Wind Erosion Control for Cropland Field Application

A. General

Charts No. 1 and No. 2 provide guidelines for development of suitable alternatives for wind erosion control in Illinois. Development of suitable alternatives requires the use of the following additional information concerning the particular field or area of land to which the alternatives are applicable.

1. Texture of surface soil.

2. Field width exposed to damaging wind; distance between fence rows, windbreaks, or other barriers such as 4 rows of cornstalks.

3. Crop residue management which may be applied, including kind and amount of residues to be left on the soil surface during late winter and early spring and use of cover crops.

Chart No. 1 was developed by SCS personnel using wind erosion research information combined with extensive field experience. The chart shows the permissible field widths for adequate control of wind erosion when differing kinds and amounts of crop residues remain on the soil surface during winter and early spring. Three curves are used, each representing a specific wind erodibility group of soils. The chart can be used to determine permissible field widths when the amount of residues to remain is known. It can also be used to determine the required amount of residues if the field width is known. Its actual use will be found to involve changes in both field width and residues when developing conservation alternatives for specific fields with decision makers.

It is recognized that wind erosion damage under Illinois climatic conditions is not expected to occur every year even though fields may be left bare. Therefore, the guidelines have been prepared with the intent that erosion will be adequately controlled in winter and early spring of years when the hazard becomes severe (due to high winds combined with dry, bare surface soils broken down by repeated freezing and thawing).

B. Soil Texture Curves

Three soil texture curves are shown on the lower portion of Chart No. 1 for easy reference. Surface soil texture is an important factor in wind erosion because it has a strong influence upon the size and stability of soil aggregates. Soils represented by Curve 1 are most erosive from wind while those in Curve 3 are least likely to be moved by the wind.

C. **Illustrations of Typical Field Applications**

Application of the technical material to field conditions in Illinois is best illustrated by the following examples:

1. Situation

A field 160 rods wide, (1 rod=16.5 ft) sandy loam surface texture, being cropped to corn and soybeans, fall plowed.

Problem
Determine permissible field width which will provide adequate control of wind erosion under the conditions given above.

Procedure

Refer to Chart No. 1. Sandy loam surface texture is in soil texture Curve 1, following Curve 1 we determine that the field width should not exceed 10 rods when the field surface is bare during winter and early spring.

Answer

10 rod field is permissible.

2. Situation

Same as No. 1

Problem
Develop two suitable alternatives for the field.

Procedure

Referring to Chart No. 1, we find that leaving approximately 2200 lbs. of corn residues on the surface during winter and early spring provides adequate protection on an unlimited field width.

Answer - Alternative #1

One alternative would be to grow corn continuously and to plow in the spring just prior to corn planting leaving all residues on the soil surface over winter.

Answer - Alternative #2

A second suitable alternative will be to plant windbreaks at a 480 feet spacing. This assumes the trees will reach a 32 feet height at approximately 20 years. 32 height x 10 = 320 ft. (20 rods) of field width protected by the trees plus 10 rods (see situation No. 1) = 30 rods permissible field width. This would require dividing the 160 rod field into 5 parts with field windbreaks for a practical field solution. Application of the first alternative would provide adequate protection from wind erosion while the trees are growing to the 32 feet height.

3. Situation

A level field, 320 rods wide, silty clay loam surface texture, is being cropped to corn and soybeans and fall plowed.

Problem

Is it adequately protected from wind erosion?

Procedure

Using Chart No. 1, we find silty clay loam in Curve 2. Under bare soil conditions, field width should not exceed 55 rods.

Answer

The field is not adequately protected.

4. Situation

A level field, silt loam, 320 rods wide.

Problem

Determine one practical wind erosion control system which provides for a maximum acreage of row crops.

