Modeling Selenium and Nitrate Reactive Transport using OTIS-MULTI on the Arkansas River in southeastern Colorado

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Abstract. Levels of selenium (Se) and nitrate (NO_3) in groundwater and surface water are above regulatory standards and threaten aquatic life and livestock in Colorado's Lower Arkansas River Valley (LARV). To identify best management practices (BMPs) that decrease the amount of Se and NO_3 in the watershed, numerical modeling tools can be used to assess the effects of implementing management practices on concentrations of Se and NO_3 in surface water. In this study, we present the development of a surface water chemical transport model that enables the dynamic reactive transport of Se, nitrogen, and other species to be simulated in the stream network of the LARV. The model is based on the OTIS (One-Dimensional Transport with Inflow and Storage) model developed by the United States Geological Survey, with modifications made to OTIS to expand its capabilities to include multiple streams and to allow for multiple, interacting chemical species. Including multiple streams allows species mass to be transported via the stream network of the Arkansas River and its tributaries, and simulation of multiple interacting chemical species is essential due to the effect of NO_3 on the transformation and speciation of Se species. The modified model, named OTIS-MULTI, is applied to the Arkansas River and its tributaries in southeastern Colorado, with preliminary results compared against observed in-stream concentrations of Se and NO_3. The ultimate goal of the project is to create, test, and apply a comprehensive regional-scale groundwater-surface water flow and reactive transport model for the region by linking OTIS-MULTI with the newly-developed MODFLOW-UZF-RT3D model, which accounts for Se and NO_3 cycling and transport in agricultural groundwater systems and incorporates determination of daily mass transfer of chemical species between the aquifer and the stream network. Accounting for mass transport in both groundwater and surface water, as well as the interaction between these zones, will enable the identification of key locations where BMPs should be implemented and an evaluation of their effectiveness in meeting regulatory and performance standards.