00 SHORT TONS OR 9359133.00 CUBIC YARDS OR 7155850.00 CUBIC METERS)

8-48

```
NOTE - REMOVE ALL CARDS WITH * IN COL 69                                        *
**********  THIS THE MOBILE RIVER BASIN EXHIBIT TC3 INPUT DATA  *****************
1---0----I----10---I----20---I----30---I----40---I----50---I----60---I----70---*
12345678901234567890123456789012345678901234567890123456789012345678901234567890*
--------------------------------------------------------------------------------*
                                            MOBILE RIVER BASIN - SEDIMENTATION & RURAL RU
NOFF                         EXHIBIT TC3
                      INVOLVING MINOR RIVER BASINS IN ALABAMA, GEORGIA, MISSISSI
PPI AND TENNESSEE
UNITS 1=AL35C,2=AL34T,3=AL38UT,4=AL40LT,5=AL39W,6=AL36CAM,7=AL37A,8=AL41M
UNITS TENN. 1=TN35C, GA. 1=GA35C,2=GA34T, MISS. 1=MS38UT,2=MS40LT (ST-RBB-NN)
                                         01 12          4
                                         01 ALABAMA              08
*1                                       06  3460480
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          13   12
*4                                        15  .08 35  .01 47 .005  2  .01  1  1.0
*5                                        15  .50 35 1.00 47 1.00  2 1.00  1 1.30
*6                                        4030                          1009
*7
*8
*9
*1                                       06  2584080
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          07   06
*4                                        20  .08 45  .01 34 .005  0  .01  1  1.0
*5                                        20  .50 45 1.00 34 1.00  0 1.00  1 1.30
*6                                        4030                          0100
*7
*8
*9
*1                                       05  2408960
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          13   12
*4                                        20  .08 38  .01 40 .005  1  .01  1  1.0
*5                                        20  .50 38 1.00 40 1.00  1 1.00  1 1.30
*6                                        4030                          2019
*7
*8
*9
*1                                       07  2506880
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          05   04
*4                                        20  .08 38  .01 40 .005  1  .01  1  1.0
*5                                        20  .50 38 1.00 40 1.00  1 1.00  1 1.30
*6                                        4030                          2019
*7
*8
*9
*1                                       03  4015360
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          13   12
*4                                        26  .08 35  .01 35 .005  3  .01  1  1.0
*5                                        26  .50 35 1.00 35 1.00  3 1.00  1 1.30
*6                                        4030                          0100
*7
*8
*9
*1                                       03  1195800
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          13   12
*4                                        26  .08 35  .01 37 .005  1  .01  1  1.0
*5                                        26  .50 35 1.00 37 1.00  1 1.00  1 1.30
*6                                        4030                          2524
*7
*8
*9
*1                                       06  3696000
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          05   04
*4                                        20  .08 44  .01 34 .005  1  .01  1  1.0
*5                                        20  .50 44 1.00 34 1.00  1 1.00  1 1.30
*6                                        4030                          2524
*7
*8
*9
*1                                       09  1317760
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          03   02
*4                                        20  .08 30  .01 30 .005 10  .01 10  1.0
*5                                        20  .50 30 1.00 30 1.00 10 1.00 10 1.30
*6                                        4030                          4039
*7
*8
*9
                                         47 TENNESSEE            01
*1                                       09   128000
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          13   12
*4                                        15  .08 13  .01 60 .005  1  .01  1  1.0
*5                                        15  .50 13 1.00 60 1.00  1 1.00  1 1.30
*6                                        4030                          0100
*7
*8
*9
                                         13 GEORGIA              02
*1                                       01  3520000
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          13   12
*4                                        20  .08 35  .01 43 .005  1  .01  1  1.0
*5                                        20  .50 35 1.00 43 1.00  1 1.00  1 1.30
*6                                        4030                          0100
*7
*8
*9
*1                                       04   320000
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          07   06
*4                                        20  .08 45  .01 33 .005  1  .01  1  1.0
*5                                        20  .50 45 1.00 33 1.00  1 1.00  1 1.30
*6                                        4030                          0100
*7
*8
*9
                                         28 MISSISSIPPI          02
*1                                       04  3584000
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          13   12
*4                                        15  .08 43  .01 40 .005  1  .01  1  1.0
*5                                        15  .50 43 1.00 40 1.00  1 1.00  1 1.30
*6                                        4030                          2019
*7
*8
*9
*1                                       05   256000
*2                                        10   .1 50   .2 25   .3 10   .4  5   .5
*3                                          05   04
*4                                        20  .08 38  .01 40 .005  1  .01  1  1.0
*5                                        20  .50 38 1.00 40 1.00  1 1.00  1 1.30
*6                                        4030                          2019
*7
*8
*9
```

Copied from Ref. 12.

Siltation

Alabama's estuaries are all relatively shallow. No one knows their original depth, but the Spanish and French explorers found Mobile Bay and Delta too shallow for their ships in the early 1700's. In more modern times these areas are open for ships and barges only because of constant channel dredging and maintenance by the U.S. Corps of Engineers.

Siltation is not just a local problem. The estuaries are also threatened by siltation from upstream sources. Poor land management and misuse of technology throughout the Mobile River drainage basin causes various forms of soil erosion, which results in siltation of rivers and streams. Some silt is carried downstream until it reaches the estuary, and there is it deposited as the river loses speed. Stream and lake damage occurs from improper land use near the source, at downstream locations, and finally in Mobile Delta and Mobile Bay. Failure of developers to properly provide for erosion control results in excessive land erosion. This is true with many types of land use, such as strip mining; clear cutting of forests; road construction; construction of impoundments; clearing of large land areas for development of industries, shopping centers, residential housing subdivisions, and even individual homes; and some types of farm land use. Sediment deposited in the estuaries may originate from Mississippi, Alabama, Georgia, or Tennessee, Figure 9.

The constant depositing of sediment in the estuaries is literally causing Mobile Delta and Mobile Bay to fill up. The process begins by submerged land becoming marsh or tidal land; later the marsh land becomes dry land. The end result is the loss of the area's valuable estuarine characteristics. The Mobile River system carries 4.7 million tons of sediment per year into the Mobile Delta and Bay, Table 4. It is esti-

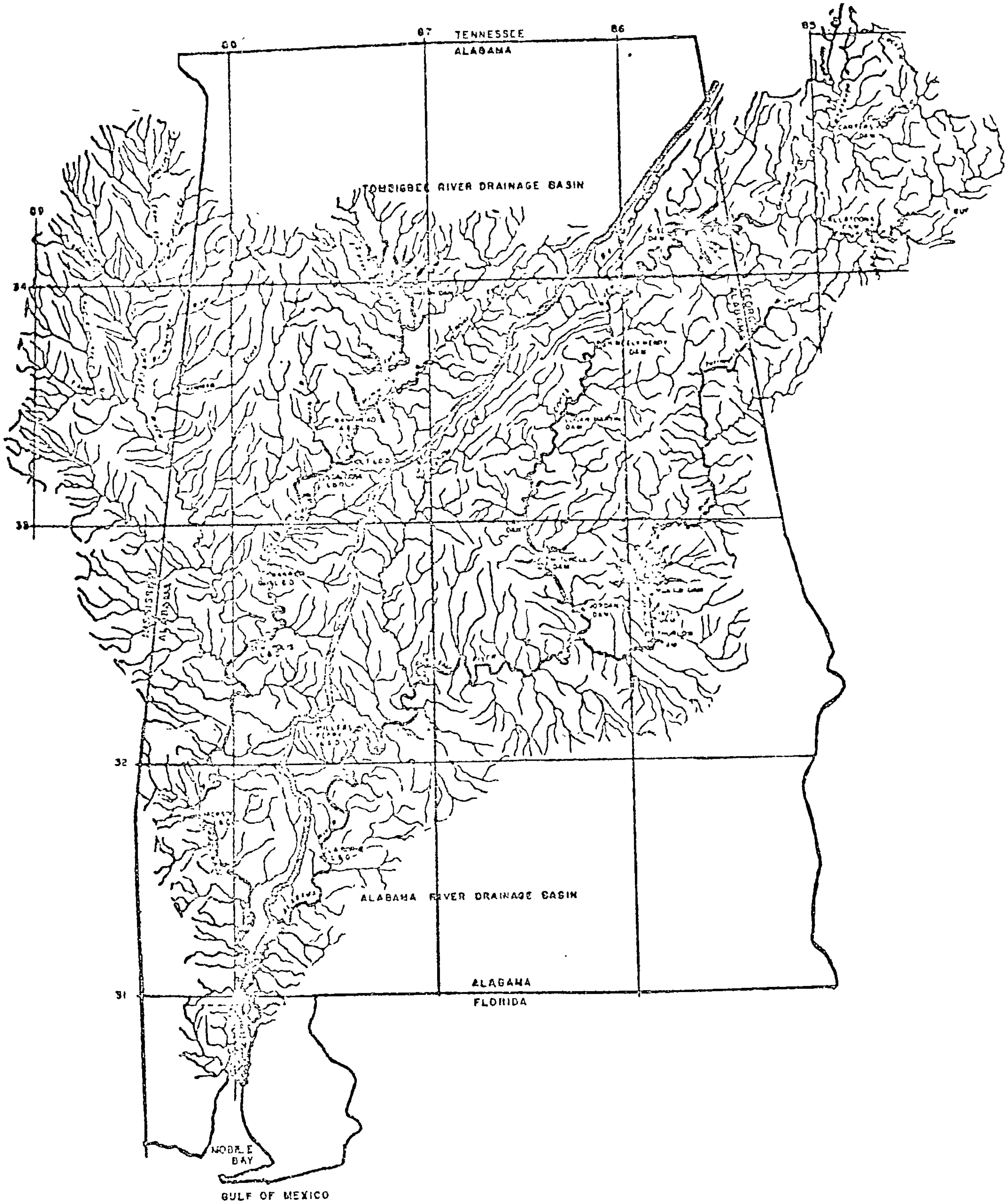

FIG. 9. Mobile River drainage basin.

Source: U.S. Army Corps of Engineers

mated that during the last 110 years this region filled up at a rate of 1.7 feet per century (some places at the rate of 3 feet). Such changes in bottom elevation, though small, will in time cause drastic alterations in the characteristics of the estuaries.

Table 4. Suspended Sediment Load (12-year monthly average) Tombigbee and Alabama River Systems (1952-1963)

Month	Tombigbee River[1]	Alabama River[2]	Combined Total
	-------------------------Tons-------------------------		
January	335,661	240,899	576,560
February	519,171	385,863	905,034
March	558,482	472,974	1,031,456
April	378,742	437,710	816,452
May	181,524	207,015	388,539
June	48,253	112,583	160,836
July	71,963	88,089	160,052
August	12,308	42,620	54,928
September	13,794	49,216	63,010
October	18,670	44,550	63,220
November	65,529	51,969	117,498
December	191,090	186,670	337,760
Annual totals	2,395,187	2,320,158	4,715,345

Source: Unpublished data--U.S. Army Corps of Engineers, Mobile District. Based on daily suspended sediment data. Average monthly data derived from Corps data by J. J. Ryan, Florida State University.

[1]Station near Leroy, Alabama.

[2]Station at Claiborne, Alabama.