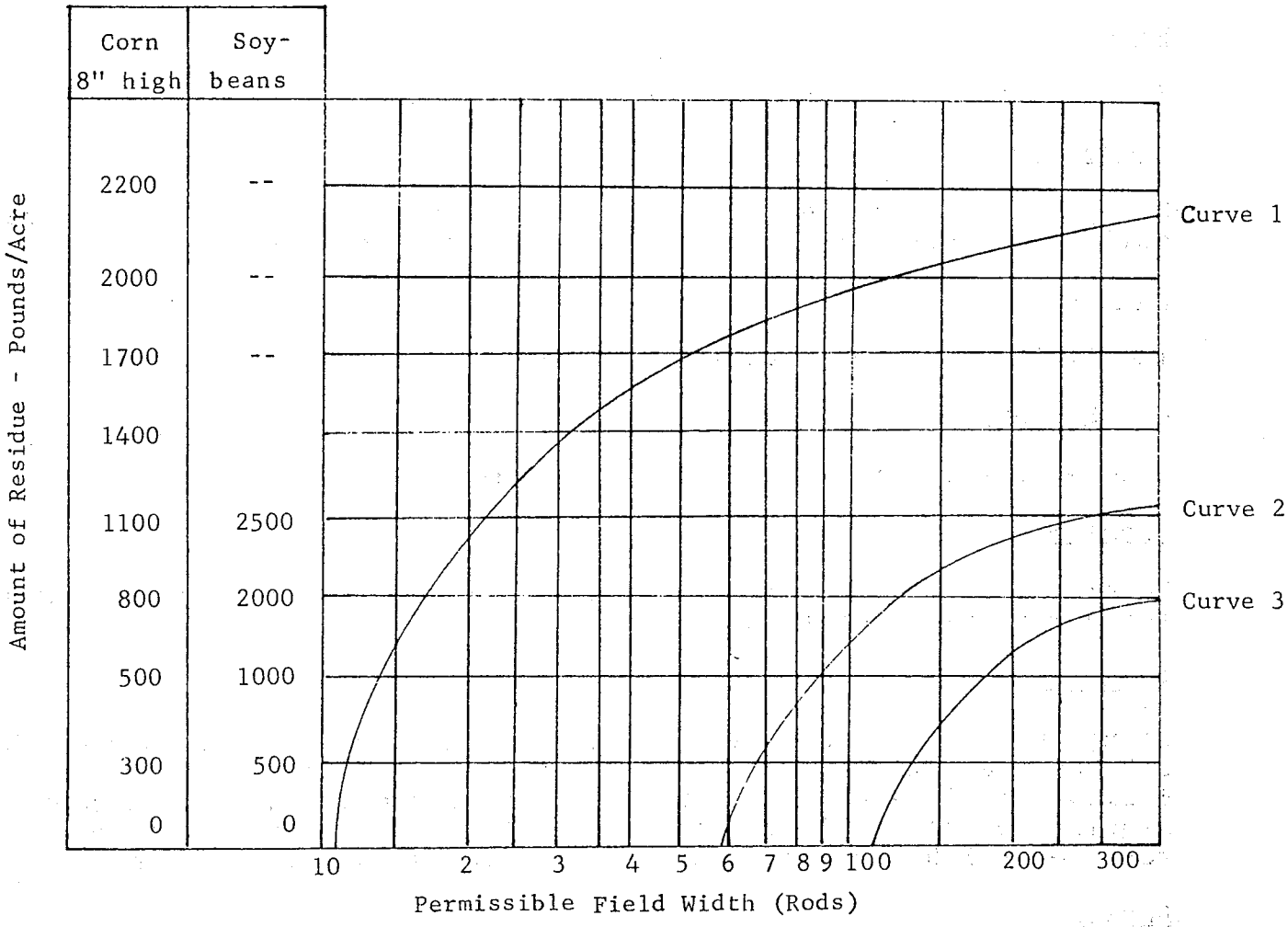
Procedure

Using Chart No. 1, silt loam is found to be in Curve 3. Locate the 320 rod field width and its point of intersection with Curve 3. Follow this line to the left to determine the amount of residues required on the soil surface over winter. 2000 lbs. of soybean residue or 800 lbs. of corn residue provide adequate protection.

