Rainfall/Rainsplash Design – Detachment of Soil Particles on Impact

Rainfall Design

- USLE / RUSLE / RUSLE2
- Agricultural Handbook 703
- USDA Protocol for Estimating Erosion on Slopes Due to Rainfall
- Computed as Product of "Factors" that Influence Erosion - A = R*LS*K*C*P
- No Standard for Failure Criteria

Rainfall Design Considerations

- Slope is Geotechnically Stable
- Vegetation Sufficient as Long Term Cover
- Consideration of Time-Influence of Design
  - RUSLE Average Annualized
  - Geosynthetics Testing Short Term Evaluation
  - Geosynthetic Testing Short Term Life
- Excessively Steep or Long Slopes May Require Additional Consideration
  - Benching
  - Sediment Control Logs
  - Drainage
- Consider Agronomic Factors for Definition of Failure
- No Equilibrium State

RECP Slope/Rainfall Performance

Total Rainfall - All Else Being Equal,

Compared To

= More Erosion

RECP Slope/Rainfall Performance

Raindrop Speed (A Function of Fall Height) - All Else Being Equal,

Compared To

= More Erosion

RECP Slope/Rainfall Performance

Slope Steepness - All Else Being Equal,

Compared To

= More Erosion

RECP Slope/Rainfall Performance

Slope Length - All Else Being Equal,

= More Erosion

Compared To

RECP Slope/Rainfall Performance

Soil Type - All Else Being Equal,

= More Erosion

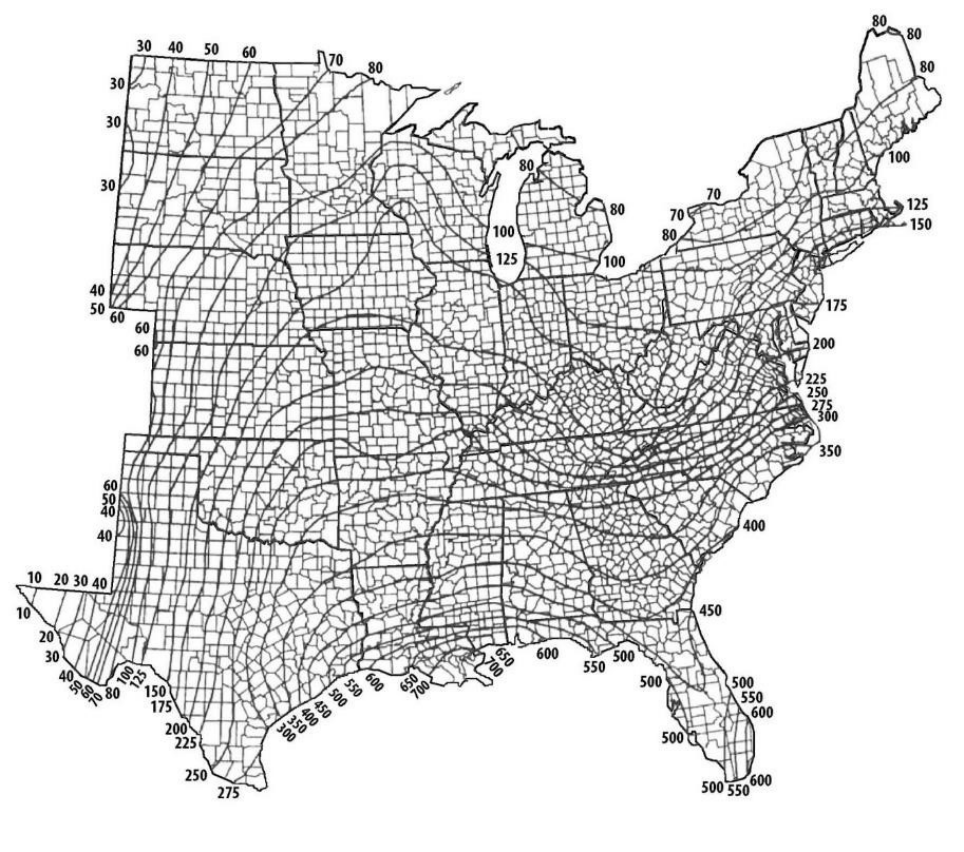
Compared To

Rainfall Design – RUSLE Factors

- R Factor – Rainfall Erosivity Factor
  - Varies by Location Around the Country
  - Computed from the “Storm Energy”, Frequency and Total of Storms in a Year, Summarized in AH 703
  - Typically Averaged Over Annual Period
  - Can Be Computed For Single, Specific Storm
  - Values Range from Approximately 10 to Approximately 800
  - Larger Values Indicate Greater Erosion

