Ephemeral and Classic Gully Erosion Worksheet

Forms of erosion by water include sheet and rill, ephemeral gully, classic gully and stream bank. Each type is associated with the progressive concentration of runoff water as it moves downstream. Erosion caused by concentrated flow begins where overland flow converges to channelized flow conditions. Erosion caused by channelized flow conditions may contribute significantly to the overall erosion on the planning unit. Detailed criteria for distinguishing rills, ephemeral gullies, and gullies are given below. Differentiating these forms of erosion requires careful judgment. This is especially true where an ephemeral gully results from runoff that follows tillage marks rather than natural depressions.

A. Definitions

Rills: Rill erosion is minimized using the Revised Universal Soil Loss Equation (RUSLE2) by adjusting crop and tillage systems. Rills may be any size, but are usually less than four inches deep. Rills have one or more of the following characteristics:

- parallel on a slope, but may converge
- uniform spacing and dimension
- appear at different locations on the landscape from year to year
- shorter than ephemeral cropland gullies
- end at a concentrated flow channel, terrace, or where a slope flattens and deposition occurs
- are on the same portion of the slope that is used to determine the length of slope for factor (L) for the RUSLE2

Ephemeral Gullies: Ephemeral gullies may be any size, but are usually larger than rills, with one or more of the following characteristics:

- recur in the same area each time they form rather than random places on the slope
- frequently form in well-defined depressions of natural drainage ways
- tend to occur in the upper reaches of a drainage network
- usually branch, but may have patterns caused by row alignment or other characteristics of field operations
- generally wider, deeper, and longer that the rills on the field
- occur in depressions into which rows or tillage marks lead
- form along sloping rows or tillage marks
- partially or totally erased and filled by tillage operations
- occur on terraced fields where overtopping of terraces occurs or piping below the terrace embankment occurs
- occur in the channel bottom of gradient and parallel tile outlet (PTO) terraces

Gullies: Permanent gullies are channels too deep for normal tillage operations to erase. Special operations are required to fill them. Gullies also have one or more of the following characteristics:

- may grow or enlarge from year to year by head cutting and lateral enlarging
- occur in depressions or natural drainage ways
- may begin as ephemeral gully that was left in the field and not erased by tillage or other operations
- may become partially stabilized by grass, weeds, or woody vegetation

The soil loss from ephemeral gullies, classic gullies, and other similar types of erosion can be determined by calculating the volume of soil removed from the eroded area. The tons of soil loss can then be determined by multiplying the volume removed by the unit weight of soil. If the time period of the erosion exceeds one year, the quantity should be divided by the number of years the gully has existed to get an average annual rate.

B. Gully Erosion Equations

To calculate the erosion occurring from ephemeral gullies or gullies, the following table and formulas will be used:

New Gully or Channel

$$\frac{(A + B) \times D \times L \times W}{2 \times 2000 \times Y} = T$$

Gully Bank Sloughing

$$\frac{2 \times D \times L \times R \times W}{2000} = T$$

Advancing Gully Head

$$\frac{(A + B) \times D \times W \times H}{2 \times 2000 \times Y} = T$$

Ephemeral Gully

$$\frac{(A + B) \times D \times L \times W \times N}{2 \times 2000} = T$$

A = top width (ft.)
B = bottom width (ft.)
D = depth (ft.)
L = length (ft.)
W = weight (lbs. / cu. ft.)
H = headward advancement (ft.)
R = average annual rate of sloughing / recession (ft. / yr.)
N = number of occurrences or events per year
T = tons per year
Y = number of years

Examples:

New Gully or Channel – Eroded silt loam soil; 10 ft. top, 2 ft. bottom, 1 ft. deep and 600 ft. long. Formed in 2 years.

$$\frac{(A + B) \times D \times L \times W}{2 \times 2000 \times Y} = T \qquad \frac{(10 + 2) \times 1 \times 600 \times 95}{2 \times 2000 \times 2} = 85.7 \text{ tons/year}$$

Advancing Gully Head – Silt loam soil; 6 ft. deep, 30 ft. top, 6 ft. bottom, advancing 5 ft. / yr.

$$\frac{(A + B) \times D \times W \times H}{2 \times 2000 \times Y} = T \qquad \frac{(30 + 6) \times 6 \times 5 \times 95}{2 \times 2000 \times 1} = 25.8 \text{ tons/year}$$

Gully Bank Sloughing – Clay loam soil; 2 sides sloughing, 60 ft. long, 4 ft. high, sloughing 1.0 ft. / yr.

$$\frac{2 \times D \times L \times R \times W}{2000} = T \qquad \frac{2 \times 4 \times 60 \times 1.0 \times 95}{2000} = 22.8 \text{ tons/year}$$

Ephemeral Gully – Clay loam soil; 3 occurrences (snow melt, tillage, 3" rain, tillage and 6" rain); 4 ft. top, 2 ft. bottom, 0.5 ft. deep and 1,200 ft. long.

$$\frac{(A + B) \times D \times L \times W \times N}{2 \times 2000} = T \qquad \frac{(4 + 2) \times 0.5 \times 1{,}200 \times 95 \times 3}{2 \times 2000} = 257.0 \text{ tons/year}$$

The following table provides a guide for approximate unit weight of various soils that can be used in the absence of better data.

APPROXIMATE SOIL WEIGHT

Soil Textural Class	Estimated Moist Bulk Density Lb. /cu. ft.
Gravel	110
Sand	105
Loamy Sand	100
Sandy Clay Loam	100
Sandy Loam	100
Clay Loam	95
Loam	95
Silt	95
Silt Loam	95
Silty Clay Loam	95
Sandy Clay	85
Silty Clay	85
Clay	80
Organic	22

1 Data and estimates from published soil surveys, laboratory data, and soil interpretation records are to be used where available. Parent materials, soil consistency, soil structure, pore space, soil texture, and coarse fragments all have an influence on unit weight. (Example – Bulk density on the soil interpretation sheet listed in g/cm^3 multiplied by 62.4 = lb. / $ft.^3$)

2 Ephemeral gully erosion may reform several times per year and sometimes does not form during a year. The voided volume which would be calculated after a runoff event would not necessarily be representative of the annual rate but would represent only the specific event. This erosion can be calculated for individual storms and can be summed for a yearly estimate.

This method estimates past erosion and cannot predict future erosion. Tillage in an area affected by ephemeral gullying removes thin layers of topsoil from ungullied areas to fill the gully. The effect on the soil is similar to that from sheet erosion. The total soil loss would include the loss predicted for sheet and rill, wind and the loss from the ephemeral gully area. Annual loss to the ephemeral gullying would be determined from the estimated amount voided each year from the ephemeral, divided by the area judged to be affected by the ephemeral gully. Total field erosion is not distributed equally on every acre. When determining management systems for soil erosion reduction all forms of erosion must be accounted for and treated by the most feasible and effective means.