Analytical Groundwater Models to Analyze Drawdowns in Leaky Three-Layer Aquifer Systems

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Abstract

Two analytical groundwater models have been developed to investigate drawdowns due to pumping in leaky three-layer aquifer systems in northeast Florida. In these models, one of which is a steady-state solution and the other a transient solution, constant rate pumping and/or recharging wells are specified in one or more of the aquifers. Each aquifer in the system is overlain and underlain by leaky confining units, whose storativities are also considered in the transient solution. In order to represent the hydrogeologic conditions in the region, the reduction in evapotranspiration due to a decline in the water table is included as the top boundary condition. The systems of ordinary differential equations for the steady-state solution and partial differential equations for the transient solution are solved using an eigenvalue-eigenvector analysis, which is a convenient method for programming purposes. Two software packages, 3LAYSS (three-layer steady-state model) and 3LAYT (three-layer transient model), have been developed for the St. Johns River Water Management District. Both programs have been tested against benchmark problems, and the results have verified the accuracy of the analytical models. The analytical solutions and related computer programs are general in nature and applicable to other leaky three-layer aquifer systems with horizontal, homogeneous, and isotropic layers of infinite extent. The drawdown models and programs illustrate how analytical models can be used to assess future pumping impacts due to drawdowns in three-layer aquifer systems.

Keywords: analytical groundwater models, leaky three-layer aquifer, evapotranspiration

Challenge addressed: population growth and land use change impacts to water resource sustainability

Issue addressed: water availability