Answer

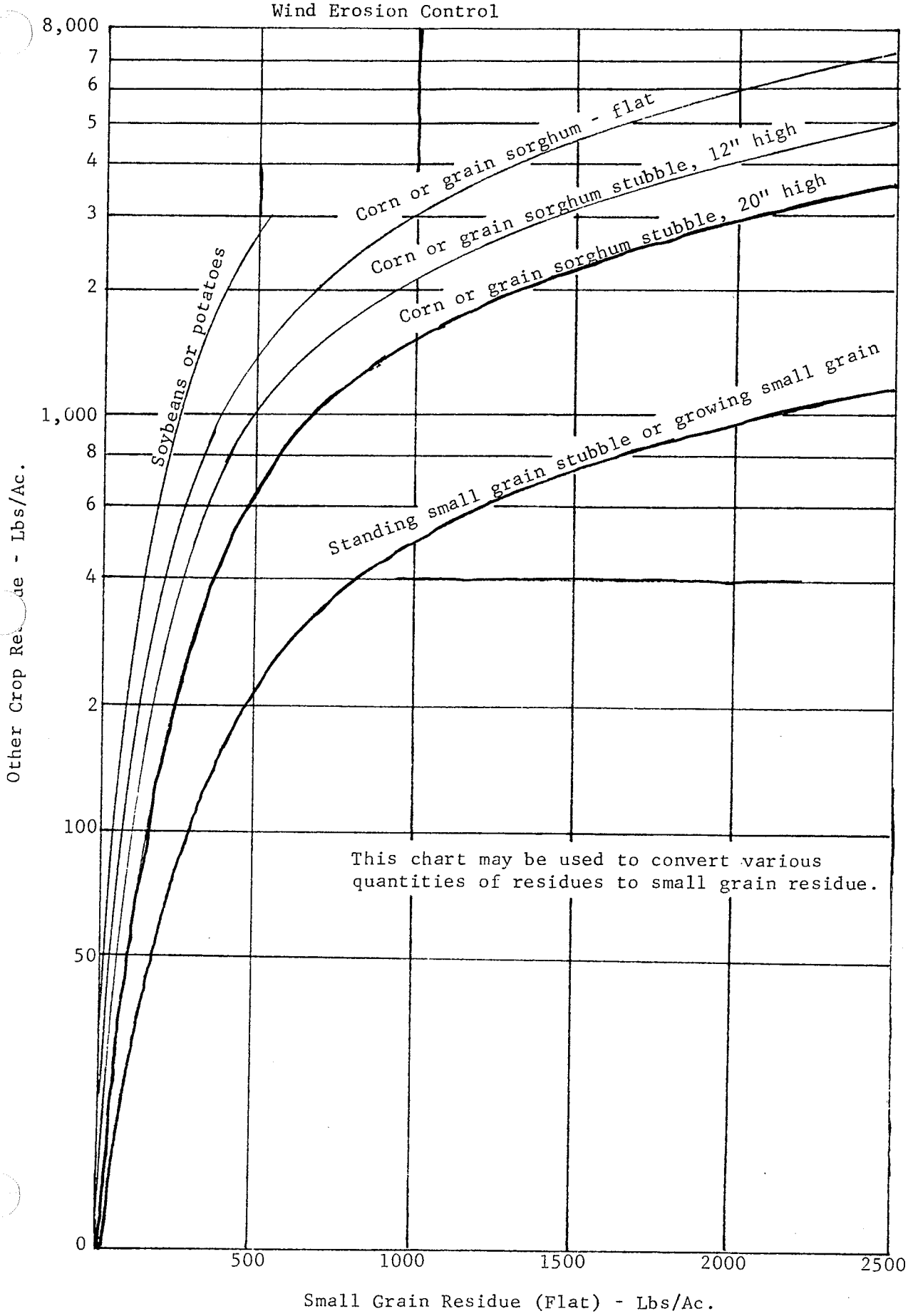
The entire field may be planted to corn or beans if all soybean residues remain on the soil surface over winter and if a tillage system leaving not less than 800 lbs. of corn residue on the surface over winter is followed.

Chart No. 1 CROP RESIDUE - FIELD WIDTH CHART



Curve 1	Curve 2	Curve 3
Sands, loamy sands	Silty clay loam	Loam, silt
Sandy loam	Silty clay, clay	Silt loam
Fine sandy loam	Clay loam	

Chart No. 2 - Comparison of Crop Residue - Wind Erosion Control



Introduction
Ephemeral Gully Erosion Prediction

Ephemeral gully erosion occurs on cropland where runoff water concentrates into a channel flow. Normally, the area where channel flows occur can be visually distinguished in the field whether or not an ephemeral gully is present. These channel flows are not protected by vegetation and are easily eroded with velocities of approximately two feet per second or higher. Ephemeral gullies are filled with adjacent soil using normal tillage tools such as moldboard plow, chisel plow, and disk. Voiding and refilling of an ephemeral gully may occur more than one time annually.

