CLIMATIC FACTOR - "C"

Wind Erosion Equation $E=f[(IKC)LV]$

"C" Factor Objectives

These materials will help the participant understand:

- The definition of the WEQ "C" factor
- The climatic effects that are used to determine the "C" factor
- The meaning and use of erosive wind energy (EWE) distribution

"C" Climatic Factor

The "C" factor is an index of the relative climatic erosivity, specifically wind speed and surface soil moisture. The factor for any given location is based on long-term climatic data and is expressed as a percentage of the "C" factor for Garden City, Kansas which has been assigned a value of 100. It is based on long term data (temperature, precipitation, and windspeed), and is generally expressed as a percentage. Example: A "C" factor of 40 is equal to 40% or 0.40.

The information required to calculate the "C" factor includes:

- Average annual wind speed
- Average monthly precipitation
- Average monthly temperature

Two different calculations are required in order to determine a "C" factor. The first calculation determines the Thornthwaite precipitation effectiveness (PE) index or effectiveness of surface soil moisture. The annual PE is the sum of the 12 monthly PE indices, and is determined using the following equation:

$$PE = \sum^{12} 115 \left(\frac{P}{T - 10} \right)^{10 / 9}$$

PE = precipitation-effectiveness index

P = average monthly precipitation

T = average monthly temperature

The second calculation, below, determines the annual "C" factor. It uses the annual precipitation effectiveness index. This equation is based on the assumption that soil movement is proportional to the windspeed cubed. A small change in velocity can make a large difference in the "C" factor. It also assumes that soil movement varies inversely with the surface soil moisture.

$$C = \frac{(34.48)V^3}{(PE)^2}$$

Where:

C = annual climatic factor
34.48 = constant
V = average annual wind velocity
PE = annual precipitation effectiveness index

"C" Climatic Factor Concepts

- As average annual wind speed increases, "C" factor values increase
- As average monthly precipitation increases, "C" factor values decrease
- As average monthly temperature increases, "C" factor values increase

Annual Climatic Factor

A national "C" factor isoline map was developed by NRCS in 1987. The isolines were drafted using 1951-1980 weather data and were correlated across state and regional boundaries. NRCS state agronomists may develop local or county isolines where local data is available. Precipitation, temperature, and wind velocity data must be available in order to support locally developed "C" factors. The influence of topography may also be considered. Locally developed isolines must be consistent with the national isoline map. Interpolation between national or state developed isolines is generally done in increments of not less than 5. In some states, where isolines are consistent throughout a county, a county may be given one "C" factor to use. Where lines are not consistent, isolines with more than one value per county have been used. State agronomists should assure that "C" factors are consistent from county to county and across state and regional boundaries.

A sample "C" factor calculation is shown in Table 18. The formula can be solved manually or by use of a computer spreadsheet program.

TABLE 18.
ANNUAL EFFECTIVE PE AND ESTIMATED C

Constraints: Monthly P = > 0.5 inches
Monthly T = > 28.4 degrees F

MONTH	P	ADJ. P	T	ADJ. T-10	PE
JANUARY	0.41	0.5	26.7	18.4	2.1
FEBRUARY	0.60	0.60	32.6	22.6	2.0
MARCH	1.33	1.33	39.7	29.7	3.7
APRIL	1.83	1.83	52.4	42.4	3.5
MAY	3.42	3.42	62.3	52.3	5.6
JUNE	3.68	3.68	72.2	62.2	5.0
JULY	3.35	3.35	77.8	67.8	4.1
AUGUST	2.61	2.61	76.3	66.3	3.2
SEPTEMBER	2.16	2.16	66.8	56.8	3.1
OCTOBER	1.41	1.41	55.7	45.7	2.4
NOVEMBER	0.73	0.73	40.3	30.3	1.8
DECEMBER	0.46	0.50	31.1	21.1	1.8
Avg. Annual	21.99		52.8		38.2

Estimated V = 13
Estimated C = 51.8

The annual C factors map for the United States is found in Figure 13.

The annual C factors map for New Mexico is found in Figure 14.

