

## Revised Universal Soil Loss Equation Version 2 (RUSLE2) Factor Updates

U.S. Environmental Protection Agency's (EPA) Pollutant Load Estimation Tool (PLET) provides county-level defaults for the universal soil loss equation (USLE) factor values. In PLET, USLE and revised USLE (RUSLE) factors are used to compute annual long-term sediment loadings in tons/year. For more information on the history and usage of USLE, refer to [background information and supporting documentation](#) (USDA 2023a) provided by the U.S. Department of Agriculture (USDA) Agricultural Research Service. Since USLE was first published, the USDA Agriculture Research Service has provided updates to the technology and methodology for estimating and deriving USLE factor values. These updates include the RUSLE and a further-enhanced Windows version called RUSLE version 2 (RUSLE2). This documentation summarizes the January 2024 update of PLET USLE factors to reflect RUSLE2 methodology.

The factors included in the RUSLE2 are:

R – rainfall runoff erosivity factor

K – soil erodibility factor

L – slope length factor

S – slope steepness factor

C – cover and management factor

P – support practice factor

LS – topographic factor derived from L and S factors (see equation 1)

Before the January 2024 update, the USLE factors were transferred over from the Spreadsheet Tool for Estimating Pollutant Loads (STEPL). These values were derived from the 1992 Natural Resource Inventory (NRI), produced by the USDA Natural Resources Conservation Service. The [NRI](#) (USDA 2023b) is a statistical survey conducted annually to assess the status, condition, and trends in land, soil, and water resources of the United States, excluding Alaska. NRI estimates of sheet and rill erosion use standard USLE technology for estimates before 2008 and the revised USLE version 2 (RUSLE2) methodology for 2008–2017 ([USDA 2020](#)). At the time of the January 2024 update, the 2017 NRI dataset was the most recent NRI release for the RUSLE2 factor values. The 1992 dataset used in STEPL only included cropland USLE factor values, with pastureland and forestland values extrapolated from the cropland factor values. The 1992 NRI provided R, K, LS, C, and P factor values for cropland. The cropland R, K, and LS values were applied to pastureland and forestland. The C factor was set at 0.04 for pastureland and 0.003 for forestland, and the P factor was set at 1 for both pastureland and forestland.

### Derivation of Updated Factor Values

For the January 2024 RUSLE2 update, the 2015 cropland and 2017 cropland and pastureland R, K, L, S, C, and P were obtained from NRI. The LS factor was calculated based on the slope length (L) and percent slope (S). To provide the most up-to-date factor values in PLET, data from the 2017 NRI were used preferentially. If a jurisdiction did not have 2017 data, 2015 data were used, and if 2015 data were also unavailable, the original 1992 values were applied. In cases where the 1992 data were applied, the values still represent USLE and have not been updated to RUSLE. The supporting documentation of individual values by jurisdiction contains a column denoting which data years were applied to a particular jurisdiction for a given land use. This data is available upon request. In the future, PLET factor values for RUSLE2 will be updated on a routine basis as NRI datasets are released.

The factor values were derived and applied as follows:

***R – Rainfall Runoff Erosivity Factor***

- Cropland – reported R factor in 2017 NRI, or 2015 NRI R factor if 2017 data are unavailable, or 1992 R factor if both 2017 and 2015 data are unavailable.
- Pastureland – reported R factor in 2017 NRI, or 1992 R factor, which is derived from 1992 cropland R factor, if 2017 data are unavailable.
- Forestland – average value of the applied cropland and pastureland R factor.

***K – Soil Erodibility Factor***

- Cropland – reported K factor in 2017 NRI, or 2015 NRI K factor if 2017 data are unavailable, or 1992 K factor if both 2017 and 2015 data are unavailable.
- Pastureland – reported K factor in 2017 NRI, or 1992 K factor, which is derived from 1992 cropland K factor, if 2017 data are unavailable.
- Forestland – value of the applied pastureland K factor.
- In the 2017 and 2015 NRI datasets, both the USLE and RUSLE2 K factors were provided. The RUSLE2 values are used in the PLET update.

***LS – Slope Length and Steepness Factor***

- Cropland – derived from the percent slope (S) and slope length (L) factors in 2017 NRI or 2015, if applicable, using the formula ([Ag Handbook No. 537](#) – Wischmeier and Smith 1978):

$$LS = [0.065 + 0.0456 (\text{slope}) + 0.006541 (\text{slope})^2](\text{slope length} \div \text{constant})^{NN} \quad (\text{Equation 1})$$

Where: slope = slope steepness in %; slope length = length of slope in meters (feet);  
constant = 22.1 metric (72.5 Imperial); NN = exponent determined based on the percent slope (refer to Table 1)

**Table 1. NN Values**

S	<1	1 ≤ Slope <3	3 ≤ Slope <5	≥5
NN	0.2	0.3	0.4	0.5

If data for 2017 and 2015 data are unavailable, the LS factor from 1992 is applied.

