Report for 2001LA2541B: Determining Uncertainty in Capture Zones and Interference from High Volume Wells

There are no reported publications resulting from this project.

Report Follows:

SYNOPSIS

Title: **Determining Uncertainty in Capture Zones and Interference from High Volume Wells**

Project Number **2001LA2541B**

Start Date: **3/01/01**

End Date: **2/28/03 (extension approved)**

Research Category

Focus Categories: **GW, WS, M&P**

Descriptors: **Groundwater Modeling, Uncertainty, Water Supply**

Lead Institution: **Louisiana State University**

Investigators: **Clinton S. Willson, PhD**

Number of Students supported: **1 PhD student**

Problem and Research Objectives

Louisiana has a tremendous amount of fresh water in aquifers---an average of over 1 billion gallons per day (GPD) of ground water was removed from various aquifers in 1995 (Lovelace and Johnson, 1995). Industry is becoming increasingly aware of Louisiana's tremendous ground water supply and its advantages; high quality water is becoming a dominant factor in the decision to locate new plants throughout Louisiana. In addition to the groundwater resource, Louisiana is also centrally located between two large consumer bases; northeastern U.S. and rapidly growing Mexico and Central America.

While the amount of freshwater in Louisiana aquifers is enormous, the supply is not infinite, particularly in a local sense. Water levels have been dropping in many aquifers and some regions have experienced an increase in salinity levels. The Sparta Aquifer in north Louisiana provides water to almost 800,000 citizens in 15 parishes. The rate of consumption has outpaced the rate of aquifer recharge for the past two decades which has resulted in dropping water levels at a rate of 1 to 4 feet per year with a simultaneous degradation in water quality. Similar problems with long-term water level decline have begun to appear for portions of the Florida parishes, a region characterized by multiple fresh water aquifers and tremendous fresh water reserves. Water levels are dropping in the Florida Parishes Aquifer System also, in some instances to the point of causing individual water wells to run dry. In East Baton Rouge Parish, salt water is moving across a regional fault boundary and into primary drinking water aquifers. In addition to dropping water levels and interference problems, saltwater pockets have also been discovered in

parts of the Chicot aquifer in the Lake Charles area. Corrective measures have been taken, but aquifer recovery takes time.

The purpose of this project is to provide a scientifically-based framework with which to guide groundwater policy and management decisions. The results from this project will lead to a methodology demonstrating the significance of uncertainty associated with hydrogeological parameters on determining the groundwater hydraulics of high-volume point source withdrawals. In particular, the modeling framework will provide information and data, in a probabilistic framework, concerning the location and capture zone of production wells for water supply and the potential interference with existing water supply wells.

This project is focused on the Chicot aquifer system in southwestern Louisiana and complements a joint project with the Louisiana Geological Survey (LGS) being funded by the LA Department of Transportation and Development (LA DOTD). The objective of the LA DOTD project is to evaluate the aquifer capacity to sustain long-term ground water withdrawal from point sources.

The results will be useful in the planning and management of groundwater systems in the state and across the nation. The methodology will also be useful for scientists and engineers who are trying to convey to policy makers or regulators a better description of the uncertainty associated with groundwater systems. This project is forming the basis for a PhD dissertation.

Methodology

Our approach is to use a low-resolution groundwater model to study the regional flow in the Chicot aquifer and to provide boundary conditions for higher-resolution inset models created using telescopic mesh refinement (TMR). These high-resolution models allow us to incorporate more data and information into the study region, including aquifer heterogeneities, recharge rates, and pumping locations and rates. Despite increasingly sophisticated techniques for quantifying this data and information, there are still spatial and temporal uncertainties. At the current time, we are focusing on the heterogeneities in the hydraulic conductivity field and their impact on the groundwater flow dynamics (e.g., drawdowns, capture zones, etc…). Geostatistical methods and conditional simulations are used to model spatial uncertainty of the hydraulic conductivity. Spatial maps of hydraulic conductivity are created using two sequential simulation techniques, Sequential Gaussian Simulation (SGS) and Simulated Annealing (SA) and are compared. GIS techniques will be used to construct probability maps for the exceedance of critical hydraulic conductivity values and for typical scnarios associated with water supply and management problems such as capture zones. The information from this study will improve our ability to manage groundwater supplies.

The hydrogeological conditions in the study area that are relevant to the design of the model are obtained from the existing geologic literature, geologic data from the files of the U.S. Geological Survey, Water Resources Division, and data acquired during a project the P.I. currently has with the Louisiana Geological Survey. There is an extensive set of U.S.G.S. publications concerning the Chicot aquifer that are being utilized for this project Hydraulic conductivity data is obtained from both the literature and from analysis of pump tests and specific capacity tests obtained from

the LA DOTD water well database. The locations and pumpages of existing water supply wells is obtained from publications of the U.S.G.S. and records of the LA DOTD.

Reports

- Hanson, B., R. Milner, A. Rahman, C. Willson, and R. Paulsell, 2001. Evaluation of Aquifer Capacity to Sustain Long Term Ground Water Withdrawal from Point Sources: A Pilot Study, Final Report submitted to the Louisiana Department of Natural Resources.

National Presentations

- Rahman, A, Hartano, S. and C.S. Willson, 2003, Incorporating Uncertainty into High-resolution Groundwater Supply Models, accepted abstract for the World Water and Environmental Resources Congress, sponsored by the ASCE Environmental and Water Resources Institute, to be held June 20-23, 2003, Philadelphia, PA
- Rahman, A., R. Milner, B. Hanson, and C.S. Willson, 2001, Linking Local- and Aquifer-scale Groundwater Models Using Telescopic Mesh Refinement, presented at the 2001 American Geophysical Union Fall Meeting, December 10-14, 2001.

Local Presentations

- Willson, C.S., 2001, Groundwater Issues in Louisiana, presented to the Baton Rouge Leadership Program, November 13, 2001.
- Willson, C.S., 2001, Groundwater Modeling of the Chicot Aquifer Underlying Acadia Parish, presented to the Baton Rouge Geological Society, November 8, 2001.