Rainfall Design – RUSLE Factors

- R Factor
- Variable Across Country
- Summary in Databases or Isoerodent Map

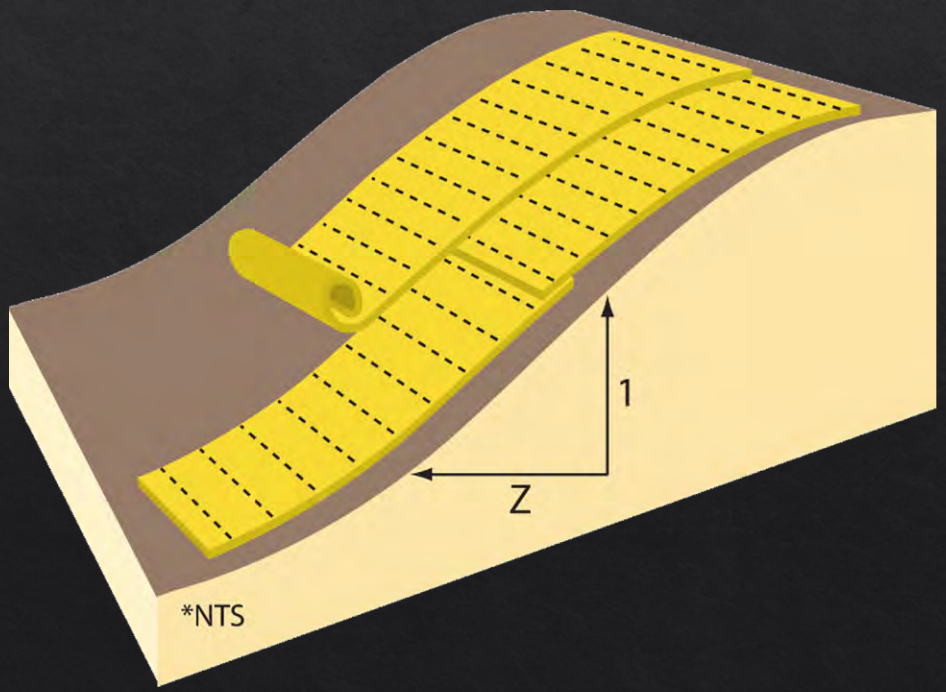


Rainfall Design – RUSLE Factors

- LS Factor – Slope Steepness Factor
  - LS Increases by Increases in Slope Length and Increases in Slope Steepness
  - LS Significantly More Sensitive to Steepness than to Length
  - LS Varies by Condition of Soil (Rill to Inter-Rill Erosion Ratio)
  - Varies From Approximately 0.50 to Approximately 15.0
  - Larger Values Indicate Greater Erosion

Rainfall Design – RUSLE Factors

- LS Factor
- Variable by Slope Length, Steepness and Condition
- Tabulated Values or Explicitly Computed



Rainfall Design – RUSLE Factors

- K Factor
  - Soil Erodibility Factor
  - Varies by Soil Type
  - Computed or Estimated
  - Values Range from Approximately 0.15 to 0.70
  - Greater Value Indicates Greater Erosion

Rainfall Design – RUSLE Factors

- K Factor
- Estimated from Table or
- Computed from Soil Properties:
  - Percentage Silt
  - Percentage Very Fine Sand
  - Percentage Clay
  - Percentage Organic Matter
  - Structural Class
  - Permeability Class

Typical K-Values			
Soil Type	K Low	K High	K Average
Stiff Clay; Colloidal	0.13	0.29	0.21
Fine Sand; Noncolloidal	0.15	0.35	0.25
Alluvial Silts; Colloidal	0.20	0.30	0.25
Ordinary firm loam	0.25	0.40	0.33
Sandy Loam; Noncolloidal	0.25	0.40	0.33
Silt Loam; Noncolloidal	0.30	0.50	0.40
Alluvial Silts; Noncolloidal	0.40	0.60	0.50

Rainfall Design – RUSLE Factors

- P Factor
  - Practice Factor
  - Accounts for Terracing and Other Means of Structured Slope Enhancement
  - Range from 0 to 1
  - Typically Neglected, Assigned Value of 1