As shown by Figure 9, the Mobile River system drains some 64 per cent of Alabama and portions of three adjoining states. The flow from these areas contains not only sediment but often municipal and industrial pollution. This is especially true during periods of high rainfall and heavy runoff when all upstream deposits are "flushed out."

```
      C      WIDE AREA EROSION LOSS, SEDIMENTATION MOVEMENT AND RURAL RUNOFF
      C        PREDICTION PROCESS.
      C      HOWARD A. TRUE - JUNE 1974.
      C      SAD DIV. EPA-SERL, ATHENS, GA. PHONE 404-546-3139.
             DIMENSION IST(56,19), PF(34,14),IT2(100),ISN(5),SLP(100),SLL(100)
             DIMENSION SEF(100),CM(100),EC(100),SD(100),DV(3,3,10),SR(100)
             COMMON IST,PF,IT2,ISN,SLP,SLL,SEF,CM,EC,SD,DV,NI,TSEGT,SR
             COMMON ISSW,VRSS,IPS,IPF,XPF,IRF,ICD,IK,VK,ISPI,ILLI,VLS,IC,VC,IP
             COMMON VP,NP,SGPLS,VA,ISC,ICNT,ACSG,SDNF,SDPF,SDKF
             COMMON XPSL,XSLG,XSLD,SDA,XSLGD,SDD
             COMMON ISE1,ISE2,ISE3,ISE4,ISE5,SEF1,SEF2,SEF3,SEF4,SEF5
             COMMON ICM1,ICM2,ICM3,ICM4,ICM5,CMF1,CMF2,CMF3,CMF4,CMF5
             COMMON IEC1,IEC2,IEC3,IEC4,IEC5,ECF1,ECF2,ECF3,ECF4,ECF5
             COMMON IS,SYF,TSEGY,SEDET,SEDCY,SEDCM,VR,SDBOD,SDTOC,SRESP,SRESD
      C      HOUSEKEEPING.
             ISSW = 1
             ISSWT = 1
             ISSWP = 1
             ISSWD = 1
             ISSC  = 1
             IN1 = 0
             IN2 = 0
             ISW1= 1
             ISW2= 2
      C      SET DV TO ZERO.
             DO 54 I=1,3
             DO 54 J=1,3
             DO 54 K=1,10
          54 DV(I,J,K) = 0.0
             DO 79 I = 1,56
             DO 79 J = 1,19
          79 IST(I,J) = 0
             DO 89 I=1,34
             DO 89 J=1,14
          89 PF(I,J) = 0.0
      C      READ STATE SEGMENT TABLES EI CODES & R VALUES.
         110 READ(5,111) (IST(56,J),J=1,19)
         111 FORMAT(I2,18X,9I2,2X,9I3,13X)
             IF(IST(56,1)-99) 113,119,119
         113 IF(IST(56,1)-55) 115,115,110
         115 CONTINUE
             II = IST(56,1)
             DO 117 J=1,19
         117 IST(II,J) = IST(56,J)
             GO TO 110
      C      READ EP FACTORS, BUILD PF TABLE.
         119 CONTINUE
         120 READ(5,121) (PF(34,J),J=1,13)
         121 FORMAT(F2.0,18X,12F5.2)
             IF(PF(34,1)-99.)123,135,135
         123 PF(34,14) =1.0
         125 CONTINUE
             JT = PF(34,1) + .5
              DO 136 J=1,14
         136 PF(JT,J) = PF(34,J)
             GO TO 120
         135 CONTINUE
      C      READ TOTAL AREA DATA - AREA CARDS 1-6.
```

```
  300 READ(5,301) (IT2(I),I=1,20)
      READ(5,301) (IT2(I),I=21,40)
      READ(5,301) (IT2(I),I=31,50)
      READ(5,301) (IT2(I),I=51,70)
      READ(5,301) (IT2(I),I=61,80)
      READ(5,301) (IT2(I),I=81,100)
  301 FORMAT(20A4)
C     READ AREA CARD #7.
      READ(5,303) IPS,IPF,IRNS,ICTS,LT,LP,LD
  303 FORMAT(40X,I2,I3,1X,I7,I3,1X,3I1)
      ISSS = ICTS
      ISSWT = ISSWT + LT
      ISSWP = ISSWP + LP
      ISSWD = ISSWD + LD
      ISSC = ISSC + LT + LP + LD
      IF(IPS.EQ. 0) GO TO 7303
      GO TO 7304
 7303 ISSW = 2
      VRSS = IPF
      IPS = 01
      IPF = 0
 7304 IF(IPF.EQ.0) IPF = 12
      IF(IRNS.EQ.0) IRNS = 3451427
C     INITIALIZE RANDOM NUMBER GENERATOR.
      CALL RNG(IRNS,IN1,IN2,ISW1)
      SEDET = 0.0
C     READ STATE CARD.
  306 READ(5,307) ISC,(ISN(J),J=1,5),ICTSS
  307 FORMAT(40X,I2,1X,5A4,I2)
      ICTSG = ICTSS
      ICNT = 0
      GO TO (9303,8301),ISSWT
 8301 CALL PRTTBL
      CALL LSTBL
      CALL RNOTBL(IRNS)
C     RESET TABLE SWITCH AFTER PRINTING TABLES.
      ISSWT = 1
      LT = 0
 9303 GO TO (8302,8302,8303,8303),ISSC
 8302 IF(ICTS.NE.ISSS) GO TO 8303
      CALL HEADS
 8303 CONTINUE
C
C
C       READ A LAND UNIT CARD GROUP OF 9 CARDS.
C
C
C     READ UNIT CARD #1.
  310 READ(5,311) ISGN,ACSG,SGPLS
  311 FORMAT(40X,I2,1X,F8.0,F4.0)
      ICNT = ICNT + 1
      IF(SGPLS.NE.0.0) GO TO 312
      I = SQRT(ACSG)
      SGPLS = ACSG / I
C     SEARCH TABLE AND CALCULATE PERIOD FACTOR.
  312 XSGN = IST(ISC,ISGN+1)
      DO 1305 I = 1,33
      IF(XSGN.EQ.PF(I,1)) GO TO 1306
```

```
 1305 CONTINUE
      I = 1
 1306 XPF = PF(I,IPF+2) - PF(I,IPS+1)
C     UNIT CARD #2.
C     READ SE CARD AND BUILD 100 VALUE TABLE. SEF(100)  K VALUES.
      READ(5,313) ISE1,SEF1,ISE2,SEF2,ISE3,SEF3,ISE4,SEF4,ISE5,SEF5
  313 FORMAT(40X,5(I3,F5.0))
      IS52 = ISE1 + ISE2
      IS53 = IS52 + ISE3
      IS54 = IS53 + ISE4
      IS55 = IS54 + ISE5
      DO 319 I=1,100
      IF(I.GT.ISE1) GO TO 315
      SEF(I) = SEF1
      GO TO 319
  315 IF(I.GT.IS52) GO TO 316
      SEF(I) = SEF2
      GO TO 319
  316 IF(I.GT.ISE3) GO TO 317
      SEF(I) = SEF3
      GO TO 319
  317 IF(I.GT.IS54) GO TO 318
      SEF(I) = SEF4
      GO TO 319
  318 IF(I.GT.IS55) GO TO 320
      SEF(I) = SEF5
      GO TO 319
  320 SEF(I) = .33
  319 CONTINUE
C     UNIT CARD #3.
C     READ SLOPE % & SLOPE LENGTH CARD, BUILD 100 VALUE PROB. TABLES.
      READ(5,331) XPSL,XSLD,XSLG,XSLGD
  331 FORMAT(40X,4F5.0)
      XSPL = XPSL - XSLD
      XSPH = XPSL + XSLD
C     FOR MULTI-ACRE PLOT SIZE WITH NO GIVEN SLOPE LENGTH, THE SLOPE
C      RANGE OF 46.7 TO 233.5 FEET (1 ACRE EQ.) IS ASSIGNED.
      IF (XSLG) 332,332,333
  332 XSLGD = 93.4
      XSLG = 140.1
  333 CONTINUE
      XLL = XSLG - XSLGD
      XLH = XSLG + XSLGD
      XSPI = (XSPH - XSPL) / 100.0
      XSLI = (XLH - XLL) / 100.0
      DO 334 I = 1,100
      SLP(I) = XSPL
      XSPL = XSPL + XSPI
      SLL(I) = XLL
      XLL = XLL + XSLI
  334 CONTINUE
C     UNIT CARD #4.
C     READ CROPPING MGT. CARD AND BUILD 100 VALUE TABLE. CM(100).
      READ(5,336) ICM1,CMF1,ICM2,CMF2,ICM3,CMF3,ICM4,CMF4,ICM5,CMF5
  336 FORMAT(40X,5(I3,F5.0))
      IF(ICM1+ICM2+ICM3+ICM4+ICM5) 1435,1435,1436
 1435 ICM1 = 24
      CMF1 = .08
```

```
            ICM2 = 19
            CMF2 = .01
            ICM3 = 32
            CMF3 = .005
            ICM4 = 10
            CMF4 = .01
            ICM5 = 15
            CMF5 = 1.0
       1436 IC42 = ICM1 + ICM2
            IC43 = IC42 + ICM3
            IC44 = IC43 + ICM4
            IC45 = IC44 + ICM5
            DO 349 I=1,100
            IF(I.GT.ICM1) GO TO 345
            CM(I) = CMF1
            GO TO 349
        345 IF(I.GT.IC42) GO TO 346
            CM(I) = CMF2
            GO TO 349
        346 IF(I.GT.IC43) GO TO 347
            CM(I) = CMF3
            GO TO 349
        347 IF(I.GT.IC44) GO TO 348
            CM(I) = CMF4
            GO TO 349
        348 IF(I.GT.IC45) GO TO 350
            CM(I) = CMF5
            GO TO 349
        350 CM(I) = .174
        349 CONTINUE
C           UNIT CARD 75.
C           READ EROSION CONTROL CARD AND BUILD 100 VALUE TABLE. EC(100)
            READ(5,351) IEC1,ECF1,IEC2,ECF2,IEC3,ECF3,IEC4,ECF4,IEC5,ECF5
        351 FORMAT(40X,5(I3,F5.0))
            IF(IEC1+IEC2+IEC3+IEC4+IEC5) 352,352,354
        352 IEC1 = 24
            ECF1 = .50
            IEC2 = 19
            ECF2 = 1.0
            IEC3 = 32
            ECF3 = 1.0
            IEC4 = 10
            ECF4 = 1.0
            IEC5 = 15
            ECF5 = 1.3
        354 IE32 = IEC1 + IEC2
            IE33 = IE32 + IEC3
            IE34 = IE33 + IEC4
            IE35 = IE34 + IEC5
            DO 359 I=1,100
            IF(I.GT.IEC1) GO TO 355
            EC(I) = ECF1
            GO TO 359
        355 IF(I.GT.IE32) GO TO 356
            EC(I) = ECF2
            GO TO 359
        356 IF(I.GT.IE33) GO TO 357
            EC(I) = ECF3
```

```
              GO TO 359
          357 IF(I.GT.IE34) GO TO 358
              EC(I) = ECF4
              GO TO 359
          358 IF(I.GT.IE35) GO TO 360
              EC(I) = ECF5
              GO TO 359
          360 EC(I) = .930
          359 CONTINUE
C             UNIT CARD #6.
C             READ SED. DEL. %,N,P,K,BOD,TOC FACTORS & SEDIMENT MIGRATION %.
C             BUILD 100 VALUE SEDIMENT DELIVERY & SEDIMENT MIGRATION TABLES.
              READ(5,371) SDA,SDD,SDNF,SDPF,SDKF,SDBOD,SDTOC,SRESP,SRESD
          371 FORMAT(40X,F3.0,F2.0,5F5.0,F3.0,F2.0)
              SDL =(SDA - SDD) * .01
              SDH =(SDA + SDD) * .01
              SDI = (SDH - SDL) * .01
              SRL = (SRESP - SRESD) * .01
              SRH = (SRESP + SRESD) * .01
              SRI = (SRH - SRL) * .01
              DO 374 I = 1,100
              SD(I) = SDL
              SDL = SDL + SDI
              SR(I) = SRL
              SRL = SRL + SRI
          374 CONTINUE
C             UNIT CARD #7.
C             READ LIVESTOCK/FOWL COUNTS CARD.
              READ(5,376) COWT,COWD,SWINE,POULT,WFOWL,BROIL
          376 FORMAT(20X,6F10.0)
              ZBODD= 0.0
              ZBODW= 0.0
              ZTOCD= 0.0
              ZTOCW= 0.0
              ZNITD= 0.0
              ZNITW= 0.0
              ZPO4D= 0.0
              ZPO4W= 0.0
              ZT = COWT + COWD + SWINE + POULT + WFOWL + BROIL
              IF(ZT.EQ.0.0) GO TO 384
C             CALCULATE 100% R.O. WEIGHTED BOD TOC NIT PO4 PERIOD LOADS.
              BEEF = COWT - COWD
              POULT = POULT + BROIL/4.5
              GO TO (378,377),ISWW
          377 WFF = 0.0
              XLFF = 7.0/365.0
              GO TO 383
          378 WFF = 0.0
              XLFF = 0.0
              DO 382 I = IPS,IPF
              XLFF = XLFF + .0833
              IF(I.GT.06) GO TO 382
              IF(I.LE.02) WFF = WFF + .0833
              IF(I.EQ.03) WFF = WFF + .0417
              IF(I.EQ.04) WFF = WFF + .0417
              IF(I.EQ.05) WFF = WFF + .00833
              IF(I.EQ.06) WFF = WFF + .00833
          382 CONTINUE
```

```
      383 CONTINUE
          WFF = WFF * 365.0
          XLFF = XLFF * 365.0
          ZBODW = WFOWL * .0206 * WFF
          ZBODD = ((BEEF*.03)+(COWD*.19)+(SWINE*.154)+(POULT*.00050))*XLFF
          ZTOCW = WFOWL * .0000 * WFF
          ZTOCD = ((BEEF*.10)+(COWD*.23)+(SWINE*.156)+(POULT*.00070))*XLFF
          ZNITW = WFOWL * .0057 * WFF
          ZNITD = ((BEEF*.008)+(COWD*.034)+(SWINE*.009)+(POULT*.00020))*XLFF
          ZPO4W = WFOWL * .0076 * WFF
          ZPO4D = ((BEEF*.003)+(COWD*.027)+(SWINE*.005)+(POULT*.00003))*XLFF
      384 CONTINUE
C         UNIT CARD #8.
C         READ LITTER CARD.
          READ(5,386) XLPA,XLNF,XLPF,XLKF,XLBOD,XLTOC
      386 FORMAT(40X,F5.0,5F5.0)
          FORAC = SGPLS * ICM3 * .01
          XLTA = XLPA / 2000.0
C         UNIT CARD #9.
C         READ MINE DRAINAGE CARD.
          READ(5,389) XMDA,XMDAP
      389 FORMAT(40X,2F10.0)
          XMDPA = 0.0
          IF(XMDA.EQ.0.0) GO TO 390
          XMDPA = (XMDA / ACSG) * XMDAP * SGPLS
      390 CONTINUE
          GO TO (8602,8601),ISSWP
     8601 CALL PRTPRT
C         RESET PROBABILITY TABLE PRINT SWITCH AFTER PRINTING.
          ISSWP = 1
          LP = 0
     8602 GO TO (8604,8604,8603,8604),ISSC
     8603 CALL HEADS
          ISSC = 1
     8604 CONTINUE
C         CALCULATE EACH SMALL PLOT AND ACCUMULATE FOR SEGMENT.
          NP = ACSG/SGPLS
          DO 434 NI=1,NP
C         CALCULATE ANNUAL AND PERIOD SOIL LOSS IN TONS
C         A = R * K * LS * C * P
C          WHERE: A -- IS TONS/ACRE/YEAR.                                  CALC.
C                 R -- IS NUMBER OF EROSION INDEX UNITS (EI).              TBL.SEL.
C                 K -- IS SOIL ERODIBILITY FACTOR (BASED ON SOIL TYPE).    PRB.DIST
C                 LS - IS SLOPE LENGTH  & % SLOPE FACTOR FOR A SMALL AREA. PRB.DIST
C                 C -- IS CROPPING MANAGEMENT OR SOIL COVER FACTOR.        PRB.DIST
C                 P -- IS EROSION CONTROL PRACTICE FACTOR.                 PRB.DIST
C
C         SELECT R FROM IST TABLE.
      400 ICD = IST(ISC,ISGN+1)
          IRF = IST(ISC,ISGN+10)
          VR= IRF
          GO TO (405,5405),ISSW
     5405 VR = VRSS
C         GENERATE RANDOM NUMBER AND SELECT K FROM PROB.DIST. SEF.
      405 CALL RNG(IRNS,IN1,IN2,ISW2)
          IK = IN2
          VK= SEF(IK)
C
```

```
              C      GENERATE RANDOM NUMBER BETWEEN 1 - 100 FOR LENGTH.
 0295           403 CALL RNG(IRNS,IN1,IN2,ISW2)
 0296               ILLI = IN2
              C      GENERATE RANDOM NUMBER BETWEEN 1-100 FOR SLOPE % SELECTION.
 0297           410 CALL RNG(IRNS,IN1,IN2,ISW2)
 0298               ISPI = IN2
              C      CALCULATE LS VALUE.
 0299           415 VLS = ((SLL(ILLI)/ 75.0)** 0.6) * ((SLP(ISPI) / 9.0) ** 1.4)
              C
              C      GENERATE RANDOM NUMBER AND SELECT C FROM CM.
              C      RANDOM NUMBER AT IC WILL ALSO BE USED FOR EROSION CONTROL.
 0300           420 CALL RNG(IRNS,IN1,IN2,ISW2)
 0301               IC = IN2
 0302               IP = IC
 0303               VC= CM(IC)
              C
              C      RANDOM NUMBER FROM IC USED TO SELECT P FROM EC.
 0304           425 VP= EC(IP)
              C
              C      ACCUMULATE TONS FOR THE SEGMENT
 0305           430 VA = VR*VK*VLS*VC*VP*XPF
 0306               TSEGT = SGPLS * VA
              C      GENERATE RANDOM NUMBER AND SELECT SED. YIELD %.
 0307               CALL RNG(IRNS,IN1,IN2,ISW2)
 0308               IS = IN2
 0309               SYF = SD(IS)
 0310               TSEGY = TSEGT * SYF
 0311               DV(1,1,2) = DV(1,1,2) + TSEGT
 0312               DV(1,1,3) = DV(1,1,3) + TSEGY
              C      GENERATE RANDOM NUMBER AND SELECT SEDIMENT MIGRATION %.
 0313               CALL RNG(IRNS,IN1,IN2,ISW2)
 0314               IR = IN2
 0315               SEDEF = SR(IR)
 0316               SEDET = SEDET + (TSEGY * SEDEF)
              C      CALCULATE LITTER.
 0317               XLITF = XPF * SYF * (FORAC + ((SGPLS - FORAC)/ 4.0))
 0318               XLITT = XLITF * XLTA
 0319               XLITP = XLITF * XLPA
 0320               DV(1,1,4) = DV(1,1,4) + XLITT
 0321               DV(1,1,5) = DV(1,1,5) + (TSEGY * SDNF * 20.0)+(XLITP * XLNF * .01)
 0322               DV(1,1,6) = DV(1,1,6) + (TSEGY * SDPF * 20.0)+(XLITP * XLPF * .01)
 0323               DV(1,1,7) = DV(1,1,7) + (TSEGY * SDKF * 20.0)+(XLITP * XLKF * .01)
 0324               DV(1,1,8) = DV(1,1,8) + (TSEGY*SDBOD*20.0) + (XLITP*XLBOD*.01)
 0325               DV(1,1,9) = DV(1,1,9) + (TSEGY*SDTOC*20.0) + (XLITP*XLTOC*.01)
 0326               DV(1,1,10) = DV(1,1,10) + (XPF * XMDPA)
 0327               GO TO (8403,8401),ISSWD
 0328          8401 CALL PRTDET
 0329          8403 CONTINUE
 0330           434 CONTINUE
 0331               GO TO (8441,8440),ISSWD
 0332          8440 CALL HEADS
 0333          8441 CONTINUE
 0334               DV(1,1,1) = ACSG
 0335               SXF = DV(1,1,3) / DV(1,1,2)
 0336               DV(1,2,5) = (ZNITD * SXF) + ZNITW
 0337               DV(1,2,6) = (ZPO4D * SXF) + ZPO4W
 0338               DV(1,2,8) = (ZBODD * SXF) + ZBODW
 0339               DV(1,2,9) = (ZTOCD * SXF) + ZTOCW
```

```
0340                DO 435 J=1,10
0341            435 DV(1,3,J) = DV(1,1,J) + DV(1,2,J)
0342                I = ICTSS + 1 - ICTSG
0343                WRITE(6,4401) I,SGPLS,(DV(1,1,K),K=1,10)
0344           4401 FORMAT(T1,' ',I3,' LAND   (',F6.1,')  ',4F12.2,6F10.0)
0345                IF(ZT.EQ.0) GO TO 4406
0346                WRITE(6,4403)  (DV(1,2,K),K=5,9)
0347           4403 FORMAT(T1,'        LIVESTOCK/FOWL     ',48X,5F10.0)
0348                WRITE(6,4405)  (DV(1,3,K),K=1,10)
0349           4405 FORMAT(T1,'  UNIT TOTALS              ',4F12.2,6F10.0/)
0350           4406 CONTINUE
              C     RESET DETAIL PRINT SWITCH AFTER PRINTING ONE UNIT.
0351                ISSW0 = 1
0352                LD = 0
              C     ACC. SEG. TO STATE, CLEAR SEG.
0353                DO 5441 J = 1,3
0354                DO 5441 K = 1,10
0355                DV(2,J,K) = DV(2,J,K) + DV(1,J,K)
0356           5441 DV(1,J,K) = 0.0
0357                ICTSG = ICTSG - 1
0358                IF(ICTSG) 442,442,310
0359            442 CONTINUE
0360                IF(ZT.EQ.0) GO TO 4414
0361                WRITE(6,4411)  (DV(2,1,K),K=1,10)
0362           4411 FORMAT(T1,'   STATE GROUP LAND         ',4F12.2,6F10.0)
0363                WRITE(6,4413)  (DV(2,2,K),K=5,9)
0364           4413 FORMAT(T1,'         LIVESTOCK/FOWL   ',48X,5F10.0)
0365           4414 WRITE(6,4415)  (ISN(J), J=1,5),(DV(2,3,K),K=1,10)
0366           4415 FORMAT(T1,' ',5A4,2X,4F12.2,6F10.0/)
              C     ACC. STATE TO GRAND TOTAL, CLEAR STATE.
0367                DO 445 J= 1,3
0368                DO 445 K = 1,10
0369                DV(3,J,K) = DV(3,J,K) + DV(2,J,K)
0370            445 DV(2,J,K) = 0.0
0371            446 ICTS = ICTS - 1
0372                IF(ICTS) 450,450,306
              C     COMPLETE REPORT
0373            450 CONTINUE
0374                IF(ZT.EQ.0) GO TO 4424
0375                WRITE(6,4421)  (DV(3,1,K),K=1,10)
0376           4421 FORMAT(T1,'   AREA LAND                ',4F12.2,6F10.0)
0377                WRITE(6,4423)  (DV(3,2,K),K=5,9)
0378           4423 FORMAT(T1,'         LIVESTOCK/FOWL   ',48X,5F10.0)
0379           4424 WRITE(6,4425)  (DV(3,3,K),K=1,10)
0380           4425 FORMAT(T1,'   GRAND TOTALS             ',4F12.2,6F10.0)
0381                IF(SEDET) 4429,4429,4426
0382           4426 XCF = SEDET * (2000.0/58.4)
0383                SEDCY = XCF / 27.0
0384                SEDCM = SEDCY / 1.3079
0385                WRITE(6,4427) SEDET,SEDCY,SEDCM
0386           4427 FORMAT(T1,'0(SEDIMENT MIGRATION TO A TERMINAL POINT= ',F12.2,
                   1' SHORT TONS OR ',F12.2,' CUBIC YARDS OR ',F12.2,' CUBIC METERS)')
0387           4429 CONTINUE
0388                CALL EXIT
0389                END
```

```
0001          SUBROUTINE RNG(IA,IN1,IN2,ISW)
        C     GENERATE AND RETURN A RANDOM NUMBER 1-10 AT IN1 & 1-100  AT IN2.
0002          DIMENSION IST(56,19), PF(34,14),IT2(100),ISN(5),SLP(100),SLL(100)
0003          DIMENSION SEF(100),CM(100),EC(100),SD(100),DV(3,3,10),SR(100)
0004          COMMON IST,PF,IT2,ISN,SLP,SLL,SEF,CM,EC,SD,DV,NI,TSEGT,SR
0005          COMMON ISSW,VRSS,IPS,IPF,XPF,IRF,ICD,IK,VK,ISPI,ILLI,VLS,IC,VC,IP
0006          COMMON VP,NP,SGPLS,VA,ISC,ICNT,ACSG,SDNF,SDPF,SDKF
0007          COMMON XPSL,XSLG,XSLD,SDA,XSLGD,SDD
0008          COMMON ISE1,ISE2,ISE3,ISE4,ISE5,SEF1,SEF2,SEF3,SEF4,SEF5
0009          COMMON ICM1,ICM2,ICM3,ICM4,ICM5,CMF1,CMF2,CMF3,CMF4,CMF5
0010          COMMON IEC1,IEC2,IEC3,IEC4,IEC5,ECF1,ECF2,ECF3,ECF4,ECF5
0011          COMMON IS,SYE,ISEGY,SEDEI,SEDCY,SEDCM,VR,SDHUD,SDTOC,SRESP,SRESD
0012          GO TO (991,992),ISW
0013      991 IX = IA
0014      992 IY = IX * 65539
0015          IF(IY) 5,6,6
0016        5 IY = IY + 2147483647 + 1
0017        6 YFL = IY
0018          YFL = YFL * .4656613E-9
0019          IN2 =(YFL * 100.)
0020          IF(IN2.EQ.0) IN2 = 100
0021          IN1 = IN2/10
0022          IX = YFL * 10000000.
0023          RETURN
0024          END
```

```
0001                SUBROUTINE HEADS
              C     WRITE REPORT HEADINGS.
0002                DIMENSION IST(56,19), PF(34,14),IT2(100),ISN(5),SLP(100),SLL(100)
0003                DIMENSION SEF(100),CM(100),EC(100),SD(100),DV(3,3,10),SR(100)
0004                COMMON IST,PF,IT2,ISN,SLP,SLL,SEF,CM,EC,SD,DV,NI,TSEGT,SR
0005                COMMON ISSW,VRSS,IPS,IPF,XPF,IRF,ICD,IK,VK,ISPI,ILLI,VLS,IC,VC,IP
0006                COMMON VP,NP,SGPLS,VA,ISC,ICNT,ACSG,SDNF,SDPF,SDKF
0007                COMMON XPSL,XSLG,XSLD,SDA,XSLGD,SDD
0008                COMMON ISE1,ISE2,ISE3,ISE4,ISE5,SEF1,SEF2,SEF3,SEF4,SEF5
0009                COMMON ICM1,ICM2,ICM3,ICM4,ICM5,CMF1,CMF2,CMF3,CMF4,CMF5
0010                COMMON IEC1,IEC2,IEC3,IEC4,IEC5,ECF1,ECF2,ECF3,ECF4,ECF5
0011                COMMON IS,SYF,TSEGY,SEDET,SEDCY,SEDCM,VR,SDBOD,SDTOC,SRESP,SRESD
0012                WRITE(6,304) (IT2(I),I= 1,100)
0013            304 FORMAT(T1,'1',T2,30A4/T1,' ',T2,30A4//T1,' ',T2,20A4/T1,' ',T2,20A
                   14)
0014                GO TO (7405,7401),ISSW
0015           7401 WRITE(6,7402) VRSS
0016           7402 FORMAT(T1,' **** SINGLE STORM WITH EI= ',F5.0/)
0017                GO TO 3060
0018           7405 WRITE(6,305) IPS,IPF
0019            305 FORMAT(T1,' **** PERIOD MONTHS ',I2,' - ',I2/)
0020           3060 CONTINUE
0021                WRITE(6,309)
0022            309 FORMAT(T1,' '/
                   1T1,' UNIT/TYPE  (PLOT AC.)         ACRES   S.L. TONS * * * * * * *
                   2* * * * * * * * * * TO WATER BODIES  ',T100,16('* ')/
                   3T1,' ---------  ----------         -----   ---------   SED. TONS LI
                   4TTER TONS   NIT.LBS  PHOS.LBS   <K> LBS   BOD LBS   TOC LBS  ACID
                   5LBS'/T1,50(' '),'---------  ----------   -------  --------  ------
                   6--   -------   -------  ---------'/)
0023                END
```

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                    SUBROUTINE PRTTBL
              C     PRINT TABLES FOR VERIFICATION.
                    DIMENSION IST(56,19), PF(34,14),IT2(100),ISN(5),SLP(100),SLL(100)
                    DIMENSION SEF(100),CM(100),EC(100),SD(100),DV(3,3,10),SR(100)
                    COMMON IST,PF,IT2,ISN,SLP,SLL,SEF,CM,EC,SD,DV,NI,TSEGT,SR
                    COMMON ISSW,VRSS,IPS,IPF,XPF,IRF,ICD,IK,VK,ISPI,ILLI,VLS,IC,VC,IP
                    COMMON VP,NP,SGPLS,VA,ISC,ICNT,ACSG,SDNF,SDPF,SDKF
                    COMMON XPSL,XSLG,XSLD,SDA,XSLGD,SDD
                    COMMON ISE1,ISE2,ISE3,ISE4,ISE5,SEF1,SEF2,SEF3,SEF4,SEF5
                    COMMON ICM1,ICM2,ICM3,ICM4,ICM5,CMF1,CMF2,CMF3,CMF4,CMF5
                    COMMON IEC1,IEC2,IEC3,IEC4,IEC5,ECF1,ECF2,ECF3,ECF4,ECF5
                    COMMON IS,SYF,TSEGY,SEDET,SEDCY,SEDCM,VR,SDBOD,SDTOC,SRESP,SRESD
                    WRITE(6,190)
               190  FORMAT(T1,'1 TABLE OF STATE DATA',//)
                    DO 192 I=1,55
                    IF(IST(I,1)) 192,192,1190
              1190  WRITE(6,191)  (IST(I,J),J=1,19)
               191  FORMAT(T1,' ',I2,5X,9I3,5X,9I4)
               192  CONTINUE
                    WRITE(6,193)
               193  FORMAT(T1,'1 TABLE OF PERIOD FACTORS',//)
                    DO 1194 I=1,33
                    IF(PF(I,1).EQ.0.0) GO TO 1194
                    WRITE(6,194)  (PF(I,J), J=1,14)
               194  FORMAT(T1,' ',F3.0,4X,13F5.2)
              1194  CONTINUE
              3000  CONTINUE
                    END
```

```
0001              SUBROUTINE PRTPRT
            C     PRINT PROBABILITY TABLES.
0002              DIMENSION IST(56,19), PF(34,14),IT2(100),ISN(5),SLP(100),SLL(100)
0003              DIMENSION SEF(100),CM(100),EC(100),SD(100),DV(3,3,10),SR(100)
0004              COMMON IST,PF,IT2,ISN,SLP,SLL,SEF,CM,EC,SD,DV,NI,TSEGT,SR
0005              COMMON ISSW,VRSS,IPS,IPF,XPF,IRF,ICD,IK,VK,ISPI,ILLI,VLS,IC,VC,IP
0006              COMMON VP,NP,SGPLS,VA,ISC,ICNT,ACSG,SDNF,SDPF,SDKF
0007              COMMON XPSL,XSLG,XSLD,SDA,XSLGD,SDD
0008              COMMON ISE1,ISE2,ISE3,ISE4,ISE5,SEF1,SEF2,SEF3,SEF4,SEF5
0009              COMMON ICM1,ICM2,ICM3,ICM4,ICM5,CMF1,CMF2,CMF3,CMF4,CMF5
0010              COMMON IEC1,IEC2,IEC3,IEC4,IEC5,ECF1,ECF2,ECF3,ECF4,ECF5
0011              COMMON IS,SYF,TSEGY,SEDET,SEDCY,SEDCM,VR,SDBOD,SDTOC,SRESP,SRESD
0012              WRITE(6,8004) ISC,ICNT,ACSG,SGPLS,SDNF,SDPF,SDKF,SDBOD,SDTOC,SRESP
0013         8004 FORMAT(T1,'1**PROB.TBLS.**STATE= ',I2,'  UNIT= ',I4,' UNIT AC.= ',
                 1F10.2,' PLOT SZ. AC.= ',F6.1,' N-(%)= ',F6.2,' P-(%)= ',F6.2,
                 2' K-(%)= ',F6.2/T1,' ',T80,'BOD%=',F6.2,' TOC%=',F6.2,' SED.MIG.%=
                 3',F6.2)
0014              WRITE(6,8006)
0015         8006 FORMAT(T1,'0S.E. FACTORS(SEF)',T24,'SLOPE %(SLP)',
                 1T44,'SLOPE LGTH.(SLL)',T64,'CROPPING MGT.(CM)',T84,'EROSION CTL.(E
                 2C)',T104,'SED. DEL. (SD)')
0016              WRITE(6,8007) ISE1,SEF1,XPSL,XSLG,ICM1,CMF1,IEC1,ECF1,SDA,
                 1                 ISE2,SEF2,XSLD,XSLGD,ICM2,CMF2,IEC2,ECF2,SDD,
                 2                 ISE3,SEF3,            ICM3,CMF3,IEC3,ECF3,
                 3                 ISE4,SEF4,            ICM4,CMF4,IEC4,ECF4,
                 4                 ISE5,SEF5,            ICM5,CMF5,IEC5,ECF5
0017         8007 FORMAT(T1,' ',I3,' %= ',F6.3,T24,' AVG= ',F6.3,T44,' AVG= ',F6.0,
                 1      T64,I3,' %= ',F6.3,T84,I3,' %= ',F6.3,T104,' AVG. % = ',F6.2/
                 2        T1,' ',I3,' %= ',F6.3,T24,' DEV= ',F6.3,T44,' DEV= ',F6.0,
                 3      T64,I3,' %= ',F6.3,T84,I3,' %= ',F6.3,T104,'      DEV= ',F6.2/
                 4  3(T1,' ',I3,' %= ',F6.3,T64,I3,' %= ',F6.3,T84,I3,' %= ',F6.3/))
0018              WRITE(6,8008)
0019         8008 FORMAT(T1,' ',2('  # FACTOR'),2('  #    PCT.'),2('  #    FEET'),
                 12('  # FACTOR'),2('  #    PCT.'),2('  # FACTOR')/)
0020              DO 8011 I=1,50
0021              I2= I + 50
0022              WRITE(6,8010) I,SEF(I),I2,SEF(I2),I,SLP(I),I2,SLP(I2),I,SLL(I),
                 1I2,SLL(I2),I,CM(I),I2,CM(I2),I,EC(I),I2,EC(I2),I,SD(I),I2,SD(I2)
0023         8010 FORMAT(T1,' ',2(I4,F6.4),2(I4,F6.2),2(I4,F6.0),2(I4,F6.4),2(I4,F6.
                 22),2(I4,F6.4))
0024         8011 CONTINUE
0025         8012 CONTINUE
0026              END
```

```
0001             SUBROUTINE PRTDET
           C     PRINT DETAIL.
0002             DIMENSION IST(56,19), PF(34,14),IT2(100),ISN(5),SLP(100),SLL(100)
0003             DIMENSION SEF(100),CM(100),EC(100),SD(100),DV(3,3,10),SR(100)
0004             COMMON IST,PF,IT2,ISN,SLP,SLL,SEF,CM,EC,SD,DV,NI,TSEGT,SR
0005             COMMON ISSW,VRSS,IPS,IPF,XPF,IRF,ICD,IK,VK,ISPI,ILLI,VLS,IC,VC,IP
0006             COMMON VP,NP,SGPLS,VA,ISC,ICNT,ACSG,SDNF,SDPF,SDKF
0007             COMMON XPSL,XSLG,XSLD,SDA,XSLGD,SDD
0008             COMMON ISE1,ISE2,ISE3,ISE4,ISE5,SEF1,SEF2,SEF3,SEF4,SEF5
0009             COMMON ICM1,ICM2,ICM3,ICM4,ICM5,CMF1,CMF2,CMF3,CMF4,CMF5
0010             COMMON IEC1,IEC2,IEC3,IEC4,IEC5,ECF1,ECF2,ECF3,ECF4,ECF5
0011             COMMON IS,SYF,TSEGY,SEDET,SEDCY,SEDCM,VR,SDBOD,SDTOC,SRESP,SRESD
0012             IF(NI.EQ. 1) WRITE(6,2400)
0013        2400 FORMAT(T1,'1 DETAIL CALCULATIONS FOR EACH SMALL PLOT'//)
0014             WRITE(6,2401) VR,ICD
0015        2401 FORMAT(T1,' R-EROSION INDEX UNITS (IRF) = ',F6.0,'  EI-NO. = ',I5)
0016             WRITE(6,2403) IK,VK
0017        2403 FORMAT(T1,' K-SOIL ERODIBILITY RNO= ',I3,' (VK) = ',F6.4)
0018             WRITE(6,2405) ISPI,SLP(ISPI),ILLI,SLL(ILLI),VLS
0019        2405 FORMAT(T1,' SLOPE% RNO= ',I2,'  SLOPE %= ',F6.2,'  LGTH RNO= ',I2,
                1'  LGTH= ',F6.0,'  LS= ',F6.2)
0020             WRITE(6,2407) IC,VC
0021        2407 FORMAT(T1,' C-CROPPING MGT. RNO= ',I3,' VC = ',F8.4)
0022             WRITE(6,2409) IP,VP
0023        2409 FORMAT(T1,' P-EROSION CONTROL RNO= ',I3,' VP = ',F8.2)
0024             WRITE(6,2410) IS,SYF,TSEGY
0025        2410 FORMAT(T1,' SED. RNO= ',I3,' SED. YIELD FACTOR= ',F10.5,' SED. YIE
                1LD TONS= ',F10.5)
0026             WRITE(6,2411) NP,SGPLS,IPS,IPF,XPF,VA,TSEGT
0027        2411 FORMAT(T1,' NO.OF PLOTS = ',I8,' ACRES/PLOT = ',F8.2,' PERIOD = ',
                1  I2,' TO ',I2,' UNLESS SINGLE STORM INDICATED'/
                2                T1,' PERIOD FACTOR = ',F6.2,' TONS/ACRE = ',F8.2,
                3  ' ACCUMULATED TONS FOR SEG.& PERIOD = ',F12.2)
0028             WRITE(6,2413)
0029        2413 FORMAT(T1,' ',120('-')/)
0030             END
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      SUBROUTINE RNOTBL(ISEED)
C     GENERATE TABLE OF RANDOM NUMBERS USING INPUT SEED.
      DIMENSION IT(50,40)
      IX = ISEED
      DO 20 J=1,40
      DO 20 I=1,50
C     RANDOM NUMBER GENERATOR.
      IY = IX * 65539
      IF(IY) 5,6,6
    5 IY = IY + 2147483647 + 1
    6 YFL = IY
      YFL = YFL * .4656613E-9
      IT(I,J) = YFL * 100.
      IX = YFL * 10000000.
   20 CONTINUE
      WRITE(6,25)
   25 FORMAT(T1,'1TABLE OF RANDOM NUMBERS - READ DOWN COL BY COL - ZERO
     1IS CONVERTED TO 100 FOR SUBSCRIPTING 100 VALUE TABLES'/)
      DO 30 I = 1,50
      WRITE(6,26) (IT(I,J),J= 1,40)
   26 FORMAT(T1,' ',T2,40(1X,I2))
   30 CONTINUE
      END
```

