Project APRICOT: Case Study of a Wide-Scale Urban Reclaimed Water System

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APRICOT (A Prototype Realistic Innovative Community Of Today) is the name given to the city of Altamonte Springs' public-access reuse system. Collectively, it refers to the city's tertiary wastewater treatment plant, variable-speed pumping equipment, storage facilities, and distribution system.

APRICOT delivers annually, on average, about 94 percent of its treated domestic wastewater for residential and commercial irrigation, cooling tower make-up, other commercial applications, and aesthetic uses. On a daily basis, between 0 percent and 175 percent of the domestic sanitary sewage flow is reused.

APRICOT, as one of the first wide-scale public reuse systems, has been at the forefront of operating, permitting and growth in water reuse. Also, because it is a "mature" system dealing with the success and, at times, excessive demand for the resource, many lessons have been learned. As the water industry and consuming public begins to understand the importance of using water resources efficiently, the city's experiences can benefit existing and new reclaimed-water utilities.

Physical Facilities

Altamonte Springs Regional Water Reclamation Facility

The Altamonte Springs Regional Water Reclamation Facility (RWRF) is a 12.5-MGD tertiary domestic wastewater treatment facility accepting domestic sanitary sewage from the city as well as neighboring municipal collection systems. Current flows average 6.0 to 6.5 MGD.

Primary treatment is accomplished with coarse screening, grit removal, fine screening, and primary clarification. Secondary treatment achieves biological nitrogen removal through the use of anoxic and aerated zones. Secondary clarification is followed by alum addition, flocculation, and denitrifying deep-bed filters. The effluent is then re-aerated, disinfected, and passed to a low-head transfer pump facility.

The reuse water is transferred to two on-site, 3-million-gallon ground storage tanks. Five variable-speed, high-service pumps are used to maintain pressure in the distribution system at 40 to 65 psi. Average annual reuse of water accounts for approximately 94 percent of the treated flows. When not reused, the effluent is dechlorinated and discharged to the Little Wekiva River.

Distribution Network

The APRICOT distribution system consists of 83 miles of 4-inch through 30-inch transmission mains, one elevated 500,000-gallon storage tank, approximately 6,000 residential service connections, several hundred commercial connections, and a surface storage/augmentation facility. The transmission mains serve four quadrants of roughly equal area coinciding with the construction phases of the system.

With very few exceptions, every city resident has access to APRICOT and pays a monthly availability charge. Individual residents are given the option of turning on their connection along with their potable water service; those who accept are billed an additional flat amount monthly with their water and sewer fees. The fee structure was designed to support the capital operating expenditures associated with the reuse system.

Surface Water Storage

While on an annual basis the city has achieved near-parity in terms of supply and demand, seasonal fluctuations create a cyclical shortage and surplus of reclaimed water. Noting this, in 2001 the city requested permission to utilize the impoundment known as Cranes Roost as a storage facility for excess reclaimed water.

Cranes Roost Park is a 40-acre waterbody and surrounding amenities operated as both a city park and a regional stormwater facility while serving as the centerpiece of the city's downtown development area. Use of this facility for the storage and subsequent withdrawal of excess reclaimed water provides two major benefits to the city:

- Attenuation of cyclical demands, resulting in less "wasted" reclaimed water (minimizing discharges to the Little Wekiva River). In addition, operation of the RWRF in a constant mode provides greater operating efficiencies and fewer chances of permit violations during river discharges.
- Maintenance of aesthetic water levels for cultural and special events while not encroaching on the flood-protection aspect of the regional stormwater facility.

In order to accomplish this use, the city and the Florida Department of Environmental Protection (FDEP) cooperated in developing an operating protocol that allows continued use by the city for numerous special events while monitoring the impacts of introducing reuse water into a medium-to-large water body.

Historical Backdrop

Historically, Altamonte Springs (and many others) discharged secondary-treated wastewater effluent to the Little Wekiva River, a source of the St. Johns River. The Little Wekiva has been subjected to significant alterations of its natural watershed through intensive urban development in Orange and Seminole counties. At the time, the twin concerns of hydraulic and ecological impacts on the river were attracting some attention.

While the hydraulic impact of the city's effluent discharges is debatable, several researchers noted a clear degradation of the river's water quality. Of primary concern was the nutrient loading to the system, due in part to treated wastewater discharges of water relatively high in nitrogen and phosphorus.

As it became apparent that the nature of the discharges would need to change, the city's then-public works director reportedly drew inspiration from *The Water Supply of the City of Rome*, written about 97 A.D. by Sextus Julius Frontinus. In that text, it was reported that a lower-quality aqueduct sup-

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plied water for non-potable uses to Rome. From the standpoint of the modern utility, the reuse of water, in addition to providing an alternate disposal method, could also be used to diminish the use of higher-quality waters for lower-quality purposes.

The regulatory climate in Florida at that time did not allow for reuse of water in this way. Through constant coordination and diligence on the parts of the city and the FDEP, APRICOT was allowed to proceed.