Rainfall Design – RUSLE Factors

- C Factor – Cover Factor
  - Accounts for Reduction in Erosion Due to Vegetation, Cover or RECP
  - Range from 0 to 1
  - Highly Variable Based on Product/Cover Applied
  - Determined From Performance Testing for RECPs
  - Varies by LS, K and R
  - Principle Design Parameter for Rainfall Analysis

RUSLE Unprotected Example

- A (Erosion) = R * LS * K * C * P
  - R = 400
  - LS = 2.81
  - K = 0.25
  - C = 1
  - P =1
  - A = 400 * 2.81 * 0.25 * 1 * 1 = 281 Ton / Acre /Year

RUSLE Protected Example

- A (Erosion) = R * LS * K * C * P
  - R = 400
  - LS = 2.81
  - K = 0.25
  - C = 0.05
  - P =1
  - A = 400 * 2.81 * 0.25 * 0.05 * 1 =

    14 Ton / Acre /Year

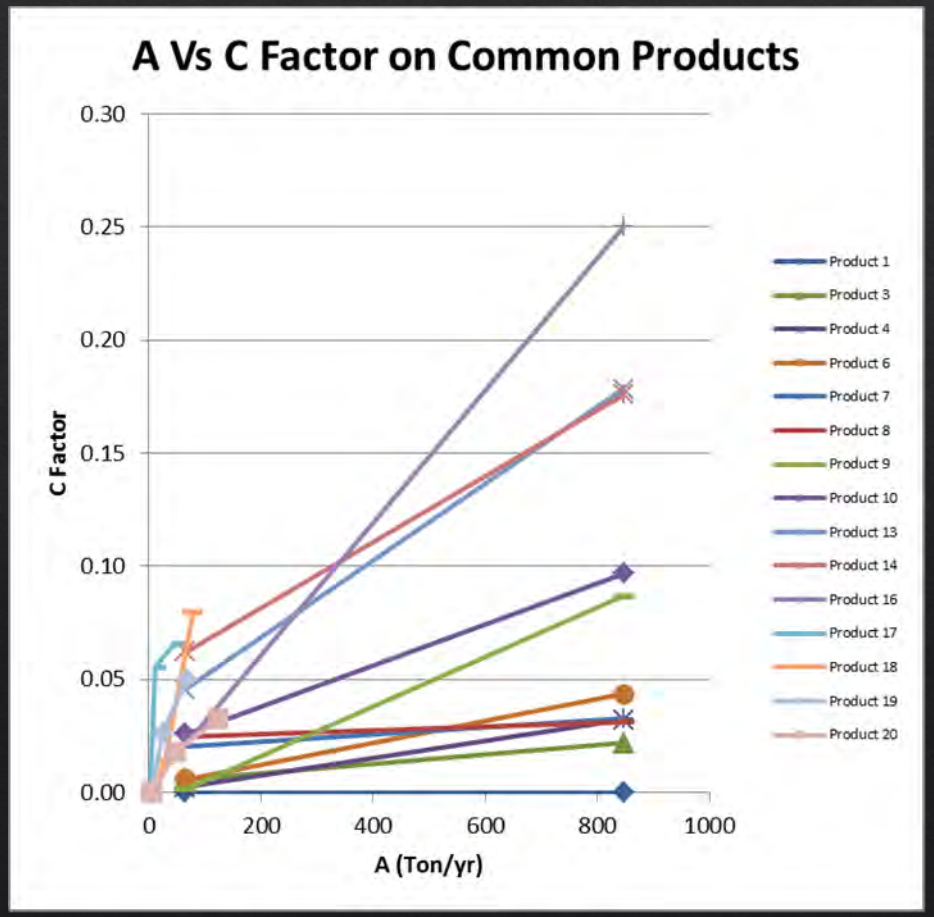
95
% Reduction

Large Scale Testing - Rainfall

- Conducted at Full Scale
  - Install Unprotected and Protected Plot
  - Expose Both to Identical Rainfall Conditions
  - Measure Sediment Yield
- Basic Measure of Performance Ratio of Protected to Unprotected Sediment Yield
  - Performance Quantified as “C Factor”

Rainfall Performance Testing

Product Performance in Design

Variability in Performance

- Study of Performance Results, IECA 2013
- Variable Performance with Respect to Conditions
- Suggests Single Performance Ratings for Products Potentially Non-Conservative