VERTICAL TRANSPORT OF SECONDARILY TREATED WASTEWATER FROM THE BOULDER ZONE OF THE FLORIDAN AQUIFER SYSTEM TO AN UNDERGROUND SOURCE OF DRINKING WATER IN SOUTHEASTERN FLORIDA: SIMULATION OF PREFERENTIAL TRANSPORT THROUGH KARST COLLAPSE STRUCTURES

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Since June 1997, the Miami-Dade Water and Sewer Department has injected secondarily treated wastewater from the North District Wastewater Treatment Plant about one kilometer below ground surface into the Boulder Zone at the base of the Floridan aquifer system. In May 1998, the department first detected wastewater beneath the plant in the Avon Park permeable zone, about 400 meters above the Boulder Zone. In 2008, the department first detected wastewater beneath the plant in an underground source of drinking water, about 700 meters above the Boulder Zone.

In the mid-2000s, the Miami-Dade Water and Sewer Department stated that wastewater transport at the North District from the Boulder Zone to the Avon Park permeable zone was caused by a three-to-five day breach in confinement during well construction in 1997; and that the breach was sealed when the well was completed. In a 2018 scientific investigations report, the USGS showed with numerical simulation that preferential transport paths through karst collapse structures that span confining units explain wastewater in the Avon Park. In about 2010---during the investigation described in the 2018 report---I determined with numerical simulation that a temporary breach in confinement during well construction in 1997 did not explain wastewater in the Avon Park. I used a modified version of the variable-density groundwater flow and constituent transport code SEAWAT, the parameter estimation code PEST, and the USGS supercomputer Yeti to minimize an objective function that described the fit of simulated to measured head, simulated to measured total dissolved solids concentration, and simulated to measured total ammonium concentration, from 1997 to 2011.

In 2016, following several USGS investigations, the Miami-Dade Water and Sewer Department drilled a three-kilometer-deep, exploratory well, searching for confined, permeable, hydrogeologic units below the Floridan aquifer system, for future disposal of treated wastewater. Deep injection of wastewater is one strategy to satisfy a 2008 State of Florida requirement prohibiting the discharge of secondarily treated wastewater to the ocean. One unintended benefit of deep injection of treated wastewater may be the sequestration of carbon that would otherwise be discharged to the ocean. Injection of a mixture of wastewater and ocean water may densify the mixed fluid, decreasing buoyancy and mitigating the potential for vertical migration into overlying underground sources of drinking water.