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The U.S. Geological Survey Greater Everglades Priority Ecosystems Science Initiative

Review of Aquifer Storage and Recovery Performance in the Upper Floridan Aquifer in Southern Florida

Introduction

Interest and activity in aquifer storage and recovery (ASR) in southern Florida has increased greatly during the past 10 to 15 years. ASR wells have been drilled to the carbonate Floridan aquifer system at 30 sites in southern Florida, mostly by local municipalities or counties located in coastal areas (fig. 1). The primary storage zone at these sites is contained within the brackish to saline Upper Floridan aquifer of the Floridan aquifer system. The strategy for use of ASR in southern Florida is to store excess freshwater available during the wet season in an aquifer and recover it during the dry season when needed for supplemental water supply. Each ASR cycle is defined by three periods: recharge, storage, and recovery.

This fact sheet summarizes some of the findings of a second phase retrospective assessment of existing ASR facilities and sites (Reese and Alvarez-Zarikian, 2006, in press) and updates information and data from the first phase (Reese, 2002). The purpose of this investigation is to compile and synthesize data from existing ASR sites in southern Florida and identify specific hydrogeologic, design, and management factors that control the recovery of freshwater recharged into ASR wells. Reese and Alvarez-Zarikian (2006, in press) provide a full evaluation of performance at each site and an updated (2004 ASR cycle data) comparative analysis of all ASR sites in the Upper Floridan aquifer.

Results of Cycle Testing and Performance

The primary measure used to evaluate ASR site performance in southern Florida is the potable water per-cycle recovery efficiency. This measure, calculated for 18 sites, is defined as the percentage of the volume of freshwater recharged that is recovered prior to recovered water chloride concentration exceeding 250 mg/L.

By the end of 2004, many utility-operated ASR facilities with constructed wells have experienced cycle testing or operational delays caused by unresolved regulatory issues, mechanical problems, such as pump failure, inadequate source-water supply, or other reasons. Although construction began at 21 sites in the 1990s or earlier, only 6 sites had conducted more than 6 cycles by the end

