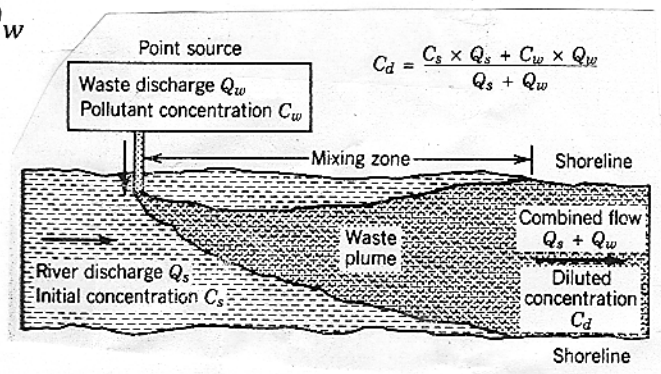
# Mass Balance Equation

$$c_d = \frac{c_s Q_s + c_w Q_w}{Q_s + Q_w}$$

where $c_d$ = diluted concentration or temperature
$c_s$ = original stream concentration or temperature
$c_w$ = waste concentration or temperature
$Q_s$ = stream discharge
$Q_w$ = waste discharge




Make sure you have the same units of measure for all concentrations and all Q's.
Note: million gallons = $10^6$, so 25 mgd = 25 x $10^6$ gallons/day

Details on Example 5.1, Nathanson

**EXAMPLE 5.1**

The $BOD_5$ of an effluent from a municipal sewage treatment plant is 25 mg/L, and the effluent discharge is 4 ML/d. The receiving stream has a $BOD_5$ of 2 mg/L and the streamflow is 40 ML/d. Compute the combined 5-day BOD in the stream just below the mixing zone.

$C_w = 25\ mg/L \quad C_s = 2\ mg/L$

$Q_w = 4\ ML/d \quad Q_s = 40\ ML/d$

we want $c_d$.

$$C_d = \frac{(2\ mg/L)(40\ \cancel{ML/d}) + (25\ mg/L)(\cancel{4\ ML/d})}{40\ \cancel{ML/d} + 4\ \cancel{ML/d}}$$

$$C_d = \frac{80 + 100}{44} = \frac{180}{44}$$

$$\boxed{C_d = 4.1\ mg/L}$$

# Mass Balance Equation

$$c_d = \frac{c_s Q_s + c_w Q_w}{Q_s + Q_w}$$

Example – Rearranging Equation

A sewage effluent containing excessive nitrate is released into a stream at a flow rate of 30 mgd. The nitrate concentration in the receiving stream is 2 mg/L and its flow rate is 175 mgd. After the effluent and stream are completely mixed, the nitrate concentration is 10 mg/L. What was the concentration of nitrate in the sewage effluent?

We want $C_w$.

$C_s = 2\ mg/L$ $\quad C_w = ?$

$Q_s = 175\ mgd$ $\quad Q_w = 30\ mgd$

$C_d = 10\ mg/L$

$$10\ mg/L = \frac{(2\ mg/L)(175\ mgd) + C_w(30\ mgd)}{175\ mgd + 30\ mgd}$$

$$205 \times 10 = \frac{350 + 30C_w}{205} \times 205$$

$$2050 = 350 + 30C_w$$
$$-350 \quad -350$$

$$\frac{1700}{30} = \frac{30C_w}{30}$$

$$56.7\ mg/L = C_w$$

nitrate