The following ephemeral gully erosion prediction equation can be used to:

1. Predict where an ephemeral gully will occur.
2. Predict the length of an ephemeral gully.
3. Predict the average annual soil loss from an ephemeral gully.
4. Predict offsite sediment delivery rates by using a sediment delivery ratio with the ephemeral gully erosion prediction equation.
5. Determine, during conservation planning, what, and where conservation practices are needed to control ephemeral gully erosion.

The universal soil loss equation (USLE) is used to predict only sheet and rill erosion and this is in tons per acre per year. The ephemeral gully erosion prediction equation is used to predict only ephemeral gully erosion and this is in tons per year.

The two equations can be used together to predict the annual total tons of soil erosion on a field but cannot be used together to predict the annual tons per acre of erosion on a field.

Background

Ephemeral gullies begin when concentrated flows become large and fast enough to produce a scour velocity greater than the erosion resistant velocity of the soil. The factors that produce the scour velocity are amount and intensity of rainfall, runoff curve number, drainage area size and shape,

channel slope, channel cross section shape, and channel roughness. The erosion resistant velocity is determined by the soil type, hydrologic soil group, and K value of the soil.

Light textured soils are usually considered to have little resistance to erosion while heavy textured soils are more resistant when both types of soil are saturated. Three soil erosion resistance groups (SERG) were developed assuming SERG I being resistant to erosion with a maximum velocity of 2.5 fps, SERG II being moderately resistant with maximum velocity of 2.0 fps, and SERG III having little resistance to erosion with maximum velocity of 1.5 fps.

Index numbers were developed for each of the hydrologic soil groups, A, B, C, D using runoff data from various antecedent moisture conditions. These index numbers for each hydrologic soil group were multiplied by the various K values to get an index of a given soil's resistance to erosion under saturated conditions. These indices were then grouped into three SERG's as shown in Table 1. The SERG for any soil series can quickly be determined from Table 1 by identifying the appropriate SERG based on the T value and hydrologic soil group of that soil.

The length tables for Q_2 - 24 hour rainfall and 2 inch - 24 hour rainfall (Tables 5 and 6) shows the distance downhill in a concentrated flow channel from the uppermost point of a drainage area that an ephemeral gully would begin to erode. Both tables are specific by SERG, hydrologic soil group, and channel slope. Table 5 is also specific for the amount of a Q_2 - 24 hour rainfall. A field office would use only the table 5 that is specific to the Q_2 - 24 hour rainfall for that county. Table 6 is used statewide as it represents the lengths for a 2 inch - 24 hour rainfall and is used to determine a second voiding within a year. The lengths in Tables 5 and 6 were developed by a model which computed the concentrated flow velocities from the various runoff parameters, and, when the scour velocity exceeded the erosion resistant velocity, also computed the distance from the uppermost point of a drainage area to the point that scour velocity exceeded erosion resistant velocity.

Tables 2, 3, and 4 contain factors for various eroded lengths of ephemeral gullies, channel slopes, and type of fall tillage, respectively. These factors, when multiplied by the appropriate constants, give the average tons per lineal foot of voiding.

<u>Use of Equation</u>

1. Measure length of drainage area (L) from uppermost part of drainage area to the bottom end of channel flow. The uppermost part is the drainage divide

from where runoff water would flow to the concentrated area being inventoried. The bottom end of the channel flow would be the location that the channel decreases grade and deposition would occur, the channel enters another concentrated flow channel such as a grassed waterway, road ditch, or another ephemeral gully, or a stabilized area. Normally, this distance can be measured from an aerial photograph. (See note 1)

2. Determine the dominant soil series for the drainage area.

3. Measure the percentage slope of the channel. When the channel slope varies, use the dominant slope. (See note 2)

4. Determine type of fall tillage. Untilled or no fall tillage would be residues left undisturbed or a light disking of corn stalks. Chisel plowed would be chiseled corn stalks or a heavy disking that would leave at least 50% of the residue on the surface. Moldboard plowed would be fall tillage using a moldboard plow or offset disk leaving less than 50% of the residue on the surface. In a rotation, use the type of fall tillage on the corn residue.

