**Problem 9.3**

Dense non-aqueous phase liquids (DNAPLs) are liquids that are heavier than water and have very low solubility in water. Typical DNAPLs include chlorinated solvents like the dry-cleaning fluid perchloroethylene (PCE), also called tetrachloroethylene or tetrachloroethene. When a DNAPL enters an aquifer it will sink under gravity until it encounters a layer of low permeability, such as clay. It then spreads into a thin layer. Consider the pool of PCE depicted below which was created at time t = 0. For t < 0 the PCE concentration in the aquifer is zero. For t > 0, PCE slowly diffuses into the water above. The coefficient of diffusion is D = 4.4 x 10$^{-9}$ m$^2$s$^{-1}$. The ground water is stagnant and the aquifer is 2 meters thick above the DNAPL. PCE has a solubility in water of 150 mg/L. The Maximum Contaminant Level (MCL) for PCE in drinking water is 5 ppb. When will the concentration of PCE throughout the aquifer be above the MCL?



2 m

Ground water

Pool of PCE DNAPL