Effluent Disposal and Water Supply Coming Together at Orange County's Northwest Water Reclamation Facility

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Orange County recently expanded the treatment capacity of its Northwest Water Reclamation Facility (NWWRF) from 3.5 MGD to 7.5 MGD. The facility, however, is limited by effluent disposal capacity, which is currently 4.5 MGD and consists of on-site rapid infiltration basins (RIBs). In 1997 the county completed a Reuse Feasibility Study to evaluate alternative ways of expanding the plant's reuse/effluent disposal capacity to match the plant capacity.

The county evaluated the feasibility of developing a public-access, reclaimed-water irrigation supply system, emphasizing agricultural irrigation because of the many nurseries, greenhouses, and ferneries in the service area. The treatment plant, however, is located in a relatively isolated part of unincorporated Orange County and is constrained by service areas of adjacent utilities.

The service area was divided into eight subareas as shown in Table 1. Agricultural irrigation demands were estimated for five different types of land uses in each of the subareas. Residential irrigation was not considered at the time, but it was recognized that if an agricultural irrigation system were developed, it could eventually be expanded to new residential construction. Retrofitting into currently developed residential areas was not considered for economic reasons.

Table 1 summarizes the potential agricultural demands and approximate distance from the plant. These demands were estimated based on the irrigation rates presented in Table 2. As indicated in Table 1, the demands were not concentrated near the plant. The county explored the possibility of supplying the adjacent utilities with reclaimed water, but the idea was met with little interest. The only remaining choice was to look for potential reclaimed-water irrigation customers in areas that were far from the NWWRF and not cost-effective to supply. At first because of economic considerations, Orange County began to focus on ways to increase the recharge of reclaimed water to the Floridan aquifer.

Water Supply Planning

While county officials focused on solving the effluent disposal deficits at the NWWRF, they also kept an eye on regional water resource issues. Regional evaluations indicated that projected withdrawals from the Floridan aquifer by various utilities near the NWWRF were going to result in unacceptable drawdowns in the aquifer and in the surficial groundwater table in the same area. These issues became particularly evident when Orange County began to renew its Consumptive Water Use Permit (CUP) from the St. Johns River Water Management District for the county's Western Regional Wellfield, which is located just two miles east of the NWWRF.

A review of the trends in water levels showed that there has been a long-term reduction in the potentiometric elevation of the Floridan aquifer, as shown in the hydrograph from nearby USGS monitor well OR47 (Figure 3). The available Floridan aquifer monitoring data were interpolated to estimate Floridan potentiometric elevations under lakes surrounding the NWWRF at times when lake-stage elevations had been recorded. The lake levels generally correlated strongly with Floridan aquifer potentiometric elevations, with regression gradients close to 1, and intercepts of only a few feet. This means that the lake levels generally move up and down, with an approximately constant offset, just a few feet higher than the Floridan potentiometric elevation. An example is shown for Lake Mitchell in Figure 4.

From a water-supply perspective, the finding that many of the lakes in this area essentially "float" on the Floridan aquifer potentiometric surface is highly significant. It means that future potable withdrawals are likely to be constrained by the potential effects on surface water bodies, and that one way to mitigate these constraints is to find a means of increasing recharge to the Floridan aquifer. The county is now looking at reclaimed water as a resource that can be used to prevent the projected impacts of increased withdrawals. Orange County negotiated an

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Table 1. Annual Average Irrigation Demands

Subarea Number	Location	Annual Average Agricultural Demand (MGD)	Approximate Distance from NWWRF to Centroid of Subarea (miles)
1	Vicinity of NWWRF	0.83	0
2	West of Apopka	1.80	5
3	Northwest Area	2.18	9
4	Northeast Area	1.06	9
5	East of NWWRF	0.43	4
6	East of Apopka city Limits	0.25	4.5
7	South Area	1.09	6
8	Winter Garden Vicinity	0.49	7
	Total	**8.13**	

Table 2. Annual Average Irrigation Rates (Inches/Week)

Land Use	Inches/Week
Citrus	0.15
Fernery	1.26
Greenhouses	1.26
Nursery	0.61
Parks/Lawns	0.51