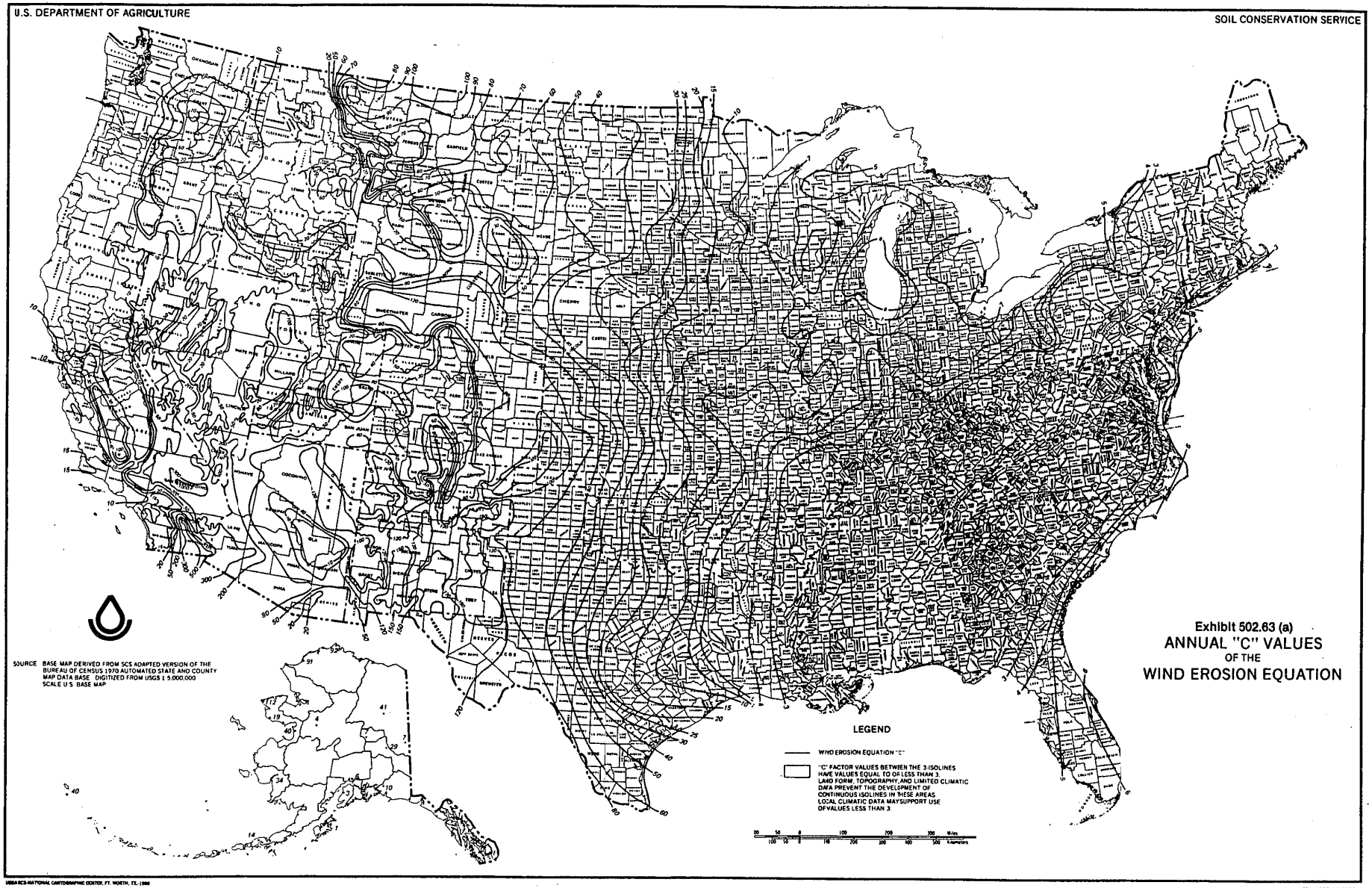
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOURCE BASE MAP DERIVED FROM SCS ADAPTED VERSION OF THE BUREAU OF CENSUS 1970 AUTOMATED STATE AND COUNTY MAP DATA BASE DIGITIZED FROM USGS 1 5,000,000 SCALE U S BASE MAP
LEGEND
WIND EROSION EQUATION "C"
"C" FACTOR VALUES BETWEEN THE 3-ISOLINES HAVE VALUES EQUAL TO OR LESS THAN 3. LAND FORM, TOPOGRAPHY, AND LIMITED CLIMATIC DATA PREVENT THE DEVELOPMENT OF CONTINUOUS ISOLINES IN THESE AREAS LOCAL CLIMATIC DATA MAYSUPPORT USE OFVALUES LESS THAN 3
Exhibit 502.63 (a)
ANNUAL "C" VALUES
OF THE
WIND EROSION EQUATION
May 1987 1000359

