UNSHELTERED DISTANCE "L"

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

In the Wind Erosion Equation, the "L" factor represents the unsheltered distance along the prevailing wind erosion direction for the field or area to be evaluated. Its place in the equation is to relate the "isolated, unsheltered, and wide" field condition of "I" to the size and shape of the field for which the erosion estimate is being prepared. Because "V" is considered after "L" in the 5-step solution of the equation, the unsheltered distance is always considered as if the field were bare except for vegetative barriers.

Definition of Unsheltered Distance

"L" begins at a point upwind where no saltation or surface creep occurs and ends at the downwind edge of the area being evaluated.

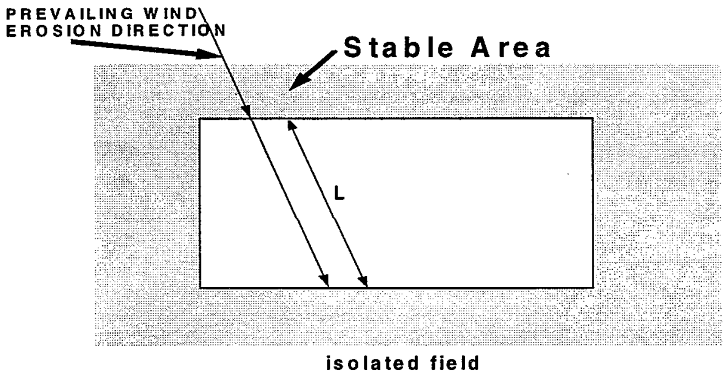


Figure 15. Isolated Field - "L" Calculated Using Field Width

The upwind point may be at the field border when a stable condition is present or it may be upwind where vegetation is sufficient to eliminate the erosion process. Where the stable condition is upwind of the field border a "new" field area is created for determining "L." A strip of vegetation should be considered stable only if it can trap or hold virtually all expected saltation and surface creep from upwind.

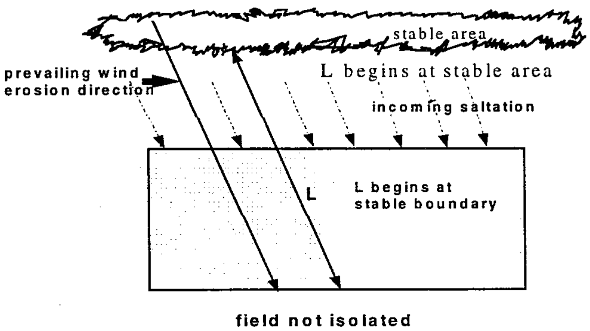


Figure 16. Field Not Isolated - "L" Begins Upwind of Field Boundary

When a properly designed wind stripcropping system is applied, alternate strips are protected during erosive periods by a growing crop or by crop residue. These strips are considered stable and "L" is measured across each erosion-susceptible strip, along the prevailing wind erosion direction.

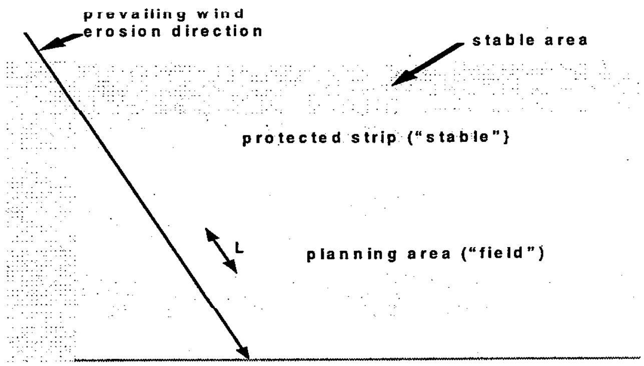


Figure 17. Properly Installed Wind Stripcropping System

Where vegetative barriers, grassed waterways, or other stable areas divide an agricultural field being evaluated, each subdivision is "isolated" and is evaluated as a separate "field."

