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A Model of Groundwater Flow in the Surficial and Intermediate Aquifers in the Vicinity of the Collier-Hogan Oil Well

A three-dimensional groundwater flow and solute transport model was constructed to represent the Surficial Aquifer and Intermediate Aquifer Systems in the vicinity of the Collier-Hogan oil well and the path that a potential impact to the water table aquifer would follow. The model was constructed using the South Florida Water Management District's Lower West Coast Surficial Aquifer System (LWC-SAS) model developed by Marco Water Engineering, Inc. in 2006 and the ground water flow model of western Collier County, Florida (Bennett, 1992).

The purpose of this effort was to develop a groundwater flow model to represent the combined aquifer systems represented by the two models described above, i.e., The LWC-SAS includes the water table aquifer, Lower Tamiami aquifer, and the Sandstone aquifer, and the Western Collier County model includes the above, in addition to the Mid-Hawthorn and Lower Hawthorn aquifers. The model was developed using the U.S. Geological Survey (USGS) modular, three-dimensional, finite difference, groundwater flow model MODFLOW in the graphical user interface Groundwater Vistas, Version 6.0 (Environmental Simulations, Inc.).

The quasi-three dimensional flow model explicitly represents the aquifers of the Surficial and Intermediate Aquifer systems; however, the confining units separating the aquifers are implicitly represented using leakance coefficients. This approach is commonly used to model multi-aquifer flow systems because the additional layers and cells required for confining units are not required to simulate the flow system and simulations run more efficiently because they require less space and memory. The model simulates the natural flow system using hydraulic boundaries and aquifer parameters from both models and pumpage from nearby potable well fields were updated. Since the LWC-SAS model is regional in horizontal extent, model boundaries were taken from the smaller western Collier Model. Recent hydraulic boundaries identified to exist in the vicinity of the site that could potentially affect groundwater flow patterns were also included in the current model. The model was calibrated to observed heads in the vicinity of the site, from the LWCSAS report

Solute transport was conducted with the USGS particle-tracking model MODPATH (Pollock, 2012). MODPATH calculates three-dimensional flow paths using output flow field from a MODFLOW simulation. The program uses a semianalytical particle-tracking scheme using an analytical expression of a particle's flow within each finite-difference grid cell to simulate flow by advection. MODPATH does not represent sorption, decay, and hydrodynamic dispersion; therefore, the estimates are considered conservative. Three particles were set up around the immediate vicinity of the oil well, to simulate a potential impact to the water table aquifer and the effective porosity was set to 15%. The results indicate that a conservative contaminant particle released at present would migrate horizontally to the south-southwest approximately 1500 ft within ten years or approximately 0.4 ft/day, without migrating to the deeper Lower Tamiami aquifer that underlies the water table aquifer. This rate of migration is an over-estimate because it does not include adsorption, degradation, and dispersion. The potential risks to private and municipal water supplies from a potential surface release in the vicinity of the Collier-Hogan oil well appear to be minimal.