```
      SUBROUTINE LSTBL
C     PRODUCE SLOPE & SLOPE % TABLE OVER RANGE 1-25% AND 10 - 300 FT.
      DIMENSION XLSR(25,30),ISL(30)
      DO 19 I=1,25
      DO 19 J=1,30
      XI = I
      XJ = J * 10.0
      ISL(J) = J * 10
      XLSR(I,J) = ((XJ/75.0)** 0.6) * ((XI/9.0)** 1.4)
   19 CONTINUE
      WRITE(6,20)
   20 FORMAT(T1,'1TABLE OF LS FACTORS FOR PROBABLE SLOPE % & SLOPE LENGT
     1H COMBINATIONS'//)
      WRITE(6,21) (ISL(J),J=1,30)
   21 FORMAT(T1,'  SLOPE FT.>>',30I4/)
      DO 24 I=1,25
      WRITE(6,22) I,(XLSR(I,J),J=1,30)
   22 FORMAT(T1,' ',I2,' %SLOPE   ',30F4.1)
   24 CONTINUE
      END
```

SPECIAL NOTES AND RECOMMENDATIONS

1. The greatly reduced copy of USDA-ARS Handbook 282 in Section 11 is not intended for general reading purposes because the print is too small. The main purpose is to display the tables and curves which are referred to throughout this writeup by such terms as Figure 1, Table 1 etc.

2. Some specific references are made to the reference list; however over a hundred articles and publications were reviewed and many default values and theories are composites of several sources and not attributable to any single source. The author has drawn heavily on his past operations research experience in industry and land use analytical methods developed while affiliated with a resource management firm.

3. Section 11 contains literature extracts that might prove helpful or explain why certain values were used.

4. Section 5 Key Punch Instructions carries special notes about each card; however the following statements may shed some additional light:

   Area Cards: Cards 1-4 are for 2-120 position report heading lines and the middle characters of these lines should be centered at column 60 of cards 1&3. Card 7 has a Field to Modify the Sequence of Random Numbers Generated (Power Residue Method) if desired; however the default seed (Pregnancy Analogy) value of 3451427 will give about 500,000 2 position random numbers (00-99) before repeating the same sequence. SW1 (1 in column 58) of card 7 also produces a small table of random numbers that will be used with the injected seed value but the first table random number will not be used in the active program. See Section 7 for table illustrations.

   State Card: The list of State FIPS (Federal Information Processing Standard 5 11/1/68) numbers is in Section 11.

   Land Unit Cards: Card #1: The state regionalized map S11 is in Section 11. Card #2: K values are obtained by relating an unlisted soil type to those listed in Section 11 HB 282 Table 1 on page 5. Card #4: This card is vital in that the forest percentage in SET #3 is used later by the Litter Calculating Process, it would be advisable to completely punch this card or leave it totally blank if the CEQ-SMSA default values are adequate. Card #5: This card can be left blank unless better values than the Good Set of Default Values are known. Cards 6, 7, 8 & 9, should be carefully developed because they supply the information to the Basic Process Structure to produce a meaningful report.

5. New knowledge is being disseminated continuously by EPA-R&D in the Five Technology Transfer Series and many improved loading factors from published special studies fit right into this process to make it a highly refined operational tool.

MAP S11

FIGURE 4-1.
Iso-erodent Map (R Values for the Erosion Equation).
(Wischmeier and Smith, 1965)

PERIOD TABLE - Input cards for 33 Sub-Areas.

```
NOTE - REMOVE ALL CARDS WITH * IN COL 60                                                  *
*********  THIS IS THE TABLE OF PERIOD FACTORS  **********************************
|---00---|----10---|----20---|----30---|----40---|----50---|----60---|----70---*
123456789012345678901234567890123456789012345678901234567890123456789012345678 9*
---------------------------------------------------------------------------------*
```

01	.00	.00	.00	.01	.03	.11	.37	.63	.89	.97	1.00	1.00
02	.00	.00	.01	.02	.06	.18	.42	.67	.85	.95	.99	1.00
03	.00	.00	.01	.02	.06	.22	.52	.69	.85	.93	.98	1.00
04	.00	.01	.03	.05	.12	.27	.47	.62	.75	.89	.97	.99
05	.00	.02	.04	.09	.21	.37	.53	.64	.73	.87	.94	.98
06	.00	.00	.00	.02	.07	.27	.45	.60	.74	.87	.98	1.00
07	.00	.01	.03	.06	.13	.40	.56	.67	.75	.85	.98	.99
08	.00	.02	.07	.14	.27	.47	.60	.67	.77	.85	.92	.98
09	.00	.04	.09	.17	.28	.42	.54	.62	.69	.77	.85	.93
10	.00	.02	.06	.12	.21	.39	.52	.61	.70	.82	.91	.95
11	.00	.03	.07	.10	.17	.34	.45	.56	.68	.79	.89	.96
12	.00	.00	.01	.02	.05	.15	.38	.62	.85	.95	.98	.99
13	.00	.00	.01	.03	.07	.18	.47	.65	.81	.93	.98	.99
14	.00	.00	.02	.05	.10	.20	.38	.62	.79	.90	.96	.98
15	.00	.01	.02	.05	.11	.22	.40	.60	.79	.90	.95	.98
16	.00	.01	.04	.08	.14	.25	.44	.64	.78	.88	.94	.98
17	.00	.02	.04	.06	.10	.19	.39	.62	.82	.91	.95	.98
18	.00	.03	.06	.11	.20	.34	.50	.63	.74	.83	.92	.97
19	.00	.03	.09	.16	.25	.37	.50	.63	.77	.83	.90	.95
20	.00	.03	.07	.13	.19	.26	.40	.62	.80	.88	.92	.95
21	.00	.07	.13	.19	.26	.33	.47	.68	.60	.86	.90	.95
22	.00	.07	.13	.22	.33	.44	.55	.67	.74	.81	.86	.93
23	.00	.05	.11	.18	.27	.35	.45	.60	.74	.83	.88	.93
24	.00	.06	.13	.20	.29	.37	.51	.68	.80	.86	.92	.97
25	.00	.03	.07	.13	.19	.28	.40	.53	.69	.88	.94	.96
26	.00	.04	.09	.16	.25	.36	.47	.68	.81	.87	.91	.95
27	.00	.02	.05	.10	.17	.26	.37	.57	.80	.92	.95	.97
28	.00	.03	.07	.12	.17	.24	.35	.55	.77	.87	.92	.97
29	.00	.02	.04	.07	.11	.17	.30	.54	.75	.89	.95	.98
30	.00	.02	.03	.06	.10	.19	.35	.55	.75	.65	.92	.97
31	.00	.01	.02	.04	.07	.17	.32	.55	.77	.88	.94	.98
32	.00	.02	.03	.06	.10	.17	.32	.52	.68	.80	.88	.96
33	.00	.02	.06	.11	.15	.20	.32	.46	.64	.77	.85	.94
99												

STATE TABLE - Input cards for 37 states.

