Title: Optimum Management of Ground-Water Resources in the Lower Fox River Valley

Project I.D.: DNR Project # 122

Investigators: James T. Krohelski and Terrence D. Conlon

Period of Contract: 8/1/95 – 9/30/97

Background/Need: Pumping from closely-spaced wells in the Lower Fox River Valley has resulted in large drawdown in the sandstone aquifer. The Lower Fox River Valley includes two main pumping centers, the Green Bay Metropolitan area and the Fox Cities area. Recent water-level measurements indicate that the cones of depression from the two main pumping centers have merged so that pumping in one area affects the other area. With water use projected to increase, there is a need to approach groundwater management from a regional perspective.

Objectives: The objective of this study is to determine if groundwater optimization techniques can be used to manage the groundwater resources in the Lower Fox River Valley and provide an alternative to Lake Michigan for future water supply.

Methods: A 3-dimensional ground-water flow model was used along with optimization techniques to determine the optimal withdrawal rates for a variety of management alternatives. The simulations were conducted separately for the Central Brown County area and the Fox Cities area. For all simulations, the objective of the optimization was to maximize total ground-water withdrawals.

Results and Discussion: The results indicate that ground water can supply nearly all of the projected 2030 demand for Central Brown County municipalities if all of the wells are managed (including the city of Green Bay), 8 new wells are installed, and the water-levels are allowed to decline to 100 ft below the bottom of the confining unit. Ground water can supply nearly all of the projected 2030 demand for the Fox Cities if the municipalities in Central Brown County convert to surface water. Relaxing the water-level constraint in a few wells, however, would likely result in increased availability of water. In all cases examined, optimization alternatives result in a rebound of the steady-state water levels due to projected 2030 withdrawal rates to levels at or near the bottom of the confining unit, resulting in increased well capacity. Because the simulations are steady-state, if all of the conditions of the model remain the same these withdrawal rates would be sustainable in perpetuity.

Conclusions/ Implications/ Recommendations: The results presented in this report verify that optimization is a valuable tool for allocating ground-water resources. This statement is valid given the underlying assumptions of the analysis: (1) managed wells are not allowed to inject water into the aquifer; (2) the maximum withdrawal rate of a particular well is fixed based on the well's actual capacity; (3) the distribution systems of communities sharing water are interconnected; (4) the calibrated ground-water flow model is a realistic representation of the flow system; and (5) all solutions are steady state, thus

represent sustainable withdrawals in perpetuity if all conditions of the model remain the same.

Two general conclusions are specific to the results of the individual management alternatives presented. First, if the municipalities in Central Brown County convert to surface water, there is a substantial increase in ground water available to the Fox Cities. Second, optimization alternative results indicate steady-state water levels due to projected 2030 withdrawal rates will rebound to levels within 100 feet of the bottom of the confining unit, resulting in increased well capacity.

Two conclusions pertain to the general use of optimization modeling for ground-water management. First, in some cases either a single managed well or a few closely spaced wells can control the results of an entire simulation. Second, comparisons with other factors remaining constant indicate that managing withdrawals will result in increased withdrawals and a more uniform water-level distribution.

Related Publications: Conlon, T.D., 1997, Hydrogeology and simulation of ground-water flow in the sandstone aquifer, Northeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 97-4096, 64 p.

Key Words: Water Supply, Groundwater, Model Studies, Systems Analysis, Spatial Distribution, Pumpage

Funding: DNR

Final Report: A final report containing more detailed information on this project is available for loan from Wisconsin's Water Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706 (608) 262-3069. The citation for the report is as follows: Walker, J.F., D. A. Saad and J. T. Krohelski, 1998, Optimization of Ground-Water Withdrawal in the Lower Fox River Communities, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 97-4218.