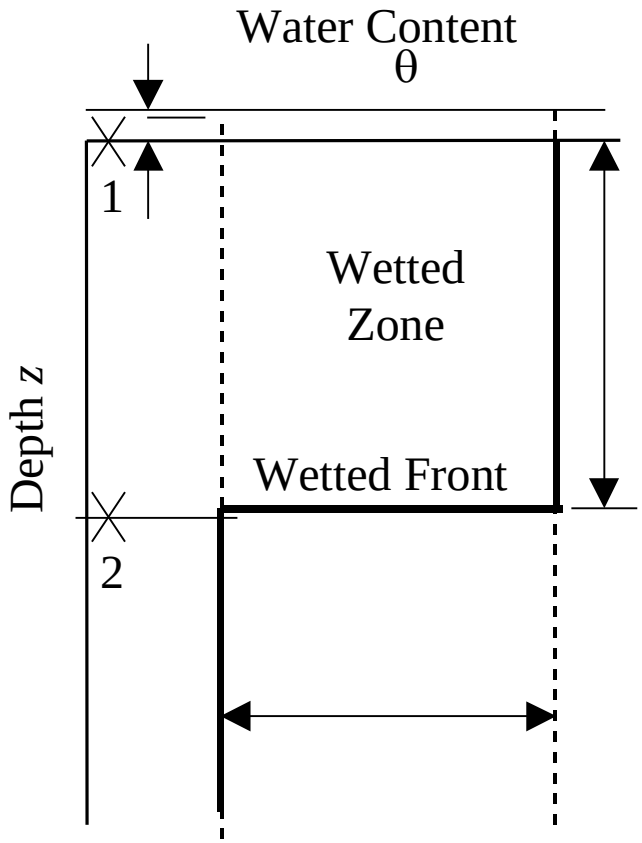
Lesson 14: Green-Ampt Infiltration Equations



θ_i initial moisture content

η moisture content at saturation (porosity)

$\Delta\theta$ increase in moisture content at the wetting front ($\Delta\theta = \eta - \theta_i$)

L depth to wetting front

h_0 ponding depth

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Equations

$$f^*(t) = K\left[\frac{\psi\Delta\theta + F^*(t)}{F^*(t)}\right]$$ potential infiltration rate

$$F^*(t) = Kt + \psi\Delta\theta \ln\left(1 + \frac{F^*(t)}{\psi\Delta\theta}\right)$$ potential cumulative infiltration

$$t_p = \frac{K\psi\Delta\theta}{i(i-K)}$$ ponding time

$$F_p = it_p$$ cumulative infiltration at ponding

$$t_0 = t_p - \frac{1}{K}\left[F_p - \psi\Delta\theta \ln\left(1 + \frac{F_p}{\psi\Delta\theta}\right)\right]$$ equivalent time origin

$$F(t) = K(t - t_0) + \psi\Delta\theta \ln\left(1 + \frac{F(t)}{\psi\Delta\theta}\right)$$ actual infiltration (after ponding)

$$f(t) = K\left[\frac{\psi\Delta\theta + F(t)}{F(t)}\right]$$ actual infiltration rate (after ponding)

Parameters

Green-Ampt parameters are determined by soil class based on the Brooks-Corey parameterization:

ψ (see Table 4.3.1 by soil class).

K (see Table 4.3.1 by soil class)

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Initial Conditions

The initial moisture conditions can be chosen in several ways. One approach is to specify θ_i directly. Then $\Delta\theta$ is found using:

$$\Delta\theta = \eta - \theta_i$$

Another approach uses the *effective saturation* s_e, which ranges from 0 (dry) to 1 (saturated). Then $\Delta\theta$ is found using:

$$\Delta\theta = (1 - s_e)\theta_e$$

where θ_e is the *effective porosity* (see Table 4.3.1 by soil class), and is defined as:

$$\theta_e = \eta - \theta_r$$

where θ_r is the residual water content.

TABLE 4.3.1
Green-Ampt infiltration parameters for various soil classes

Soil class	Porosity η	Effective porosity θ_e	Wetting front soil suction head ψ (cm)	Hydraulic conductivity K (cm/h)
Sand	0.437 (0.374–0.500)	0.417 (0.354–0.480)	4.95 (0.97–25.36)	11.78
Loamy sand	0.437 (0.363–0.506)	0.401 (0.329–0.473)	6.13 (1.35–27.94)	2.99
Sandy loam	0.453 (0.351–0.555)	0.412 (0.283–0.541)	11.01 (2.67–45.47)	1.09
Loam	0.463 (0.375–0.551)	0.434 (0.334–0.534)	8.89 (1.33–59.38)	0.34
Silt loam	0.501 (0.420–0.582)	0.486 (0.394–0.578)	16.68 (2.92–95.39)	0.65
Sandy clay loam	0.398 (0.332–0.464)	0.330 (0.235–0.425)	21.85 (4.42–108.0)	0.15
Clay loam	0.464 (0.409–0.519)	0.309 (0.279–0.501)	20.88 (4.79–91.10)	0.10
Silty clay loam	0.471 (0.418–0.524)	0.432 (0.347–0.517)	27.30 (5.67–131.50)	0.10
Sandy clay	0.430 (0.370–0.490)	0.321 (0.207–0.435)	23.90 (4.08–140.2)	0.06
Silty clay	0.479 (0.425–0.533)	0.423 (0.334–0.512)	29.22 (6.13–139.4)	0.05
Clay	0.475 (0.427–0.523)	0.385 (0.269–0.501)	31.63 (6.39–156.5)	0.03

The numbers in parentheses below each parameter are one standard deviation around the parameter value given. *Source:* Rawls, Brakensiek, and Miller, 1983.