Implementation

In order to effectively implement APRICOT, three changes were necessary:

- Upgrades to the city's treatment plant to more effectively produce a high-quality effluent suitable for either surface-water discharge or public-access reuse.
- Planning, design and construction of a second water distribution system reaching the entire city.
- Effective public education regarding the suitability and advantages of the reuse of treated wastewater.

Of the three, public acceptance was considered the most crucial, since success as an alternative discharge for the majority of the effluent, as well as success as a free-standing utility, would demand participation by a large portion of the city's residents.

Treatment plant upgrade

The treatment plant upgrades related to APRICOT resulted in the addition of the following:

- An anoxic zone to the biological reactor for nutrient removal.
- Deep-bed denitrifying filters for additional effluent nitrogen removal.
- Low-head transfer pumping capability.
- Two 3-million-gallon storage tanks.
- High-service pumping capability.
- Assorted telemetry equipment.

Improvements to the RWRF were accomplished coincidentally with other plant enhancements and funded by bond issuance.

Distribution Network Construction

The distribution network was designed to provide four roughly equal distribution zones and was constructed over a 15-year period at a cost of approximately $40 million. In general, significant projects (i.e., involving larger pipe and/or taking place in right-of-way serving as minor collectors and above) were bid out and performed by utility contractors.

An in-house installation crew was also formed, consisting of a supervisor/backhoe operator, several laborers, and the appropriate heavy and ancillary equipment. In existing residential areas where relatively small lengths of main were required, this crew performed the work. Of the overall construction, approximately 10 percent was installed in this way.

Extensions of the system have also been mandated as part of the city's land development code. All new residential developments must include reclaimed-water piping and must connect to the system. Commercial developments, if located where the distribution network has not yet reached, must install "dry lines" in anticipation of future connections.

In several residential areas (one single-family and four multi-family), construction of the reclaimed-water system coincided with a potable-water distribution system upgrade. The existing potable system in these areas was undersized in terms of fire flows. Rather than retrofit the potable system and construct a new reclaimed system, the city decided to leave the "old" potable system in place and constructed the new reclaimed system with fire hydrants. In all, 75 reclaimed-water fire hydrants were placed into service.

Public Outreach / Installation Agreements

As stated previously, public acceptance of APRICOT was essential to achieve a successful implementation. To this end, the city created a public-relations position within the Public Works Department, the "information liaison."

On a full-time basis, this person issued press releases, coordinated with homeowners and condominium associations, and became the single spokesperson to the public for APRICOT. This approach allowed for a consistent message to be delivered to any party who expressed an interest in the program. If the need arose for more technical information and/or discussion, the information liaison arranged for the public works director or city engineer to meet with the interested party.

From 1986 through approximately 1995, the city produced two videos and several brochures primarily discussing water-quality issues, which appeared to be the major concerns of potential users. Through a highly proactive outreach program providing clear, concise data, city residents and businesses quickly accepted the concept of reclaimed irrigation.

Existing developments were initially brought into the system on the basis of petition. In order for the city to bring reclaimed water into the development, two-thirds of the residents would need to sign a petition requesting installation of reclaimed distribution pipe within their neighborhoods. Upon receipt of the executed document and verification of installation feasibility, the work was scheduled for design, bid (if necessary), and construction.

For development contracts after 1992, installation of reclaimed pipe became mandatory.

Operation

Effective operation of a reclaimed-water utility requires a careful blend of treatment technology, consistently high-quality plant operations, supporting ordinances and rules, and a well-trained, committed field staff. Consistent, positive support from the highest levels of the utility (city manager, mayor, and commission in terms of a municipal utility) is essential so the staff can carry out their duties knowing that their work supports the utility's goals and objectives.

Treatment Quality

The paramount importance of water quality, both from a real and a perceived perspective, can not be minimized. The wastewater plant must employ appropriate technology to achieve the desired or required level of treatment. The process must be adequately controlled, either by 24-hour staffing or high-level SCADA, to ensure for the utility's customers that no substandard reclaimed water will enter the system.

The wastewater operators, while primarily concerned with operation of the treatment system, must be aware of, and trained in, the basic philosophy of the utility's reclaimed-water operations, as well as the expectations of management and consumers. The plant's effluent can not be considered just another disposal method; the higher use of the plant's product must form the basis of all operations.

Ordinances

In the case of a public utility, strong and consistent ordinances must be in place to support the production of reclaimed water as well as the expansion and use of the distribution system across a wide geographic area. Without these rules, a reclaimed-water system will find it difficult to maintain a broad-enough customer base to support continued operation without strain on other enterprise funds.

The city has created the following ordinances, all of which directly or indirectly serve to maintain high-quality reclaimed water while maintaining adequate safety and providing for continued expansion of the system (and resulting demand):

- **Reclaimed Water Ordinance.** This ordinance, part of the city's utility code, establishes the rate-making authority of the util-

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ity as well as the various classes of customer (residential, commercial, etc.).

- **Cross-Connection Control Ordinance.** For the city of Altamonte Springs, this ordinance makes the placement of backflow protection devices on all potable-water connections mandatory, regardless of reclaimed connection status. This prevents unintended connections on the customer's property from affecting others within the system.
- **Industrial Pretreatment Program.** One side effect of this state-required rule is that the "raw material" of the process (sanitary sewage) consistently falls in a quality range that is predictable and treatable.
- **Various Land Development Code Requirements**. The city's land development code establishes the mandatory construction and connection requirements for new developments. It also requires that all reclaimed-water pipe, valves and appurtenances are installed as if they were potable-water system elements. By requiring that all reclaimed facilities meet drinking-water standards, it is easier for the city to maintain the system and ensure that the distribution system performs to the expectations of management and consumers.

Field Operations

Field operations represents the most volatile component of the recurring costs of maintaining a reclaimed-water system. Without effective control over this component, costs can adversely affect the overall utility's funding and customer perception.

The city of Altamonte Springs combined its potable-water and reclaimed-water field operations into a consolidated Water Distribution Division whose employees monitor and repair both systems. This approach provides a consistent response time and cost across all water-utility operations. The only major difference between the two systems, from a field-operation point of view, is that a late-night reclaimed-water line break is typically not repaired until the next business day unless fire protection is involved.

The city's policy of requiring that all reclaimed-water installations be constructed as if they were potable-water systems relieves the need to stock two lines of parts and materials at the city warehouse.

The Water Distribution Division also maintains dedicated staff to specifically enforce the requirements of the Cross-Connection Control Ordinance. These personnel conduct inspections of backflow devices, offer free customer education, and serve as sworn code enforcement officers should the need for enforcement action arise.

Once each year the city holds a "Reclaimed Holiday" during which the reclaimed high-service pumps are shut down and certain key valves are closed in the distribution system. The "holiday" typically lasts for one or two days and occurs in early December.

While one objective of the exercise is to perform system maintenance and repair, the more important value is in the discovery of any illicit cross-connections. Through pressure monitoring at the city's lift stations (where reclaimed water is used for irrigation), irregularities implicating a potable-water connection can be identified and acted upon.

When Demand Reaches Supply

Any well-planned reclaimed-water system will reach a point at which demand exceeds supply. Strategies adopted early in the implementation phase of the project will directly affect the utility's flexibility in meeting the needs and desires of its customers.

Users – A Few Large or Many Small?

In many reclaimed systems, the temptation to secure a long-term commitment for acceptance of the reclaimed flow by a few large users is difficult to overcome. A critical question must be considered when undertaking a reclaimed-water project: What is the ultimate purpose of the system?

If the primary objective is eliminating an existing problematic discharge and the demographics don't support small-scale use, then it may be appropriate to secure one or two major uses such as golf courses and/or agricultural customers. If, however, the utility is located in a moderate growth area, it is likely that future consumptive use of potable-water sources may be contingent on the provision of wider reuse. These areas are also attracting homeowners who are coming to expect that reclaimed water be provided by their utility. The large majority of water-consumers are aware of the fragility of the resource and want to do their "part" in the water-conservation arena.

Coping With High Demand

As APRICOT demand began to consistently match and then exceed supplies on a daily basis, the city implemented various strategies to cope:

- **Augmentation.** The need to supply fire protection in some areas, coupled with the original assurance that the water would be available at all times, caused the city to introduce groundwater augmentation of the reclaimed system. This was accomplished by modifying an out-of-service water plant. The city's Water Treatment Plant #3 had been out of service due to diminishing water quality for some time. The plant's wells (400 feet deep) were rehabilitated and the ground storage tank/high-service pumps were connected to the reclaimed system. Typical groundwater augmentation has ranged from zero to approximately 3.5 MGD during high demand times. One difficulty of using this source for augmentation is that the well withdrawals are part of the city's consumptive use of water and have an effect on the potable uses. Additional augmentation sources include various stormwater facilities around the city. In these cases, excess wastewater plant capacity is used to treat the stormwater before it is used in the APRICOT system.
- **Improved/Increased Storage.** In addition to the use of Cranes Roost Park discussed previously, the city is also considering the use of other surface-water bodies and ASR technology. ASR is not currently being actively considered because the reclaimed water would require further treatment to bring it into compliance with drinking-water standards.
- **Demand Management.** The city is also actively managing demand by enforcing mandatory watering restrictions. The city's customers may use their irrigation systems two days per week (except 10 a.m. to 4 p.m.) without penalty. Through monitoring by field operations personnel and a significant fine structure, the city was able to reduce groundwater augmentation in 2001 by greater than 90 percent.

The next step in demand management entails conversion of the remaining reclaimed-water fire hydrants to potable-water use. This, coupled with operation of major distribution-system valves, will allow the city to turn off the reclaimed system in large areas of the city.

Conclusion

APRICOT has been a great success story for both the city of Altamonte Springs and the reclaimed-water industry in general. By applying some of the lessons learned, operating practices, and careful system planning and implementation, new reclaimed-water systems can maximize their potential while providing a product of ever-increasing relevance and value.

Did you know...

- 300 million gallons of water are needed to produce a single day's supply of U.S. newsprint.
- About two-thirds of the human body is water. Some parts of the body contain more water than others. For example, 70 percent of your skin is water.

Source: American Water Works Association