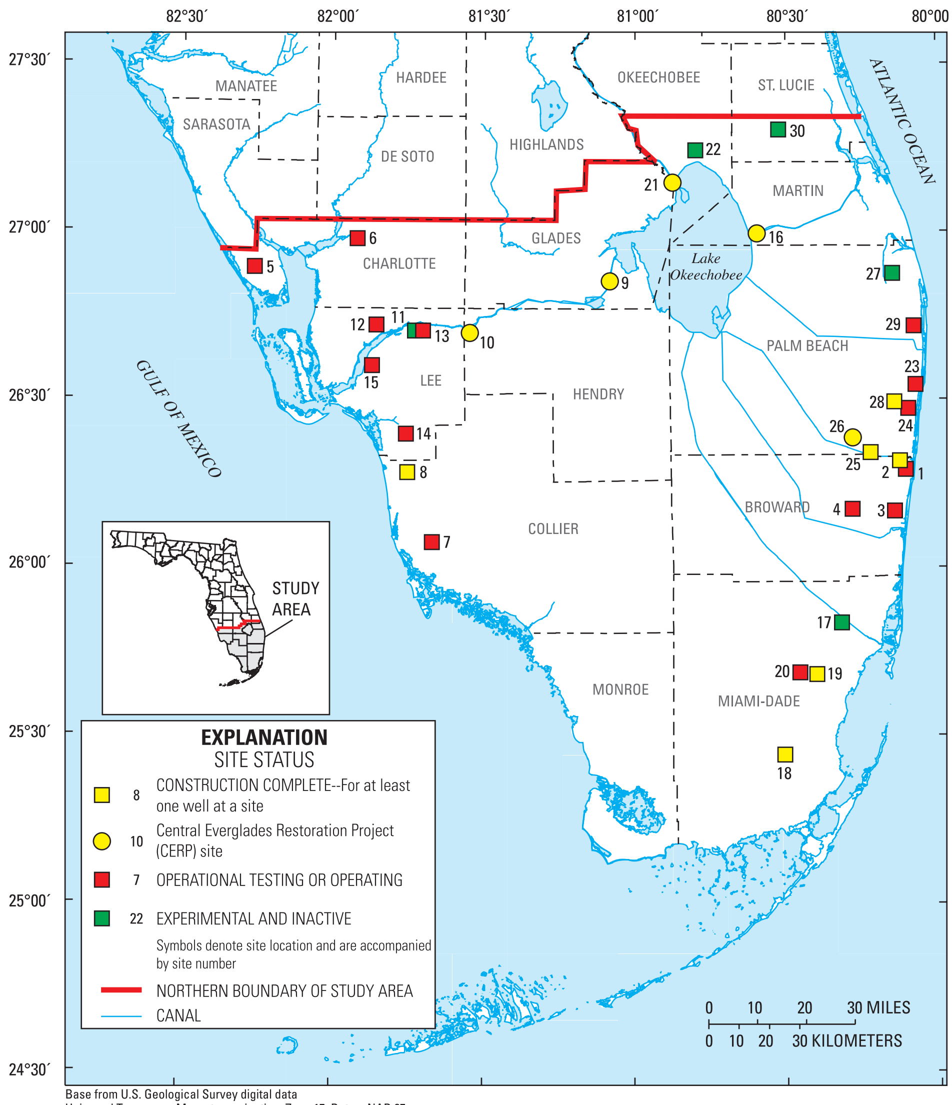

Figure 1. Study area and location and status of aquifer storage and recovery sites in the Floridan aquifer system.

of 2004. Five of ten sites with wells constructed in the 1990s have conducted only three cycles or less, and two others have not conducted any cycle testing.

Per-cycle potable water recovery efficiencies vary widely, from 0 to 94 percent. High potable efficiency on a per cycle basis can be associated with *water banking*—an operational approach in which a large volume of water is recharged during an initial cycle. This process flushes out the aquifer around the well and can build up a temporary buffer zone that may increase recovery efficiency substantially during subsequent cycles conducted with much lower recharge volumes.

A comparison of cumulative recharge volume and elapsed time since the beginning of cycle testing for all sites illustrates there are large differences in the overall rate of recharge (fig. 2A). Elapsed time was calculated at the end of each cycle. A high overall recharge rate (greater than 300 million gallons per year) can improve recovery efficiency because of the water-banking effect. Cumulative potable recovery efficiencies display substantially less variability than per-cycle recovery efficiencies (fig. 2B).

Using cumulative potable recovery efficiencies, the relative performance for 15 of the 30 sites was determined by arbitrarily grouping performance into "low" (0 to 20 percent cumulative recovery), "medium" (20 to 40 percent) and "high" (greater than 40 percent) categories (fig. 2B); 3 sites were rated high, 6 were rated medium, and 6 were rated low. Fifteen sites could not be categorized due to limited data and/or no cycle testing.

The performance of all sites rated was compared with hydrogeologic and well design factors: storage zone thickness, transmissivity, ambient chloride concentration (correlated with salinity), and the aquifer thickness extending above the storage zone. Respective threshold values of 150 ft, 30,000 ft^2/d, 2,500 mg/L, and 50 ft, respectively, were chosen for these factors to represent the approximate values above which recovery efficiency could be adversely affected.

Correlation of the performance ratings with the number of factors exceeding their respective threshold value is evident. As the ratings decrease from high to low, the number of sites with two or more factors that exceed threshold values increases. The best correlation is found with the transmissivity and ambient chloride concentration factors, but some correlation also is indicated with the thickness of the storage zone.

Long intercycle or storage periods also may adversely affect recovery efficiency, particularly among southeastern Florida sites. Here, the Upper Floridan aquifer has higher ambient salinity, higher apparent vertical hydraulic conductivity, and more sites with storage zones that lie 50 ft or more below the top of the aquifer. Because of the potential for enhanced vertical hydraulic conductivity in the upper part of the Upper Floridan aquifer in the southeastern coastal area, upward migration of fresh recharge water during long storage or intercycle periods could occur, resulting in diminished recovery efficiency.