Figure 2. Northwest WRF Site Plan

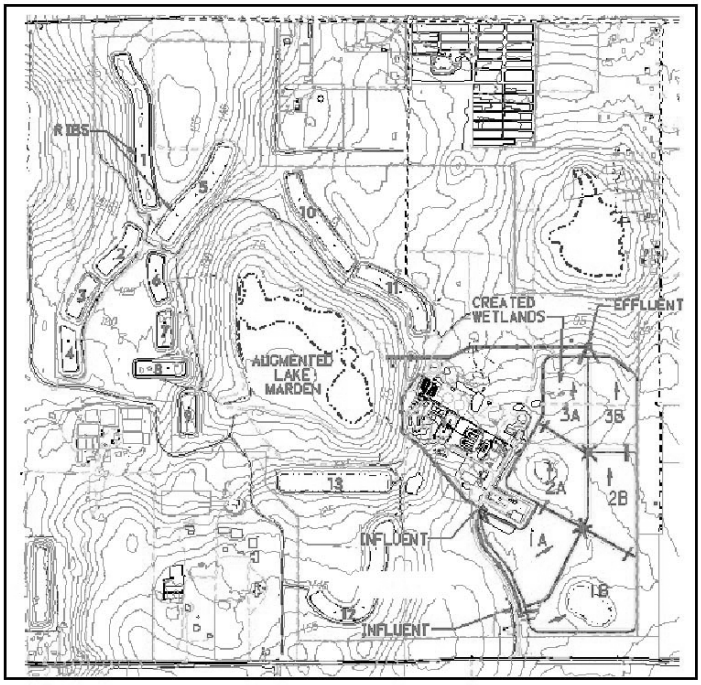


Figure 3. Trends in the Floridan Aquifer Potentiometric Elevation

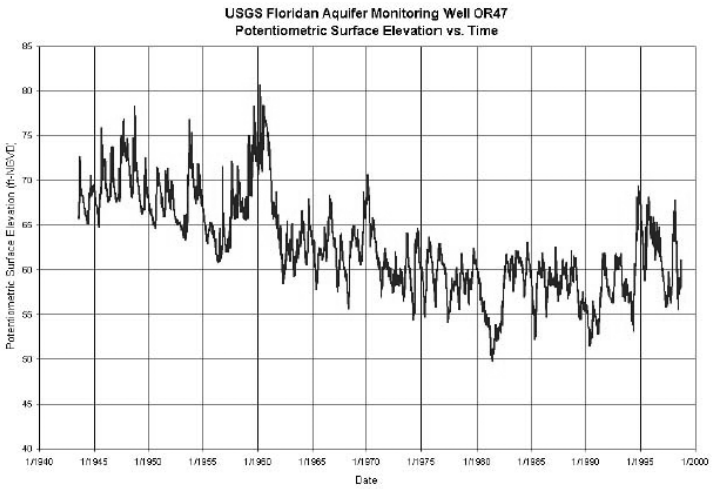
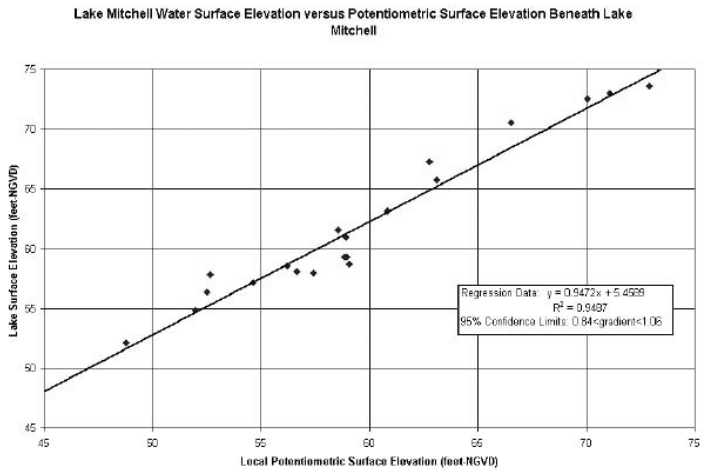


Figure 4. Example of Correlation between Lake Stage and Floridan Aquifer Potentiometric Elevation



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extension of its CUP allocation in return for a commitment to develop a plan to increase recharge in two areas south of the NWWRF that has been made a special condition of its CUP.

On-Site Rapid Infiltration Basins

The NWWRF site consists of 700 acres containing the wastewater treatment plant, 13 RIBs surrounding Lake Marden, and vacant land. Lake Marden is a wholly owned, on-site, closed depression. The site and its surrounding RIBs have a permitted capacity of 4.5 MGD. The site is located in a well-drained recharge area just south of Apopka and north of Ocoee. A site map is presented in Figure 2.

A geologic cross section of the site is shown in Figures 5 and 6. The surficial aquifer system is divided into an upper layer of highly permeable fine sands, typically five to 15 feet thick, and a much less permeable lower layer of silty and clayey fine sands that is sometimes referred to as the Citronelle formation. The surficial aquifer system is separated from the Floridan aquifer system by the confining clays of the Hawthorn formation.

The upland ridge areas generally show relatively thick sequences of the less permeable Citronelle and Hawthorn formations, while these formations are thin or completely missing in the sinkhole lakes between the ridges. As a result, the surficial aquifer system tends to show lateral flow away from the crests of the upland ridges toward the leakier sinkhole lakes. The capacity of the RIBs is based mostly on the ability of the surficial aquifer system to convey water from the upland RIB locations to the sinkhole lake locations, where it can more readily recharge downward to the Floridan aquifer.

