Groundwater Modeling of Recharge and Seepage in Coastal Area of Shelter Island West of Coecles Inlet

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ABSTRACT

Shelter Island draws all of its water from a thin wedge (with an average thickness of ~ 80') of the anisotropic and unconfined Upper Glacial aquifer, that is surrounded on all sides and below by saline groundwater. Consequently, the aquifer is vulnerable to contamination, mainly salt water intrusion that may be aggravated by well pumping near the coast. In order to assess and manage threats to the water supply, such as chemical contamination and salt water intrusion, it is necessary to understand the nature of groundwater flow and its interplay with coastal dynamics in the region. The overall objective of this study is to construct a 3-dimensional, finite-difference model of the groundwater flow for the coastal areas of Shelter Island using the MODFLOW code.

The prediction of a numerical model is sensitively dependent on the boundary conditions. For a steady flow model, it is necessary to prescribe the spatial extent and recharge of the contributing area, and the spatial extent of the seepage face. The transition from fresh to sea water is idealized to occur at a sharp boundary, and therefore the transitional surface also needs to be prescribed as a boundary condition. Previous work has established the general hydrogeologic conditions of Shelter Island. Soren (1978) provides an excellent overview of the hydrogeology. By analyzing the compiled data on recharge and water table, Schubert (1998) recently identified and mapped out the key contributing areas on Shelter Island.

Our preliminary modeling is focused on the coastal area in the vicinity of Coecles Inlet. With constraints from piezometric data, geophysical logging and continuous seepage measurements, Paulsen, Smith and Wong (1997) developed an analytic model for salt-water intrusion and seepage in our study area. The 2-dimensional model is based on the Dupuit approximation for an anisotropic aquifer (characterized by the ratio K_x/K_z, where K_x and K_z are the horizontal and vertical hydraulic conductivities, respectively). Once the recharge (controlled by the water table profile) is prescribed, the geometric attributes of the seepage face and fresh/salt water interface as well as the seepage rates can be determined. The major limitation of this model is that it only provides the flow net for a 2-dimensional cross-section, and therefore it is desirable to develop a more

comprehensive 3-dimensional model with boundary conditions and hydrological parameters calibrated with the analytic model.

Selected transects in the study area (for which the Dupuit approximation is expected to be applicable) were identified, and the analytic expressions derived by Paulsen, Smith and Wong (1997) were used to delineate the horizontal lines and curvilinear segments that correspond to the seepage faces and fresh/salt water interfaces in the 2-dimensional sections. By interpolation of these lines and curvilinear segments, the seepage faces and fresh/salt water interfaces were determined for the 3-dimensional model, and then they were discretized and input accordingly as boundary conditions for the finite-difference model. The hydraulic conductivity and anisotropy ratio were chosen to coincide with those of Paulsen, Smith and Wong (1997), and the recharge was assumed to be uniformly distributed over the contributing area as characterized by Schubert (1998). The finite-difference grid has been constructed, and we are currently running simulations with the MODFLOW code. Preliminary results and a more detailed examination of the study area and the theory figures will be presented at the conference.

REFERENCES

Paulsen, R.J., C.F. Smith, and T.-f. Wong, Development and evaluation of an ultrasonic groundwater seepage meter, in *Geology of Long Island and Metropolitan New York*, 88-97, 1997.

Soren, J., Hydrogeologic conditions in the town of Shelter Island, Suffolk County, Long Island, New York, *U.S. Geological Survey Water Resources Investigation* 77-77, 22 pp., 1978.

Schubert, S. E., Areas contributing groundwater to the Peconic estuary and groundwater budgets for North and South Forks and Shelter Island, Eastern Suffolk County, New York, *U.S. Geological Survey Water Resources Investigation* 97-4136., in press, 1998.