Chemical species such as tracers disperse as they are advected by a fluid flowing within a permeable matrix. The dispersion is a mechanical process caused by mixing as the fluid makes its way through complicated pathways in the porous material. Dissolved species not only move "down-stream", but also spread in all directions; the rate of dispersion depends on the porous structure and the fluid speed.

Mathematical models are developed to estimate concentrations at fluid sampling points in a geologically-layered aquifer structure that hosts a steady fluid flow. The layers may have different physical properties, their non-constant thicknesses are assumed small compared to the lateral extent of the aquifer, and their interface slopes are also small; some layers may be of finite extent (lenses). Changes in concentration within any layer may occur by advection and dispersion, and also by transfer of the pollutant across the layer interfaces. The linear advection-dispersion equations that describe the fluid and species transport then have coefficients that depend mainly on layer properties; they are coupled by water and species mass flux continuity requirements at the layer interfaces.

In some cases, full or partial analytic solutions for the species concentration can be expressed in terms of Green functions, with only a small amount of computation required to evaluate the concentrations. Some illustrative results will be presented. The signature of the species at withdrawal points is shown to depend strongly on the layering, as well as on the injection and sampling depths.