2.1.3 Peak Flow Rate

The NRCS-TR 55 Graphical Peak Discharge method relates a unit peak discharge (q_p) multiplied with watershed area (A_m), runoff depth (Q_{CN}) and a ponding factor (F_p) to peak discharge (q_p) (Eqn 7).

$$q_p = q_u \times A_m \times Q_{CN} \times F_p \quad \text{(Eqn 7)}$$

In this equation, q_p is expressed in cubic feet per second (cfs), while q_u, A_m, and Q_{CN} (Eqn 1) are expressed in cubic feet per second per square mile per inch (csm/in), square miles (mi^2), and inches, respectively. F_p is governed by the percent area within the watershed that is ponds or swamps and can be looked up in tables in the NRCS TR-55 manual (Cronshey, 1986). The q_u variable is found from empirically constructed tables in the NRCS TR-55 manual and is dependent upon T_c, appropriate rainfall distribution (type II for the entire state of Tennessee), P (Eqn 1), and I_a (Eqn 1).

2.2 Estimating Sediment Yield

Sediment yield is a critical design element for EPSC measures on construction sites in regard to sediment storage capacity and maintenance. Erosion potential is dependent on four primary factors: soil erodibility, vegetative cover, topography, and climate. Understanding the parameters affecting soil loss helps EPSC management by informing planners which project stages have the largest predicted soil losses. One of the most well-known models for estimating long-term soil loss is the Universal Soil Loss Equation (USLE), which was developed in the 1950s by the United States Department of Agriculture's Agricultural Research Service (USDA-ARS), Soil Conservation Service (SCS, now known as NRCS), and Purdue University. The USLE model is on its second revision, the Revised Universal Soil Loss Equation 2 (RUSLE2), which was developed in the 1990s. Though the use of RUSLE2 is recommended for calculating soil loss on any development project, it is especially useful when site specific designs are required. The CGP (TDEC) requires that site specific calculations be completed to design temporary sediment basins with a contributing drainage area of 25 acres or greater.

2.2.1 RUSLE2

2.2.1.1 Model

The RUSLE2 model is freely available at the USDA-ARS website and is recommended for use as opposed to performing hand calculations (https://fargo.nserl.purdue.edu-/rusle2_dataweb/RUSLE2_Index.htm). Foster and Toy (2005) and Toy and Foster (2007) are excellent resources for learning the software. The RUSLE2 model calculates sediment loss on slopes from rill and interrill erosion. The interrill erosion process (also known as sheet erosion), starts with raindrop impact detaching soil particles (i.e., sediment), thereby allowing the particles to move across the soil surface. Interrill erosion forms rills on the hill slope.

Sediment is transported through the rills down the slope until the runoff slows enough to allow the deposition on either the land surface or in concentrated flow areas such as channels. Specific variables for RUSLE2 include annual erosivity (R), soil erodibility (K), slope length and steepness (LS), cover management factor (C), and a support practices factor (P) all of which are used to predict the average soil loss (A) from rill and interrill erosion (Eqn 8).

$$A = R \times K \times LS \times C \times P \qquad \text{(Eqn 8)}$$

Each variable in the RUSLE2 equation is determined based on a set of empirical equations and is dependent on a number of factors. Computation of variables requires caution and time; therefore, use of the model is advised. A brief explanation of the variables is provided, but for further specifics, the user is referred to the RUSLE2 user's manual (USDA, 2001).

The R-factor quantifies the amount and rate of runoff likely associated with rain by assessing raindrop impact on soil. This is impacted by weather, climate, and seasonal variations in temperature, rainfall, and wind. The R-factor has units of hundreds of [ft × tonf × in × (ac × hr × yr)$^{-1}$] and has typically been expressed as an annual average. However, in RUSLE2 the R-factor can be multiplied by a fractional amount of erosion to obtain daily, weekly, monthly, etc. values.

The K-factor is the rate of soil loss per rainfall erosion index plot, has a unit of [ton × ac × hr × (hundreds of ac × ft × tonf × in)$^{-1}$] and is influenced by temperature, precipitation, and intrinsic soil properties. In general, soils with high clay or sand content have lower values of K. In high clay soils, the low value is because the attraction forces between clay particles are often stronger than the forces applied to soils by raindrops. In sandy soils, it is due to the high infiltration capacity. Conversely, silty soils typically yield moderate to high values of K because particles can be easily detached by the forces imparted by raindrop impact and the soils are unable to infiltrate rainfall at a high enough rate.

Topography is accounted in RUSLE2 by considering the horizontal distance from the origin of overland flow to the point where either (1) the slope gradient decreases enough for deposition to begin or (2) runoff enters a defined channel and becomes concentrated (slope length). Topography is also accounted for by the gradient of the slope length (slope steepness). Slope length is typically limited to 400 feet, although longer sections may be applicable in certain scenarios. Together, slope length (feet) and steepness (%) are used to obtain a unitless LS factor from tables in Renard (1997) or within the RUSLE2 model.

The C-factor is a unitless variable reflecting the effect of cover crops and management practices (e.g., vegetation type, growth, application of biomass, crop rotation, conservation tillage, and surface roughness) on erosion rates. The C-factor is split into subfactors including canopy, ground cover, surface roughness, ridges, below ground biomass, soil consolidation,