- Pastureland – derived from the percent slope (S) and slope length (L) factors in 2017 NRI using the formula described above, or applying the LS factor from 1992, if 2017 data are unavailable.
- Forestland – the applicable pastureland LS factor.

***C – Cover and Management Factor***

- Cropland – reported C factor in 2017 NRI, or 2015 NRI C factor if 2017 data are unavailable, or 1992 C factor if both 2017 and 2015 data are unavailable. Reported C factors below 0.2 are set at 0.2 to reflect conventional tillage and avoid double counting conservation tillage if it is applied as a BMP in a PLET scenario. C factors above 0.2 are retained.

- Pastureland – reported C factor in 2017 NRI or 1992 C factors if 2017 data are unavailable. Reported C factors below 0.04 are set at 0.04 to reflect conventional management practices and avoid double counting when other BMPs are applied in a PLET scenario. Note that in STEPL and the original PLET, all pastureland C factors were set at 0.04.
- Forestland – consistent with STEPL and the original PLET, all forestland C factors are set at 0.003. The value of 0.003 agrees with published C factor values and ranges (provided in Appendix A).

#### **P – Support Practice Factor**

- Cropland – reported P factor in 2017 NRI, or 2015 NRI R factor if 2017 data are unavailable, or 1992 R factor if both 2017 and 2015 data are unavailable.
- Pastureland – reported P factor in 2017 NRI, or if 2017 data are unavailable, set to 1. Approximately 90% of jurisdictions in the 2017 NRI have a P factor of 1. Note that in STEPL and the original PLET, all pastureland P factors were set at 1.
- Forestland – all forestland P factors are set at 1. Note that in STEPL and the original PLET, all forestland P factors were set at 1.

While the NRI includes all states, except for Alaska<sup>1</sup> and Puerto Rico, no single year of NRI annual data contained a complete dataset of all counties within the United States. To build a complete default dataset for PLET that included all counties, the RUSLE2 update includes a mixture of the 1992, 2015, and 2017 NRI datasets. Despite attempts to include all counties, a small subset of jurisdictions lacks NRI data for the years 1992, 2015, and 2017. For example, missing jurisdictions for cropland values accounted for less than 1% of all jurisdictions, and missing jurisdictions for pastureland accounted for less than 3.5% of all jurisdictions. It appears that the subset of jurisdictions without NRI data likely contained no cropland or pastureland within their boundaries, e.g., New York, NY; Philadelphia, PA; and independent cities within Virginia.

#### References

USDA (U.S. Department of Agriculture). 2023a. *About the Universal Soil Loss Equation*. Agricultural Research Service. National Soil Erosion Research Laboratory, West Lafayette, IN. <https://www.ars.usda.gov/midwest-area/west-lafayette-in/national-soil-erosion-research/docs/usle-database/research/>. Accessed on December 3, 2023.

USDA (U.S. Department of Agriculture). 2023b. *National Resources Inventory*. <https://www.nrcs.usda.gov/nri>. Accessed on December 3, 2023.

USDA (U.S. Department of Agriculture). 2020. *Summary Report: 2017 National Resources Inventory*. Natural Resources Conservation Service, Washington, DC, and the Center for Survey Statistics and Methodology, Iowa State University, Ames, IA. [https://www.nrcs.usda.gov/sites/default/files/2022-10/2017NRI\\_Summary\\_Final.pdf](https://www.nrcs.usda.gov/sites/default/files/2022-10/2017NRI_Summary_Final.pdf).

Wischmeier, W.H. and D.D. Smith. 1978. *Predicting rainfall erosion losses – a guide to conservation planning*. Agriculture Handbook No. 537. U.S Department of Agriculture, Washington, DC.

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<sup>1</sup> Due to a lack of NRI data, factors values are not included for Alaska in the January 2024 update.