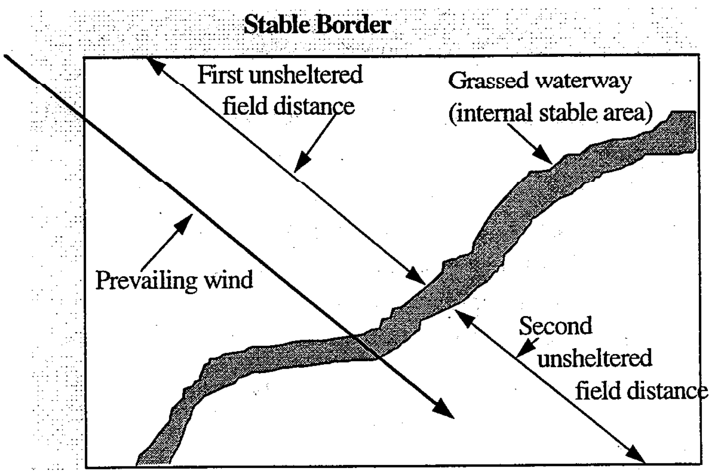
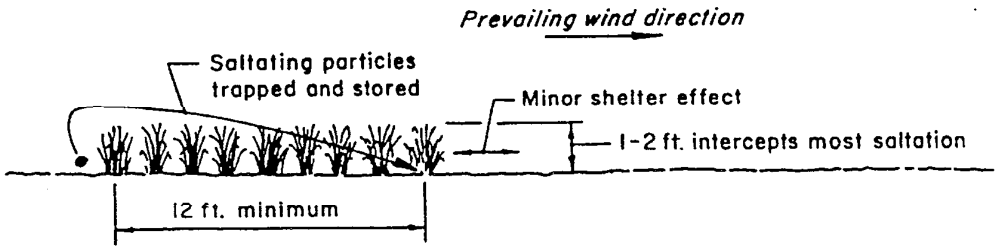


Figure 18. Stable Area Inside Field Starts a New "L"

Stable Condition

A stable condition is present when an area has sufficient vegetative cover to trap and hold expected saltation and surface creep from upwind. Factors to consider when evaluating an area for stability are width of vegetated strip as well as density and height of vegetation. Strips 12-15 feet in width with a dense stand of upright, ridged vegetation standing one foot tall or taller, as shown in figure 19, are considered stable. When vegetation is less than one foot in height, strip width should be increased to a 25 foot width before being considered stable.



Trap Strip

Figure 19.

When erosion estimates are being calculated for cropland or other relatively unstable conditions, upwind pasture or rangeland should be considered a stable border. However, if the estimate is being made for a pasture or range area, "L" should be determined by measuring from the nearest stable point upwind of the area or field in question. The only case where "L" is equal to zero is where the area is fully sheltered by a barrier.

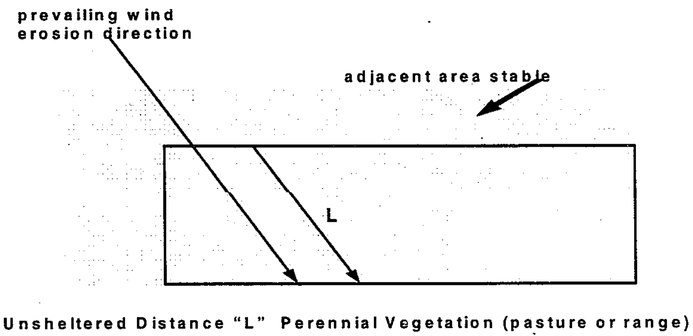
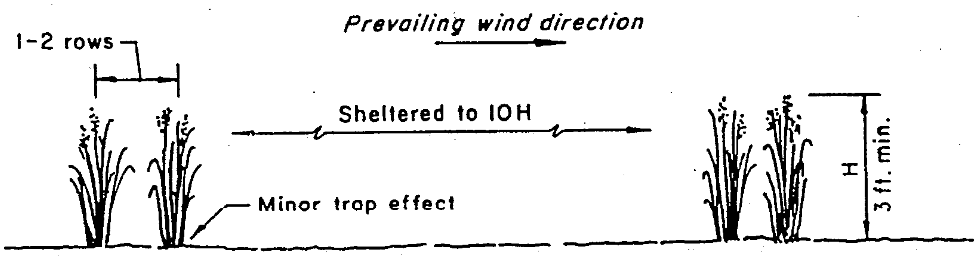


