Contaminant Hydrogeology Equation Sheet

$$\rho_b = \frac{M_{dry}}{V_T} \qquad \rho_s = \frac{M_s}{V_S} \qquad n = \frac{V_v}{V_T} \qquad \theta = \frac{V_w}{V_T} \qquad S_w = \frac{V_w}{V_v}$$

$$Q = -KA\left(\frac{dh}{dl}\right) \qquad q = \frac{Q}{A} \qquad v = \frac{q}{n} \qquad K = k_i\left(\frac{\rho g}{\mu}\right) \qquad v_z = \frac{q_z}{\theta} = -\frac{K(\theta)}{\theta}\cdot\frac{d}{dz}\left(\psi(\theta)+z\right)$$

$$J_P = -D_p\frac{\partial C}{\partial x} \qquad \text{and} \qquad \frac{\partial C}{\partial t} = D_p\frac{\partial^2 C}{\partial x^2}$$

Where D_p is the pore diffusion coefficent ($D_p = D_l\omega n$)

$$J_A = q_x C = v_x n C \qquad \text{and} \qquad \frac{\partial C}{\partial t} = -q_x\frac{\partial C}{\partial x} = -v_x n\frac{\partial C}{\partial x}$$

$$J_D = -D_L\frac{\partial C}{\partial x} \qquad and \qquad \frac{\partial C}{\partial t} = D_L\frac{\partial^2 C}{\partial x^2} - v_x\frac{\partial C}{\partial x}$$

Where D_L is the longitudinal hydrodynamic dispersion ($D_L = \alpha_L v_x + D_p$)

$$R\frac{\partial C}{\partial t} = D_L\frac{\partial^2 C}{\partial x^2} - v\frac{\partial C}{\partial x}$$

Where R is the retardation factor

$$R = (1 + \frac{\rho_b}{n}K_d)$$

other sorption relations are given as

$$C^* = K_d C_{aq} \qquad \text{and} \qquad K_d = K_{oc}\cdot f_{oc} \qquad \text{where} \qquad K_{oc} \propto K_{ow}$$

For one dimensional flow with three dimensional dispersion, the ADE with retardation is given a

$$R\frac{\partial C}{\partial t} = D_{xx}\frac{\partial^2 C}{\partial x^2} + D_{yy}\frac{\partial^2 C}{\partial y^2} + D_{zz}\frac{\partial^2 C}{\partial z^2} - v_x\frac{\partial C}{\partial x}$$

Mobile - Immobile mass transport equation

$$\theta_m\frac{\partial C_m}{\partial t} + \theta_{im}\frac{\partial C_{im}}{\partial t} = \theta_m D_m\frac{\partial^2 C_m}{\partial z^2} - \theta_m v_m\frac{\partial C_m}{\partial z}$$

where

$$\theta_{im}\frac{\partial C_{im}}{\partial t} = \beta(C_m - C_{im})$$