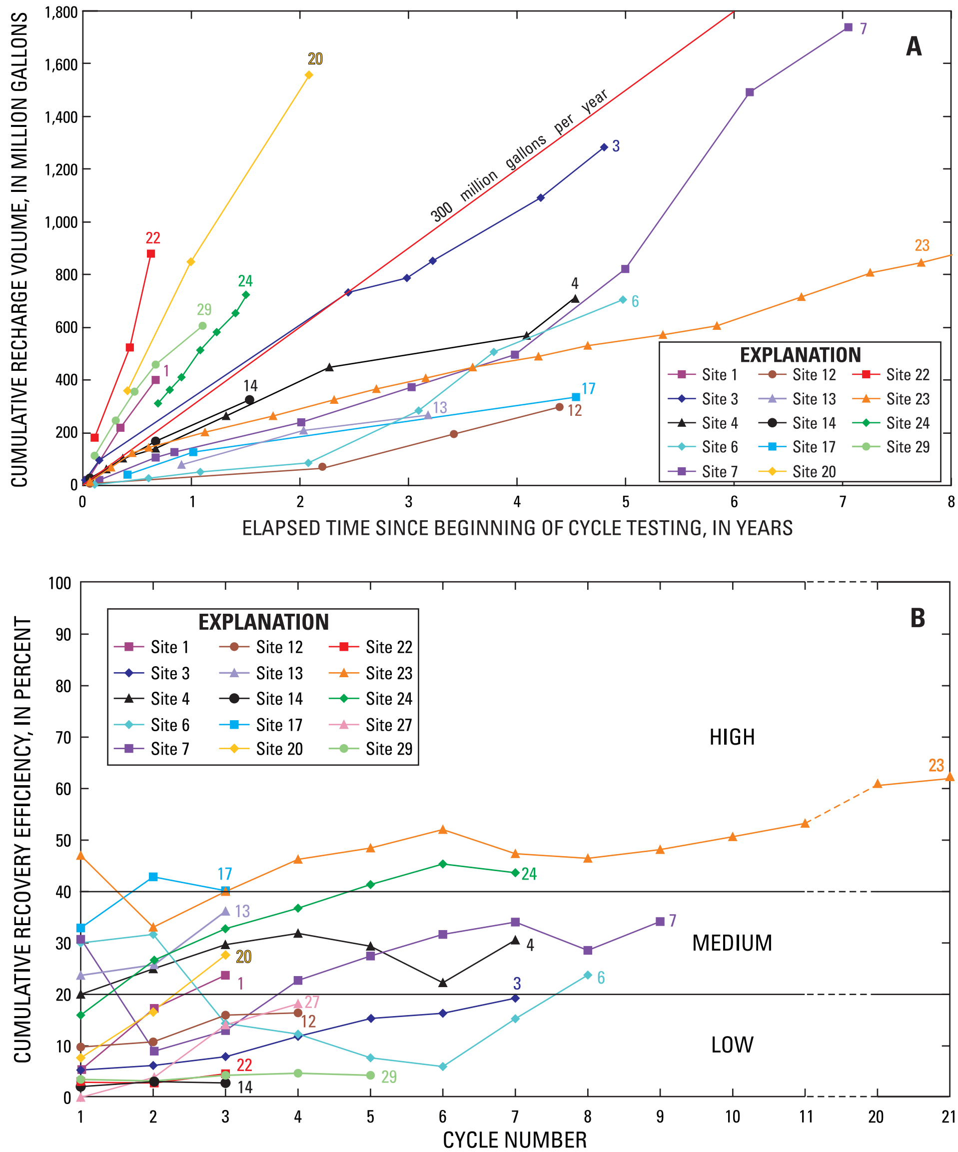

Figure 2. Comparisons of (A) cumulative recharge volume and time since the beginnng of cycle testing, and (B) cumulative potable water recovery efficiencies for sites with at least three cycles (including test cycles).

References

Reese, R.S., 2002, Inventory and review of aquifer storage and recovery in southern Florida: U.S. Geological Survey Water-Resources Investigations Report 02-4036, 56 p.

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