Figure 13

Annual "C" Values
Of The Wind Erosion Equation
New Mexico

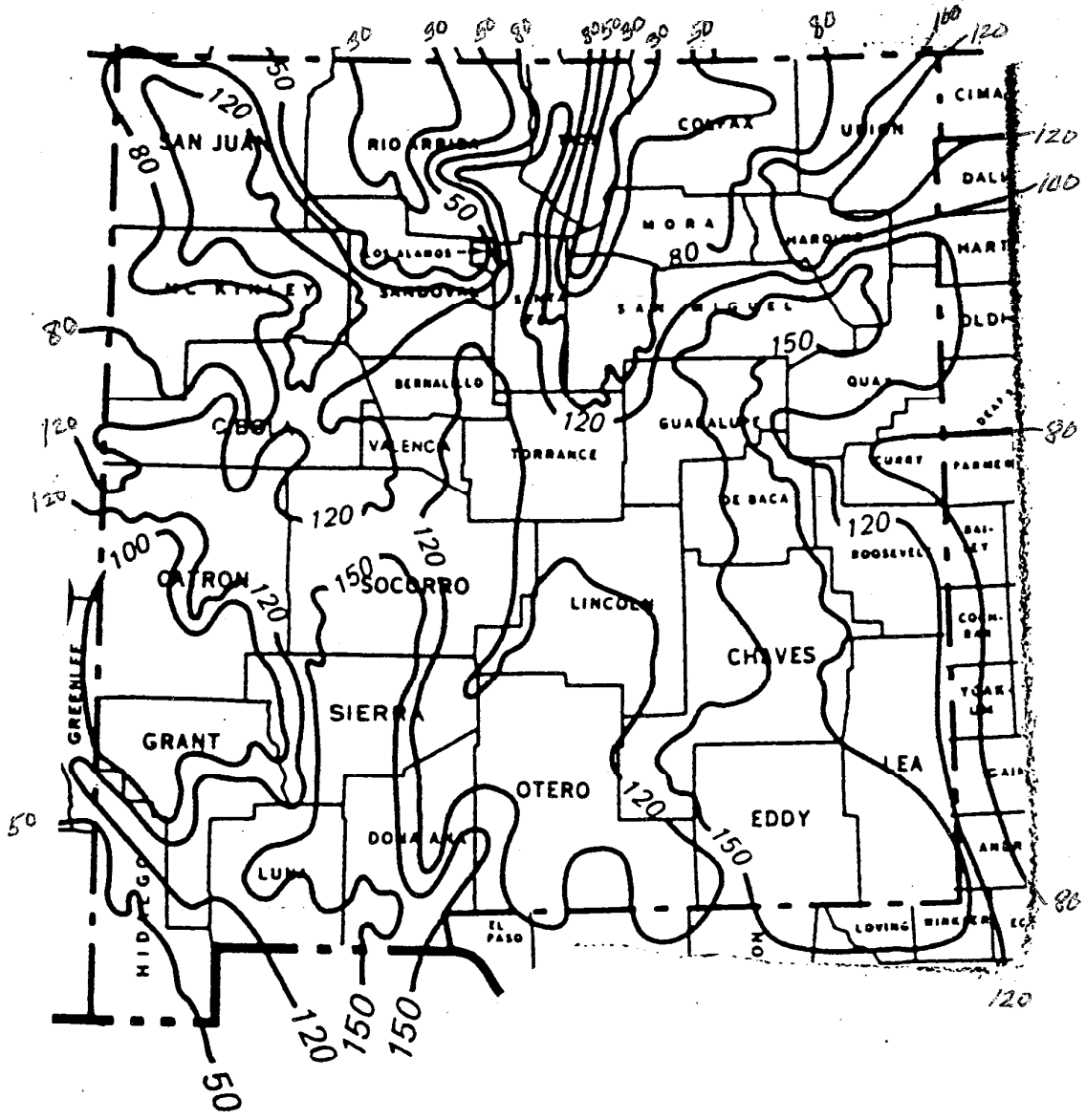

Figure 14

Erosive Wind Energy Distribution

This is the expected distribution, by month, of erosive wind energy at a given geographic location. Using the monthly erosive wind energy values, planners can identify the months in which the greatest potential erosion, and develop conservation systems that will minimize erosion. When using the management period method, the erosion rate as obtained from the "E" tables, for the period, is multiplied by the percent of erosive wind energy for the same time period. Monthly wind direction, preponderance, and erosive wind energy values for locations in New Mexico are shown in Table 19.

Adjustment to Ewe During Irrigation – Irrigation Factor – (IF)

Wetting of soil by irrigation makes it less erodible. This technology is explained in the National Agronomy Manual, Circular No. 2. This adjustment procedure will be used in New Mexico.

New Mexico Random Roughness, Climate Factor, and Irrigation Adjustment Procedure

The New Mexico adjustment procedure will be applied to irrigated cropland to adjust for random roughness, the climatic factor, and the application of irrigation water. For each management period, adjust the predicted erosion rate by multiplying it by the factor found in Exhibit B, at the end of this section. When this modification procedure was developed in 1987, the factors were developed for each of the four administrative areas in the state. Those areas no longer exist. Refer to the map at the beginning of exhibit B. Select the quarter of the state that applies to the location of the field being evaluated. These quarters are divided into the northwest, southwest, northeast, and southeast. To find the correct factor, refer to the chart that is specific to the C and I factors for each field. Select the factor on the table, based on the V that is present for that management period, and multiply the predicted erosion by that factor. Total the revised erosion estimates for all the management periods and divide by the number of years in the rotation to determine the average annual erosion rate.

