Answer 6.1

Station 1: A 50-mg/l solution of tracer is injected at the rate of $Q_i = 100\ cm^3/s$.

Station 2: Located 100-m downstream of Station 1.
Dye concentration, $C_{dye} = 10\ \mu g/l$
Lindane concentration, $C_{L2} = 0.5\ \mu g/l$

Station 3: Located 200-m downstream of Station 1.
Dye concentration, $C_{dye} = 8\ \mu g/l$
Lindane concentration, $C_{L3} = 0.9\ \mu g/l$

If dye is well-mixed and concentration is steady, then the flow at stations 2 and 3 is

$Q_2 = Q_iC_i/C_{dye} = (100\ cm^3s^{-1})(50\ mgl^{-1})/(0.01\ mgl^{-1}) = 0.50\ m^3s^{-1}$

$Q_3 = Q_iC_i/C_{dye} = (100\ cm^3s^{-1})(50\ mgl^{-1})/(0.008\ mgl^{-1}) = 0.63\ m^3s^{-1}$

If no tributaries or sewer outfalls exist between stations 2 and 3, then we expect the groundwater inflow between these stations to be

$Q_{GW} = Q_3 - Q_2 = 0.13\ m^3s^{-1}$.

To find the Lindane concentration in the groundwater we evaluate conservation of mass within the river between station 2 and 3. Influxes of Lindane to this control volume are at station 2 and from groundwater. The outflow is at station 3. Such that

$Q_2C_{L2} + Q_{GW}C_{LGW} = Q_3C_{L3}$

Solving for the groundwater concentration

$$C_{LGW} = \frac{Q_3C_{L3} - Q_2C_{L2}}{Q_{GW}} = 2.4\ \mu g/l$$