Experience has shown that the RIB capacity is constrained by the limited conveyance capacity of the surficial aquifer that results from the thin upper layer of highly permeable sands. Consequently, Lake Marden is capable of recharging more water to the Floridan aquifer than can be conveyed to the lake through the surficial aquifer. It appears that the most effective way to overcome this limitation is to augment the lake by direct discharge to the surface water.

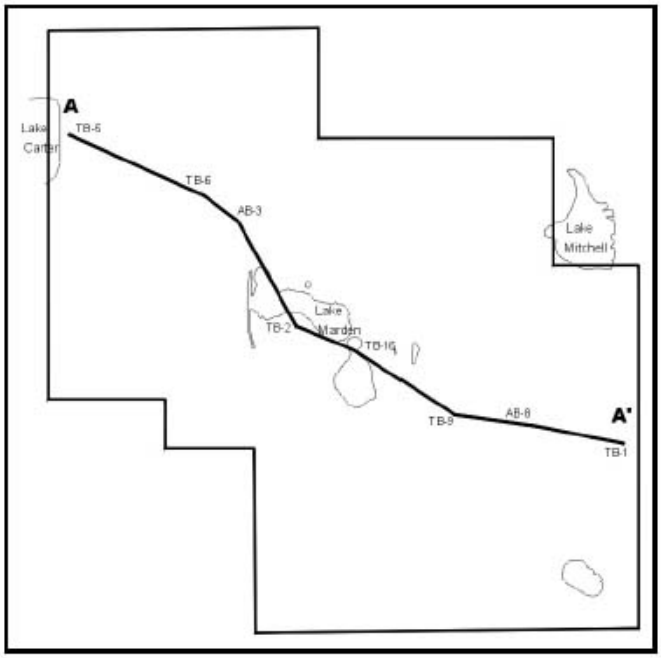
Groundwater Modeling

A regional groundwater model covering some 3,000 square miles of east Central Florida was used to assess the interactions between numerous wellfields and aquifer recharge systems. The regional model showed that in most areas, the proposed increase of recharge from the Lake Marden Augmentation Project only partially offset the effect of future drawdowns from increased pumping at Orange County wellfields.

Preliminary analyses indicated that an additional 2.5 to 3.0 MGD of reclaimed water could be recharged through Lake Marden by raising the average lake level by 10 to 15 feet, providing additional on-site reclaimed water reuse capacity. The concept of direct discharge to Lake Marden was then discussed with the Florida Department of Environmental Protection.

One of the primary concerns associated with raising the lake level to increase the recharge was the off-site impact on

Figure 5. Geologic Cross Section Location



the groundwater table. A local groundwater model, using boundary conditions developed from the regional model, was developed to evaluate the ability of Lake Marden to recharge more water into the Floridan Aquifer. Model parameters were established from a combination of borings and ground-penetrating radar information that were used to characterize the site. Aerial photography was used to establish ground elevations. Nearby monitoring wells and lake-level data were used to establish a correlation between the surficial groundwater elevations and the Floridan aquifer potentiometric surface, as discussed above. The regional and local groundwater models demonstrated that the proposed recharge and wellfield systems would not create significant negative offsite impacts.

Wetlands System

The concept of a constructed wetlands treatment system was developed to remove additional nitrogen before discharge to Lake Marden in order to supplement the recharge provided by the RIBs. The southeast corner of the existing property was selected as the site for approximately 70 wetted acres of constructed wetlands. The conceptual layout is shown in Figure 2. The facility is currently in the permitting phase and is being designed to treat an annual average daily flow of 3.0 MGD, which results in an annual loading of 22.5 acres/MGD and average detention times of 22 days.

The wetlands are being designed with two parallel trains, each consisting of three cells in series. The first cells will be planted with a variety of deep marsh species with a dominance of bulrush. It is anticipated that cattails will invade and compete with the planted bulrush. The second and third pairs of cells will be planted with mixed marsh vegetation designed to enhance the wildlife habitat. Water elevations will be maintained progressively shallower from upstream to downstream. Since the selected site is located in a sandy ridge, a containment system will be designed to minimize lateral seepage to off-site properties. The effluent from the wetland will be piped to Lake Marden to increase recharge to the Floridan aquifer.

Additional Recharge Opportunities

While Orange County is proceeding with the permitting and design of the Lake Marden augmentation project, it is already looking for additional opportunities to increase recharge in the vicnity of the NWWRF in order to avoid the predicted impacts of increased groundwater withdrawals from its Western Regional Wellfield. The county is particularly interested in the possibility of locating direct-recharge wells near its western wellfields, strategically located in areas where the projected drawdowns are expected to cause negative impacts. The wetland system with direct augmentation to the on-site closed depression could prove to be a model for other nearby closed depressions. Also, the potential to initiate an Indirect Potable Recharge project in the area is being explored.