TABLE 19

DIRECTION, PREPONDERANCE, AND CUMULATIVE EROSIVE WIND ENERGY

NM Alamagordo	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	202	203	225	247	203	180	157	180	180	158	225	180
Preponderance	1.5	1.2	1.6	1.9	1.4	1.8	1.7	2.1	3.5	2.7	1.4	1.3
Erositivity (EWE)	4.2	7.1	16.5	24.7	13.2	14.2	5.1	2.7	2.6	3.0	2.4	4.3
Cumulative EWE	4.2	11.3	27.8	52.5	65.7	79.9	85.0	87.7	90.4	93.3	95.7	100.0
NM Albuquerque	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	112	112	292	247	90	112	112	112	112	90	90	112
Preponderance	2.2	2.1	1.9	1.5	1.5	2.0	3.4	2.5	3.3	2.8	2.3	2.4
Erositivity (EWE)	1.7	5.4	15.7	24.6	17.9	13.4	3.9	1.8	4.1	5.4	2.4	3.5
Cumulative EWE	1.7	7.1	22.8	47.4	65.3	78.8	82.7	84.5	88.7	94.0	96.5	100.0
NM Carlsbad	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	247	247	247	247	247	247	157	157	338	247	247	247
Preponderance	12.2	5.0	6.1	6.0	1.9	1.1	1.8	1.6	2.5	1.9	5.0	4.5
Erositivity (EWE)	12.4	11.4	29.2	14.2	8.4	4.9	1.0	0.5	0.4	1.7	5.2	10.5
Cumulative EWE	12.4	23.8	53.0	67.2	75.7	80.6	81.6	82.1	82.5	84.3	89.5	100.0
NM Clovis	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	270	23	247	247	225	202	180	22	23	23	45	247
Preponderance	2.1	2.2	1.8	1.8	1.8	1.8	2.3	2.3	2.5	3.2	1.5	1.9
Erositivity (EWE)	10.1	9.0	19.7	16.7	11.8	6.5	2.0	1.0	1.6	5.2	6.7	9.7
Cumulative EWE	10.1	19.1	38.8	55.5	67.3	73.8	75.8	76.8	78.4	83.6	90.3	100.0
NM Columbus	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	247	270	247	270	292	247	292	293	90	270	292	270
Preponderance	2.5	2.6	2.7	2.0	2.2	2.3	1.7	3.0	2.5	1.7	2.3	1.9
Erositivity (EWE)	9.2	9.3	29.8	17.9	9.9	4.7	3.4	1.4	1.0	1.3	3.4	8.6
Cumulative EWE	9.2	18.5	48.3	66.2	76.1	80.8	84.3	85.7	86.7	87.9	91.4	100.0