## Appendix A – C Factors for Forestland

Land use	C Factor Value	Source	Notes
Managed woodland 75%–100% tree canopy	0.001	Novotny 2003	Adapted from Steward et al. 1975; Wischmeier and Smith 1965; and Wischmeier 1972
Managed woodland 40%–75% tree canopy	0.002–0.004	Novotny 2003	Adapted from Steward et al. 1975; Wischmeier and Smith 1965; and Wischmeier 1972
Managed woodland 20%–40% tree canopy	0.003–0.01	Novotny 2003	Adapted from Steward et al. 1975; Wischmeier and Smith 1965; and Wischmeier 1972
Forest	0.005	Benavidez et al. 2018	From Dymond 2010, New Zealand
Scrub	0.005	Benavidez et al. 2018	From Dymond 2010, New Zealand
Forest	0.001–0.006	Benavidez et al. 2018	From David 1989, Philippines
Scrub	0.007–0.9	Benavidez et al. 2018	From David 1989, Philippines
Forest	0.001	Benavidez et al. 2018	From Morgan 2005, various locations
Scrub	0.01	Benavidez et al. 2018	From Morgan 2005, various locations
Forest	0.001	Benavidez et al. 2018	From Fernandez et al. 2003, USA
Scrub	0.003	Benavidez et al. 2018	From Fernandez et al. 2003, USA
Forest	0.001	Benavidez et al. 2018	From Dumas and Fossey, 2009, Vanuatu
Scrub	0.16	Benavidez et al. 2018	From Dumas and Fossey, 2009, Vanuatu
Forest	0.003–0.048	Benavidez et al. 2018	From Land Development Department (Thailand), 2002 in Nontananandh and Changnoi, 2012
Scrub	0.01–0.1	Benavidez et al. 2018	From Land Development Department (Thailand), 2002 in Nontananandh and Changnoi, 2012
Deciduous forest	0.003	MT DEQ 2009	
Evergreen forest	0.003	MT DEQ 2009	
Mixed forest	0.003	MT DEQ 2009	
Undisturbed forestland 75%–100% canopy, 90%–100% covered by duff	0.0001–0.001	Wischmeier and Smith 1978	
Undisturbed forestland 45%–70% canopy, 75%–85% covered by duff	0.002–0.004	Wischmeier and Smith 1978	
Undisturbed forestland 20%–40% canopy, 40%–70% covered by duff	0.003–0.009	Wischmeier and Smith 1978	
Trees over 13 feet (ft); no appreciable low brush; 25%–100% canopy; 95% ground cover with grass, decaying compacted duff, and leaf litter	0.003	Wischmeier and Smith 1978	Intended for pasture, range, and idle land, but under permanent woodland conditions, adjust by 0.7 (i.e., 0.002)
Trees over 13 ft, no appreciable low brush, 25%–100% canopy, 95% ground cover with herbaceous plants or undecayed residues	0.011	Wischmeier and Smith 1978	Intended for pasture, range, and idle land, but under permanent woodland conditions, adjust by 0.7 (i.e., 0.008)

Land use	C Factor Value	Source	Notes
Trees over 13 ft; no appreciable low brush; 50%–100% canopy; 80% ground cover with grass, decaying compacted duff, and leaf litter	0.012–0.013	Wischmeier and Smith 1978	Intended for pasture, range, and idle land, but under permanent woodland conditions, adjust by 0.7 (i.e., 0.008–0.009)
Trees over 13 ft, no appreciable low brush, 50%–100% canopy, 80% ground cover with herbaceous plants or undecayed residues	0.041–0.042	Wischmeier and Smith 1978	Intended for pasture, range, and idle land, but under permanent woodland conditions, adjust by 0.7 (i.e., 0.029)
Describes the underlying variables to develop site-specific C factor values, no overall estimates		Dissmeyer and Foster 1980	

Benavidez, R., B. Jackson, D. Maxwell, and K. Norton. 2018. A review of the (Revised) Universal Soil Loss Equation (R/USLE): with a view to increasing its global applicability and improving soil loss estimates. *Hydrol. Earth Syst. Sci. Discussions*. <https://doi.org/10.5194/hess-2018-68>.

Dissmeyer, G.E. and G.R. Foster. 1980. *A Guide for Predicting Sheet and Rill Erosion on Forest Land*. U.S. Department of Agriculture, Forest Service, Southern Region, Atlanta, GA.

MT DEQ (Montana Department of Environmental Quality). 2009. *Upper Jefferson River Tributary Sediment TMDLs & Framework Water Quality Improvement Plan – Appendix D*. Upland USLE Based Sediment Model, Sediment Contribution from Hillslope Erosion for Tributaries of the Upper Jefferson TMDL Planning Area. Montana Department of Environmental Quality, Helena, MT.

Novotny, V. 2003. *Water Quality: Diffuse Pollution and Watershed Management*, 2nd ed., John Wiley & Sons, Inc., Hoboken, NJ.

Wischmeier, W.H. and D.D. Smith. 1978. *Predicting rainfall erosion losses – a guide to conservation planning*. Agriculture Handbook No. 537. U.S. Department of Agriculture, Washington, DC.