let

$$\boxed{K_Q = lq S_Q} \qquad \boxed{S_Q = k S_M} \qquad (7)$$

and using $\frac{\partial}{\partial z} = \frac{1}{H_\theta}\frac{\partial}{\partial s}$ and adding horizontal dissipation $\mathcal{D}_{ql}$ gives

$$\frac{\partial}{\partial t}\left(\frac{H_\theta q^2 l}{mn}\right) + \frac{\partial}{\partial \xi}\left(\frac{H_\theta u q^2 l}{n}\right) + \frac{\partial}{\partial \eta}\left(\frac{H_\theta v q^2 l}{m}\right) + \frac{\partial}{\partial s}\left(\frac{H_\theta \Omega q^2 l}{mn}\right)$$

$$- \frac{\cancel{H_\theta}}{mn}\frac{1}{\cancel{H_\theta}}\frac{\partial}{\partial s}\left[\frac{K_Q}{H_\theta}\frac{\partial}{\partial s}(q^2 l)\right] = \frac{H_\theta}{mn} l E_1 (P_s + P_b) - \frac{H_\theta}{mn}\frac{q^3}{B_1}\tilde{W} + \frac{H_\theta}{mn}\mathcal{D}_{ql}$$

or

$$\boxed{\frac{\partial}{\partial t}\left(\frac{H_\theta q^2 l}{mn}\right) + \frac{\partial}{\partial \xi}\left(\frac{H_\theta u q^2 l}{n}\right) + \frac{\partial}{\partial \eta}\left(\frac{H_\theta v q^2 l}{m}\right) + \frac{\partial}{\partial s}\left(\frac{H_\theta \Omega q^2 l}{mn}\right) - \frac{\partial}{\partial s}\left[\frac{K_Q}{mn H_\theta}\frac{\partial}{\partial s}(q^2 l)\right] = \frac{H_\theta}{mn} l E_1 (P_s + P_b) - \frac{H_\theta}{mn}\frac{q^3}{B_1}\tilde{W} + \frac{H_\theta}{mn}\mathcal{D}_{ql}} \qquad (8)$$