5. Determine K value and hydrologic soil group (soil Sec II of Tech Guide) of soil series identified in step 2 and identify the soil erosion resistant group (SERG) from table 1.

6. Determine L_1 from Table 5 (see Chapter 2 of Engineering Field Manual) for the appropriate SERG, hydrologic soil group, and channel slope. L_1 is the distance from the uppermost point of the drainage area to the point ephemeral erosion would begin in the concentrated flow channel. If L_1 is greater than L (from step 1), ephemeral erosion will not occur so do not proceed any farther.

7. If L is greater than L_1, determine the difference and select appropriate L_{1f} from table 2. $L-L_1$ is the length of the ephemeral gully that will erode. Select appropriate S_f and T_f factors from tables 3 and 4 respectively.

8. Determine L_2 from table 6. L_2 is the distance from the uppermost point of the drainage area to the point an ephemeral gully would begin revoiding after spring tillage has filled the initial voiding. If L_2 is greater than L, there would be

9. Compute the soil loss using the equation with the appropriate factors inserted. The soil loss will be the annual average tons of erosion for the specific ephemeral gully being inventoried.

10. Several factors are assumed for this equation and it is recognized they are variable in the field.

    a. L_1 is based on a Q_2-24 hour storm and L_2 is based on a 2" = 24 hour storm.

    b. Drainage area shape is assumed to be of average shape.

    c. Runoff curve numbers for hydrologic soil groups A, B, C, D, are 65, 75, 80, 85, respectively.

    d. Annual average soil loss assumes one voiding from the time of fall harvest until just before the first spring tillage and one revoiding occurring 50 percent of the time from the time of the first spring tillage operation until fall harvest.

Note 1: Channel flows that branch from a main channel flow would be computed separately.

Note 2: If a channel has two very significantly different slopes of significant lengths for each, the equation can be computed twice with the sum of soil loss for each computation being the total for the ephemeral gully. The bottom end of the channel flow for each use of the equation would be the bottom end of the slope percentage being used.

Ephemeral Gully Erosion Prediction Equation

$$(L-L_1)(.069 \times L_{1f} \times S_f \times T_f) + (L-L_2)(.069 \times L_{2f} \times S_f \times T_f \times .5) = \text{Average tons per year}$$

L = Length of drainage area from uppermost point of drainage area to bottom end of concentrated flow.

L_1 = Length from Q2 - 24 hour rainfall table (If L_1 exceeds L then L_1 = L) (Table 5)

L_2 = Length from 2 in 24 hour rainfall table (If L_2 exceeds L, then L_2 = L) (Table 6)

L_{1f} = Length factor (Table 2)

L_{2f} = Length factor (Table 2)

S_f = Slope of channel factor (Table 3)

T_f = Fall tillage factor (Table 4)

.069 = Constant

.5 = Constant

Table 1
SOIL EROSION RESISTANT GROUPS (SERG)

K FACTOR	HYDROLOGIC SOIL GROUP			
	A	B	C	D
0.15	III	I	I	I
0.17	III	I	I	I
0.20	III	II	I	I
0.24	III	II	I	I
0.28	III	II	II	I
0.32	III	II	II	II
0.37	III	III	II	II
0.43	III	III	II	II

Table 2
LENGTH FACTOR

(FEET) LENGTH	L_{1f}&L_{2f} FACTOR
0-99	0.72
100-199	0.74
200-299	0.78
300-399	0.84
400-499	0.93
500-599	1.08
600-699	1.18
700-799	1.22
800-899	1.26
900-1000	1.28
>1000	1.30

Table 3
CHANNEL SLOPE FACTOR

% SLOPE	S_f FACTOR
1	1.15
2	1.12
3	1.09
4	1.05
5	1.02
6	0.98
7	0.95
8	0.92
9	0.88
10	0.85

Table 4
FALL TILLAGE FACTOR

FALL TILLAGE	T_f FACTOR
No Fall Tillage	0.62
Fall Chisel Plow	1.04
Fall Mold-board Plow	1.35

