TECHNICAL NOTES

U. S. DEPARTMENT OF AGRICULTURE NEVADA SOIL CONSERVATION SERVICE

TN - AGRONOMY NV-58 June 8, 1989

MEASURING AND ESTIMATING CONCENTRATED FLOW AND
EPHEMERAL GULLY EROSION ON CROPLAND

Attached is Idaho Agronomy Tech Note No. 31. File for future reference.

Jim W. Doughty

Jim W. Doughty
State Resource Conservationist

Attachment

TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE BOISE, IDAHO SOIL CONSERVATION SERVICE

Agronomy Tech Note No. 31 April 24, 1989

Prepared by Floyd G. Bailey, State Conservation Agronomist,
SCS, Boise, Idaho

Measuring and Estimating Concentrated Flow and Ephemeral Gully Erosion on Cropland

When runoff water from several individual rills within a small watershed, begins to converge into concentrated flows, soil erosion occurs that is not estimated by the Universal Soil Loss Equation (USLE). This erosion is referred to as concentrated flow erosion when it covers broad surface areas without eroding deep gullies and ephemeral gully erosion when gullies are eroded. Concentrated flow and ephemeral gullies are obliterated each year by subsequent tillage operations and do not show up in the following cropping seasons.

Measuring Concentrated Flow and Ephemeral Gully Erosion

Concentrated flow and ephemeral gully erosion can be measured in the watershed or field when the average width, depth and length of the gully are known. The amount of soil eroded away can be estimated by using the formula:

$$CFEG = \frac{W \times D \times L \times SW}{2000 \text{ lbs/ton}}$$

Where:

- CFEG = Concentrated Flow and Ephemeral Gully Erosion in tons
- W = Average width in feet
- D = Average depth in feet
- L = Length in feet
- SW = Soil weight in pounds per cubic foot. Soil weight can be calculated from the bulk density for an individual soil map unit. Bulk density is found on the SOILS-5, soil survey reports and CAMPS Soil Data Base. Bulk density is in grams per cubic centimeter. The formula for converting grams/cc to lbs/cu.ft. = 62.44 x grams/cc = lbs/cu.ft. Bulk density does not include rock fragments. When significant amounts of rock are present, the soil weight must be adjusted. Rocks usually weigh about 2 times as much as soil.
- 2000 = Pounds per ton.

EXAMPLE:

A 40 acre field has two ephemeral gullies (A and B) and one concentrated flow (C) with the following dimensions:

A - 6 inches wide, 6 inches deep and 1320 feet long
B - 8 inches wide, 5 inches deep and 660 feet long
C - 36 inches wide, 3 inches deep, and 451 feet long.
The soil weight is 90 pounds per cubic foot.

Question: How many tons of soil have eroded in the ephemeral gullies and concentrated flow?

Solution:

Gully A = .5 ft. x .5 ft. x 1320 ft. = 330 cu. ft.
Gully B = .66 ft. x .41 ft. x 660 ft. = 179 cu. ft.
Gully C = 3 ft. x .25 ft. x 451 ft. = 338 cu. ft.
TOTAL 847 cu. ft.

847 cu. ft. x 90 lbs./cu. ft. = 76230 lbs. ÷ 2000 lbs./ton =38 tons.

Where the answer is needed for a field or watershed representing the average tons per acre, the formula can be modified to:

$$CFEG = \frac{\frac{W \times D \times L \times SW}{2000 \text{ lbs./ton}}}{A} \quad OR \quad \frac{W \times D \times L \times SW}{2000 \text{ lbs./ton} \times A}$$

Where:
A = acres in the field or watershed.

EXAMPLE:

Using the same previous sample, what is the average soil loss in tons/ac. for the 40 acre field?

Since we already have determined 38 tons of soil has eroded, all we have to do is divide that amount by the acres in the field $\frac{38}{40}$ = .95 tons/acre.

Estimating Long-Term Average Annual Concentrated Flow and Ephemeral Gully Erosion

Estimates of the amount of soil loss occurring over time from concentrated flow and ephemeral gully erosion can be made by developing a volumetric measure of the amount of area that has been voided by the gullies and allocating the amount back out to the area of the field or watershed and the time interval involved.

When estimating the amount of long-term concentrated flow and ephemeral gully erosion, the soil conservationist has to look at the whole field or watershed, and observe the runoff patterns developed over time. These runoff patterns show up on the landscape as shallow, round-edged gullies or depressions where water flows when runoff occurs. Annual tillage has worked soil back into the gully smoothing the eroded area into more of a rounded depression on the landscape. As tillage has worked soil into the voided area, it has widened the gully. The resulting cross-sectioned shape is usually trapezoidal. Aerial photographs can be helpful in locating these trapezoidal depressions caused by long-term concentrated flow and ephemeral gully erosion.

The depressions voided by concentrated flow and ephemeral gully erosion can be measured to gain an estimate of the volume of soil that has eroded

away. The measurements are made on a cross section for average width and average depth of the depression. The length can be measured from beginning at the upper end of the field or slope where the depression begins and measuring downslope to the end of the depression. The object of the measurement is to get a representation of the volume of soil that has been eroded, forming the depression over time. The time period for the depression to form must be known or estimated. This is usually the length of time the area has been cultivated.

The formula for estimating long-term average annual concentrated flow and ephemeral gully erosion for a trapezoidal depression is:

$$CFEG = \frac{TW + BW \times .5 \times D \times L \times SW}{2000 \text{ lbs/ton} \times \text{acres} \times \text{years}}$$

Where: TW = depression top width in feet
BW = depression bottom width in feet.

EXAMPLE:

A 40 acre field has a water flow depression where concentrated flow and ephemeral gully erosion occurs. The depression is 16 feet wide across the top and 4 feet wide across the bottom. The depression is 1.5 feet deep at the center. The length of the depression is 1285 feet from where it starts to where it leaves the field. The soil weighs 90 pounds/cu. ft. This field has been farmed the same for the past 60 years.

Question: What is the estimated long-term average annual concentrated flow and ephemeral gully erosion from the field?

Solution:

$$\frac{16 \text{ ft} + 4 \text{ ft} \times .5 \times 1.5 \text{ ft} \times 1285 \text{ ft} \times 90 \text{ lbs/cu.ft}}{2000 \text{ lbs/ton} \times 40 \text{ acres} \times 60 \text{ years}} = \frac{1{,}734{,}750 \text{ lbs.}}{4{,}800{,}000 \text{ T/ac/yr.}} =$$

.36 T/ac./yr.

When a field has more than one watershed with a representative concentrated flow or ephemeral gully depression, the amount of erosion for each can be calculated then added together to gain the total long-term average annual erosion from concentrated flow and ephemeral gully erosion for the field.

In project activities where broad-based planning estimates are used, the soil conservationist can make an estimate of concentrated flow and ephemeral gully erosion occurring by developing an estimate of the long-term average concentrated flow erosion per acre per year on representative sample fields within a treatment unit or watershed and expand the data to the total acreage within the treatment unit or watershed. This will provide representative erosion rates with sufficient accuracy for broad area resource planning.