Figure 20. "L" Determination for Fields Surrounded by Perennial Vegetation

Barriers

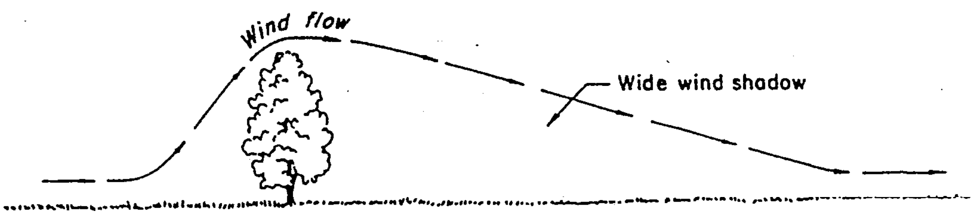
Barriers can reduce "L." A barrier can be vegetative, such as a strip or row of trees, shrubs, or tall grass; or structural, such as a row of hay bales or snow fencing. Plants must have an effective height of 3 feet before they are considered a barrier. Barriers with a density of 40-60% are considered to provide the greatest downwind area of protection.



Vegetative Barriers

Figure 21

NRCS considers the sheltered or protected area to be ten times the height of the barrier or 10H. Within this sheltered zone soil erosion rates are considered to be zero and for planning purposes the wind erosion process and the unsheltered distance begins at a point downwind 10H from the barrier.



Barrier Effect

Figure 22

When a barrier is present on the upwind side of a field, as in Figure 23, measure "L" across the field along the prevailing wind erosion direction and subtract the distance sheltered by the barrier. Use ten times the barrier height (10H) for the sheltered distance.

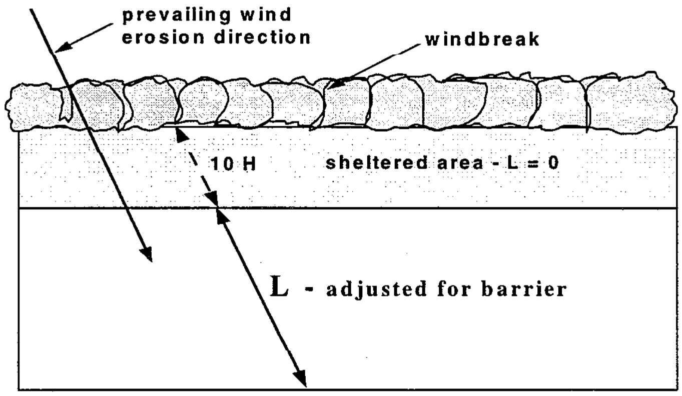


Figure 23. Barrier Effect on "L"

"L" In Single Annual Calculations

For uses of the Wind Erosion Equation involving a single annual calculation, the prevailing wind erosion direction during the critical period is used. "L" should be the measured distance across the area along the prevailing wind erosion direction from the stable upwind edge of the field to the downwind edge of the field. When prevailing wind erosion direction is at an angle from perpendicular, "L" can measured along that angle or can be determined by multiplying the width of the field by the appropriate conversion factor obtained from the Table 22.

TABLE 22.

WIND EROSION DIRECTION
FACTORS FOR CALCULATING "L"

ANGLE OF DEVIATION	ADJUSTMENT FACTOR*
0	1.00
22.5	1.08
45	1.41
67.5	2.61
90	"L" = LENGTH OF FIELD

Use these adjustment factors only for the annual method of calculation. These adjustment factors are applicable only when preponderance is not considered. "L" cannot exceed the longest possible measured distance across the field.

"L" In Management Period Calculation

For uses of the Wind Erosion Equation based on the management period method, "L" is a calculated value determined by multiplying a measured field width by a Wind Erosion Direction Factor determined from the appropriate table.

The information needed to determine "L" for a management period method analysis includes: **Prevailing Wind Erosion Direction** for each identified management period; **Preponderance** values for each identified management period; **Field Length to Width ratio**; **Field Orientation**; **Angle of Deviation**; and a **Wind Direction Factor**.