Table 5

Length Table for Q_2 - 24 hour rainfall of 2.6

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	24115	3289	1799	1230	13432	2164	1230	824	5200	1089	704	490
2	7114	1479	860	614	3524	860	565	403	1988	565	389	298
3	3104	785	512	389	1896	565	375	297	896	314	241	198
4	1698	512	361	280	1058	361	261	220	512	220	172	143
5	1230	389	280	220	660	280	220	172	375	197	143	143
6	746	280	220	172	416	197	172	143	220	143	108	108
7	546	226	181	157	306	170	140	125	181	125	108	108
8	346	172	143	143	197	143	108	108	143	108	108	108
9	259	140	125	125	170	125	108	108	125	83	83	83
10	172	108	108	108	143	108	108	108	108	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	966	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 2.7 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	21298	3040	1698	1088	11860	2078	1230	785	4590	1028	660	466
2	6342	1359	823	614	3167	824	565	389	1779	565	361	280
3	2274	745	490	375	1698	512	361	280	785	298	241	197
4	1592	478	346	280	930	346	261	220	466	220	172	142
5	996	361	261	220	614	261	197	172	330	172	142	142
6	660	280	220	172	375	197	142	142	197	142	108	108
7	487	226	181	157	273	152	125	125	170	125	108	108
8	314	172	142	142	172	108	108	108	142	108	108	108
9	243	140	125	125	140	108	108	108	100	83	83	83
10	172	108	108	108	108	108	108	108	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 2.8 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	18971	2910	1698	1058	10578	1896	1230	785	4111	964	660	454
2	5679	1359	785	565	2842	746	500	375	1592	490	346	280
3	2484	704	478	361	1591	490	346	280	704	280	220	197
4	1359	454	330	261	860	330	241	197	416	197	172	172
5	896	346	261	220	565	241	197	172	297	172	142	142
6	614	261	197	172	346	172	142	142	172	108	108	108
7	447	216	170	140	259	140	125	125	140	108	108	108
8	280	172	142	108	172	108	108	108	108	108	108	108
9	211	140	125	108	140	108	108	108	83	83	83	83
10	142	108	108	108	108	108	108	108	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 2.9 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	17020	2704	1591	1028	9489	1799	1088	746	3692	930	614	442
2	5516	1230	746	565	2559	704	478	361	1479	466	330	261
3	2248	660	454	346	1359	466	330	261	660	280	220	172
4	1230	429	314	261	785	314	241	197	375	197	172	142
5	823	330	241	197	490	241	197	172	280	172	142	108
6	565	241	197	172	314	172	142	142	172	108	108	108
7	413	191	170	140	228	140	125	125	140	108	108	108
8	261	142	142	108	142	108	108	108	108	108	108	108
9	201	125	125	108	125	108	108	83	83	83	83	83
10	142	108	108	108	108	108	108	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 3.0 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	15368	2559	1479	996	8565	1698	1027	745	3349	860	565	429
2	4636	1230	745	565	2329	704	466	361	1359	442	330	261
3	2078	660	442	346	1230	442	314	261	614	261	197	172
4	1230	416	314	241	704	297	220	197	346	197	143	143
5	745	314	241	197	442	220	172	172	261	143	143	108
6	478	241	197	172	280	172	143	143	143	108	108	108
7	360	192	170	140	211	140	125	125	125	108	108	83
8	241	143	143	108	143	108	108	108	108	108	108	59
9	191	125	125	108	125	108	83	83	83	83	83	59
10	142	108	108	108	108	108	59	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 3.1 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	13948	2484	1479	963	7763	1698	996	704	3041	823	565	416
2	4210	1058	704	501	2078	660	442	346	1230	429	314	261
3	1896	614	416	330	1230	416	314	261	565	241	197	172
4	1027	389	297	241	660	280	220	197	314	172	143	143
5	704	297	241	197	403	220	172	143	241	143	143	108
6	442	220	172	172	261	172	143	108	143	108	108	108
7	331	181	157	140	202	140	125	108	125	108	83	83
8	220	143	143	108	143	108	108	108	108	108	59	59
9	164	125	125	108	125	108	83	83	83	83	59	59
10	108	108	108	108	108	108	59	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	966	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 3.2 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	12740	2329	1479	930	7114	1592	963	704	2274	785	565	403
2	3853	1027	660	490	1988	614	429	330	1058	403	297	241
3	1799	614	403	314	1027	403	297	241	478	241	197	172
4	963	375	280	241	614	280	220	172	297	172	143	143
5	614	280	220	197	375	197	172	143	220	143	143	108
6	403	220	172	143	241	143	241	143	143	108	108	108
7	300	181	140	125	175	125	125	108	125	108	83	83
8	197	143	108	108	108	108	108	108	108	108	59	59
9	152	125	108	108	108	83	83	83	83	83	59	59
10	108	108	108	108	108	59	59	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	966	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 3.3 inches