```
NOTE - REMOVE ALL CARDS WITH * IN COL 60
*********  THIS IS THE STATE EI TABLE FACTORS  **********************************
|---00---|----10---|----20---|----30---|----40---|----50---|----60---|----70---
1234567890123456789012345678901234567890123456789012345678901234567890123456789
-------------------------------------------------------------------------------
```

01 ALABAMA	222423242323232323	325300350350375375500450600
05 ARKANSAS	181822182222092222	275275275325325325365365365
09 CONNECTICUT	3333	175150
10 DELAWARE	30	200
11 DIST. OF COL.	30	150
12 FLORIDA	2325252925	600550450450500
13 GEORGIA	242424242626262629	300275275325275275375375400
17 ILLINOIS	141414161616161919	175160165190165175200225220
18 INDIANA	151515161616191916	165160150180175160220165180
19 IOWA	020212021314131314	150155165155160175170175180
21 KENTUCKY	202019202020191920	180175240200225150250200180
22 LOUISIANA	092222222222222223	400400400525525525600600600
23 MAINE	32323232	075075100100
24 MARYLAND	30303030	125200200200
25 MASSACHUSETTS	323333	140125135
26 MICHIGAN	121212151515151515	085080075075075090080125115
27 MINNESOTA	010101010101121212	075060065100115120120135145
28 MISSISSIPPI	222222222223222323	325325350350390400500550600
29 MISSOURI	131616161616161819	200200200220215215245240240
31 NEBRASKA	020202020202020313	060065125075100140100125150
33 NEW HAMPSHIRE	3233	100120
34 NEW JERSEY	3030	175200
36 NEW YORK	313131313131313131	085085100100090085095130150
37 NORTH CAROLINA	262828292126282929	225225275350225250270350400
38 NORTH DAKOTA	010101010101010101	050050060050055060050060075
39 OHIO	161617161617161620	125125125150140150165150150
40 OKLAHOMA	060405040405040505	120175255175225290190260320
42 PENNSYLVANIA	173030173030173030	115100115120120150125125155
44 RHODE ISLAND	33	150
45 SOUTH CAROLINA	282727272727292929	300250250275275300375350340
46 SOUTH DAKOTA	010101010202020202	050065085050065085060075100
47 TENNESSEE	192222222122222221	250215210160150300250240225
48 TEXAS	071011071011071011	125250400120225375090160250
50 VERMONT	323232	085100125
51 VIRGINIA	303030302828283030	175155165220150150185210250
54 WEST VIRGINIA	171717173017171717	150150150140125150150150150
55 WISCONSIN	011212121214141414	110100090150125095165140115
99		

Federal Information Processing Standard 5

November 1, 1968

SPECIFICATIONS FOR

States of the United States

1. Name of Standard. States of the United States.

2. Category of Standard. Federal General Data Standard, Representations and Codes.

3. Explanation. This standard provides identification and codes for representing the 50 States, the District of Columbia, and the outlying areas, all of which are considered to be "first order subdivisions" of the United States.

4. Specifications.

TABLE 1. States of the United States (including the District of Columbia) with their assigned codes.

Name	Code	Name	Code
ALABAMA	01	MISSOURI	29
ALASKA	02	MONTANA	30
ARIZONA	04	NEBRASKA	31
ARKANSAS	05	NEVADA	32
CALIFORNIA	06	NEW HAMPSHIRE	33
COLORADO	08	NEW JERSEY	34
CONNECTICUT	09	NEW MEXICO	35
DELAWARE	10	NEW YORK	36
DISTRICT OF COLUMBIA	11	NORTH CAROLINA	37
FLORIDA	12	NORTH DAKOTA	38
GEORGIA	13	OHIO	39
HAWAII	15	OKLAHOMA	40
IDAHO	16	OREGON	41
ILLINOIS	17	PENNSYLVANIA	42
INDIANA	18	RHODE ISLAND	44
IOWA	19	SOUTH CAROLINA	45
KANSAS	20	SOUTH DAKOTA	46
KENTUCKY	21	TENNESSEE	47
LOUISIANA	22	TEXAS	48
MAINE	23	UTAH	49
MARYLAND	24	VERMONT	50
MASSACHUSETTS	25	VIRGINIA	51
MICHIGAN	26	WASHINGTON	53
MINNESOTA	27	WEST VIRGINIA	54
MISSISSIPPI	28	WYOMING	56
		WISCONSIN	55

Note: The following codes are reserved for possible future use in identifying American Samoa (03), Canal Zone (07), Guam (14), Puerto Rico (43), and Virgin Islands (52).

RAINFALL-EROSION LOSSES FROM CROPLAND EAST OF THE ROCKY MOUNTAINS

Guide for Selection of Practices for Soil and Water Conservation

AGRICULTURE HANDBOOK NO. 282

AGRICULTURAL RESEARCH SERVICE · U.S. DEPARTMENT OF AGRICULTURE
IN COOPERATION WITH PURDUE AGRICULTURAL EXPERIMENT STATION

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PREDICTING RAINFALL-EROSION LOSSES FROM CROPLAND EAST OF THE ROCKY MOUNTAINS

Guide for Selection of Practices for Soil and Water Conservation

By WALTER H. WISCHMEIER and DWIGHT D. SMITH, Soil and Water Conservation Research Division, Agricultural Research Service

PURPOSE OF HANDBOOK

Scientific farm planning for soil and water conservation requires knowledge of the relations between those factors that cause loss of soil and water and those that help to reduce such losses on cropland. Since 1930 controlled studies on field plots and small watersheds have supplied much valuable information regarding these complex factor interrelations. But the greatest possible benefits from such research efforts can be realized only when the findings are rapidly converted to sound practice on the numerous farms throughout the country. Specific guidelines are needed to help select the control practices best suited to the particular needs of each farm.

The soil-loss prediction procedure presented in this handbook provides such guidelines. It is a technique whereby all pertinent research information is methodically condensed to provide design data for conservation plans.

The empirical soil-loss equation underlying this technique is applicable in any location where numerical values of the equation's factors are known or can be determined. Research has supplied information from which at least approximate values of these factors can be derived for any location in the major agricultural areas of the United States. Tables and charts make this information readily available for field use.

Research is continuing to obtain more complete and more precise information on the interrelations of topography, soil, and management practices. Additional knowledge gained can be readily brought into the present prediction procedure. Experience has shown, however, that the factor values reported herein are sufficiently accurate to provide very valuable guidelines for conservation farm planning and to aid in estimating gross erosion from watersheds.

The soil-loss equation in its present form is the result of more than 20 years of development and has had many contributors.

HISTORY OF SOIL-LOSS EQUATIONS

Development of equations for calculating field soil loss began about 1940 in the Corn Belt States. The soil-loss estimating procedure developed in that region between 1940 and 1956 has been generally referred to as the slope-practice method. Zingg (25)[1] published an equation in 1940 relating soil loss rate to length and percentage of slope. In the following year, Smith (12) added crop and conservation practice factors and the concept of a specified soil-loss limit, to develop a graphical method for determining conservation practices needed on the Shelby and associated soils of the Midwest. Browning and coworkers (1) added soil erodibility and management factors and prepared a set of tables to simplify field use of the equation in Iowa. Other advances and adaptations of the procedure in the Corn Belt were made by Smith and Whitt (13, 14) and by Van Doren and Bartelli (23). Research scientists and operations personnel in the North Central States worked together in developing the slope-practice method for use throughout the Corn Belt States.

In 1946, a nationwide committee on soil-loss prediction met in Ohio for the purpose of adapting the Corn Belt equation to other cropland areas with erosion problems. This committee reappraised the Corn Belt factor values and added a rainfall factor (9). The resulting formula, generally known as the Musgrave equation, has been widely used for estimating gross erosion from watersheds in flood abatement programs. A graphical solution of the equation was published in 1952 by Lloyd and Eley (7) and used by the Soil Conservation Service in the Northeastern States.

[1] Italic numbers in parentheses refer to Literature Cited, p. 44.

Years of field experience by the Soil Conservation Service in the Corn Belt and the Northeastern States proved the value of soil-loss prediction as a tool to help guide conservation farm planning. Extension of the usefulness of these equations to new areas was seriously hampered by the lack of procedures and basic information for adjusting measured factor values for differences in rainfall distribution, types of rainstorms expected, levels of farming methods, length of growing season, and other variables.

A universal soil-loss equation developed in the latter part of the 1950's (18, 20) overcame many of the limitations of the earlier equations. The improved equation was developed at the Runoff and Soil-Loss Data Center of the Agricultural Research Service, established at Purdue University in 1954. Most of the basic runoff and soil-loss data obtained in studies in the United States since 1930 were assembled at this location for summarization and further analyses.[2] These analyses resulted in several major improvements that were incorporated in the new soil-loss equation: (1) an improved rainfall-erosion index (21), (2) a method of evaluating cropping-management effects on the basis of local climatic conditions (22), (3) a quantitative soil erodibility factor, and (4) a method of accounting for effects of interrelations of such variables as productivity level, crop sequence, and residue management.

These developments freed the equation from some of the generalizations and the geographic and climatic restrictions inherent in earlier models. Because of its general applicability, the improved equation presented in this handbook has been referred to in some of the literature as the "universal" soil-loss equation (10, 16, 17, 15, 20).

SOIL-LOSS TOLERANCES

The term "soil-loss tolerance" is used to denote the maximum rate of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely. This rate has usually been expressed in terms of average soil loss per acre per year. [illegible]

[illegible] the land use and management combination best suited to his particular farm enterprise.

Establishment of tolerances for specific soils and topography has been largely a matter of collective judgment. Both physical and economic factors are considered. [illegible]

[illegible]

[2] [illegible]

THE SOIL-LOSS EQUATION

The Equation Model

The soil-loss equation is

$$A = R\,K\,L\,S\,C\,P$$

where A is the computed soil loss per unit area.

R, the rainfall factor, is the number of erosion-index units in a normal year's rain. The erosion index is a measure of the erosive force of specific rainfall.

K, the soil-erodibility factor, is the erosion rate per unit of erosion index for a specific soil in cultivated continuous fallow, on a 9-percent slope 72.6 feet long. The reasons for selection of these conditions as unit values is explained in the detailed discussion of this factor.

L, the slope-length factor, is the ratio of soil loss from the field slope length to that from a 72.6-foot length on the same soil type and gradient.

S, the slope-gradient factor, is the ratio of soil loss from the field gradient to that from a 9-percent slope.

C, the cropping-management factor, is the ratio of soil loss from a field with specified cropping and management to that from the fallow condition on which the factor K is evaluated.

P, the erosion-control practice factor, is the ratio of soil loss with contouring, stripcropping, or terracing to that with straight-row farming up-and-down slope.

[illegible]

ready reference table or chart from which locational values of that factor may be obtained. Limitations of the data available for evaluation of some of the factors are also pointed out.

The Rainfall Factor (R)

One major difference between the universal soil-loss equation and its predecessors is in the manner and precision with which locational differences in rainfall are brought into the soil-loss computations. The Corn Belt slope-practice equation was based on an overall average of the severity and distribution of the rainfall that occurred on the plot studies in that region. This average rainfall effect was reflected in an 8-ton base soil-loss rate for a 4-year rotation of corn, oats, and 2 years meadow. The Musgrave equation assumed that the erosivity of any rainfall varied as the 1.75 power of the 2-year maximum 30-minute rainfall. This relation was based on limited data taken in Wisconsin in the 1930's. Research since 1946 has not supported the accuracy of this term as an indicator of annual rainfall erosivity. Furthermore, [illegible]

[illegible]

The Rainfall Erosion Index

[illegible]

[illegible]

Iso-Erodent Map

[illegible]

Probability Values of the Erosion Index

[illegible]

The Soil-Erodibility Factor (K)

[illegible]

ification of soils according to erodibility (4, 6, 7, 11, 19). Generally, however, soil classifications used for erosion prediction have been largely subjective and have been only relative rankings.

The relative erodibility of different soils is difficult to judge from field observations. Even a soil with a relatively low erodibility factor may show signs of serious erosion when the soil occurs on long or steep slopes or in localities having numerous high-intensity rainstorms. A soil with a high natural erodibility factor, on the other hand, may show little evidence of actual erosion under gentle rainfall when it occurs on short and gentle slopes or when the best possible management is practiced. The effects of rainfall differences, slope, cover, and management are accounted for in the prediction equation by the symbols R, L, S, C, and P. Therefore, the soil-erodibility factor, K, must be evaluated independently of the effects of the other factors.

Definition of the Factor K

The soil-erodibility factor, K, in the soil-loss equation is a quantitative value experimentally determined. For a particular soil, it is the rate of erosion per unit of erosion index from unit plots on that soil.

A unit plot is 72.6 feet long, with a uniform lengthwise slope of 9 percent, in continuous fallow, tilled up and down the slope. Continuous fallow, for this purpose, is land that has been tilled and kept free of vegetation for a period of at least 2 years or until prior crop residues have decomposed. During the period of soil-loss measurements, the plot is plowed and placed in conventional corn seedbed condition each spring and is tilled as needed to prevent vegetal growth or serious surface crusting. When all of these conditions are met, each of the factors L, S, C, and P has a value of 1.0 and K equals A/EI.

The conditions listed above were selected as unit values in the soil-loss equation because they represent the predominant slope length and the median gradient on which past erosion measurements in the United States have been made and the designated management provides the surface condition least influenced by differences in climate and local cropping systems.

Direct measurements of K on well-replicated unit plots as described should reflect the combined effects of all the variables that significantly influence the ease with which a soil is eroded by rainfall and runoff. To evaluate K for soils that do not usually occur on a 9-percent slope, soil-loss data from plots that meet all the other specified conditions are adjusted to 9-percent slope by means of the slope factor.

Values of K

Values of K determined for 23 major soils on which erosion plot studies were conducted since 1930 are listed in table 1. Seven of these values are from continuous fallow. The others are from row crops averaging 20 plot-years of record per location and requiring a minimum of adjustment for management effects (10).

TABLE 1.—*Computed K values for soils on erosion-research stations*

Soil	Source of data	Computed K
Dunkirk silt loam	Geneva, N.Y.	[1] 0.69
Keene silt loam	Zanesville, Ohio	.48
Shelby loam	Bethany, Mo.	.41
Lodi loam	Blacksburg, Va.	.39
Fayette silt loam	LaCrosse, Wis.	[1] .38
Cecil sandy clay loam	Watkinsville, Ga.	.36
Marshall silt loam	Clarinda, Iowa	.33
Ida silt loam	Castana, Iowa	.33
Mansic clay loam	Hays, Kans.	.32
Hagerstown silty clay loam	State College, Pa.	[1] .31
Austin clay	Temple, Tex.	.29
Mexico silt loam	McCredie, Mo.	.28
Honeoye silt loam	Marcellus, N.Y.	[1] .28
Cecil sandy loam	Clemson, S.C.	[1] .28
Ontario loam	Geneva, N.Y.	[1] .27
Cecil clay loam	Watkinsville, Ga.	.26
Boswell fine sandy loam	Tyler, Tex.	.25
Cecil sandy loam	Watkinsville, Ga.	.23
Zaneis fine sandy loam	Guthrie, Okla.	.22
Tifton loamy sand	Tifton, Ga.	.10
Freehold loamy sand	Marlboro, N.J.	.08
Bath flaggy silt loam with surface stones > 2 inches removed	Arnot, N.Y.	[1] .05
Albia gravelly loam	Beemerville, N.J.	.03

[1] Evaluated from continuous fallow. All others were computed from row-crop data.

Other soils on which valuable erosion studies have been conducted (see footnote 2, p. 2) were not included in the table because of uncertainties involved in adjustments of the data for effects of cropping and management. Short periods of record from plots cropped to rotations that provide good canopy or residue protection most of the time cannot presently serve for authentic evaluation of K, even though the studies were well designed and provided valuable data for evaluation of other factors in the equation.

Soil-erodibility values for numerous other soils have been approximated by comparing a soil's characteristics and comparing the estimate of its erodibility against the established values for the 23 soils listed in table 1. Such estimated values for all the major soils in the several major geographic regions were prepared at joint ARS-SCS Regional Soil Loss Prediction Workshops.[4]

[4] See footnote 3, p. 2.

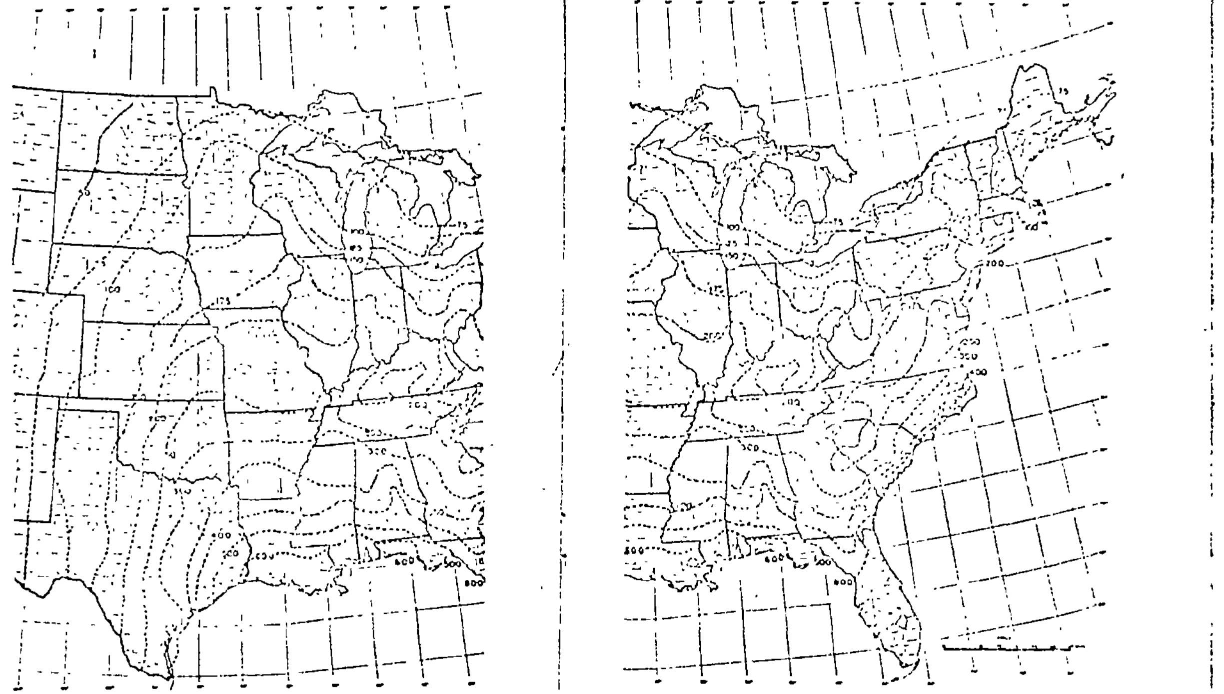


FIGURE 1.—Average annual values of the rainfall factor, R.

Increased research efforts begun in 1961 at several locations are designed to identify and evaluate the various soil properties that influence erodibility. Additional benchmark values are also being obtained by direct measurement of K on unit plots.

Factors for Slope Length (L) and Gradient (S)

The rate of soil erosion by water is very much affected by both slope length and gradient (percent slope). The two effects have been evaluated separately in research and are represented in the erosion equation by L and S, respectively. In field application of the equation, however, it is convenient to consider the two as a single topographic factor, LS.

The Slope-Effect Chart

The factor LS is the expected ratio of soil loss per unit area on a field slope to corresponding loss from the basic 9-percent slope, 72.6 feet long. This ratio for specific combinations of slope length and gradient, may usually be taken directly from the slope-effect chart (fig. 2). For example, a 10-percent slope, 300 feet long, would have an LS ratio of 2.6.

When the equation is used as a guide for selection of practices on an area where several slopes are combined into a single field, the slope characteristics of the most erosive significant segment of the field should be used for figure 2. Use of field averages on such slope complexes would underestimate soil movement on significant parts of the field.

The slope-effect chart assumes essentially uniform slopes. Field slopes are often either convex (steepening substantially toward the lower end) or concave (flattening toward the lower end). The effect of convexity or concavity of slopes on soil-erosion rates has not been fully evaluated. However, limited data indicate that use of the average gradient of the entire slope length would substantially underestimate soil loss from the convex slopes and would overestimate the loss from concave slopes.

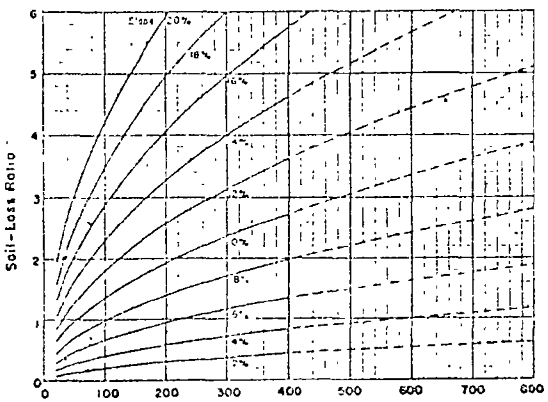


FIGURE 2.—Slope-effect chart (topographic factor, LS).

When the lower end of the slope is steeper than the upper end, the gradient of the steepest segment should be used with the overall slope length to enter the slope-effect chart. On a concave slope, deposition may occur on the lower end of the field. In such cases, the appropriate length and gradient are those of that segment of the slope that is above the point where it flattens enough for deposition to occur.

The broken-line portions of the curves on the chart were extrapolated to provide the best estimates now available for slopes longer than those measured in plot studies. Subsequent investigation on slopes longer than 300 feet may show need for revision of these segments of the curves.

Values of LS for slope percentages not shown on the chart may be computed by solving the following equation:

$$LS = \sqrt{\lambda}\,(0.0076 + 0.0053s + 0.00076s^2)$$

where λ is the field slope length in feet, and s is the gradient expressed as slope percent.

Slope Length

Slope length is defined as the distance from the point of origin of overland flow to either of the following, whichever is limiting for the major part of the area under consideration: (1) the point where the slope decreases to the extent that deposition begins or (2) the point where runoff enters a well-defined channel that may be part of a drainage network or a constructed channel such as a terrace or diversion (15).

Numerous plot studies have shown that the soil loss per unit area is proportional to some power of slope length. Since the factor L is the ratio of field soil loss to that from a 72.6-foot slope, the value of L may be expressed as $\left(\frac{\lambda}{72.6}\right)^m$, where λ is field slope length in feet and the exponent m is determined from field data. The magnitude of the exponent m in this expression is not the same for all locations or for all conditions at a given location (17). Its average value in past investigations under natural rainfall has been about 0.5. This is the value used for development of the slope-effect chart (fig. 2).

The value of m is significantly influenced by the interaction of slope length with gradient and may also be influenced by soil properties, type of vegetation, and management practices. On slopes steeper than 10 percent, a value of 0.6 for m is recommended. A value of 0.3 appears applicable to the very long slopes of less than one-half percent gradient encountered in the furrow-irrigated sections of the High Plains of western Texas. Data from gently sloping Houston clay and Mansic clay loam soils that were frequently dry and deeply cracked showed a decrease in runoff with increased slope length and indicated a value of m = 0.3 for these particular soils. Other than for these special cases, use of the 0.5 power of slope reflected in figure 2 is presently recommended. However, future research investigation may soon provide a basis for recommending other deviations from this overall average.

Figure 3 provides a graphical method for determining the value of LS when conditions indicate that a length exponent other than 0.5 is applicable. For example, assume a 400-foot slope length on Houston clay with 4-percent gradient and an exponent of 0.3. Entering figure 2 with the 140 feet from figure 3, the LS value for the assumed situation is about 0.65. A 400-foot slope length under conditions where the length exponent is 0.3 is shown to be equivalent to a 140-foot length under conditions where the exponent is 0.5.

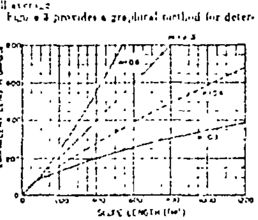


FIGURE 3.—Equivalent slope lengths for use of slope-effect chart when the value of the length exponent is not 0.5.

Slope Gradient

A. W. Zingg in 1940 concluded that soil loss varies as the 1.4 power of percent slope (25). In 1946, the Musgrave Committee (14) recommended use of the 1.35 power of percent slope. Based on analyses of the data assembled at the Runoff and Soil-Loss Data Center, Smith and Wischmeier (16) in 1957 proposed the relation:

$$S = \frac{0.43 + 0.30s + 0.043s^2}{6.613}$$

where s is the gradient expressed as percent slope and S is the slope factor in the erosion equation. The latter relation was used to derive figure 2.

The relation of soil loss to gradient is influenced by density of vegetal cover and by soil particle size. However, research data are presently not adequate to determine the specific conditions

under which deviations from the expressed average relation would be significant.

The Cropping-Management Factor (C)

The effects of cropping and management variables cannot be evaluated independently, because of the many interrelations involved. Almost any crop can be grown continuously, or it can be grown in any one of numerous rotations. The sequences of crops within a system can be varied. Crop residues can be removed, left on the surface, incorporated near the surface, or plowed under. When left on the surface, they can be chopped or they can be allowed to remain as left by the harvesting operation. Seedbeds can be left rough, with much available capacity for surface storage of rainfall, or they can be left smooth. Different combinations of these variables are likely to have different effects on soil loss.

In addition, the effectiveness of crop-residue management will depend on how much residue there is. This in turn depends on rainfall distribution, on the fertility level, and on various management decisions made by the farmer. Similarly, the erosion-control effectiveness of meadow sod turned under before corn or other row crops depends on the type and quality of the meadow and on the length of time elapsed since the sod was turned under.

The canopy protection of crops not only depends on the type of vegetation, the stand, and the quality of growth, but it also varies greatly in different months or seasons. Therefore, the overall erosion-reducing effectiveness of a crop depends largely on how much of the erosive rain occurs during those periods when the crop or management practice provides the least protection.

Definition of Factor C

The factor C in the soil-loss equation is the ratio of soil loss from land cropped under specified conditions to the corresponding loss from tilled continuous fallow. This factor measures the combined effect of all the interrelated cover and management variables listed in the preceding three paragraphs.

