Lesson 13: Infiltration Applications
Infiltration Example: Philips Equation

Given

Constant rainrate storm i = 20 mm/hr for 4 hours
S = 20 mm $hr^{-1/2}$
K = 10 mm/hr

Find

f and F at t = 1 hr
f and F at t = 4 hr (end of storm)

Compute t_p :

$$t_p = \frac{S^2\left(i-(K/2)\right)}{2i(i-K)^2} = \frac{20^2\left(20-(10/2)\right)}{2(20)(20-10)^2} = 1.5 \text{ hr}$$

Compute t_0 :

$$t_0 = t_p - \frac{1}{4K^2}\left(\sqrt{S^2+4KF_p} - S\right)^2 = 1.5 - \frac{1}{4(10)^2}\left(\sqrt{20^2+4(10)(1.5\cdot 20)} - 20\right)^2 = 0.5 \text{ hr}$$

Find f and F at t = 1 hr:

$t < t_p$ (Case 1: Supply Limited), therefore

$f(1) = i$ = 20 mm/hr

$F(1) = it = 20(1) = 20$ mm

Find f and F at t = 4 hr:

$t > t_p$ (Case 2: Transport Limited), therefore

$$f(t) = f^*(t-t_0) = f^*(4-0.5) = f^*(3.5)$$

$$f(4) = \frac{1}{2}(20)(3.5)^{-1/2} + 10 = 15.35 \text{ mm/hr}$$

$$F(4) = (20)(3.5)^{1/2} + 10(3.5) = 72.42 \text{ mm/hr}$$