TABLE 19

DIRECTION, PREPONDERANCE, AND CUMULATIVE EROSIVE WIND ENERGY

NM Farmington	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	270	292	292	292	225	292	337	180	292	293	292	292
Preponderance	3.9	3.5	3.7	2.5	1.1	2.0	2.0	1.6	3.2	1.6	3.1	3.6
Erositivity (EWE)	0.7	5.6	24.8	36.7	13.5	7.8	3.2	1.3	0.8	1.5	3.5	0.4
Cumulative EWE	0.7	6.3	31.1	67.8	81.3	89.2	92.4	93.7	94.6	96.0	99.6	100.0
NM Gallup	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	225	247	247	225	225	247	247	247	225	247	225	23
Preponderance	3.5	3.1	3.0	2.8	2.4	2.9	1.7	2.0	3.1	2.8	2.9	4.1
Erositivity (EWE)	0.3	3.0	19.9	24.5	19.8	12.1	3.0	3.1	4.0	2.1	4.8	3.3
Cumulative EWE	0.3	3.4	23.2	47.8	67.6	79.7	82.7	85.8	89.8	91.9	96.7	100.0
NM Hobbs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	247	225	247	225	225	158	158	158	0	225	247	247
Preponderance	2.3	1.6	2.0	1.8	1.2	1.9	2.0	1.5	1.9	3.1	1.3	1.8
Erositivity (EWE)	9.3	10.3	22.7	13.2	12.6	8.1	3.5	1.9	1.6	2.4	5.5	8.9
Cumulative EWE	9.3	19.6	42.3	55.5	68.1	76.2	79.7	81.6	83.2	85.5	91.1	100.0
NM Las Cruces	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	270	270	270	270	270	247	158	180	270	270	270	270
Preponderance	15.8	14.2	7.3	9.7	5.5	1.2	1.1	2.8	7.3	3.3	14.8	9.1
Erositivity (EWE)	4.1	23.7	26.8	17.6	11.0	1.6	0.4	0.2	0.9	1.3	5.0	7.6
Cumulative EWE	4.1	27.8	54.5	72.1	83.1	84.7	85.1	85.3	86.2	87.5	92.4	100.0
NM Las Vegas	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	247	247	247	247	225	225	202	225	225	225	225	247
Preponderance	3.2	2.8	2.6	2.5	2.7	3.5	1.5	2.1	2.5	2.8	2.0	1.9
Erositivity (EWE)	9.7	9.1	18.8	18.8	12.7	8.1	1.3	0.9	2.5	3.9	4.7	9.4
Cumulative EWE	9.7	18.9	37.7	56.5	69.2	77.3	78.6	79.5	82.0	85.9	90.6	100.0