The loss that would occur on a particular field if it were continuously in fallow condition is computed by the four-factor product, RKLS, in the erosion equation. Actual loss from the cropped field is usually much less than this amount. Just how much less depends on the particular combination of cover, crop sequence, and management practices. It also depends on the particular stage of growth and development of the vegetal cover at the time of the rain. The factor C adjusts the soil-loss estimate to suit these conditions.

The correspondence of periods of expected highly erosive rainfall with periods of poor or good plant cover differs between regions or locations. Therefore, the value of C for a particular cropping system will not be the same in all parts of the country. In order to derive the appropriate C values for a given locality, it is necessary to know how the erosive rainfall in that locality is likely to be distributed through the 12 months of the year. It is also necessary to know how much erosion control protection the growing plants, the crop residues, and various tillage operations will provide at the time when erosive rains are likely to occur. A procedure has been developed for deriving locational values of the factor C on the basis of available weather records and research data that reflect effects of cover and management. The cropping and weather data needed for this purpose appear in ready-reference form in the subsections entitled "Soil-loss Ratios" and "Erosion-Index Distribution Curves."

[illegible] For this purpose, it was necessary to divide the year into a series of crop-stage periods so defined that cover and management effects may be considered approximately uniform within each period.

Crop Stage Periods

The five crop-stage periods that are used for computation of locational C values are defined as follows:

Period F.—Rough fallow. Turn plowing to seeding.

Period SB.—Seedbed. Seedbed preparation to 1 month after planting.

Period 1.—Establishment. From 1 to 2 months after spring or summer seeding. For fall-seeded grain, period 1 includes the winter months, ending about May 1 in the Northern States, April 15 in the Central States, and April 1 in the Southern States.

Period 2.—Growing and maturing crop. End of period 1 to crop harvest.

Period 3.—Residue or stubble. Crop harvest to plowing or new seeding. (When meadow was established in small grain, grain period 3 was assumed to extend 2 months beyond the grain harvest date. After that time, the vegetation was classified as established meadow.)

Some adjustment in length of periods 1 through 3 may be necessary for vegetable crops.

Effects of Cropping System and Management on Soil Loss

About 10,000 plot-years of runoff and soil-loss data assembled from 47 research stations in 24 States (10) were analyzed to obtain empirical measurements of the effects of cropping system and management on soil loss within each crop-stage period. Several significant factor relations that became apparent from the analyses provide background information for interpretation of the soil-loss-ratio table.

Erosion From Fallow Soil.—The rate at which fallow soil eroded depended on cropping history and the nature and quantity of residues turned under, as well as on inherent characteristics of the soil itself. [illegible] were more effective in reducing both runoff and erosion. Effects of cropping history are a part of the factor C in the erosion equation.

Productivity Level and Soil Loss.—In general, soil losses decreased as crop yields increased. Since good crop yields are usually associated with good stands and good foliage growth, the canopy cover is better and more residues are returned to the soil. Both help to decrease erosion losses. However, the added erosion-reducing effect of each additional unit of crop yield becomes less as yield becomes higher.

Crop Residue Management.—The soil loss reduction resulting from prior crop residues left on the field depended on the type and quantity of residues produced and the method of handling. Residues were most effective when left at the surface. But after several years of turning heavy crop residues under with a moldboard plow before row-crop seeding, both runoff and soil loss from the row crop were much less than from similar plots from which cornstalks and grain straw were removed at harvesttime. The effectiveness of any crop-residue residues was greatest during the fallow and seedling periods.

Erosion From Row Crop After Meadow.—Specific year erosion losses from corn after meadow ranged from 14 to 48 percent of corresponding losses from continuous corn on adjacent plots. Mixtures of grass and legume were more effective than legumes alone. In general, the effectiveness of grass and legume meadow sod plowed under before corn in reducing soil loss from the corn was directly proportional to meadow yields. Its erosion-control effectiveness was greatest during the rough fallow and seedbed-seedling periods and decreased as the corn year moved along. The total reduction in soil loss effected by the meadow depended [illegible] largely upon the stage of development of the corn when the erosive rains occurred. The length of the period during which the turned sod remained effective in reducing erosion was also directly related to meadow yields.

Effect of Length of Meadow Periods.—Direct comparisons of corn after first, second, and third years of meadow were very limited and the data were too sporadic for overall differences to be statistically significant. When second-year meadow was allowed to deteriorate under poor management, it was less effective than 1 year of meadow. When succeeding meadows were more productive than first year, they were usually more effective in reducing erosion from the corn after the meadow. The effectiveness of sequences [illegible] periods of continuous alfalfa in which grass became well established was longer lasting than that of 1 or 2 years of rotation meadow.

Grass and legume catch crops established in spring-seeded small grain and plowed under at corn planting time in the following year effected significant reductions in soil loss during the corn seedling period, but their effectiveness was shorter lived than that of a full year of meadow.

Winter Cover Seedings.—The erosion control attained with winter-cover seedings depended upon time and method of seeding, time of plowing, rainfall distribution, and type of cover seeded. Covers such as vetch and rye grass seeded between the corn or cotton rows before harvest and turned under in April were effective in reducing erosion not only in the winter months but also during the seedling and establishment periods of the following crop. Small grain alone seeded in corn or cotton residues and plowed under in spring was of some value during the winter period but showed no residual erosion-reducing effect after the next year's corn or cotton planting. Very limited data indicated crimson clover alone to be of doubtful value as a winter cover, but when it was combined with a quick starting grass, effective protection was provided. Small grain or vetch seeded in the fall on plowed cotton land and turned under in spring for another cotton seeding, lost about 50 percent more soil than adjacent plots with undisturbed cotton residues on the surface.

Soil-Loss Ratios

Humid Areas.—An empirical measure of the erosion-control effectiveness of each crop grown in various sequences was obtained from the assembled plot data. Ratios of soil loss from the cropped plots to corresponding losses from continuous fallow were computed. This ratio was computed for each of the five cropstage periods previously defined, for each particular crop in various combinations of crop sequence and productivity level.

A 10-column, 100-line table of the computed soil-loss ratios was published in 1961 by Wischmeier (22). This table was not as comprehensive as would be desirable from an application viewpoint. Some combinations of conditions encountered in field soil-loss estimation in various parts of the United States were omitted from the table because not enough research data were available to make sound evaluations of these particular combinations. Nevertheless, the table was comprehensive enough to test the validity and value of the new procedure for deriving rotation *C* values on a locational basis. It also provided

a broad set of benchmark values from which other ratios could be estimated by subjective comparisons.

Table 2 is an expansion of the previously published soil-loss-ratio table. It lists, for each cropstage period, the expected ratio of soil loss from the designated crop and practice combination to corresponding loss from the base fallow condition. The table is entered on the basis of crop, crop sequence, residue management, and crop productivity level in that order. The soil-loss ratio for each cropstage period is taken from the seven columns at the right. Three columns are needed for cropstage period 4 in order to reflect effects of different ways of managing the field during that period. Suggestions for estimating soil-loss ratios under some of the conditions not directly listed in this table are shown in table 3.

TABLE 2.—*Ratio of soil loss from cropland to corresponding loss from continuous fallow*

Line No.	Cover, sequence, and management [1]	Productivity [2]: Hay yield	Productivity [2]: Corn yield	Soil loss ratio for crop stage period [3]: F	1	2	3 [4]	4L	4R	4L + WC
	CORN IN ROTATION	Tons	Bu.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See footnotes at end of table.

TABLE 2.—*Ratio of soil loss from cropland to corresponding loss from continuous fallow*—Continued

Line No.	Cover, sequence, and management [1]	Productivity [2]: Hay yield	Productivity [2]: Corn yield	Soil loss ratio for crop stage period [3]: F	1	2	3 [4]	4L	4R	4L + WC
	CORN IN ROTATION—continued	Tons	Bu.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
	COTTON IN ROTATION									
	SMALL GRAIN IN ROTATION									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See footnotes at end of table.

TABLE 2.—*Ratio of soil loss from cropland to corresponding loss from continuous fallow*—Continued

Line No.	Cover, sequence, and management [1]	Productivity [2]: Hay yield	Productivity [2]: Corn yield	Soil loss ratio for crop stage period [3]: F	1	2	3 [4]	4L	4R	4L + WC
	SMALL GRAIN IN ROTATION—continued	Tons	Bu.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
	ESTABLISHED MEADOWS									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible footnotes]

TABLE 3.—*Suggestions for approximating soil loss ratios for cropping and management combinations not listed in table 2*

Cover, sequence, and management	Soil loss ratios
Corn: After fall chiseling in northern half of United States	[illegible]
After 2 or more full years of meadow	[illegible]
With small grain seeding for winter cover	[illegible]
Grain sorghum	[illegible]
Meadow: New	[illegible]
Established	[illegible]
Peanuts	[illegible]
Potatoes: After potatoes or truck crop	[illegible]
After grass and legume hay yield	[illegible]
After corn or small grain	[illegible]
Soybeans: After grass and legume hay or after corn	[illegible]
After soybeans	[illegible]
Late planted	Select values from comparable crop sequences in lines 5, 6, 16, 17, 27, 28, 44, [illegible]
Sweet corn	Do.
Truck crops	For low residue truck crops after grass and legume hay of [illegible] for crops, [illegible] periods 1 and [illegible] values from corn [illegible] periods 2, 3, and 4 values from lines 7, 18, 29, 34 [illegible]. For second or more year of truck crop, use values from line 33 or 16 for all periods.

Other combinations of crops and management variables are being included in studies as rapidly as possible. Rainfall simulators have been developed to decrease the time required to obtain data. In the meantime, the data in table 2 will be helpful for estimating the effectiveness of covers or management practices that have not been measured directly. Such estimates are facilitated by the fact that the table values are given for each cropstage period separately. Cover and surface conditions as they occur in each cropstage period of an untested crop or with a new tillage practice may usually be compared with the conditions reflected in one of the lines of soil loss ratio table. This procedure is illustrated in table 3, which suggests a number of specific comparisons.

Semiarid Areas.—Water erosion is a serious problem also in most semiarid regions. Inadequate moisture at periods often limits, reduce the periods when growing plants provide good soil cover, and [illegible] quantity of plant residues produced. [illegible] are not uncommon, and [illegible] the [illegible] crops [illegible]. Because of the difficulty of establishing meadows and the competition for available soil moisture, sod-based rotations are often impractical.

Proper management of available residues offers one of the most important opportunities for a higher level of soil and moisture conservation. However, accurate soil-loss ratios for stubble mulching and summer fallowing practices on the western Plains are not yet available from research data. The ratios given in table 4 are approximations based on observations of experi-

TABLE 4.—*Approximations of soil-loss ratios for crop stage periods and number of tillage operations with stubble mulching and summer fallow in western Plains areas*

Cover, sequence and management	Residue on surface at seeding time	Soil loss ratio for cropstage period: F	1	2	3	4L	4R
Small grain without meadow seeding:	Pounds	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Cover, sequence and management	Residue on surface at seeding time	Soil loss ratios for following number of tillage operations after grain harvest: 1	2	3	4	5
Summer fallow: After small grain	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
After row crop	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

enced field personnel,[3] guided by very limited data on the erosion-control effectiveness of various amounts of surface mulch and by the experimentally determined values of table 2. These approximations appear to be consistent with present knowledge of erosion research and runoff and will provide valuable guides until more precise evaluations can be obtained through additional research.

Erosion-Index Distribution Curves

The rainfall factor, *R*, in the erosion equation does not completely describe the effects of lo-

[3] [illegible] J. J. Pierre, and J. W. Turelle, Soil Conservation Service, for [illegible] contributions toward expanding the scope and usefulness of the soil-loss-ratio data from which table 2 was derived. Table 4 was taken from unpublished material developed by J. W. Turelle and D. L. Craig in cooperation with the Agricultural Research Service's runoff and soil-loss data center.

cational differences in rainfall pattern on soil erosion. On cropped fields, rainfall distribution within the year is also important. The erosion-control effectiveness of a cropping system on some particular field depends on how the erosive rainfall is distributed among the five cropstage periods [illegible] therefore expected [illegible] distribution of erosive rainfall at a particular location [illegible] of the cropping and management [illegible].

It was previously [illegible] that [illegible] erosion [illegible] *EI* values of individual storms [illegible] distribution of the erosion index can also be computed from long-time rainfall data. This was done for all the station rainfall records abstracted for development of the isoerodent map.

On the basis of monthly distribution of the erosion index, the 37 States of figure 1 were divided into 33 geographic areas shown in figure 4. For practical purposes, the monthly distribution may be considered uniform throughout any one of these areas but different from monthly distribution in any of the other 32 areas. Actually, the changes in distribution are usually gradual transitions from one area to another rather than abrupt changes at the area boundaries. Therefore, wide differences between average distributions within two adjacent areas are often not apparent. However, at some part of the distribution curve, the difference is sufficient to affect C-value derivations for some cropping systems. For widely separated geographic areas, differences in the erosion-index distributions are much more apparent.

The erosion-index distribution curve applicable in each of the 33 subareas of figure 4 is shown in figures 5 to 21, respectively. The numbers of the plotted curves in these figures correspond with the area numbers shown on the key map (figure 4). Average monthly erosion-index values were expressed as percentages of average annual values and plotted cumulatively against time. Thus, the percentage of the annual erosion index that is to be expected within any particular cropstage period may be found by reading the curve at the last and first date of the period and subtracting.

Procedure for Deriving Rotation C-Values for a Particular Locality

To compute the value of C for any particular rotation on a given field, one needs first to determine the most likely seeding and harvest dates

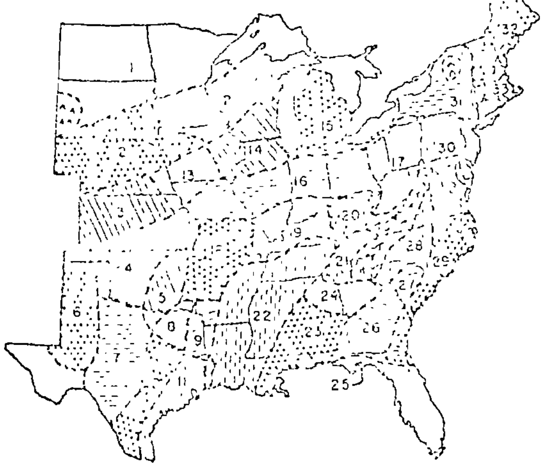


FIGURE 4.—Key map for selection of applicable erosion-index distribution curve.

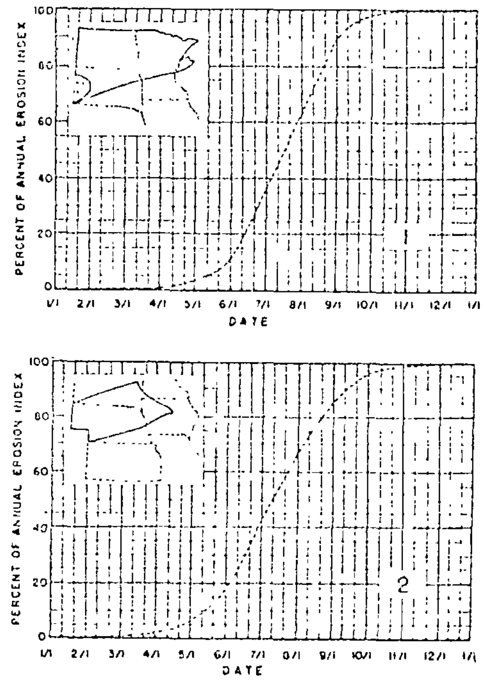


FIGURE 5.—Erosion-index distribution curves 1 and 2, the Dakotas and parts of Minnesota, Nebraska, and Iowa.

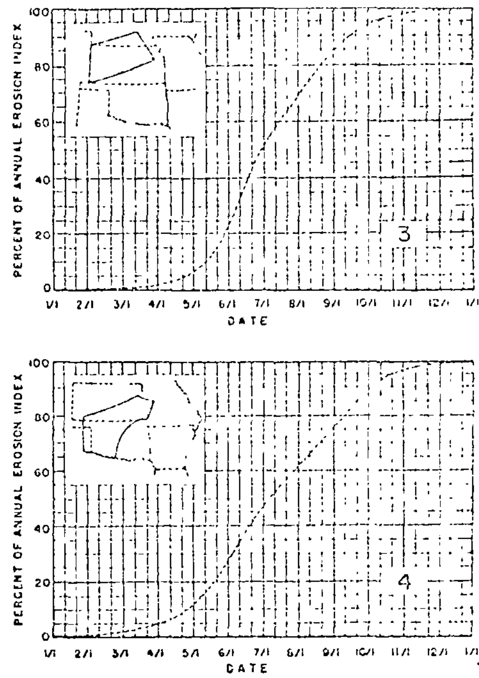


FIGURE 6.—Erosion-index distribution curves 3 and 4, parts of Nebraska, Kansas, and Oklahoma.

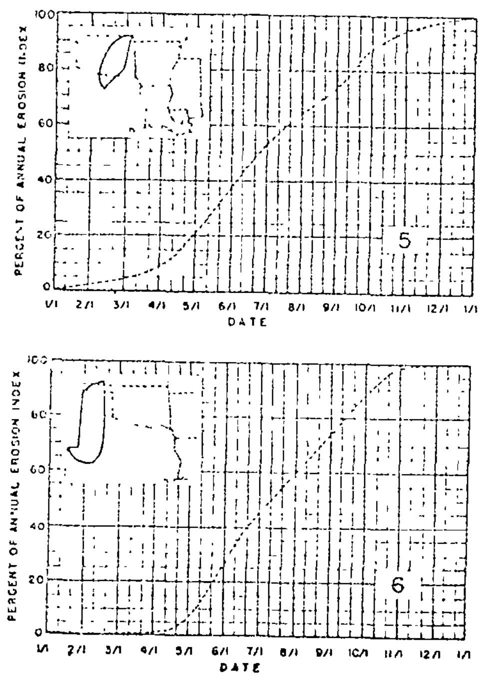


FIGURE 7.—Erosion-index distribution curves 5 and 6, parts of Oklahoma and Texas.

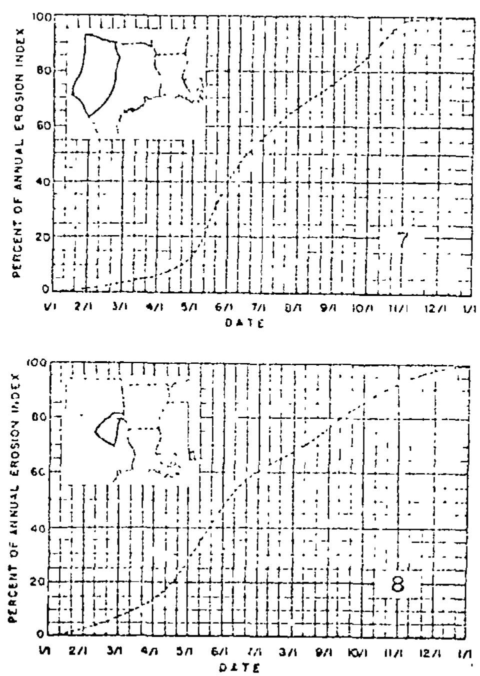


FIGURE 8.—Erosion-index distribution curves 7 and 8, parts of Texas.

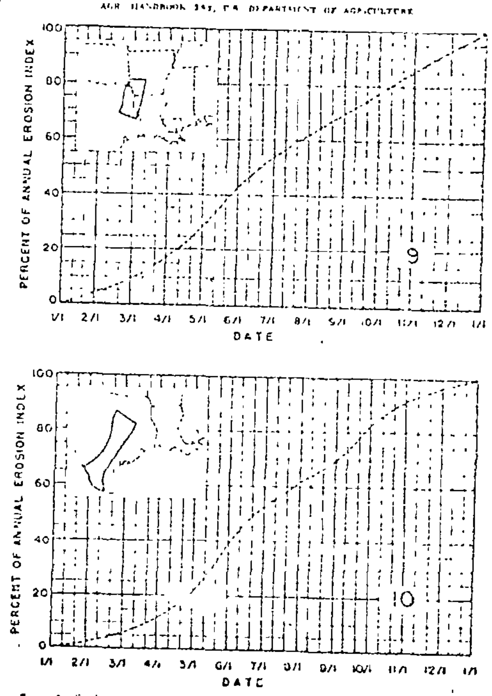
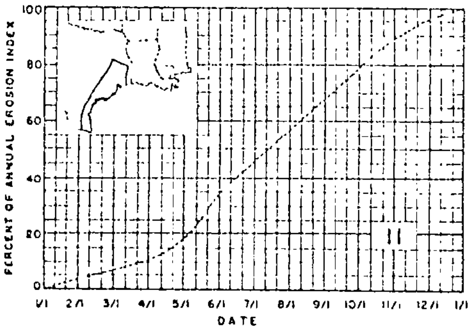
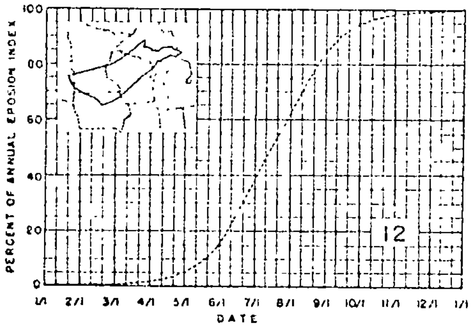
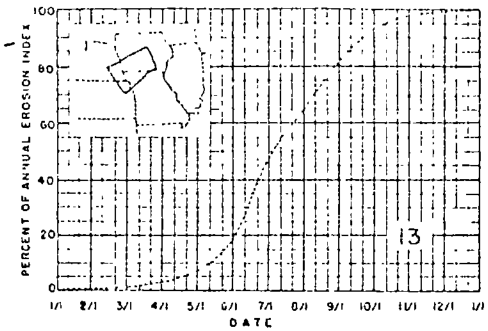


FIGURE 9.—Erosion-index distribution curves 9 and 10, parts of Texas, Arkansas, and Louisiana.





...re 10.—Erosion-index distribution curves 11 and 12: parts of Texas, Minnesota, Iowa, Wisconsin, and Michigan.



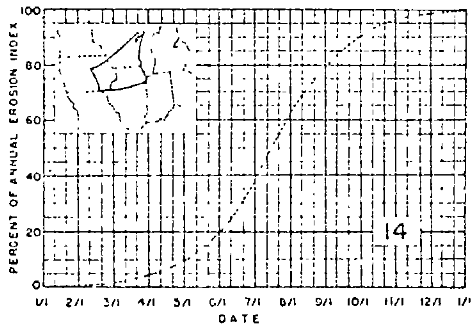
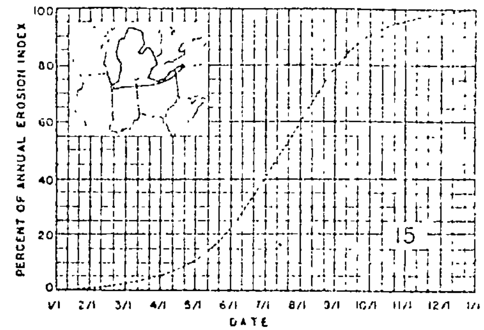
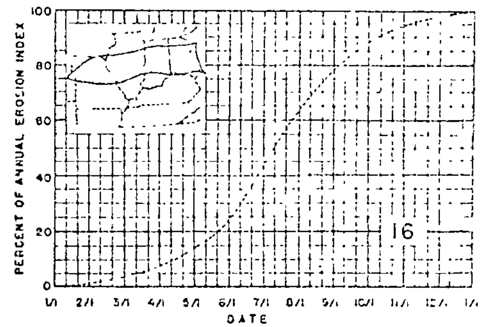
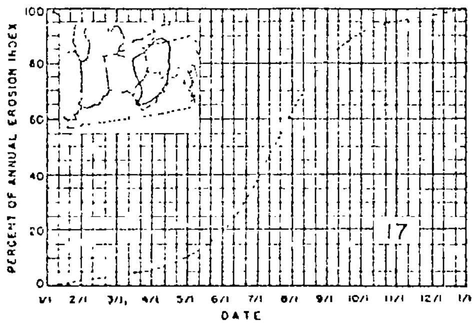


Figure 11.—Erosion-index distribution curves 13 and 14: parts of Nebraska, Kansas, Missouri, Iowa, Illinois, and Wisconsin.





...re 12.—Erosion-index distribution curves 15 and 16: parts of Michigan, Missouri, Illinois, Indiana, and Ohio.



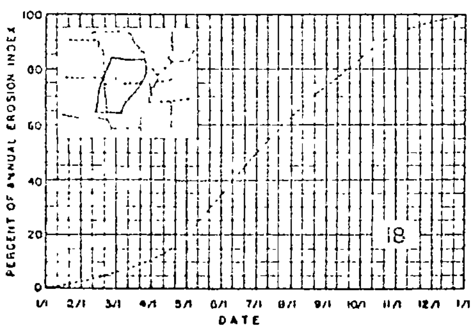
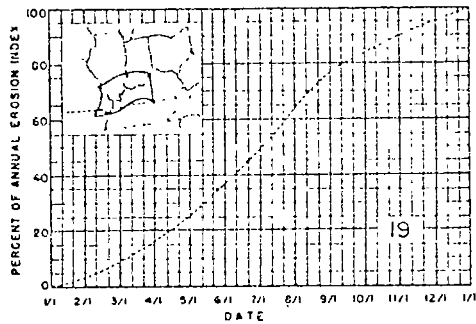
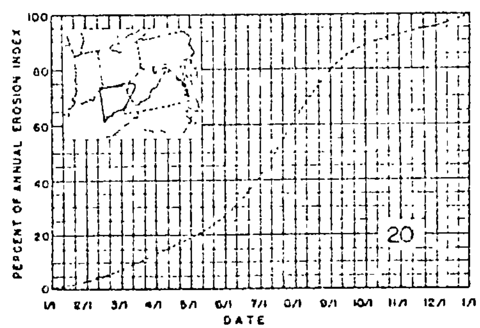
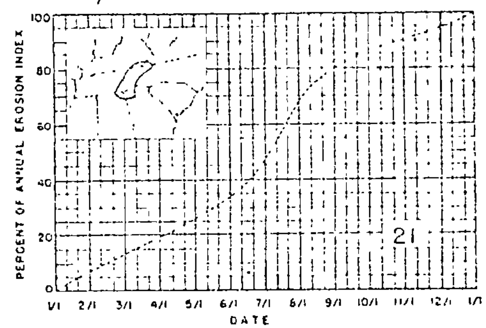


Figure 13.—Erosion-index distribution curves 17 and 18: parts of Ohio, Pennsylvania, West Virginia, Missouri, Arkansas.





...re 14.—Erosion-index distribution curves 19 and 20: parts of Missouri, Illinois, Indiana, and Kentucky.



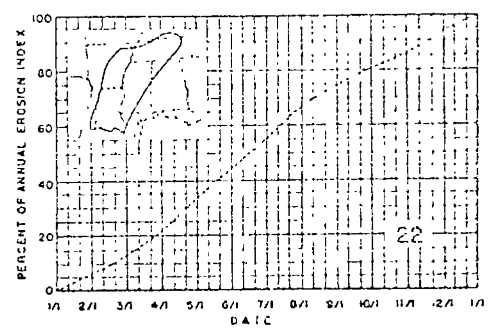


Figure 15.—Erosion-index distribution curves 21 and 22: parts of Tennessee, Arkansas, Louisiana, Mississippi, and Alabama.

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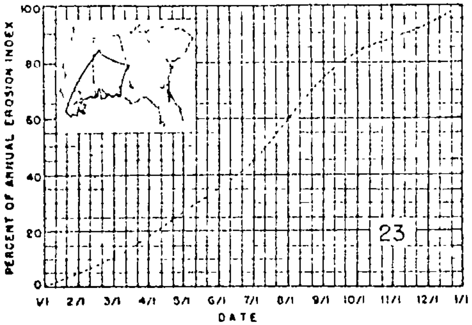
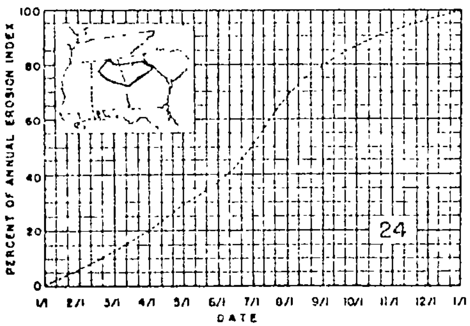
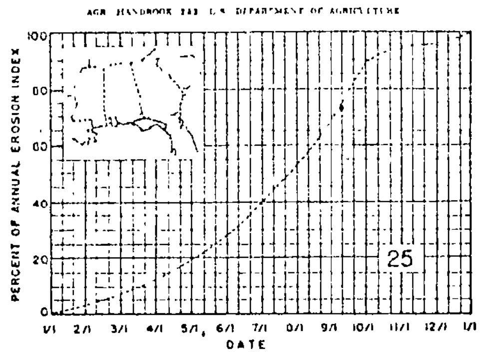




...RE 16.—Erosion-index distribution curves 23 and 24: parts of Mississippi, Alabama, Florida, and Georgia.



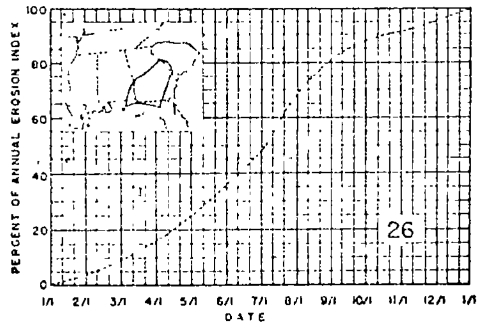
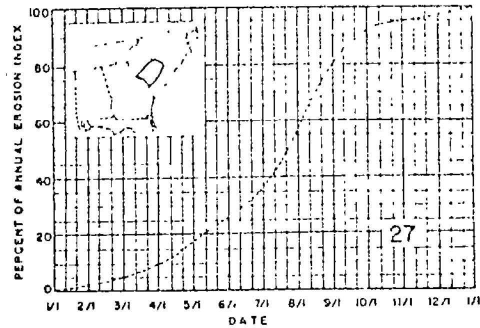
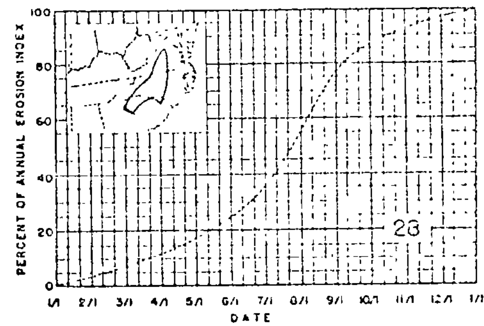
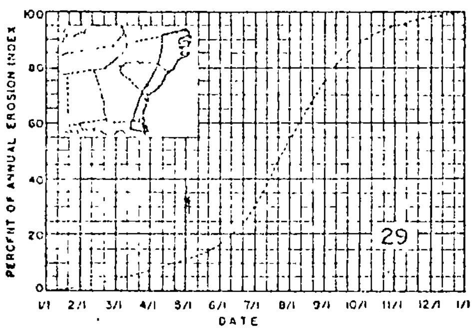


FIGURE 17.—Erosion-index distribution curves 25 and 26: parts of Florida and Georgia.





...RE 18.—Erosion-index distribution curves 27 and 28: parts of South Carolina, North Carolina, and Virginia.



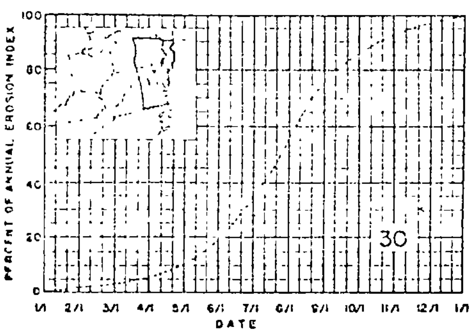
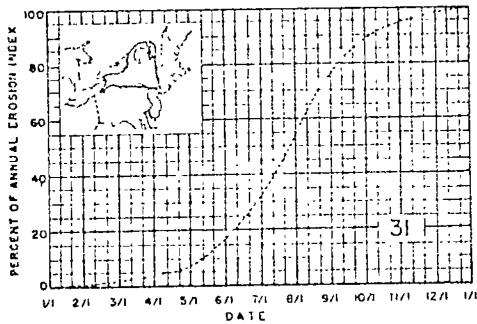
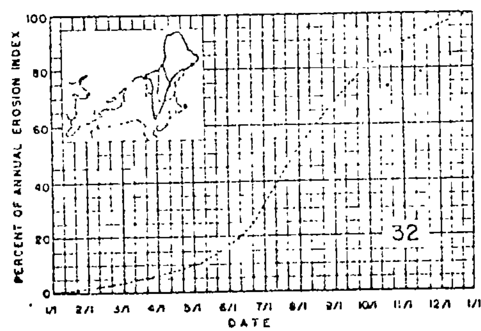


FIGURE 19.—Erosion-index distribution curves 29 and 30: Atlantic coast from New Jersey to Florida.





...URE 20.—Erosion-index distribution curves 31 and 32: New York and parts of Maine, New Hampshire, Vermont, and Massachusetts.

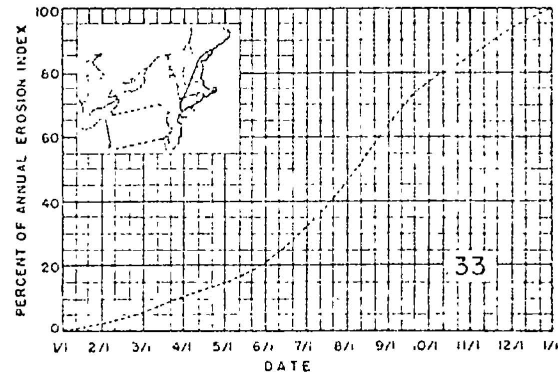


FIGURE 21.—Erosion-index distribution curve 33: Connecticut, Rhode Island and parts of Massachusetts, New Hampshire, and Maine.

method of seedbed preparation and residue management, and average crop yields to be expected with this system [illegible] with the conventional [illegible]. Tables 2 to 4 and figures 4 to [illegible] then supply the research data needed to complete the computation. The procedure will be explained by means of an example.

Problem.—Evaluate C for a [illegible] rotation of wheat with meadow seeding, meadow, corn, corn [illegible] with [illegible] and average production [illegible] with [illegible] and yield averages of only 12 to 15 bushels of wheat, 2 tons of hay, and 40 to [illegible] bushels of corn. Assume that the meadow is a mixture of grass and legume such as alfalfa and brome or timothy and clover, that crop residues are left on the field, that cornstalks are plowed under about May [illegible] for corn planting or disked for wheat seeding about October 15, and that wheat is harvested about July 10.

Procedure.—Set up a working table such as that illustrated in table 5, obtaining the needed information as follows:

Column 1 lists in chronological sequence all seeding and harvest dates (other than hay) involved in the rotation.

Column 2 lists the beginning date of each successive crop stage period. [illegible] The [illegible] period begins 2 months after wheat harvest and extends to plowing date. Thus all the dates in column 2 are determined by the locational seeding and harvest dates.

Column 3 records values read from the appropriate erosion index distribution curve. Figure 4 shows that the curve applicable in central Indiana is No. 16. This curve appears in figure 12. The curve is read for each successive date listed in column 2, adding one to the "hundreds" column each time January 1 is passed.

Column 4 identifies the cropstage period ending with the date shown on that line.

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Column 4 lists the percentage of the erosion index applicable to each successive crop-stage period. The values are determined [illegible] ... table 2 [illegible] ... to locate the lines in table 2 from which the values were taken.

The crop yield figure for entering table 2 is the expected average yield [illegible] ... below the expected average is appropriate. From an erosion viewpoint, the adverse effects of a meadow failure in a rotation [illegible] ... All row crop values in the table that are not otherwise identified assume moldboard plowing, smoothing, for seedbed, and cultivation after emergence.

Col. 8 period precedes the crop year with which it is associated in the table. For example, the [illegible]

value for cornstalk fallow after first-year corn appears [illegible] ... Column 7 is self-explanatory. [illegible] ... Columns 9 and 10 replace column 6 when solving parts 2 and 3 of the problem. [illegible] ... 1 from 0.119 to 0.075, a 37 percent reduction. A productivity level as low as that specified in part 3 would increase the C value for the rotation to 0.180, an increase of 50 percent. Expected

TABLE 5.—*Working table for derivation of C value for 4-year rotation in central Indiana*

(1) Operation	(2) Date	(3) [illegible]	(4) [illegible]	(5) [illegible]	(6) [illegible]	(7) [illegible]	(8) Value of C	(9) [illegible]	(10) [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

soil loss from the field would be increased by the same percentage.

[illegible] computed for the rotation in the example are directly applicable only within [illegible] ... or smaller.

It should be pointed out here that all these detailed computations are not required of each farm field. The procedure and basic data for derivation of the C values are provided primarily to enable computation of tables of C-values handbook tables of values applicable in specific States of geographic areas. Knowledge of the procedure will, however, lead to a better understanding of the significance of such tables and will permit field computation of values for unusual situations.

The Erosion-Control Practice Factor (P)

In general, whenever sloping soil is to be cultivated [illegible] ... the amount of soil it can carry. The most important of these supporting practices for cropland are contour tillage, contour stripcropping on the contour, terrace systems, and stabilized waterways. [illegible] ... the factor P [illegible]

Contouring

The practice of tillage and planting on the contour has been [illegible] effective in reducing [illegible] ... from individual storms of moderate to low intensity, but it provided little or no protection against the occasional severe storms that caused extensive breakovers of the contoured rows. [illegible] ... approaches 1.0. As slope increases, contour row capacity decreases and the soil-loss ratio again approaches 1.0.

Practice Factor Values for Contouring.—After available data and observations were considered, a joint ARS-SCS [illegible] slope-practice workshop group meeting at Purdue University in 1956 adopted the values of P shown in table 6.

TABLE 6.—*Practice factor values for contouring*

Land slope (percent)	P value
1.1 to 2	0.60
2.1 to 7	.50
7.1 to 12	.60
12.1 to 18	.80
18.1 to 24	.90

These are average values for the factor. Location values may vary with soil type, cropping, residue management, and rainfall pattern.

The full benefit of contouring is obtained only on fields relatively free from gullies and depressions other than grassed waterways. The effectiveness of this practice is reduced if a field contains numerous small gullies and rills that are not obliterated by normal tillage operations. In such instances, land smoothing should be considered before contouring. [illegible] ... should be used when computing the benefits for contouring.

Contour Listing.—Contour listing, with the corn planted in the furrows, has been more effective than surface planting on the contour (5). However, [illegible] ... of this practice is limited to the time from the date of listing to [illegible] ... The soil-loss ratios [illegible] ... after the lister ridges have been largely obliterated by two corn cultivations.