Prevailing Wind Erosion Direction

The prevailing wind erosion direction is the direction from where the greatest amount of erosive wind occurs during the critical wind erosion period or the period being evaluated for the management period method. The direction is expressed as one of the 16 compass points in degrees from true north. When predicting erosion by management periods, the prevailing wind erosion direction may be different for each period.

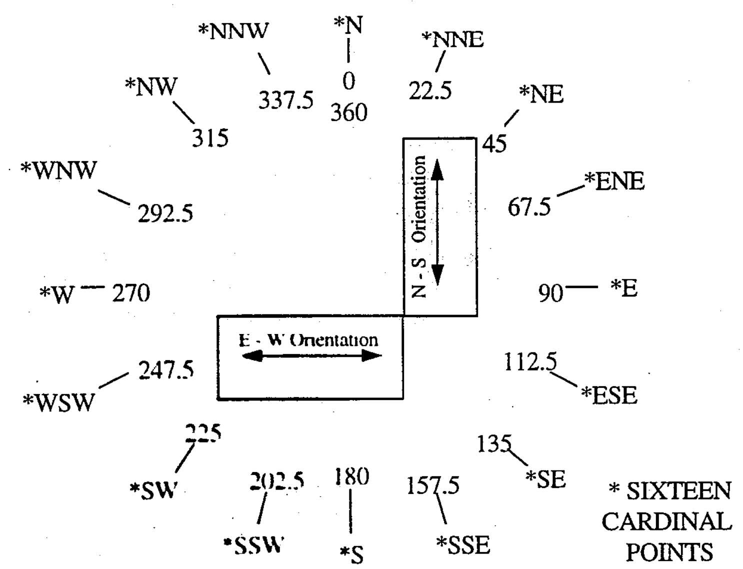


Figure 24. Graphic Representation of Wind Directions

Preponderance

Erosion estimates can be refined by analyzing time steps or management periods of the crop year and/or crop rotation. For "L" determinations each period considers the variability in wind direction or **preponderance** during the period.

Preponderance is a ratio between wind erosion forces parallel and those forces perpendicular to the prevailing wind erosion direction. Wind forces considered include winds blowing in both directions along the identified direction.

A preponderance value of 1.0 indicates that as much erosive wind energy is exerted perpendicular to the prevailing wind direction as along that direction. Wind patterns are normally complex. A low preponderance indicates high complexity. A high preponderance value indicates that more of the force is parallel to the prevailing wind erosion direction. Research shows that using a preponderance value greater than 4.0 makes little difference in wind erosion estimates. Therefore, the FOCS WEQ application caps preponderance values at 4.0.

Values for wind direction and preponderance are available in the National Agronomy Manual (Part 502.63(b)) for several locations throughout the country. Select a location near the area being evaluated for these values. Table 23 shows these values for Cheyenne, WY.

TABLE 23

PREVAILING WIND EROSION DIRECTION, PREPONDERANCE, AND EROSIVE WIND ENERGY

CHEYENNE, WYOMING

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Prev Wind Direction	292.0	293.0	315.0	315.0	315.0	293.0	0.0	338.0	293.0	315.0	292.0	292.0
Preponderance	4.0	2.9	2.2	2.4	2.3	2.1	1.6	2.0	2.1	2.0	2.8	3.7
Erosivity (EWE)	23.6	11.9	11.3	6.7	3.7	2.4	1.4	1.8	2.8	4.6	9.4	20.4
Cumulative (EWE)	23.6	35.5	46.8	53.5	57.2	59.5	60.9	62.7	65.5	70.2	79.6	100.0

Field Length to Width Ratio, Field Orientation, and Angle of Deviation

The shape of the field or area being evaluated as well as the orientation relative to the prevailing erosive winds are used in determining "L." Divide the field length (long dimension) by the width (short dimension) to determine the length:width ratio. Round to the nearest ratio found in the Wind Erosion Direction Factor Tables.

For example, an 80 acre field is 2640 ft. long and 1320 ft. wide. The length to width ratio is calculated as follows: 2640/1320 = 2:1 ratio

When determining "L," the angle of deviation is the angle between the prevailing wind erosion direction and an imaginary line perpendicular to the long side of the field. The angle of deviation is determined for each identified management period.