TABLE 19

DIRECTION, PREPONDERANCE, AND CUMULATIVE EROSIVE WIND ENERGY

NM Otto	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	270	292	270	247	270	270	90	90	270	270	293	270
Preponderance	2.2	2.4	3.0	1.6	2.1	3.3	2.7	3.9	1.4	1.3	2.3	2.2
Erositivity (EWE)	7.5	6.5	30.3	14.3	10.9	5.3	1.1	0.3	0.9	2.0	6.2	14.9
Cumulative EWE	7.5	14.0	44.2	58.5	69.4	74.6	75.7	76.0	76.9	78.9	85.1	100.0
NM Raton/Crews	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	270	22	247	225	225	225	180	22	23	225	22	292
Preponderance	2.6	1.3	1.2	1.8	1.7	2.0	1.7	2.2	2.7	2.4	1.7	2.5
Erositivity (EWE)	13.2	9.1	20.8	16.9	17.2	7.5	1.2	0.5	1.7	2.4	2.9	6.4
Cumulative EWE	13.2	22.4	43.2	60.1	77.3	84.9	86.1	86.6	88.3	90.7	93.6	100.0
NM Roswell	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	292	292	270	270	248	202	203	270	22	247	293	293
Preponderance	3.7	2.4	1.9	2.4	1.1	1.5	1.0	1.6	2.2	1.2	1.8	3.0
Erositivity (EWE)	6.6	14.1	20.5	21.3	11.0	5.7	1.4	1.2	1.8	2.7	4.8	9.0
Cumulative EWE	6.6	20.7	41.1	62.4	73.4	79.2	80.6	81.8	83.6	86.2	91.0	100.0
NM Roswell/Walk.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	315	315	293	270	225	180	180	180	180	0	0	315
Preponderance	2.4	2.0	1.7	2.1	1.6	2.2	2.4	3.0	3.0	3.2	1.1	2.8
Erositivity (EWE)	5.2	13.2	22.9	17.4	17.1	8.5	3.3	1.4	1.8	2.2	3.5	3.7
Cumulative EWE	5.2	18.4	41.3	58.6	75.7	84.2	87.5	88.9	90.7	92.8	96.3	100.0
NM Santa Fe	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	338	292	270	247	270	270	157	135	157	292	338	23
Preponderance	1.1	1.2	2.3	2.0	1.4	1.4	1.2	1.7	1.1	1.2	1.4	1.1
Erositivity (EWE)	8.8	7.3	17.2	16.0	12.6	9.2	2.9	1.7	3.4	4.3	7.5	9.1
Cumulative EWE	8.8	16.1	33.3	49.3	61.8	71.0	73.9	75.6	79.1	83.4	90.9	100.0

TABLE 19

DIRECTION, PREPONDERANCE, AND CUMULATIVE EROSIVE WIND ENERGY

NM Truth or Cons.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	180	203	225	225	203	202	315	338	202	202	202	202
Preponderance	1.2	1.5	2.1	1.9	2.7	2.7	1.5	1.6	3.8	4.2	3.6	2.0
Erositivity (EWE)	3.8	8.9	17.9	21.8	18.6	10.8	3.7	2.2	1.8	2.9	4.5	3.1
Cumulative EWE	3.8	12.7	30.6	52.4	71.0	81.9	85.6	87.7	89.5	92.4	96.9	100.0
NM Tucumcari	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	247	247	247	247	225	225	202	203	225	225	247	247
Preponderance	2.0	1.9	2.2	1.8	1.8	1.6	2.4	2.7	2.9	2.7	2.3	2.3
Erositivity (EWE)	6.9	9.1	15.9	19.1	10.8	9.8	3.5	2.4	4.2	4.6	5.9	7.6
Cumulative EWE	6.9	16.1	31.9	51.1	61.9	71.8	75.3	77.7	81.9	86.5	92.4	100.0
NM Zuni	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prev Wind E. Dir.	247	247	247	247	247	247	270	225	247	247	270	247
Preponderance	4.6	6.1	6.0	3.8	6.8	6.1	2.3	1.1	5.4	3.0	3.6	5.8
Erositivity (EWE)	0.8	4.9	17.7	39.8	17.9	8.2	0.9	0.6	2.9	3.1	2.0	1.2
Cumulative EWE	0.8	5.7	23.4	63.2	81.1	89.3	90.2	90.8	93.7	96.8	98.8	100.0

Tables 20 and 21 illustrate the effect of climate ("C" Factor) on predicted soil erosion.

TABLE 20.

SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR SOIL LOSS C = 100
SURFACE - K = 1.0 I = 86

V - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

L UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	86.0	75.3	60.7	46.4	30.0	16.8	8.8	4.6	2.9	1.1	0.3		
8000	86.0	75.3	60.7	46.4	30.0	16.8	8.8	4.6	2.9	1.1	0.3		
6000	86.0	75.3	60.7	46.4	30.0	16.8	8.8	4.6	2.9	1.1	0.3		
4000	86.0	75.3	60.7	46.4	30.0	16.8	8.8	4.6	2.9	1.1	0.3		
3000	85.6	74.9	60.4	46.1	29.7	16.6	8.7	4.6	2.9	1.1	0.3		
2000	82.7	72.3	58.1	44.2	28.3	15.7	8.1	4.2	2.6	1.0			
1000	76.4	66.5	53.1	40.0	25.3	13.7	6.9	3.5	2.2	0.7			
800	74.2	64.6	51.5	38.6	24.3	13.0	6.6	3.3	2.0	0.7			
600	69.3	60.1	47.7	35.4	22.1	11.6	5.7	2.8	1.7	0.5			
400	62.2	53.7	42.4	31.0	19.0	9.6	4.6	2.2	1.3				
300	57.6	49.6	38.7	28.1	17.0	8.4	4.0	1.9	1.1				
200	51.4	44.1	34.1	24.4	14.5	6.9	3.2	1.4	0.8				
150	45.6	38.9	29.8	21.0	12.1	5.6	2.5	1.1	0.5				
100	39.8	33.8	25.6	17.7	10.1	4.5	1.9	0.8	0.4				
80	36.6	31.0	23.2	16.0	9.0	3.9	1.6	0.5					
60	31.4	26.4	19.6	13.2	7.2	3.0	1.2	0.4					
50	27.9	23.4	17.2	11.4	6.1	2.4	0.9						
40	24.4	20.4	14.8	9.7	5.1	1.9	0.7						
30	21.0	17.4	12.5	8.0	4.1	1.5	0.5						
20	15.9	13.0	9.1	5.6	2.8	0.9							
10	9.4	7.5	5.1	2.9	1.3	0.3							

TABLE 21.

SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR SOIL LOSS C = 50
SURFACE - K = 1.0 I = 86

V - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

L UNSHELTERED DISTANCE IN FEET	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	43.0	36.6	27.9	19.5	11.3	5.1	2.2	1.0	0.4				
8000	43.0	36.6	27.9	19.5	11.3	5.1	2.2	1.0	0.4				
6000	43.0	36.6	27.9	19.5	11.3	5.1	2.2	1.0	0.4				
4000	43.0	36.6	27.9	19.5	11.3	5.1	2.2	1.0	0.4				
3000	42.7	36.3	27.7	19.4	11.1	5.0	2.2	0.9	0.4				
2000	40.7	34.6	26.2	18.2	10.4	4.6	2.0	0.8	0.4				
1000	36.6	30.9	23.3	16.0	9.0	3.9	1.6	0.5					
800	35.1	29.6	22.2	15.2	8.5	3.6	1.5	0.5					
600	32.2	27.1	20.2	13.6	7.5	3.1	1.3	0.4					
400	28.0	23.5	17.3	11.5	6.2	2.4	1.0						
300	24.1	20.6	15.0	9.8	5.2	2.0	0.7						
200	21.2	17.6	12.6	8.1	4.2	1.5	0.5						
150	18.0	14.8	10.5	6.6	3.3	1.1							
100	14.8	12.1	8.4	5.2	2.5	0.8							
80	13.2	10.8	7.4	4.5	2.1	0.4							
60	10.4	8.4	5.7	3.3	1.5	0.3							
50	8.7	7.0	4.7	2.7	1.2	0.2							
40	7.0	5.5	3.6	2.0	0.8								
30	4.8	3.8	2.4	1.3	0.5								
20	3.3	2.5	1.6	0.7									
10	1.4	1.1	0.6										

"C" Factor Summary

"C" is an index of the relative climatic erosivity by geographic location. It considers average annual wind speed, average monthly precipitation, and average monthly temperature. "C" is expressed as a percentage of a factor of 100.

Erosive wind energy distribution (EWE) is used in the management period method to weight annual erosion rates based on the amount of erosive wind energy occurring during each management period.