A similar analysis would apply to commercial potato production where the potato rows are on the contour, except that in this case the 50-percent reduction would be applied only from [illegible]

Slope-Length Limits for Effective Contouring.—When [illegible] ... of contour rows, there result in concentrations of runoff that tend to become progressively greater with increases in slope length. Therefore, on slopes exceeding some critical length the amount of soil moved from a contoured field may approach or exceed that from a field on which each row carries its own runoff water down the slope. At what slope length this could be expected to occur would depend to some extent on gradient, soil properties, management, and storm characteristics. Terraces or the sod strips in a contour stripcrop system function to prevent serious

erosion damage when excessive row breakage occurs.

After the 1956 slope-practice workshop, the Soil Conservation Service prepared [illegible] reference tables for use with the Corn Belt slope-practice procedure. The values shown in table 7 were given as guides to slope-length limits for effective contouring. These are judgment values. Research data are not now available to verify or correct them. It is important to bear in mind, however, that the contour factor values given in table 6 assume slope lengths short enough for full effectiveness of the practice. Use of these values for estimating soil loss on unterraced slopes that are several terrace intervals in length is speculative.

TABLE 7.—*Length limits for contouring*

Slope (percent)	Maximum slope length
	Feet
2	400
4 to 6	300
8	200
10	100
12	80
14 to 24	60

Contour Stripcropping

Stripcropping, a practice in which contour strips of sod are alternated with strips of row crop or small grain, has proved to be a more effective practice than contouring alone. [illegible] example is found at the [illegible] near LaCrosse, Wis., where some fields are reported to have been cropped in strips for more than 70 years. Where the strips were on the contour or nearly so, good erosion control was accomplished. Where the strips were 5 percent or more off contour, very high soil losses have occurred due to the flow of runoff down the rows at high velocities.

Observations from stripcrop studies indicated that much of the soil washed from a cultivated strip was filtered out of the runoff as it spread within the first several feet of the adjacent sod strip. Thus, the stripcrop factor, derived from soil-loss measurements at the foot of the slope, accounts for off-the-field movement of soil but not for all movement within the field.

Practice Factor for Contour Stripcropping.—After review of available data and field observations, the ARS-SCS workshop group meeting at Purdue in 1956 decided to [illegible] ... The alternate grain-and-meadow strip system [illegible] able with a 4-year rotation of corn, small grain,

[illegible] ... Wisconsin [illegible] ... were recommended.

Buffer stripcropping consists of narrow protective strips [illegible] ... were recommended by the 1956 slope-practice workshop.

TABLE 8.—*Strip widths recommended for [illegible]*

Slope (percent)	[illegible]
2 to 7	[illegible]
7 to 12	[illegible]
12 to 18	[illegible]
18 to 24	[illegible]

Terracing

[illegible] ... that deposited in the [illegible]

the deposition in the terrace channel and may [illegible] ... The [illegible] of the terrace [illegible] ... the contour practice factor.

[illegible] ... percentage of slope. Erosion control between

terraces depends upon the crop rotation and other management practices. Therefore, if a control level is to be [illegible] ... the practice factor for terracing should equal the contour practice factor.

[illegible] ... with the established drainageways.

Limitations

The rainfall-erosion index measures only the erosivity of rainfall and associated runoff. Therefore, the equation does not predict soil loss that is due solely to thaw, snowmelt, or wind. In areas where such losses are significant, they must be estimated separately and combined with those predicted by the equation for comparison with soil-loss tolerances.

FIELD APPLICATIONS OF THE SOIL-LOSS EQUATION

The primary purpose of the soil-loss prediction [illegible] ... erosion equation are used and illustrated below.

Predicting Field Soil Loss

Rotation Averages

The procedure for computing the expected average annual soil loss from a given cropping system on a particular field is illustrated in the following example.

Assume a field in Fountain County, Ind., on Russell silt loam having an 8 percent slope about 200 feet long. The cropping system is a 4-year rotation of wheat, meadow, corn, corn with tillage and rows on the contour and with corn [illegible] ... The first step is to refer to the charts and

tables discussed in the preceding section and to select the values of R, K, LS, C, and P that apply to the specific conditions on this particular field.

The value of the rainfall factor R is taken from figure 1 [illegible] ... Fountain County [illegible] ... the value of the soil-erodibility factor K is [illegible] ... Russell silt loam [illegible] ... K = 0.38.

The [illegible] chart (fig. 2, p. 8) shows that, for an 8 percent [illegible] ... LS = 1.41.

Figure 4 (p. [illegible]) shows that Fountain County is within the [illegible] ... compute the C value for the rotation by the procedure illustrated in table 5 (p. 34). For the productivity level and management practices assumed in this example, factor C for a W-M-C-C rotation in area 16 was shown in table 5 to equal 0.119.

Table 6 (p. 36) shows a practice-factor value of 0.6 for contouring on 8-percent slope, and table 7

[1] See footnote 8, p. 8.

(p. 37) indicates that the 200-foot slope is not too long for this factor to be applicable. Therefore, under the conditions assumed in this example, P = 0.6.

The next step is to substitute the selected numerical values for the symbols in the erosion equation and solve for A. In this example, A = 185 × 0.38 × 1.41 × 0.119 × 0.6 = 7.1 tons of soil loss per acre per year.

If planting had been up and downslope instead of on the contour, the factor P would have equaled 1.0 and the predicted soil loss for this field would have been 185 × 0.38 × 1.41 × 0.119 × 1.0 = 11.8 tons per acre.

Had contour farming been combined with minimum tillage for all corn in the rotation, the value of the factor C would have been 0.075 (see table 5). The predicted average annual soil loss from the field would then have been 185 × 0.38 × 1.41 × 0.075 × 0.6 = 4.5 tons per acre.

Crop-Year Averages

The soil losses computed in the example are rotation averages over a long time period. Thus, the heavier losses experienced during the corn years are diluted by small losses during the meadow year. These refer again to the first solution above, in which the rotation average was 7.1 tons per acre per year. The 4-year loss from each complete rotation cycle would average 4 × 7.1, or about 28.4 tons per acre.

Use of the values in column 8 of table 5 enables one to compute the average soil loss for each of the 4 crop years. Column 8 shows a computed C value of 0.0[illegible] for the wheat period and a C of 0.476 for the entire 4-year period. The average yearly soil loss from wheat in the above example, with contouring, would be 28.4 × 0.070/0.476, or 4.2 tons per acre. First-year corn, including the winter period, would average 28.4 × 0.[illegible]/0.476, or 8.0 tons. The second-year corn would average 28.4 × 0.[illegible]/0.476 or 14.1 tons, and the 20-month meadow period would average less than 0.[illegible] ton soil loss per acre.

Soil-Loss Probabilities Other Than Average

Because rainfall differs from year to year, the actual value of the factor R also differs from year to year at any given location. Appendix table 11 lists the 50- and 5-percent probability values of R at 181 key locations. These may be used for further characterization of soil-loss hazards. Fountain County, Ind. (where our example was located) is not listed in the table, but figure 1 shows that the R value there is essentially the same as the R value at Indianapolis. Table 11 shows that, over a long period, the value of the factor R will equal or exceed 225 at Indianapolis in 20 percent of the years. This is 225 ÷ 185, or 1.22 times the average value. Returning once

more to the example, soil loss from second-year corn on the contoured field would be expected to exceed [illegible] × 14.1 [illegible] ... of the years. [illegible] ... the average value of 185. Therefore, soil loss from the second-year corn on the field assumed for our example would be expected to exceed 1.46 × 14.1 = 21 tons per acre in 5 percent of the years if the corn is contoured. Without contouring, it would exceed 21.5 ÷ 0.6 = 35.2 tons per acre in 5 percent of the years.

Individual-Storm Soil Losses

The available plot data show conclusively that the relation of soil loss to such major factors as slope, cropping, management, and conservation practices is not the same from storm to storm or from year to year, even on the same field under a continuing rotation. In a particular rainstorm, the factor relationships are influenced by such variables as antecedent moisture, [illegible] ... more favorable to rapid development of good protective cover in some years than in others. The factor values presented in the preceding section and used in the foregoing example represent averages for relations existing [illegible] ... over an extended period [illegible].

Predictions of rainfall at storm soil losses will be less accurate because effects of the minor variables cannot be precisely evaluated at this time. However, reasonable estimates of single-storm losses can be computed by the [illegible] procedure.

Instead of taking the value of R from figure 1, let R equal the computed erosion-index value for the specific storm. In place of the C value for the rotation, let C in the equation equal the soil-loss ratio shown in table 2, 3, or 4 for the specific conditions existing on the field at the time of the storm. For example, appendix table 12 shows that a 10-year rainstorm at Indianapolis has an erosion-index value of 75 [illegible]. Assume that such a rain occurred about [illegible] weeks after planting the second-year corn in the preceding example. The cropstage condition is also described by line 14 of table 2. Since the rain occurred within [illegible] days after corn planting, the value of C at the time of this particular rain is 48. The value of K is 75. Other values in the equation remain the same as in the first solution. The estimated soil loss from this single rainstorm on the second-year corn, without contouring, is then R K LS C P = 75 × 0.38 × 1.41 × 0.48 × 1.0 = 19.3 tons per acre.

Specific-Year Soil Losses

Soil losses in a particular [illegible] ... in that year [illegible] ... agreement [illegible] soil-loss tolerances [illegible]

Significance of Average Field Soil Loss

[illegible] ... deviation [illegible]

Determining Alternative Ways in which a Particular Level of Land May Be Used and Farmed Successfully to Conserve or Improve It

[illegible] ... The LS K R values are the measurements allowable C values [illegible] ... various soil and slope com-

[illegible] in the conservationist's work area. This may be published in handbook form illustrated by table 9, with a table for each major soil type which is to be considered.

C values for rotations may be similarly computed for all cropping systems encountered within a given erosion-index distribution area (fig. 4) based on average seeding and harvest dates within that area. The factor for each cropping system needs to be computed for each of several crop-productivity levels and for each of several methods of residue management and seedbed preparation. The results are then listed in a table in order of declining magnitude of C as illustrated in table 10.

To illustrate the selection process, we will assume a field in a county having a rainfall factor of 180 located within the erosion-index distribution area in which the C values of table 10 apply. Assume that the soil on this field has a K value of 0.32 and a soil-loss tolerance of 4 tons per acre per year. Past yields on the field have been from 2 to 3 tons hay and from 40 to 60 bushels corn per acre with conventional seedbed preparation and tillage.

The land slope averages about 8 percent over the upper half of a total 400-foot slope, but the lower half steepens considerably and ranges from 8 to 12 percent. The field is planted as a single unit. In conservation farming, soil movement from the more vulnerable part of the field should be held below the tolerance limit, T. Therefore, the gradient of the lower half of the field is the significant percentage of slope for the soil loss estimate. However, surface runoff from the upper half passes over the lower half. Therefore, the overall length will be the effective slope length. Thus a slope length of 400 feet and a slope gradient of 12 percent would be used to enter the ready reference table.

For the soil and slope combination, table 9 lists a maximum CP value of 0.020. Entering table 10 with this value, the farmer finds that with straight rows and conventional tillage at the Y_2 yield level, the most intensive cropping system he can safely use is 1 year of corn and 4 years (C-O-M-M-M). Any system having a C value less than that for C-O-M-M-M should provide better than the tolerable level of erosion control under the conditions assumed for this example.

With contour farming the maximum C value would be 0.040 (table 9), and he could move up the list in table 10 to a C-C-O-M-M system.

Improvement in his general level of fertility and residue management would enable the farmer to use a more intensive cropping system safely or to attain a higher level of conservation while at the same time increasing his crop yields. If he were able to reach and maintain average yields equal to Y_3 in table 10, he could move up to a C-O-M-M rotation without contouring or to C-C-O-M-M with contouring. If he then also adopted wheel-track planting and no-tillage for corn, he could move up to a 1 to 2 years of corn and 1 year of oats in a C-C-O-M rotation. Thus the table shows the farmer how he can improve his erosion-control program and still increase yields or decrease labor and tractor costs.

A system of terraces would break the slope length and permit a higher degree of conservation or more intensive cropping systems. Terraces at about 100-foot horizontal intervals would reduce the effective slope length from 400 feet to 100 feet. For a 12-percent slope 100 feet long, contoured, table 9 shows a maximum C value of 0.20. This would permit any of the cropping systems listed in table 10 up to 3 years of corn in 5 (C-C-C-O-M) or a 2-year system of corn and oats with sweetclover intercrop. With wheel-track planting, a 3-year rotation of corn, corn, oat and sweetclover would also appear satisfactory.

Estimating Source Sediment From Watersheds

Cultivated farm fields are a major sediment source in the general agricultural areas of the humid and subhumid zones. The soil-loss prediction equation may be used effectively in making predictions of the magnitude of this sediment source. Other sources of sediment production that must be considered in making estimates of total sediment loads include gullies, roadside areas, and residential subdivisions.

The erosion equation provides a method of means of computing the effects of expected rainfall pattern, soil properties, and land use on computation of that part of the sediment production that is attributable to sheet and rill erosion. The drainage area may be broken down into a series of tracts having relatively homogeneous land use and treatment. The erosion equation is then used to approximate the average annual rate of soil movement from each tract.

However, some of the sheets computed in this manner are estimates of average annual sediment production over a period of at least 25 years or more. Gross erosion on the watershed in any one particular year may be at least three or four times this average rate. In other years it will be less. This is true for a number of reasons. Table 11 shows that in one year out of 20, the rainfall erosion index is at least twice the average for that location. At the same time, abnormal distribution of erosive rainstorms would result in greater than average portion of the erosive rainfall occurring when the fields are most vulnerable to rainfall erosion. Breakover of contour rows in a severe rainstorm may increase greatly the gross erosion from that storm and also from succeeding storms until the break is obliterated by tillage. Adverse

TABLE 9.—*Maximum permissible C values (T/RKLS) for selected gradient and slope length with straight and contoured rows* [illegible]

Gradient (percent)	60	80	100	150	200	250	300	400
STRAIGHT ROW								
2	0.45	0.3[illegible]	0.33	0.26	0.22	0.20	0.17	0.15
4	.22	.19	.17	.13	.11	.10	.092	.081
6	.13	.11	.10	.081	.072	.065	.056	.050
8	.089	.077	.069	.055	.048	.043	.038	.034
10	.064	.056	.050	.040	.035	.031	.028	.024
12	.048	.042	.037	.030	.026	.023	.021	.018
14	.038	.033	.029	.024	.020	.018	.017	.014
16	.030	.026	.024	.019	.016	.015	.013	.012
18	.025	.022	.019	.016	.014	.013	[illegible]	[illegible]
20	.021	.018	.016	.013	.011	[illegible]	[illegible]	[illegible]
CONTOURED								
2	0.75	0.65	0.57	0.45	0.37	0.33	0.75	0.25
4	.44	.38	.34	.26	.22	.20	.18	.16
6	.26	.22	.20	.17	.14	.13	.12	.10
8	.15	.13	.11	.092	.080	.072	.064	.057
10	.11	.093	.083	.067	.058	.050	.046	.040
12	.085	.070	.061	.050	.043	.038	.034	.030
14	.064	.055	.049	.040	.034	.030	.027	.024
16	.051	.044	.040	.032	.027	.024	.021	.019
18	.043	.037	.033	.026	.023	.020	.018	.015
20	.036	.030	.026	.021	.019	.017	[illegible]	[illegible]

weather in one year may cause widespread meadow failure within the watershed area. Gross erosion from the first year and second year rotation corn after a poor meadow will then be substantially greater than normal. It may nearly equal that from continuous row cropping. Furthermore, one segment of the watershed may receive a severe rainstorm which another segment of the same watershed receives little or no rain. Location of the storm's center will differ from storm to storm, so that the long-time average rainfall may be nearly uniform. However, specific storm events of the sizes of both R and C may deviate a great deal from their average values for that location. When gross erosion is to be estimated for a specific short-term period, evaluation of the individual-storm rates, the specific EI value and a rotation cycle for each successive crop-stage period must be used in lieu of the annual erosion index and the rotation C value. (Refer to page 21 for details.)

Correct interpretation of watershed conditions for selection of appropriate values of the factors L and S is also very important, but interpretation is frequently quite difficult because of complex topography. Complex soil and land use patterns superimposed upon a complex topography present problems in interpretation and factor evaluation that need further research analysis. However, the definition of slope length, page 9, and the discussion of convex and concave slopes, page 6, provide helpful guides. Slope shapes and drainage patterns need to be carefully considered. A steep gradient at the lower end of a slope should not be averaged with a gentle gradient at the upper end. A depositing field does not terminate simply because of a wire fence or a change in cropping. If runoff from an area above a field is allowed to enter the field as sheet flow, the upper area is part of the slope length for computing erosion on the field. However, sediment deposition at the slope to cause deposition to begin indicates the end of a slope length.

The rest of the estimates for the individual tracts making up the watershed approximates the quantity of soil moved from its original general position. The total sediment tonnage must be adjusted downward to compensate for deposition in terrace channels, in sod waterways, in field boundaries and at the toe of field slopes. Further changes in sediment content of runoff water will occur during the stream transport phase.

The appropriate value of the factor P for a terraced field is considerably lower for purposes

TABLE 10.—*Partial list of C values for common rotations for a certain* [illegible]

Cropping system[2]: Rotations	Limits[3]	Conventional plant and till[4]: Y_1	Y_2	Y_3	Minimum tillage[4]: Y_2	Y_3
Continuous corn		0.46	0.42	0.38	0.33	0.27
C-C-C-O$_s$		.36	.31	.27	.23	.19
C-C-O$_s$		.32	.27	.24	.19	.17
C-C-C-O-M		.25	.20	.19	.16	.13
C-O$_s$		.25	.13	.17	.13	.12
C-C-O-M		.19	.14	.13	.10	.083
C-C-O-M-M		.13	.12	.10	.081	.066
C-C-O-M-M-M		.13	.096	.082	.068	.057
C-O-W-M		.13	.093	.078	.064	.049
C-O-M		.12	.078	.068	.062	.037
C-O-M-M		.038	.050	.045	.040	.029
C-O-M-M-M		.071	.044	.038	.033	.024
C-O-M-M-M-M		.060	.042	.031	.029	.026

[1] Area shown in fig. 12 for curve No. 16.
[2] Abbreviations: C—corn, O—oats, O$_s$—oats with sweetclover intercrop, W—fall-seeded grain, M—grass and legume meadow. RdL—residues left.
[3] Dashed lines indicate cropping system limits for a, straight-row farming; b, contouring; c, terraces. Applicable to slopes [illegible].
[4] Y_1—average yields [illegible]; Y_2—average yields of 2 to 3 tons hay [illegible]; Y_3—average yields of 4 to 5 tons hay, 75 bushels [illegible].

of watershed sediment prediction than it is for purposes of erosion-control planning. As much as 90 percent of the soil eroded from the area between terraces may be deposited in the channels (28). For sediment prediction, the important consideration is the quantity of soil moved completely off the field. For this purpose, P values equal to about 20 percent of the contour practice values shown in table 6 are recommended.

When runoff from a cropped field enters a grass waterway or crosses a sodded fence row or stream bank area to enter a main drain or way, part of the silt load is filtered out by the [illegible] estimated [illegible]. If the gradient decreases appreciably between the lower end of the eroding field and the point where the runoff enters [illegible], deposition may occur even if the area is not sodded. [illegible] actual gross-erosion estimates for these situations have not been evaluated.

Summary

The soil-loss prediction procedure presented in this handbook provides a methodical means for using all available research information to help guide land use and management decisions on any particular farm field where soil erosion by rainfall and runoff is a problem. The soil-loss prediction equation presented is universally applicable wherever locational values of the equation's individual factors are known or can be determined. Research data assembled from all major agricultural areas of the United States were analyzed and summarized in ready reference tables and graphs. These provide a source of information for approximating the factor values needed to apply the equation to the specific conditions in the various geographic areas.

Data and procedures are presented in considerable detail to help the user interpret the guides supplied by solutions of the equation. Applications of the procedures are illustrated in specific examples.

Use of the equation, tables, and figures for predicting soil erosion losses on a particular field under each of various alternative cropping systems and management practices is not a complicated procedure. Comparison of the predicted erosion rates with the applicable soil-loss tolerance provides very specific guidance for effecting erosion control within specified limits. For the selection of practices on an individual farm, the procedure can be reduced to use of a few reference tables derived for the particular geographic area.

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APPENDIX

TABLE 11.—*Observed range and 5-, 20-, and 50-percent probability values of erosion index at each of 181 key locations*

Location	Observed range	50-percent probability	20-percent probability	5-percent probability
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 11.—*Observed range and 5-, 20-, and 50-percent probability values of erosion index at each of 181 key locations*—Continued

Location	Observed range	50-percent probability	20-percent probability	5-percent probability
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

See footnote at end of table.

TABLE 11.—*Observed range and 5-, 20-, and 50-percent probability values of erosion index at each of 181 key locations*—Continued

Location	Observed range	50-percent probability	20-percent probability	5-percent probability
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[1] Computations based on [illegible] records [illegible].

TABLE 12.—*Expected magnitudes of single-storm erosion index values*

Location	1 year	2 years	5 years	10 years	20 years	50 years
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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TABLE 12.—*Expected magnitudes of single-storm erosion index values*—Continued

Location	Index values normally exceeded once in—				
	1 year	2 years	5 years	10 years	20 years
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 12.—*Expected magnitudes of single-storm erosion index values*—Continued

Location	Index values normally exceeded once in—				
	1 year	2 years	5 years	10 years	20 years
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Publications of the Council on Environmental Quality:*

Environmental Quality—The First Annual Report of the Council on Environmental Quality

Ocean Dumping—A National Policy

The President's 1971 Environmental Program

Toxic Substances

Environmental Quality—The Second Annual Report of the Council on Environmental Quality

The President's 1972 Environmental Program

Environmental Quality—The Third Annual Report of the Council on Environmental Quality

Integrated Pest Management

The President's 1973 Environmental Program

The Federal Environmental Monitoring Directory

Energy and the Environment—Electric Power

*Available at the U S Government Printing Office

environmental quality