Figures 25 and 26 illustrate the relationship between wind direction and field orientation, and how field orientation can affect "L."

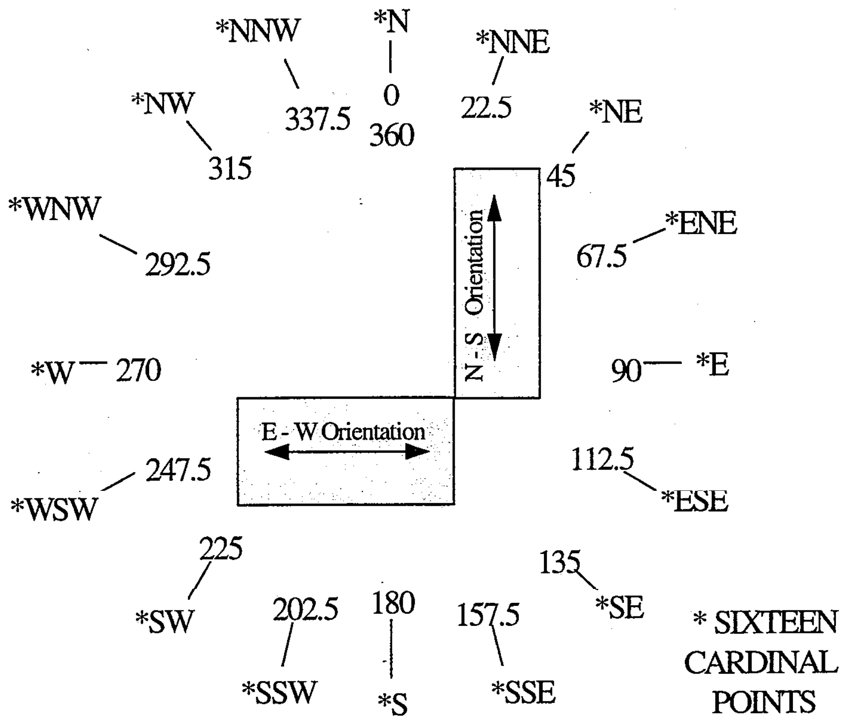


Figure 25. Principal Wind Directions

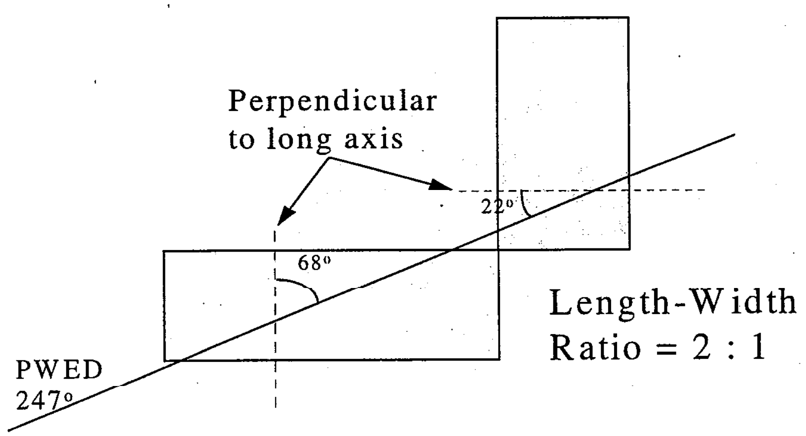


Figure 26. Effect of Field Orientation on Angle of Deviation

Management Periods Covering More Than One Month

Some management periods may extend over more than one month. This usually results in the need to consider more than one prevailing wind erosion direction and/or preponderance value when determining the wind erosion direction factor to calculate "L."

When this occurs, determine a wind erosion direction factor for each month or portion of a month using the applicable angle of deviation, preponderance, and field length to width ratio. Use the entire preponderance value listed for portions of a month. Choose the largest resulting wind erosion direction to calculate "L."

As a rule of thumb, on fields with a 1:1 length to width ratio the largest wind erosion direction factor occurs when the angle of deviation is 22.5° or 67.5°. For fields with a length to width ratio of 2:1 or greater, the wind erosion direction factor increases with an increased angle of deviation.

Steps in Determining Unsheltered Distance "L" Using Management Periods

1) Determine values for prevailing wind erosion direction and preponderance for the climate station best representing the planning site for each identified management period. This information can be found in the National Agronomy Manual Part 502, Exhibit 502.64(a).

2) Measure the actual length and width of the field or area to be evaluated. Divide length by width to determine the length/width ratio. For example, an 80 acre field is 2640 ft. long and 1320 ft. wide. The length to width ratio is calculated as follows: 2640/1320 = 2:1 ratio

3) Determine the orientation of the field or area being evaluated. Determine the angle of deviation between the prevailing wind erosion direction and a line perpendicular to the long side of the field or area.

4) Using values from steps 1, 2, and 3 determine the wind erosion direction factor from the Wind Erosion Direction Factor Tables. These factors can be found in the National Agronomy Manual in Part 502, Exhibit 502.64(b). Tables are also included at the end of this section (Tables 24 - 28).

5) Multiply the width of the field by the wind erosion direction factor to obtain "L" for the management period. For example, an 80 acre field oriented east to west has an angle of deviation of 22 degrees when the prevailing wind direction is 338 degrees. From Table 25, when the angle of deviation equals 22.5 degrees, the field length to width ratio is 2:1, and preponderance is 2.0; the wind erosion direction factor is 1.16. Multiply field width of 1320 by 1.16 to get an unsheltered "L" of 1530.

6) When a barrier is present, reduce the calculated "L" by a distance equal to ten times the height of the barrier (10H). For example, if a barrier 20 ft. in height is present along the north side of the field, the sheltered area from the barrier is 10H or 200 ft. "L" then becomes 1530 minus 200 or 1330.

7) For circular fields, "L" equals 0.915 times the diameter, regardless of direction or preponderance. For example, a center pivot on a quarter section, where the perimeter of the pivot is stable, has a diameter of 2640 ft. The diameter of 2640 ft. multiplied by 0.915 would be equal to an unsheltered distance of 2416 ft.

8) Use a measured "L" where irregular fields cannot be adequately represented by a circle, square, or rectangle, or where preponderance values are not available. Try to represent irregular fields by a square, rectangle, or circle that is close to the size and shape of the irregular field.

TABLE 24

WIND EROSION DIRECTION FACTOR TABLE

Angle of Deviation = 0°

	FIELD LENGTH/WIDTH RATIO						
	1 : 1	2 : 1	4 : 1	8 : 1	10 : 1	12 : 1	16 : 1
Preponderance							
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.30	1.45	1.53	1.56	1.58	1.62
1.4	1.03	1.20	1.28	1.32	1.35	1.37	1.40
1.6	1.03	1.14	1.18	1.20	1.22	1.23	1.25
1.8	1.02	1.10	1.11	1.12	1.13	1.14	1.15
2.0	1.02	1.07	1.07	1.07	1.08	1.08	1.08
2.2	1.02	1.05	1.05	1.05	1.05	1.05	1.05
2.4	1.02	1.04	1.04	1.04	1.04	1.04	1.04
2.6	1.01	1.03	1.03	1.03	1.03	1.03	1.03
2.8	1.01	1.02	1.02	1.02	1.02	1.02	1.02
3.0	1.01	1.02	1.02	1.02	1.02	1.02	1.02
3.2	1.01	1.01	1.01	1.01	1.01	1.01	1.01
3.4	1.01	1.01	1.01	1.01	1.01	1.01	1.01
3.6	1.00	1.01	1.01	1.01	1.01	1.01	1.01
3.8	1.00	1.01	1.01	1.01	1.01	1.01	1.01
4.0	1.00	1.01	1.01	1.01	1.01	1.01	1.01

TABLE 25

WIND EROSION DIRECTION FACTOR TABLE

Angle of Deviation = 22.5°

	FIELD LENGTH/WIDTH RATIO						
	1 : 1	2 : 1	4 : 1	8 : 1	10 : 1	12 : 1	16 : 1
Preponderance							
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.37	1.50	1.61	1.64	1.66	1.70
1.4	1.03	1.27	1.36	1.44	1.46	1.47	1.5
1.6	1.03	1.22	1.26	1.30	1.32	1.33	1.35
1.8	1.03	1.18	1.20	1.21	1.22	1.23	1.24
2.0	1.04	1.16	1.16	1.16	1.16	1.16	1.17
2.2	1.05	1.14	1.14	1.14	1.14	1.14	1.14
2.4	1.06	1.13	1.13	1.13	1.13	1.13	1.13
2.6	1.06	1.13	1.13	1.13	1.13	1.13	1.13
2.8	1.07	1.12	1.12	1.12	1.12	1.12	1.12
3.0	1.07	1.12	1.12	1.12	1.12	1.12	1.12
3.2	1.07	1.12	1.12	1.12	1.12	1.12	1.12
3.4	1.08	1.12	1.12	1.12	1.12	1.12	1.12
3.6	1.08	1.11	1.11	1.11	1.11	1.11	1.11
3.8	1.08	1.11	1.11	1.11	1.11	1.11	1.11
4.0	1.08	1.11	1.11	1.11	1.11	1.11	1.11

TABLE 26

WIND EROSION DIRECTION FACTOR TABLE

Angle of Deviation = 45°

	FIELD LENGTH/WIDTH RATIO						
	1 : 1	2 : 1	4 : 1	8 : 1	10 : 1	12 : 1	16 : 1
Preponderance							
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.44	1.63	1.72	1.75	1.77	1.81
1.4	1.03	1.42	1.57	1.62	1.65	1.67	1.70
1.6	1.03	1.42	1.52	1.55	1.57	1.58	1.61
1.8	1.03	1.42	1.49	1.51	1.52	1.53	1.55
2.0	1.03	1.42	1.48	1.49	1.49	1.49	1.50
2.2	1.02	1.42	1.48	1.48	1.48	1.48	1.48
2.4	1.02	1.42	1.48	1.48	1.48	1.48	1.48
2.6	1.01	1.42	1.48	1.48	1.48	1.48	1.48
2.8	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.0	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.2	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.4	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.6	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.8	1.01	1.42	1.48	1.48	1.48	1.48	1.48
4.0	1.01	1.42	1.48	1.48	1.48	1.48	1.48

TABLE 27

WIND EROSION DIRECTION FACTOR TABLE

Angle of Deviation = 67.5°

	FIELD LENGTH/WIDTH RATIO						
	1 : 1	2 : 1	4 : 1	8 : 1	10 : 1	12 : 1	16 : 1
Preponderance							
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.49	1.80	1.94	1.98	2.00	2.04
1.4	1.03	1.52	1.90	2.03	2.07	2.08	2.12
1.6	1.03	1.55	1.98	2.13	2.15	2.16	2.20
1.8	1.03	1.58	2.08	2.23	2.25	2.26	2.30
2.0	1.04	1.62	2.17	2.35	2.36	2.37	2.40
2.2	1.05	1.65	2.27	2.48	2.49	2.49	2.50
2.4	1.06	1.68	2.37	2.61	2.61	2.61	2.61
2.6	1.06	1.71	2.42	2.71	2.71	2.71	2.71
2.8	1.07	1.72	2.44	2.77	2.77	2.77	2.77
3.0	1.07	1.73	2.45	2.82	2.82	2.82	2.82
3.2	1.07	1.74	2.46	2.85	2.85	2.85	2.85
3.4	1.08	1.75	2.47	2.87	2.87	2.87	2.87
3.6	1.08	1.75	2.48	2.89	2.89	2.89	2.89
3.8	1.08	1.76	2.48	2.90	2.90	2.90	2.90
4.0	1.08	1.76	2.49	2.91	2.91	2.91	2.91

TABLE 28

WIND EROSION DIRECTION FACTOR TABLE

Angle of Deviation = 90°

	FIELD LENGTH/WIDTH RATIO						
	1 : 1	2 : 1	4 : 1	8 : 1	10 : 1	12 : 1	16 : 1
Preponderance							
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.50	1.90	2.10	2.16	2.23	2.32
1.4	1.03	1.55	2.10	2.40	2.50	2.60	2.75
1.6	1.03	1.66	2.30	2.70	2.87	3.00	3.25
1.8	1.03	1.80	2.55	3.10	3.32	3.50	3.85
2.0	1.02	1.96	2.78	3.50	3.84	4.08	4.56
2.2	1.02	2.00	3.06	4.05	4.47	4.80	5.40
2.4	1.02	2.00	3.35	4.63	5.12	5.60	6.40
2.6	1.01	2.00	3.56	5.30	5.93	6.50	7.60
2.8	1.01	2.00	3.74	5.85	6.64	7.50	8.90
3.0	1.01	2.00	3.92	6.51	7.60	8.80	10.6
3.2	1.01	2.00	4.00	6.89	8.20	9.30	11.5
3.4	1.01	2.00	4.00	7.08	8.40	9.60	11.8
3.6	1.00	2.00	4.00	7.26	8.60	9.90	12.3
3.8	1.00	2.00	4.00	7.45	8.91	10.3	12.8
4.0	1.00	2.00	4.00	7.64	9.20	10.6	13.3

For circular fields unsheltered distance "L" equals 0.915 times the diameter of the circle regardless of prevailing wind erosion direction or preponderance.

E Tables

The E Tables provide the predicted average annual soil erosion rate for the field or area described by the factor values I, K, C, L and V. After selecting the appropriate E Table for I, K, and C, the conservationist can readily determine what unsheltered distance "L" is wide, as well as alternative combinations of "L" and "V" that will achieve the desired soil erosion rate. In applications of the management period method, the annual erosion rate E is multiplied by the management period Erosive Wind Energy (EWE) to determine the period erosion rates.

TABLE 29.

E- TABLE - SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR
SURFACE - K = 1.0

C = 90
I = 134

L UNSHELTERED DISTANCE IN FEET	V - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE												
	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	120.6	107.1	88.8	70.8	48.4	30.0	17.1	9.9	6.6	2.9	1.4	0.2	
8000	120.6	107.1	88.8	70.8	48.4	30.0	17.1	9.9	6.6	2.9	1.4	0.2	
6000	120.6	107.1	88.8	70.8	48.4	30.0	17.1	9.9	6.6	2.9	1.4	0.2	
4000	120.6	107.1	88.8	70.8	48.4	30.0	17.1	9.9	6.6	2.9	1.4	0.2	
3000	120.6	107.1	88.8	70.8	48.4	30.0	17.1	9.9	6.6	2.9	1.4	0.2	
2000	120.6	107.1	88.8	70.8	48.4	30.0	17.1	9.9	6.6	2.9	1.4	0.2	
1000	115.5	102.4	84.6	67.1	45.5	27.9	15.7	9.0	6.0	2.5	1.3	0.2	
800	114.1	101.0	83.4	66.0	46.7	27.3	15.3	8.7	5.8	2.4	1.2	0.2	
600	108.7	96.1	74.0	62.1	41.7	25.1	13.9	7.8	5.1	2.1	1.0	0.2	
400	103.2	91.0	74.5	58.3	38.8	22.9	12.5	7.0	4.5	1.8	0.9	0.1	
300	98.9	87.1	71.0	55.2	36.5	21.3	11.5	6.3	4.1	1.6	0.8	0.1	
200	90.1	79.0	64.0	49.2	32.0	18.2	9.6	5.1	3.2	1.2	0.4		
150	82.6	72.2	58.1	44.1	28.3	15.6	8.1	4.2	2.6	0.9	0.3		
100	76.0	66.3	52.9	39.8	25.2	13.6	6.9	3.5	2.1	0.7			
80	71.0	61.6	48.9	36.5	22.8	12.0	6.0	3.0	1.8	0.6			
60	62.9	56.0	42.4	31.1	19.1	9.7	4.7	2.2	1.3				
50	57.8	49.9	38.9	28.3	17.1	8.5	4.0	1.9	1.1				
40	54.0	48.4	36.0	25.9	15.5	7.5	3.9	1.6	0.9				
30	47.3	40.4	31.0	22.0	12.9	6.0	2.7	1.2	0.5				
20	38.3	32.9	24.5	16.9	9.6	4.2	1.8	0.6					
10	26.8	22.4	16.5	10.9	5.8	2.3	0.9						

"E" Tables Exhibit

The "E" tables are found in Exhibit D, at the end of this technical reference.