% Channel Slope	SERG I Hydrologic Soil Group A	B	C	D	SERG II Hydrologic Soil Group A	B	C	D	SERG III Hydrologic Soil Group A	B	C	D
1	11668	2247	1359	896	6516	1479	930	660	2559	745	512	389
2	3580	963	660	478	1799	614	416	330	996	389	297	241
3	1592	565	389	314	963	389	297	241	442	220	197	172
4	860	361	280	220	565	261	220	172	280	172	143	143
5	614	280	220	197	346	197	172	143	197	143	108	108
6	375	220	172	143	220	143	143	108	143	108	108	108
7	286	181	140	125	164	125	125	108	125	83	83	83
8	197	143	108	108	108	108	108	108	108	59	59	59
9	152	125	108	108	108	83	83	83	83	59	59	59
10	108	108	108	108	108	59	59	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 3.4 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	10762	2164	1359	896	5981	1479	895	660	2328	704	490	375
2	3290	930	660	466	1698	565	403	314	930	375	280	241
3	1479	565	375	297	896	361	280	241	416	220	172	172
4	823	346	261	220	500	241	197	172	261	172	143	143
5	565	261	220	172	330	197	172	143	197	143	108	108
6	361	197	172	143	220	143	143	108	108	108	108	108
7	266	170	140	125	164	125	125	108	108	83	83	83
8	172	143	108	108	108	108	108	108	108	59	59	59
9	140	125	108	108	83	83	83	83	83	59	59	59
10	108	108	108	108	59	59	59	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 3.5 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	9936	2078	1230	860	5562	1359	860	614	2164	704	472	361
2	3040	896	614	454	1591	365	389	314	860	361	280	220
3	1359	501	375	297	823	346	280	220	389	220	172	143
4	745	330	261	220	446	241	197	172	241	143	143	108
5	501	261	197	172	297	72	143	143	172	143	108	108
6	330	197	172	143	197	143	108	108	108	108	108	108
7	251	170	140	125	152	125	108	108	83	83	83	83
8	172	143	108	108	108	108	108	108	59	59	59	59
9	140	125	108	108	83	83	83	83	83	83	83	83
10	108	108	108	108	59	59	59	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59

Table 5

Length Table for Q_2 - 24 hour rainfall of 3.6 inches

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	9233	1988	1230	823	5158	1359	823	614	1988	660	454	361
2	2842	860	614	442	1479	512	375	297	785	346	261	220
3	1359	489	361	297	785	346	261	220	361	197	172	143
4	704	314	261	220	429	241	197	172	220	143	143	108
5	466	241	197	172	280	172	143	143	172	108	108	108
6	314	197	172	143	197	143	108	108	108	108	108	108
7	243	152	140	125	152	125	108	108	83	83	83	83
8	172	108	108	108	108	108	108	108	59	59	59	59
9	140	108	108	108	83	83	83	83	59	59	59	59
10	108	108	108	108	59	59	59	59	59	59	59	59

Table 6

Length Table for 2 inch-24 hour rainfall

% Channel Slope	SERG I Hydrologic Soil A	B	C	D	SERG II Hydrologic Soil A	B	C	D	SERG III Hydrologic Soil A	B	C	D
1	2328	2328	2328	1592	2328	2328	1799	1088	2328	1799	996	660
2	2328	2248	1230	785	2328	1359	785	565	2328	896	565	389
3	2328	1230	745	500	2328	860	565	375	2248	500	330	261
4	2328	823	500	360	2328	565	375	280	1359	346	241	197
5	2328	614	389	280	1698	416	280	220	930	280	197	172
6	1799	441	297	241	1027	297	220	172	512	197	142	142
7	1311	351	247	206	740	234	181	140	413	170	125	125
8	823	261	197	172	454	172	142	108	314	142	108	108
9	620	216	170	140	367	157	125	108	243	125	108	84
10	416	172	142	108	280	142	108	108	172	108	108	59