the fourth annual report of the council on environmental quality

september 1973

addition, thousands of pieces of plastic, ranging from tiny scraps to lengths of fishnet 100 feet long, were found littering the beaches of Alaska's remote Amchitka Island Most of this plastic was believed to have come from foreign fishing vessels.[13]

There is a possibility that this plastic debris, lumps of tar, and other petroleum residues could interfere with some of the basic biological processes in the ocean, and laboratory investigations are underway to determine the effects that such pollution will have Because plastic does not degrade, once introduced into the environment, it will remain almost indefinitely As yet, data indicating the extent and trends of oceanic pollution are still relatively sparse, compared with those for inland and localized coastal waters However, increased attention is being directed toward this problem at both national and international levels

The Marine Protection, Research and Sanctuaries Act of 1972[14] directs NOAA, in cooperation with other Federal agencies, to initiate comprehensive and continuing programs of research on ocean dumping and ocean pollution Work is underway within NOAA to establish environmental baselines, against which possible future trends in ocean pollution can be determined Additional work on this problem, supported by the National Science Foundation as well as other Federal agencies, should also begin to provide a better understanding of the extent of ocean contamination

During 1971–72 the National Science Foundation's Office of the International Decade of Ocean Exploration (IDOE) carried out an intensive study of the baseline levels of heavy metals, halogenated hydrocarbons, and petroleum hydrocarbons in the oceans bordering the United States.[15] Alterations in trace metal concentrations in the marine environment due to man's activity were found to be restricted to estuarine and coastal areas which are influenced by industrial, domestic, or polluted river runoff. Only in the case of lead, which is transported by atmospheric processes, is there an indication of serious open ocean metal pollution

The IDOE baseline study found readily identifiable contamination in the open ocean by synthetic chlorinated hydrocarbons, such as polychlorinated biphenyls (PCB), pesticides (DDT) and their metabolites, and petroleum hydrocarbons PCB, DDT, and their metabolites were ubiquitous in samples taken from the Atlantic and Pacific Oceans and the Gulf of Mexico The highest levels were in coastal seas, but the open ocean values were high enough to cause concern. High levels of PCB or DDT were often associated with small oil or tar droplets which seem to extract the material from the sea water. These data indicate that petroleum has entered the marine food chain in both coastal and ocean waters. As in the case of the metals and chlorinated hydrocarbons, the highest levels of petroleum were found in coastal seas Petroleum hydrocarbons were concentrated in the surface films where they may constitute a particular danger for marine organisms

These observations have stimulated IDOE to initiate two major research programs, one directed at how these pollutants reach the ocean and the other at how they affect marine organisms and communities.

Land Use [16]

There is growing consensus that control over land use is probably the most important single factor in improving the quality of the environment in the United States Land use is a term which encompasses many dimensions, as we develop indicators for land use problems, it is essential to be clear about what these problems are

Land use indicators, like land use regulation, usually focus on competing uses for the same land Because each of the competing uses is likely to serve some socially beneficial purpose, it is often difficult to interpret indicators in any absolute way For example, an increase in agricultural land may or may not be desirable, depending on the competing demands There may be a few absolutes—for example, increases in the amount of unreclaimed surface-mined land are undesirable—but there are not many. The interpretation of data on land use changes usually requires a more complex framework.

One concept used in interpreting land use indicators is "carrying capacity," the intensity of use which, if exceeded, will cause adverse environmental consequences When deciding among conflicting land uses, one must know an area's natural carrying capacity so that the adverse consequences of exceeding that capacity may be considered. In many cases, one cannot say that this natural carrying capacity should not be exceeded because the adverse consequences usually can be overcome by engineering or other adjustments Then the relevant question becomes whether the costs of exceeding the natural carrying capacity are worthwhile. Or, put another way, is the "conversion cost" to increase the capacity of land, plus the other costs involved, less than the anticipated benefits?

A report to the Council by Development Sciences, Inc , illustrates this view of carrying capacity with the example of Washington, D C.:

> The Potomac River and the land which it drains have a certain limited natural capacity to deal with human land use patterns There are lands of certain soil types and there are water-bearing areas of specific limited quality and quantity. Before World War II and the accompanying population growth of the federal government, the natural cleansing capacity of the river was such that most human wastes were "treated" by natural forces, and low density land use patterns were sustained without excessive pollution or threats to the supply of water.
>
> If the land were zoned according to the carrying capacity of the soil and the river's capacity to handle wastes and supply

water, the Potomac could not have sustained the growth in land use which the demands of the growth in government placed on the natural environment. Instead, the society paid the "cost of conversion" from using land in its natural state by applying technology such as sewage treatment systems and dams and reservoirs to ensure water quantity and quality for the new population.[17]

When the natural carrying capacity of an area is exceeded, the consequent costs can be paid in the form of remedial measures, such as constructing sewage treatment plants, or in the form of increased environmental damages, such as water pollution. In the Washington, D.C., area, some of the costs of conversion clearly have been paid in the form of reduced environmental quality—more water pollution, air pollution alerts, and threatened shortages of water, for example.

Given the small number of absolute prohibitions on land uses and the limitations of the concept of carrying capacity, most land use data must be put in some type of cost-benefit or supply-demand framework if they are to indicate environmental quality. But in most cases such a framework and the relevant costs and benefits are likely to be local or regional. Many land use indicators would have limited, if any, meaning on a national scale unless they were aggregates of rather complex local or regional indicators.

For example, there is no national policy against converting agricultural or forest land to residential use, and thus national figures on such conversions do not indicate whether land use is improving or deteriorating. To make such an evaluation, one would need to look at each area where conversion is taking place and evaluate the demand for housing in the area, the regional need for open space, the value of the crops or timber produced there, the effect of the conversion on transportation routes and commercial development, the methods for disposing of the wastes generated by the residences, and several other factors. The Federal Government cannot evaluate such changes on a national basis.

The large number of factors to be considered in making and evaluating land use decisions may mean that computer-based models, which can simulate the results of alternative decisions, will be a necessary adjunct to a system of indicators. Several projects to develop such models are underway or have been completed. For example, the National Science Foundation sponsored development of a national model linking agricultural policy, land use, and water quality by Dr. Earl Heady of Iowa State University. NSF is also supporting work at Oak Ridge National Laboratory to develop regional models that can be used to determine the environmental impact resulting from the location of industrial, commercial, residential, and recreational development. The OBERS model, developed by the Departments of Commerce and Agriculture for the Water Resources Council, projects estimated population, economic activity, and land use for regions of the United States. It may also be useful for considering alternative land use policies. The Strategic Environmental Assessment System being developed by EPA is using the OBERS projections, economic and environmental models, and forecasts of land use and other changes to estimate the condition of national and regional environments 10 to 15 years in the future.

Problems of land use in the United States may be arbitrarily classified into three categories. First, we are concerned about the availability of certain types of land, such as enough agricultural land to grow food, adequate open space for recreation in densely populated areas, and sufficient timberland to meet national pulp and lumber demands. Second, we need to control development in areas of critical environmental concern, including areas of particular environmental value such as wetlands, other rare or valuable ecosystems, and scenic or historic areas. Such areas also include land which, if developed, may pose a direct hazard to man, for example, flood plains, steep slopes, soils unsuitable for development and earthquake fault zones. Third, there are types of land use development and practices that lead to other problems which, in turn, may have adverse environmental consequences. These include unreclaimed surface mining, practices that lead to soil erosion, urban development patterns which produce pollution, and the spread of areas impervious to water.

Each of the three categories will be discussed after they are put in the context of national trends in land use.

National Trends in Land Use

Total acreages for different land uses in the United States are not very informative. Last year's Annual Report presented such data for the period 1900–1969. Despite the massive changes that took place during that period, the aggregate data show little change.[18]

The U.S. population has become increasingly urbanized, and many of the most important land use changes and issues occur in metropolitan areas. Maps of standard metropolitan statistical areas (SMSA's) published by the Bureau of the Census show an increasing share of the Nation's land lying within metropolitan areas. By 1970, 13 percent of the land in the contiguous 48 states was within the SMSA's (see Figure 15).[19]

It would be a mistake, however, to consider all land in metropolitan areas as being urbanized. In fact, urban uses accounted for only about 10 percent of the land within the SMSA's, or about 1.3 percent of all land in the contiguous 48 states (see Figure 16).[20] The SMSA's are largely statistical artifacts because they are composed of entire counties and thus include not only cities but also all of the rural or urbanizing land in the county where the city is located.[21] To take an extreme example, a large portion of the San Bernardino-Riverside SMSA in California is the Mojave Desert because both the Desert and the cities are located in San Bernardino and Riverside Counties.

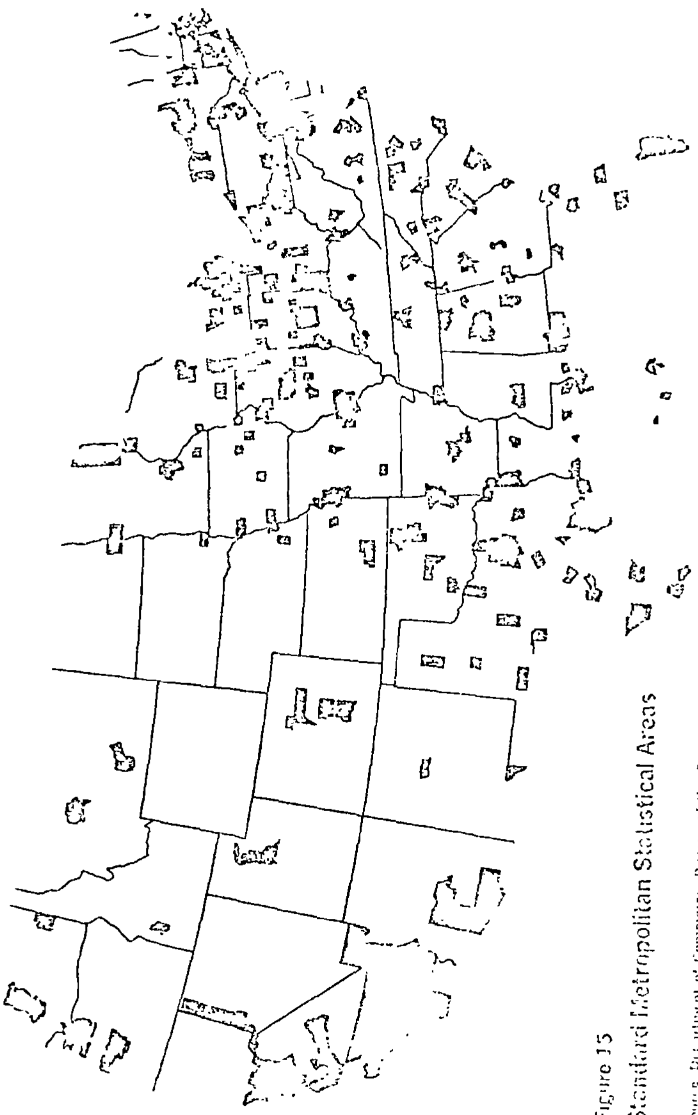
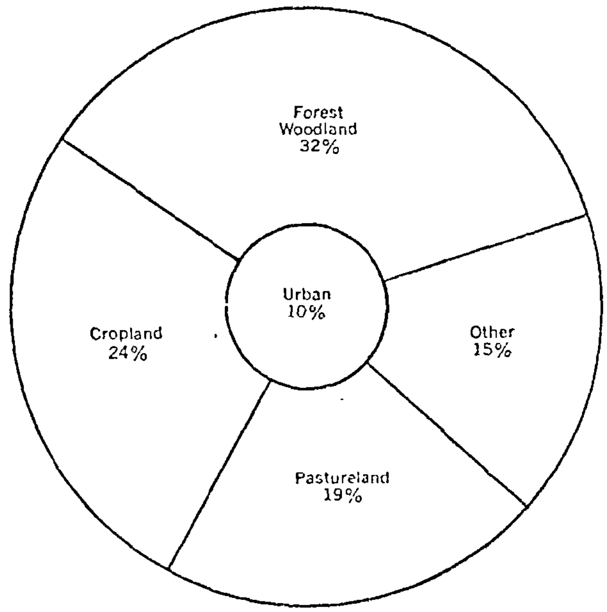


Figure 15
Standard Metropolitan Statistical Areas

Source Department of Commerce, Bureau of the Census, Number of Inhabitants, U.S. Summary 1970 Census of Population PC(1) A1 U S Summary (Bureau of the Census Washington, December 1971) pp 8–9

Figure 16
Land Use within SMSA's 1970 for the 48 Contiguous States



Source Robert C Otte, "Human Considerations and Land Use," in *National Land Use Policy Objectives, Components, Implementation* (Ankey, Iowa Soil Conservation Society of America, 1973), p 78

The largest category of land within the SMSA's in 1970 was forest woodland, which accounted for almost one-third of the land area One-quarter of the land was devoted to crops In 1961, the last year for which data are available, 16 percent of U S wheat, 17 percent of our corn, 60 percent of our vegetables, and 43 percent of our fruits and nuts were produced *within* metropolitan areas.[22]

The various land uses within metropolitan areas do not arrange themselves into neat geographical patterns Because of the way American cities have developed over the past 50 years, urban uses are widely interspersed with other kinds of uses This intermixture of different uses has come to be known as urban sprawl The pattern is not just a phenomenon of our newer cities For example, Figures 17 and 18, based on data from aerial photographs, show the scatter of built-that new homes were not built on soils unsuitable for septic tanks.[33] The Soil Conservation Service estimates that soil surveys cost only 50 cents to $1 per acre, so the cost-benefit ratio of making and using such surveys to guide development is very high.

Land Use Effects

The broadest, and probably the most significant, land-related problems are secondary consequences of land use patterns and practices. These patterns and practices create problems such as pollution, which in turn endanger man and his environment.

Patterns of land use are a major determinant of pollution levels in any area. The greater the distances that must be traveled between home, workplace, and shops, the more air pollution will be generated by automobile travel. Significant water pollution problems can be generated by development on lakeshores or by placement of septic tanks in unsuitable soil. Many forms of industrial pollution may be reduced by siting a plant so that its wastes can be productively utilized by a neighboring plant. For all types of pollution the degree of concentration of principal pollution sources is a key factor in the level of pollution to which the population is exposed.

Land use patterns also play a significant role in the consumption and availability of natural resources. Pollution often represents misplaced resources. Thus, for example, the added air pollution generated because of longer travel distances also means wasted gasoline. Land development can lead to reduced water supply (by building over ground water recharge areas, for example), reduced soil capability for growing crops (by erosion and poor farming practices), and reduced ability to extract mineral resources (by building in areas where such resources are found).

The Council, in cooperation with EPA and HUD, is conducting several studies to determine more precisely the secondary impacts of development on the environment. These studies include the impacts of highway and sewer construction, second-home developments, and the costs of alternative residential development patterns.

Three problems are covered in this section—erosion, unreclaimed surface mining, and the increasing land area covered by impervious surfaces such as roads, buildings, and parking lots. Erosion is an environmental problem arising from a variety of land use practices; surface mining is a particular type of land use which gives rise to a number of environmental problems; impervious surfaces are a characteristic of all types of urban development. Thus each is a different type of land use issue, but each represents patterns of development which can create adverse environmental impacts.

Erosion—Each day huge amounts of soil in the United States are washed off the land into rivers and streams. The results are a reduction in quality of the remaining soil and water pollution in the form of sediment, nutrients, and other contaminants attached to the sediment.

The Soil Conservation Service (SCS) estimates that more than 3.5 billion tons of soil is lost each year through erosion from the approximately two-thirds of U.S. land that is privately owned. About 40 percent of this soil becomes waterborne sediment in streams.[36]

Although no fully accurate data are available, it appears that total soil erosion losses have been sharply reduced in recent years. SCS considers cropland adequately treated against erosion if soil loss from the land is less than 5 tons per acre per year. It estimates that soil loss from properly treated pastureland averages less than 2 tons per acre per year, from rangeland, about 1.5 tons per acre per year; and from forest land, about 0.5 tons per acre per year. The portion of privately controlled land which is adequately treated to minimize erosion has risen from 35 percent in fiscal year 1965 to over 50 percent in fiscal year 1972.[37] However, this measure of overall progress does not take into account such major problems as huge sediment losses at suburban construction sites which can cause severe local water quality problems.

The dimensions of the erosion problem may be seen from Geological Survey data on sediment discharged to the oceans.[35] Each year, on the average, more than 490 million tons of sediment, 185 tons for each square mile of the conterminous United States, washes into the oceans. Fourteen million tons is discharged to the Atlantic Ocean, 378 million tons to the Gulf of Mexico, and 99 million tons to the Pacific Ocean. If this sediment were transported by train, it would fill an average of 27,000 boxcars per day. These figures underestimate the amount of soil that is eroded because in many areas reservoirs and diversions may trap up to 75 to 95 percent of the sediment. However, it should also be kept in mind that there is a significant amount of sediment that occurs naturally and that is probably uncontrollable.

Despite the staggering size of these figures, it appears that the amount of sediment discharged to the oceans has lessened over the past years. No overall figures are available, but it would appear, for example, that the average annual suspended sediment discharge carried by the Mississippi River to the Gulf of Mexico has been reduced by about 30 percent during the past 100 years. The annual sediment discharge of the Colorado River has fallen from 234 million tons during 1911–16 to 152,000 tons during 1966–67. This dramatic reduction in the Colorado is due largely to the construction of reservoirs which trap the sediment and to diversion of more water for irrigation. Improved land use practices have also helped, but much of the sediment has simply been retained upstream rather than carried to the oceans. The reservoirs and irrigation, of course, may create or aggravate other problems, such as salinity.

It is not known whether it is better to have the sediment trapped behind dams or to have it flow to the oceans. Both situations are undesirable, and the key goal is to reduce the amount of sediment which gets into rivers in the first place. It appears that progress has been made in reaching this goal.

Surface Mining—Surface mining unaccompanied by reclamation has many serious environmental consequences It can cause severe erosion, pollute water with acid drainage, cause aesthetic blight, and destroy land for other productive uses unless adequate reclamation is undertaken In last year's Annual Report, we indicated that the acreage being surface mined in the United States is increasing rapidly. Current energy supply shortages and the rising demand for low sulfur coal to meet the 1975 deadline for Federal air quality standards make it likely that surface mining will grow at an even faster rate. About 75 percent of the country's economically strippable coal reserves lies in 13 states west of the Mississippi, and it is likely that large new western areas will be opened to mining [39] How much will be reclaimed depends heavily on the effectiveness of regulation at all levels of government.

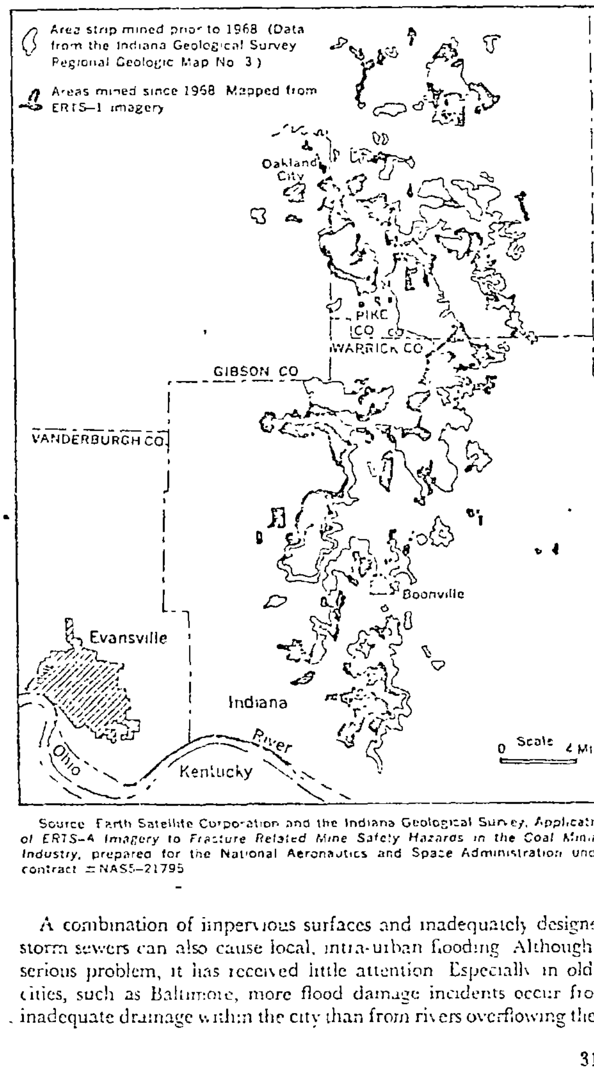
New monitoring technology should be a major help in the enforcement of surface mining laws and in keeping track of the problem. Figure 26 shows the rapid increase in surface mined area which has occurred in a portion of southern Indiana It also shows the potentially great value of earth-orbiting satellites to monitor environmental problems The map is based on pictures taken from the ERTS-1 satellite, which photographs the entire United States once every 18 days Such satellites can be used for this type of comparatively small-area analysis as well as for the type of macroscale picture reproduced in Figure 19.

Impervious Surfaces—As urban development spreads, buildings, streets, and pavement cover land where water once percolated into the soil, rendering the urban surface increasingly impervious to rainfall. This means much faster and greater water runoff, which increases the likelihood of erosion and flooding Impervious surfaces can reduce urban water supply by decreasing the flow of water to natural aquifers They can also impair water quality by increasing the amount of water discharged directly into a stream without treatment

In many urban areas, small creeks or rivers have become major flood hazards Because so much of the land around them is covered with concrete, very little of the rain from a storm is absorbed into the ground. Instead, it is channeled directly into the river. Rock Creek in Washington, D C., is a good example of this phenomenon. A study by the U.S. Geological Survey estimated that if 80 percent of an area is sewered and 60 percent is covered by impervious surfaces, the water runoff occurring in the average once-a-year flood will be more than four times greater than if none of the area were sewered or impervious.[40]

Figure 26

Mined Land Inventory Map, Pike, Warrick, and Gibson Counties, Ind.



Source Earth Satellite Corporation and the Indiana Geological Survey, *Application of ERTS-A Imagery to Fracture Related Mine Safety Hazards in the Coal Mining Industry*, prepared for the National Aeronautics and Space Administration under contract = NAS5-21795

A combination of impervious surfaces and inadequately designed storm sewers can also cause local, intra-urban flooding Although a serious problem, it has received little attention Especially in older cities, such as Baltimore, more flood damage incidents occur from inadequate drainage within the city than from rivers overflowing their

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banks. Forty percent of the 800 reports to the Office of Civil Defense and Emergency Preparedness of damage from Hurricane Agnes and another major Baltimore flood in 1971 involved flooded basements where drains backed up, raw sewage collected, and property damage and health hazards resulted. The vast majority of the other 60 percent was connected with wind and rain water damage. There were few reports of damage caused by running water from streams.

One might think that newer suburban developments, because they are of lower density, would contain less impervious surface. However, a study of Riverside, Calif., indicates that this may not be the case. Almost 60 percent of the built-up land area in Riverside is paved or covered by buildings, and almost one-third of the built-up area is more than 90 percent impervious. Wider streets, more parking area, and lower and broader buildings more than compensate for the lower density.

Clearly many of the problems that we have discussed are closely interrelated. More impervious surface, for example, may make flood plain development more hazardous and may increase erosion. The three categories of problems—land availability, areas of critical environmental concern, and land use effects—interact with each other in numerous and complex ways. Their interactions reflect the complexity of land use problems and the difficulty of developing satisfactory land use indicators.

Land Use Indicators

The discussion so far illustrates the importance of land use in determining environmental quality. But it also demonstrates the difficulty of establishing a set of national environmental land use indicators.

Land use policies, whether at the local, state, or Federal level, are designed to accommodate many conflicting and often poorly defined social goals. These include economic profit, suitable living conditions at reasonable prices, aesthetic and environmental improvement, and siting of necessary facilities such as roads, industry, and powerplants. Unlike air and water pollution programs, the goals of land use programs and policies do not lend themselves to simple description or to indicators for which the desired direction of change is obvious.

The context of land use conflicts and decisions is usually local or regional, not national. Construction of housing on agricultural land may be desirable in one city but not in another. Steep slopes or earthquake faults are problems for some regions of the country but not for others. Large parks may be a major factor in the environmental quality of Washington, D.C., but they are not what attracts people to midtown Manhattan. In addition, the basic regulatory authority over land use rests with state and local governments.

Yet it is possible to develop some indicators of land use and environmental quality. For uses such as unreclaimed surface-mined land and wetlands, simple acreage increases or decreases have meaning. Some land use problems will be reflected in other environmental indicators. For example, a significant increase in erosion may show up as increased water pollution from sediment. If automobile-related air pollutants increase despite emission controls, land use patterns must clearly be examined.

Some land use decisions, such as the siting of airports, powerplants, and deepwater ports, are becoming questions of national concern. The Federal Government owns about one-third of the land in the United States, and the use of this land will be determined by national policy. But the majority of land use decisions must be made in a local or regional context because both the costs and benefits of the decisions are primarily local or regional. Insofar as national indicators are developed, they will have to be aggregated from a series of local indicators.