Significantly, Orange County is now considering ways to transfer reclaimed water from its South WRF to the NWWRF to provide additional sources of recharge water if they should be needed. An effluent disposal problem is now becoming a water supply opportunity.

Regulatory and Institutional Issues

While Orange County is moving ahead to implement the Lake Marden Augmentation Project, it is encountering permitting and regulatory hurdles that are typical of a pioneering effort. Lake

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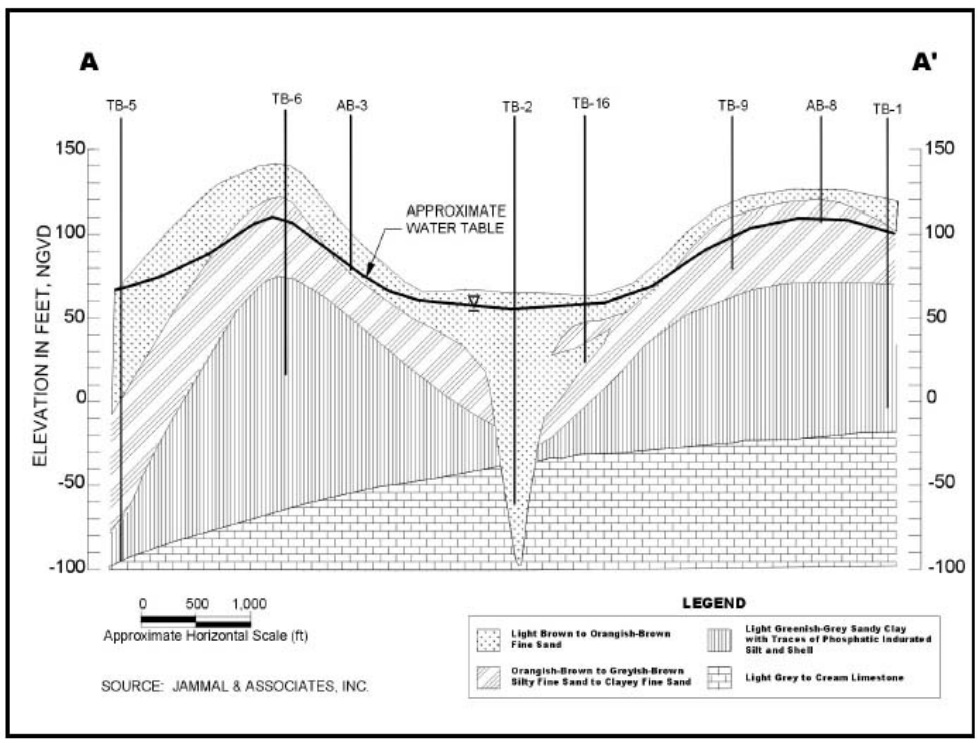
Figure 6. Geologic Cross Section A-A'



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Marden offers unique permitting opportunities because it is wholly owned by the county, which makes it exempt from federal surface-water discharge requirements. Other lakes and similar depressions that are not wholly contained within a single parcel of land will face greater permitting challenges.

In developing the project, Orange County has also run into other interesting regulatory and institutional issues. The St. Johns Water Management District is focused on minimizing or even reversing future drawdowns in the potentiometric elevations of the Floridan and surficial aquifer systems that result from increased groundwater withdrawals. The benefits of increasing the recharge in Lake Marden and bringing the Floridan and surficial aquifer system potentiometric elevations closer to historic levels are obvious on the surface. However, after years of sustained drawdown and lowered lake levels, building construction in the area has moved closer and closer to historical high groundwater elevations.

Consequently, one of the ironies encountered in developing the Lake Marden Augmentation Project was the obligation to demonstrate that the project would not be so successful in raising lake levels closer to historic levels that we would inadvertently cause flooding of structures that have encroached on the receding lakes. In fact, while the SJRWMD may ultimately restrict groundwater withdrawals, current development may very well now rely on the pumping to prevent flooding. In the future, regulatory agencies may need to take a more critical view of where facilities may be constructed, and to take into consideration the effects of past and future policies on water use.

While the Florida Department of Environmental Protection has recently adopted rules applicable to Indirect Potable Recharge, these rules have not yet been applied to a permit. Also, membrane processes are likely to be a key treatment process, yet the disposal of the reject faces its own set of challenging technical and permitting hurdles. Given the apparently significant water supply needs of Central Florida, pilot projects, demonstration projects, and permitting projects that further the ability to implement Indirect Potable Reuse need to be encouraged and expedited.