Land use, for the most part, is simply the culmination of a large number of individual decisions about how to allocate space. But like the state of the economy, which is also a cumulation of many uncoordinated decisions, land use can be guided so that the outcome is more consistent with the public interest. If such guidance is to be effective, there must be agreement on what constitutes satisfactory land use before indicators can be developed to measure whether the use of land is being better regulated. While we have identified above certain areas for which national indicators would be appropriate, most measures or indicators will have to be developed and applied primarily by local, State, and regional authorities.

Population

Population size is clearly one of the major factors underlying many environmental problems. Rapid growth in population provides impetus for growth in GNP and for the development of new technologies as well as increasing the demand on natural resources.

In 1972, for the first time in the Nation's history (see Figure 27), the total fertility rate (the number of births that a woman would have in her lifetime based on the birth rate occurring in a specified year) dropped below the replacement level (the level of fertility required for the population to replace itself exactly under projected mortality rates and in the absence of immigration). The total fertility rate was estimated at 2.0 in 1972, compared to the replacement level of 2.1.

The birth rate began to decline in the late 1950's. After leveling off in the 1968 to 1970 period, it has continued its sharp decline. This trend is most encouraging, but it must be kept in mind that the national birth rate has fluctuated sharply in the past. Thus, it cannot

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<u>Special</u>

OPEN ENDED ADDITIONS

1. Atlanta Metropolitan Area - 7/9/74 by Howard A. True.

METROPOLITAN ATLANTA CALCULATIONS OF EROSION, SEDIMENTATION AND DELIVERY OF NUTRIENTS IN SEDIMENT AND LITTER TO LOCAL WATER BODIES.

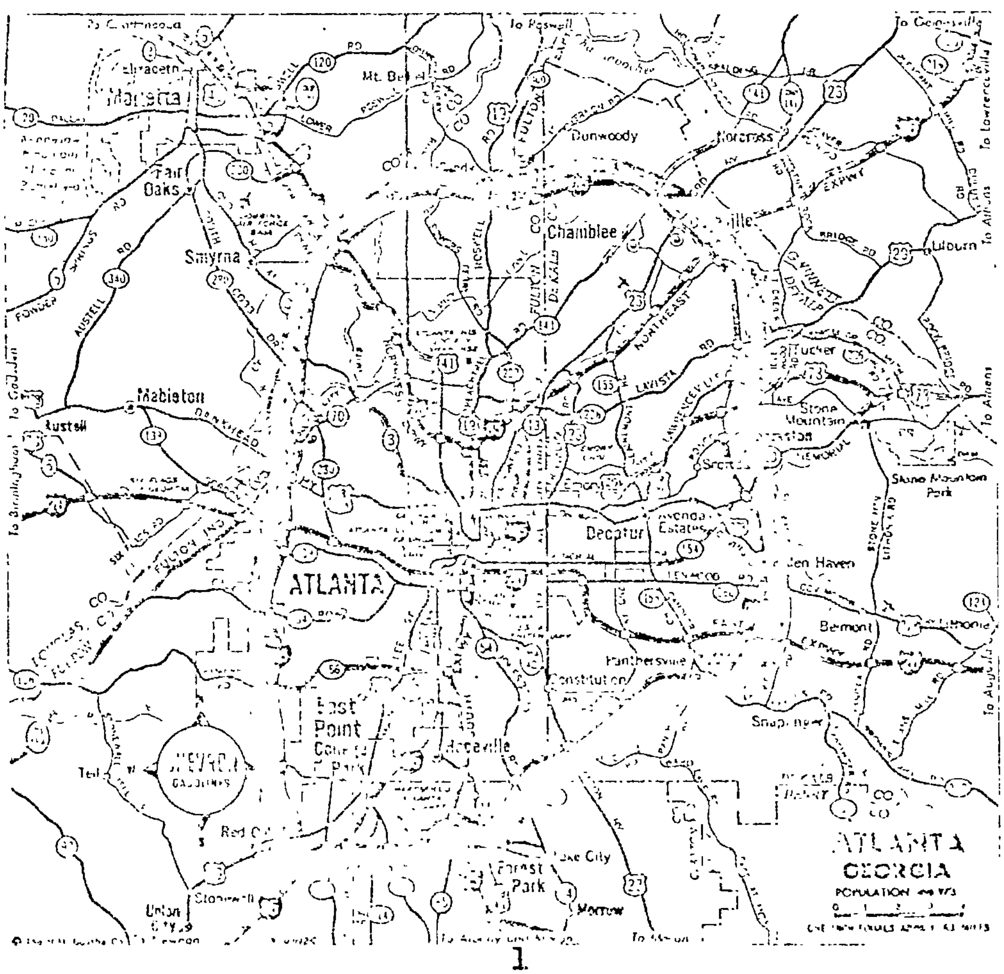
Sources of local information:

Land Use Within I-285 bounded area compiled by Mr. G.W. Spann, EES, Georgia Institute of Technology, from ERS imagery taken 10/15/72 and published by Dr. Gene E. Willcke, Ph.D., P.E. Assoc. Prof. ERC & Dept. of City Planning - "THE CHATTACHOOCHEE RIVER--SILTATION FROM URBAN DEVELOPMENT"

Land Use	Acres
Single Family Dwelling	52,382
Warehousing and Transportation	40,533
Industrial and Multi-Family	37,623
Conifers	20,362
Commercial	19,231
Hardwoods	14,871
Grassy Areas	4,907
Bare Ground	2,809
Large Buildings--concrete	2,087
Water	1,187
Total	195,992

Broad Land Types (Soil) and Slope Range Acres considered applicable to the entire area were taken from SOIL SURVEY OF FULTON COUNTY, GEORGIA, USDA-SCS 1949. (Issued 1958)

MAP OF THE CALCULATED AREA



METROPOLITAN ATLANTA, GEORGIA - ENTIRE AREA BOUNDED BY PERIMETER HIGHWAY I-285
ANNUAL EROSION OF LAND AREAS AND AMOUNT OF SEDIMENT, LITTER AND CONTAINED NUTRIENTS - A GROSS ASSESSMENT

FULTON COUNTY UNIT/SLOPE RANGE #1(0-2%) #2(2-6%) #3(6-10%) #4(10-15%) #5(15-25%)
DEKALB COUNTY UNIT/SLOPE RANGE #1(0-2%) #2(2-6%) #3(6-10%) #4(10-15%) #5(15-25%)
**** PERIOD MONTHS 1 - 12

UNIT/TYPE (PLOT AC.)	ACRES	S.L. TONS	*********	*********	*******	TO WATER BODIES	*******	*******	*******	*******
			SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND (113.7)	12850.00	779.75	408.76	4993.59	50753.	14636.	76133.	7490399.	8968486.	0.
LIVESTOCK/FOWL					37.	11.	0.	158.	281.	
UNIT TOTALS	12850.00	779.75	408.76	4993.59	50790.	14647.	76133.	7490556.	8988767.	0.
2 LAND (123.1)	15020.00	7044.20	2326.28	5791.11	62564.	19937.	134597.	8686741.	10424104.	0.
LIVESTOCK/FOWL					27.	8.	0.	118.	209.	
UNIT TOTALS	15020.00	7044.20	2326.28	5791.11	62591.	19945.	134597.	8686858.	10424313.	0.
3 LAND (196.9)	38600.00	69033.00	26844.43	14751.46	201198.	84253.	865831.	22127152.	26552448.	0.
LIVESTOCK/FOWL					81.	24.	0.	352.	626.	
UNIT TOTALS	38600.00	69033.00	26844.43	14751.46	201279.	84276.	865831.	22127488.	26553072.	0.
4 LAND (190.5)	36200.00	127954.19	50503.52	13899.99	240001.	119720.	1446004.	20849984.	25019856.	0.
LIVESTOCK/FOWL					78.	23.	0.	337.	599.	
UNIT TOTALS	36200.00	127954.19	50503.52	13899.99	240079.	119743.	1446004.	20850320.	25020448.	0.
5 LAND (119.4)	14213.00	74355.50	40952.32	5617.21	138074.	81250.	1097939.	8425865.	10111045.	0.
LIVESTOCK/FOWL					42.	12.	0.	182.	323.	
UNIT TOTALS	14213.00	74355.50	40952.32	5617.21	138116.	81262.	1097939.	8426046.	10111368.	0.
STATE GROUP LAND	116883.00	279166.62	121035.25	45053.37	692591.	319795.	3620503.	67580128.	81095920.	0.
LIVESTOCK/FOWL					266.	78.	0.	1146.	2039.	
FULTON COUNTY TOTALS	116883.00	279166.62	121035.25	45053.37	692856.	319873.	3620503.	67581248.	81097952.	0.
1 LAND (93.2)	8570.00	535.19	122.79	3062.72	30873.	8772.	43498.	4594067.	5512886.	0.
LIVESTOCK/FOWL					4.	2.	0.	20.	36.	
UNIT TOTALS	8570.00	535.19	122.79	3062.72	30877.	8774.	43498.	4594086.	5512921.	0.
2 LAND (100.1)	10012.00	4823.38	2491.83	4092.80	45911.	15446.	116317.	6139174.	7367014.	0.
LIVESTOCK/FOWL					11.	6.	0.	53.	95.	
UNIT TOTALS	10012.00	4823.38	2491.83	4092.80	45923.	15453.	116317.	6139226.	7367108.	0.
3 LAND (160.5)	25680.00	51752.04	19930.72	9645.58	136315.	58897.	625589.	14468558.	17362272.	0.
LIVESTOCK/FOWL					21.	12.	0.	100.	180.	
UNIT TOTALS	25680.00	51752.04	19930.72	9645.58	136337.	58909.	625589.	14468658.	17362448.	0.
4 LAND (156.0)	24180.00	94963.44	36882.16	8904.27	162804.	83944.	1039589.	13356594.	16027935.	0.
LIVESTOCK/FOWL					104.	42.	0.	407.	1212.	
UNIT TOTALS	24180.00	94963.44	36882.16	8904.27	162908.	83986.	1039589.	13357000.	16029147.	0.
5 LAND (97.7)	9480.00	38916.12	11892.22	3700.19	60786.	29388.	346146.	5550255.	6660312.	0.
LIVESTOCK/FOWL					6.	3.	0.	29.	52.	
UNIT TOTALS	9480.00	38916.12	11892.22	3700.19	60792.	29391.	346146.	5550283.	6660363.	0.
STATE GROUP LAND	77922.00	190990.12	71319.69	29405.56	436690.	196447.	2171137.	44108624.	52930384.	0.
LIVESTOCK/FOWL					147.	66.	0.	608.	1574.	
DEKALB COUNTY TOTALS	77922.00	190990.12	71319.69	29405.56	436836.	196513.	2171137.	44109232.	52931952.	0.
AREA LAND	194805.00	470156.75	192354.94	74458.87	1129280.	516242.	5791640.	111688752.	134026304.	0.
LIVESTOCK/FOWL					413.	144.	0.	1755.	3613.	
GRAND TOTALS	1[illegible]805.00	470[illegible]56.75	192[illegible]54.94	744[illegible]8.87	112969[illegible]	516386.	5791640.	111690480.	134029904.	0.

2

FACTORS USED - See writeup "Erosion, Sedimentation & Rural Runoff - A Gross Assessment Process" by Howard A. True, EPA Region IV SAD 6/74 for theory and application of Random Processes to Complex problems.

UNITS		1	2	3	4	5
Fulton Cty. Acres		12850	15020	38600	36200	14213
Dekalb Cty. Acres		8570	10012	25680	24180	9480
Calc. Plot Sizes *				See Report		
Slope % Ranges		0-2	2-6	6-10	10-15	15-25
Soils %(K Val.)		27(.10)	38(.10)	12(.10)	10(.10)	25(.10)
		55(.26)	8(.26)	9(.26)	10(.26)	8(.26)
		18(.35)	38(.28)	60(.28)	35(.28)	34(.28)
			8(.35)	16(.36)	39(.36)	25(.36)
			8(.36)	3(.03)	6(.03)	8(.03)
Slope Length Range		------ All Units 46.7' to 233.5' ------------				
Cropping Management(C)						
Cropland		------ All Units 0%(0.000) ------------------				
Pasture		" 3%(0.100)				
Forest		" 18%(0.005)				
Urban		" 78%(0.010)				
Other		" 1%(1.000)				
Erosion Control(P)						
Cropland		------ All Units 0%(0.0) -------------------				
Pasture		" 3%(1.0)				
Forest		" 18%(1.0)				
Urban		" 78%(1.0)				
Other		" 1%(1.3)				
Sediment Delivery		------ All Units Mean 40% Dev. + 40% ---------				
Sediment Migration		------ Not Applicable, Multiple Basins -------				
Sediment Nitrogen(N)		------ All Units .10% ----------------------				
" Phosphorus(P)		" .08%				
" Potassium(K)		" 1.25%				
" BOD		------ N/A See Litter & *** ----------------				
" TOC		"				
Livestock/Fowl:**						
Total Cows	Ful.	407	480	1220	1147	444
	Dek.	151	179	455	426	165
Dairy Cows	Ful.	17	20	53	49	19
	Dek.	38	45	115	107	41
Swine	Ful.	94	111	264	268	103
	Dek.	4	5	13	12	5
Poultry (Ex.Br.)	Ful.	6825	8060	19430	19145	7540
	Dek.	495	585	1485	1395	540
Broilers	Ful.	92100	109000	276900	260400	100700
	Dek.	7600	8350	20800	19750	7700
Litter:***						
Lbs/Forest Ac.		------ All Units 5000 Lbs/For.Ac./Yr. ---------				
Calc. Lbs/Rem.Ac.		" 1250 Lbs/Ac./Yr.				
Nitrogen(N)		------ All Units .50% ----------------------				
Phosphorus(P)		" .14%				
Potassium(K)		" .66%				
BOD		" 75.00%				
TOC		" 90.00%				
Mine Acid		------ N/A No known Coal Mines --------------				

* Report shows Plot Sizes which are approximately equal to the Square Root of the Unit Acres.

** Livestock and Fowl counts are proportionate parts of county totals from a previous Region IV SAD writeup of approximate county populations. These Nutrient Loads are very small.

*** Both Sediment and Litter contain N,P & K loads; however the entire Organic load is comprehended in Litter calculations.

For additional information contact:

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TABLE 4.—*Acreage in cultivated crops, pasture, forest, and idle, and the total acreage and the proportionate extent of soils mapped in Fulton County, Ga.*

Soils	Cultivated crops	Pasture	Forest	Idle	Total	
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Percent*
Altavista fine sandy loam						
Eroded rolling phase	334	203	66	66	669	0.2
Level phase	201	67	33	33	334	.1
Undulating phase	802	266	135	135	1,338	.4
Appling sandy clay loam						
Severely eroded hilly phase	100	402	1,606	904	3,012	.9
Severely eroded rolling phase	50	151	502	301	1,004	.3
Appling sandy loam						
Eroded hilly phase	2,411	803	3,213	1,606	8,033	2.4
Eroded rolling phase	7,364	5,523	1,841	3,681	18,409	5.5
Eroded undulating phase	2,511	1,003	503	1,003	5,020	1.5
Hilly phase	435	435	3,481	0	4,351	1.3
Rolling phase	835	336	166	336	1,673	.5
Steep phase	0	184	3,313	184	3,681	1.1
Undulating phase	334	134	67	134	669	.2
Augusta fine sandy loam	66	6	6	55	133	(1)
Buncombe loamy fine sand	46	46	140	102	334	.1
Cecil clay loam						
Severely eroded hilly phase	1,607	1,607	8,033	4,819	16,066	4.8
Severely eroded rolling phase	402	402	2,008	1,204	4,016	1.2
Severely eroded steep phase	0	67	535	67	669	.2
Cecil sandy loam						
Eroded hilly phase	6,698	2,233	8,930	4,465	22,326	6.8
Eroded rolling phase	23,980	7,994	3,996	3,996	39,966	12.1
Eroded steep phase	67	134	1,003	134	1,338	.4
Eroded undulating phase	5,022	1,674	836	836	8,368	2.5
Hilly phase	736	736	5,891	0	7,363	2.2
Rolling phase	904	603	1,505	0	3,012	.9
Steep phase	0	318	5,723	318	6,359	1.9
Undulating phase	401	134	67	67	669	.2
Chewacla fine sandy loam	803	603	401	201	2,008	.6
Chewacla silt loam	2,410	1,807	1,205	602	6,024	1.8
Congaree fine sandy loam	2,510	670	167	0	3,347	1.0
Congaree silt loam	2,008	535	134	0	2,677	.8
Davidson clay loam						
Eroded hilly phase	167	99	34	34	334	.1
Eroded rolling phase	468	134	67	0	669	.2
Eroded undulating phase	70	20	10	0	100	(1)
Grover fine sandy loam						
Eroded hilly phase	40	20	10	30	100	(1)
Eroded undulating phase	202	66	33	33	334	.1
Gullied land	0	33	168	133	334	.1
Helena sandy loam, eroded rolling phase	101	67	65	101	334	.1
Hiwassee-Louisa soils, eroded hilly phases	0	34	266	34	334	.1
Hiwassee sandy loam						
Eroded rolling phase	468	135	33	33	669	.2
Eroded undulating phase	241	69	17	17	344	.1
Iredell stony clay loam, rolling phase	168	102	32	32	334	.1
Lloyd clay loam						
Eroded steep phase	0	17	283	34	334	.1
Severely eroded hilly phase	0	134	3,129	368	3,631	1.1
Severely eroded rolling phase	0	50	854	100	1,004	.3
Lloyd gravelly sandy loam, eroded steep shallow phase	16	34	250	34	334	.1
Lloyd sandy loam						
Eroded hilly phase	1,871	1,406	937	469	4,683	1.4
Eroded rolling phase	4,519	2,712	903	903	9,037	2.7
Eroded undulating phase	1,205	401	201	201	2,008	.6
Hilly phase	33	100	536	0	669	.2
Rolling phase	200	66	34	34	334	.1
Steep phase	0	51	902	51	1,004	.3
Lockhart-Cecil clay loams:						
Severely eroded hilly phases	804	804	4,015	2,410	8,033	2.4
Severely eroded rolling phases	134	134	669	401	1,338	.4
Severely eroded steep phases	0	67	535	67	669	.2
Lockhart-Cecil sandy loams:						
Eroded hilly phases	703	235	936	469	2,343	.7
Eroded rolling phases	3,414	1,138	669	669	5,890	1.7
Eroded steep phases	34	66	503	66	669	.2
Eroded undulating phases	401	134	67	67	669	.2
Hilly phases	67	67	535	0	669	.2
Steep phases	*0*	*117*	*2,109*	*117*	*2,343*	.7

TABLE 4.—*Acreage in cultivated crops, pasture, forest, and idle, and the total acreage and the proportionate extent of soils mapped in Fulton County, Ga.—Continued*

Soils	Cultivated crops	Pasture	Forest	Idle	Total	
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Percent*
Louisa fine sandy loam:						
Eroded hilly phase	0	67	1,204	67	1,333	0.4
Eroded steep phase	0	154	3,313	154	3,681	1.1
Rolling phase	66	34	200	34	334	.1
Steep phase	0	254	5,122	254	5,630	1.7
Lounsburg sandy loam:						
Hilly phase	0	134	2,409	134	2,677	.8
Rolling phase	51	51	502	100	1,004	.3
Steep phase	0	318	5,723	318	6,359	1.9
Made land					354	.1
Madison clay loam						
Severely eroded hilly phase	218	653	2,174	1,306	4,351	1.3
Severely eroded rolling phase	66	201	669	402	1,338	.4
Madison fine sandy loam:						
Eroded hilly phase	1,807	603	2,409	1,205	6,024	1.8
Eroded rolling phase	6,165	2,055	1,028	1,028	10,276	3.2
Eroded undulating phase	2,007	670	335	335	3,347	1.0
Hilly phase	100	100	801	0	1,001	.3
Rolling phase	100	67	167	0	334	.1
Steep phase	0	66	1,206	66	1,338	.4
Madison gravelly sandy loam:						
Eroded rolling phase	1,205	401	201	201	2,008	.6
Rolling phase	501	201	502	6	1,210	.3
Madison-Grover-Louisa gravelly clay loams, severely eroded hilly phases	0	101	1,806	101	2,008	.6
Madison-Grover-Louisa gravelly sandy loams:						
Eroded hilly phases	100	502	1,004	602	2,208	.6
Hilly phases	101	101	802	0	1,004	.3
Steep phases	0	67	1,201	67	1,335	.4
Mecklenburg gravelly clay loam, eroded hilly phase	100	100	67	67	334	.1
Mecklenburg gravelly sandy loam, eroded rolling phase	166	100	34	34	334	.1
Mixed alluvium						
Poorly drained	0	167	1,339	167	1,673	.5
Somewhat poorly drained	302	1,205	1,053	452	3,012	.9
Well drained	2,465	2,983	2,982	1,491	9,941	2.7
Molena loamy sand						
Eroded undulating phase	40	26	27	40	133	(1)
Light colored variant	101	67	67	99	334	.1
Riverwash	0	0	100	0	100	(1)
Seneca fine sandy loam:						
Level phase	402	133	67	67	669	.2
Undulating phase	2,209	736	368	368	3,681	1.1
Starr loam						
Level phase	401	134	67	67	669	.2
Undulating phase	603	201	100	100	1,004	.3
Stony land						
Hilly	0	0	2,008	0	2,008	.6
Rolling	0	0	334	0	334	.1
Steep	0	0	1,338	0	1,338	.4
Unclassified city land					20,712	6.2
Wehadkee fine sandy loam	84	335	919	335	1,673	.5
Wehadkee silt loam	102	401	1,104	401	2,008	.6
Wickham fine sandy loam:						
Eroded undulating phase	233	67	17	17	334	.1
Undulating phase	467	134	34	34	669	.2
Worsham sandy loam						
Eroded rolling phase	66	134	435	33	668	.2
Eroded undulating phase	33	67	217	17	334	.1
Undulating phase	167	335	1,088	83	1,673	.5
Total					334,720	100.0

[1] Less than 0.1 percent.

ration. Terms commonly used to describe consistence include *compact, firm, friable, loose, plastic,* and *sticky.*

Compact. Dense and firm but without any cementation.

Firm. Soil material crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable.

Friable. Soil material crushes easily under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together.

Loose. Noncoherent.

Plastic. Soil material forms wirelike shape when rolled between thumb and forefinger, and moderate pressure is required to deform the soil mass.

Sticky. Adhesive rather than cohesive when wet, but usually very cohesive when dry. When wet, the soil shows a decided tendency to adhere to other material and objects.

Contour tillage. Furrows plowed at right angles to the direction of slope, at the same level throughout, and ordinarily at comparatively close intervals.

Cropland. Land regularly used for crops, except forest crops. It includes rotation pasture, cultivated summer fallow, and temporarily idle land.

Crumb (*See also* Structure, type). Generally soft, small, porous aggregates, tending toward a spherical shape, as in the A_1 horizons of many soils. Crumb structure is closely related to granular structure.

Erosion, soil. The wearing away or removal of soil material by water or wind.

Fertility, soil. The inherent quality of a soil as measured by the quantity of compounds provided for proper or balanced growth of plants.

First bottom. The normal flood plain of a stream subject to frequent or occasional flooding.

Forest. Land not in farms, bearing a stand of trees of any age or stature, including seedlings, and of species that attain a minimum average height of 6 feet at maturity, or land from which such a stand has been removed and no other use substituted. Forest on farms is commonly called woodland or farm forest.

Genesis, soil. (*See also* Horizon, soil). The mode of origin of the soil with special reference to the processes responsible for the development of the solum (horizons A and B) from the unconsolidated parent material.

Granular (*See also* Structure type). Roughly spherical aggregates that may be either hard or soft, usually more firm than crumb, and without the distinct faces of blocky structure.

Great soil group (soil classification). A broad group of soils having common internal soil characteristics.

Green-manure crop. Any crop grown and plowed under while green for the purpose of improving the soil.

Horizon, soil. A layer of soil approximately parallel to the soil surface with distinct characteristics produced by soil-forming processes.

Horizon, A. The upper horizon of the soil mass from which material has been removed by percolating waters, the eluviated part of the solum, the surface soil. It is generally subdivided into two or more subhorizons, of which A_0 is not a part of the mineral soil but the accumulation of organic debris on the surface. Other subhorizons are designated as A_1, A_2, and so on.

Horizon, B. The horizon of deposition, to which materials have been added by percolating waters, the illuviated part of the solum, the subsoil. This horizon may also be divided into several subhorizons, depending on the color, structure, consistence, or character of the material deposited. These layers are designated as B_1, B_2, B_3, and so on.

Horizon, C. The horizon of partly weathered material underlying the B horizon, the substratum, usually the parent material.

Internal drainage. The movement of water through the soil profile. The rate of movement is affected by the texture of the surface soil and subsoil, and by the height of the ground water table, either permanent or perched. Relative terms for expressing internal drainage follow: None, very slow, slow, medium, rapid, and very rapid.

Leaching, soil. The removal of materials in solution.

Massive (*See also* Structure, grade). Large uniform masses of cohesive soil, sometimes with ill-defined and irregular breakage, as in some of the fine-textured alluvial soils, *structureless.*

Morphology, soil. The physical constitution of the soil including the texture, structure, consistence, color, and other physical and chemical properties of the various soil horizons that make up the soil profile.

Mottled. Marked with spots of color and usually associated with poor drainage. Descriptive terms for mottles follow: Contrast—faint, distinct, and prominent; abundance—few, common, and many; and size—fine, medium, and coarse. The size measurements are as follows: Fine, commonly less than 5 mm. (about 0.2 in.) in diameter along the greatest dimension; medium, commonly ranging between 5 and 15 mm. (about 0.2 to 0.6 in.) along the greatest dimension; and coarse, commonly more than 15 mm. (about 0.6 in.) along the greatest dimension (11).

Natural drainage. Refers to those conditions which existed during the development of the soil as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by such factors as sudden deepening of channels or blocking of drainage outlets. The following relative terms are used to express natural drainage: Very poorly drained, poorly drained, imperfectly or somewhat poorly drained, moderately well drained, well drained, somewhat excessively drained, and excessively drained.

Normal soil. A soil having a profile in near-equilibrium with its environment, developed under good but not excessive drainage from parent material of mixed mineral, physical, and chemical composition, and expressing in its characteristics the full effects of the forces of climate and living matter.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in elaboration of its food and tissue. Essential elements include nitrogen, phosphorus, calcium, potassium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and other elements mainly from the soil, and carbon, hydrogen, and oxygen mainly from the air and water.

Parent material (*See also* Horizon C; Profile, soil; and Substratum). The unconsolidated mass of rock material (or peat) from which the soil profile develops.

Permeable. Easily penetrated, as by water or air.

Phase, soil. That subdivision of a soil type having variations in characteristics not significant to the classification of the soil in its natural landscape but significant to the use and management of the soil. The variations are *chiefly in such external characteristics as relief, stoniness, or erosion.* (Example: Cecil sandy loam, eroded hilly phase.)

Productivity, soil. The capability of a soil to produce a specified plant or sequence of plants under a defined set of management practices.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. (*See* Horizon, soil.)

Reaction, soil. (*See* Acidity in section on Soil Survey Methods.)

Relief. Elevations or inequalities of the land surface, the slope gradient and the pattern of these, considered collectively.

Runoff. This term refers to the amount of water removed by flow over the surface of the soil. The amount and rapidity of runoff are affected by factors such as texture, structure, and porosity of the surface soil, the vegetative covering, the prevailing climate and the slope. Relative degree of runoff is expressed in six classes as follows: Ponded, very slow, slow, medium, rapid, and very rapid.

Sand. Small rock or mineral fragments that have diameters ranging between 0.05 mm. (0.002 in.) and 2.0 mm. (0.079 in.). The term sand is also applied to soils containing 85 percent or more of sand.

Series, soil. A group of soils having the same profile characteristics, the same general range in color, structure, consistence, and sequence of horizons, the same general conditions of relief and drainage, and usually a common or similar origin and mode of formation. A group of soil types that are closely similar in all respects except the texture of the surface soil.

Silt. Mineral particles of soil that range in diameter from 0.05 mm. (0.002 in.) to 0.002 mm. (0.000079 in.) in diameter; soil material that contains 80 percent or more of silt and less than 12 percent clay.

Single grain soil. (*See also* Structure, grade). A structureless soil in which each particle exists separately, as in dune sand.

Slope classes. As used in this report, they are as follows:

	Percent		Percent
Level	0–2	Hilly	10–15
Undulating	2–6	Steep	15–25
Rolling	6–10		

Soil. A natural body on the surface of the earth characterized by conformable layers resulting from modification of parent material by physical, chemical, and biological forces over periods of time.

Soil classes. Based on the relative proportion of soil separates. The principal classes, in increasing order of the content of the finer separates, are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay.

Soil separates. The individual size groups of mineral soil particles, as sand, silt, and clay.

Stripcropping. The practice of growing ordinary farm crops in long strips or bands of variable widths across the line of slope, or approximately on the contour. Close-growing crops are seeded in alternate strips with clean-tilled crops.

Structure, soil. The morphological aggregates in which the individual soil particles are arranged. It may refer to their natural arrangement in the soil when in place and undisturbed or to the soil at any degree of disturbance. Soil structure is classified according to grade, class, and type.

Grade. Degree of distinctness of aggregation. Grade expresses the differential between cohesion within aggregates and adhesion between aggregates. Terms: Structureless (single grain or massive), weak, moderate, and strong.

Class. Size of soil aggregate. Terms: Very fine or very thin, fine or thin, medium, coarse or thick, and very coarse or very thick.

Type. Shapes for soil aggregates. Terms: Platy, prismatic, columnar, blocky, subangular blocky, granular, and crumb. (Example of soil structure grade, class, and type: Moderate coarse blocky.)

Subsoil. Technically, the B horizon of soils with distinct profiles; roughly, that part of the profile below plow depth.

Substratum (*See also* Horizon, C, and Parent Material). Any layer lying beneath the solum or true soil.

Surface soil. Technically, the A horizon; commonly, the part of the upper profile usually stirred by tillage.

Terrace (for control of runoff, soil erosion, or both). An embankment or ridge constructed across sloping soils on or approximately on contour lines, at specific intervals. The terrace intercepts surplus runoff to retain it for infiltration into the soil or to direct excess water to an outlet at nonerosive velocity.

Terrace (geological). An old alluvial plain, usually flat or undulating, bordering a stream, frequently called second bottoms as contrasted with flood plains, seldom subject to overflow.

Texture. Size of individual particles making up the soil mass. It specifically refers to the proportions of sand, silt, and clay. A coarse-textured soil is one high in the content of sand; a fine-textured soil has a large proportion of clay.

Type, soil. A subdivision of the soil series based on the texture of the surface soil.

Upland (geologic). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace.