Reuse Evolution: Operational and Hydraulic Improvements for Pasco County

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Reclaimed water utilities in Florida are challenged to create cost-effective solutions to balancing dry weather demand with management of excess wet weather flows. The Pasco County Master Reuse System (PCMRS) is an example of a system that must balance its demand and flows and is achieving this through the addition of new residential reuse customers, the newly constructed 500-mil-gal (MG) Boyette Road Reclaimed Water Reservoir, the 5-mil-gal-per-day (mgd) Central Pasco project currently under construction, and the Crews Lake project currently in the design and permitting stage. The vision for PCMRS, which beneficially reuses about 20 MG of water daily that's provided by seven wastewater treatment facilities, is to grow to serve over 25,000 residential customers over a 352-sq-mi service area. The PCMRS does not have a surface water discharge to help balance wet weather flows; all of the water that comes to it is beneficially reused in accordance with the requirements for Ch. 62-610 Florida Administrative Code, Part III (unrestricted access), Part IV (rapid rate infiltration basin system, or RRIBS), or Part II (sprayfield) reuse systems.

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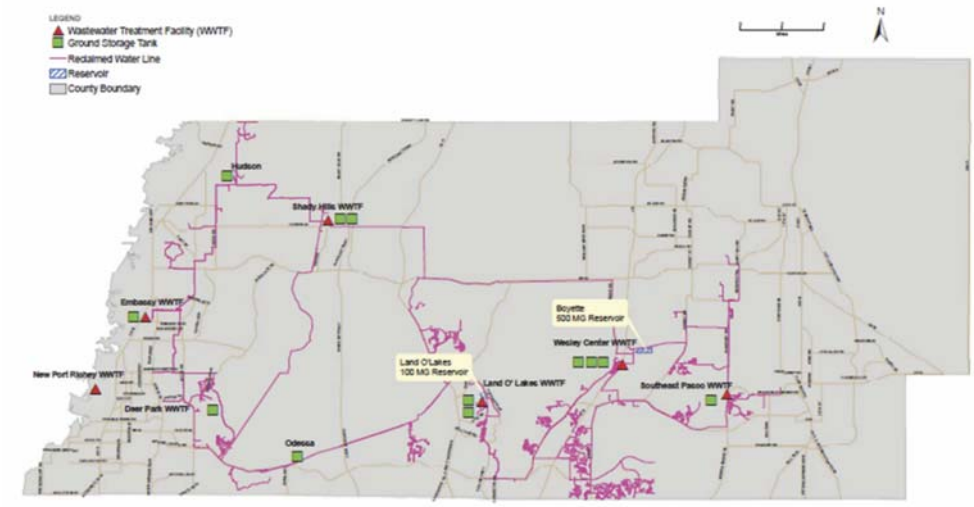

Figure 1. The Pasco County Master Reuse System. Triangles represent wastewater treatment plants, circles represent existing storage tanks, and pipes are in purple.

Figure 2. Boyette Road Reclaimed Water Reservoir.

Currently about 14,000 residential customers are serviced by PCMRS, in addition to a golf course and other bulk users of irrigation water, and one industrial facility, as shown in Figure 1. The figure also shows the location of the new Boyette Reservoir, the Land O' Lakes Reservoir, the major transmission and customer connection areas, current wastewater treatment facilities providing source water to PCMRS, and the location of the two future projects, Central Pasco and Crews Lake.

For PCMRS, the Boyette Reservoir is an integral aspect of the growing system, both for flow equalization to meet customer demand and for meeting water quality requirements into the future, and the success of PCMRS depends upon the county's ability to balance these things. This article examines some of the design considerations of the reservoir, as well as how the operational strategy is affected by the addition of new beneficial reuse features into the system. Modeling and demand projections required further development to position the county for more effective reclaimed water management.

Background

In 1986 the Pasco County Board of County Commissioners made the decision to beneficially reuse 100 percent of the effluent from the wastewater treatment facilities (WWTF) and to stop maintaining a surface water outfall. Construction began on the reuse system utilizing portions of the existing system originally designed for disposal purposes. The first customers were a few golf courses and about a half-dozen orange groves.

At its inception, PCMRS operated as separate looped systems located in the west, central,

and east portions of the county. Each section receiving supply from the WWTF within the respective loop system; however, this structure created service reliability issues.

Within a few years, the benefits of using reclaimed water for irrigation were apparent to county management, and in 1992 a master plan was developed. This plan identified potential new customers, which included residential users. It also identified the infrastructure necessary to connect the three independent systems together into one operating system, improving both service delivery and reliability.

The system today is fully integrated and receives water from six wastewater treatment facilities in the county and beneficially reuses up to 20 mgd.

During the housing boom of the early 2000s, the county was consistently ranked as one of the top 25 fastest-growing counties in the United States. The county sustained 20 percent year-over-year growth for many years. During this time, it was never envisioned that PCMRS would have more supply than the customers demanded, but by the late 2000s, with the housing crash, wet weather reuse was challenging for the operations staff. Projects were conceived and added to the capital plan to lessen the wet weather pressure on the system, and the Land O' Lakes Reservoir was also added. This growing system was fundamentally changing how the reclaimed water was being used and stored within the system, and it was apparent that the county required more sophisticated tools to manage the growing system.

Infrastructure Improvements Added Storage and Flexibility

The PCMRS has been enhanced significantly within the last few years with the addition of the Boyette Reservoir. Located on the east side of the county (Figure 1), the reservoir (Figure 2) is central to much of the current and projected future residential user base. Prior to its completion, the entire storage capacity of PCMRS was approximately 131 MG, with 100 MG located at the Land O' Lakes Reservoir and the remaining storage distributed throughout the system, co-located with current or former WWTF.

The Boyette Reservoir covers 82 acres, is 8000 ft around the perimeter, and holds 500 MG of water, which is chlorinated before being repumped back into PCMRS. Treatment is not expected or required at the reservoir; however, chlorination is utilized to ensure no algae are growing in the system and to be protective of the existing irrigation systems. Influent capacity is sufficient to accept the entire current volume of reclaimed water generated daily (23 mgd). The control structure includes three 500-horsepower variable speed pumps with the capacity to pump 15 mgd out of the reservoir and the ability to add three additional pumps when necessary. With all of the pumps running, the reservoir can be drawn down 24 in. within a day. In an emergency, the reservoir has backup generators sufficient to run a single pump, which ensures the reservoir can be drawn down 7 in. per day.

With the addition of the reservoir, county operations needed time to develop a balanced operating protocol of PCMRS as a whole, as the reservoir added a significant amount of storage to the system. The reservoir is not physically located closely to the existing wet weather disposal options (RRIBS) for the system, as noted in Figure 3.

While the reservoir provides necessary added storage to help balance out the system during wet periods, the water must ultimately be withdrawn from the reservoir back into PCMRS. The county recognized the need for additional reuse options for wet weather conditions. To resolve this, the county is in the process of designing and constructing additional wet weather beneficial reuse options, including the Central Pasco County Beneficial Water Reuse Project, also known as the 4G Wetlands, and the Crews Lake Natural Systems Restoration (CLNSR) Project.

The 4G Wetlands project, shown in Figure 4, is currently under construction. Cooperatively funded by the Southwest Florida Water Management District (SWFWMD), this multifunctional project addresses decade-long concerns regarding groundwater drawdowns in areas affected by public water supply wellfields. This project also pro-

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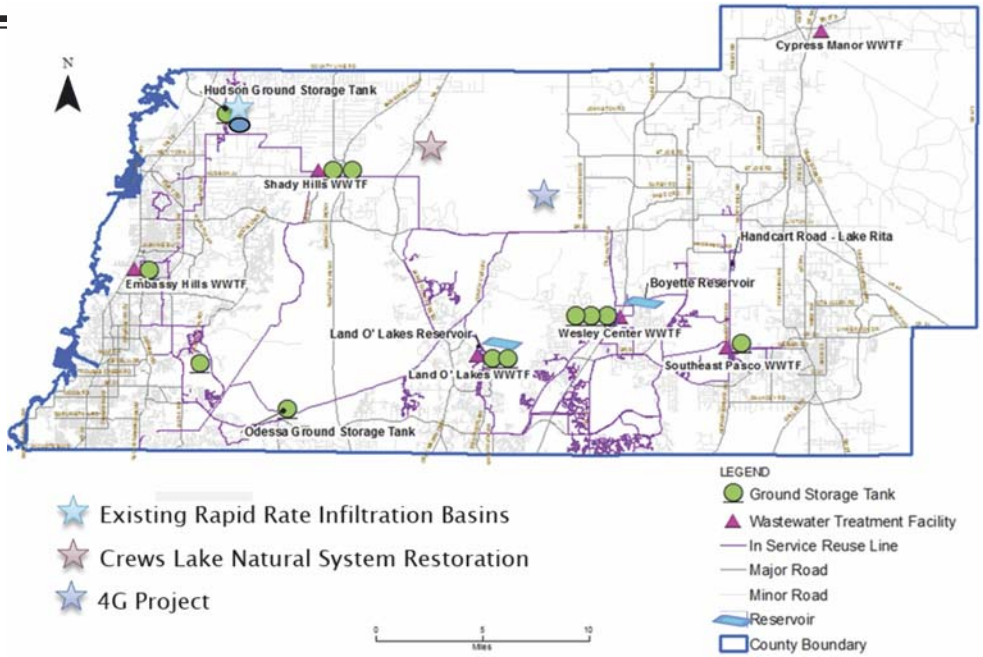

Figure 3. Location of the Boyette Reservoir and the rapid rate infiltration basin system.

Figure 4. The 4G Wetlands project's constructed wetland cells under construction.

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vides much-needed additional wet weather capacity to PCMRS, protects water quality, enhances onsite lakes and wetlands affected by the drawdowns, and creates new and diverse wetland habitats. The project involves constructing a groundwater recharge wetland system on private property through a public-private partnership with the 4G Ranch. This project is designed to work in unison with the newly constructed Boyette Reservoir to balance wet weather supply with dry weather demands.

The 4G project includes a rated capacity of 5 mgd, requires minimal operation and maintenance, and provides numerous secondary benefits, such as ecosystem enhancement.

The CLNSR is currently in the permitting stage and approaching final design. Crews Lake, which is located in northwestern Pasco County, has experienced decades of hydrologic alteration from surface water diversions and consumptive uses from wellfield drawdown, exacerbated by sinkhole formations and bifurcation of the lake by man-made berms within the lake bed. These detrimental impacts have resulted in terrestrial species, such as pine trees, to flourish in portions of the dry lake bed and the upper portion of the lake. Aquatic habitats within this system have been reduced to a few isolated wetland depressions.

With the availability of PCMRS, rehydration of the lake provided a natural solution to solve a significant water shortage, allowing mutual benefits to be realized. The feasibility of using excess reclaimed water from PCMRS to restore Crews Lake hydrology and adjacent wetlands was initially investigated in 2011. In 2015, the concept development of the CLNSR project was cooperatively funded by SWFWMD and Pasco County, and the two proposed the use of hydrologically altered wetlands in the north basin of Crews Lake as treatment wetlands to receive up to 4 mgd of reclaimed water, ensuring that water quality standards in the south basin of Crews Lake would be met. This included planning-level evaluations, permitting under 62-600 FAC, and preliminary engineering design of the CLNSR project and the expected water quality performance, hydroperiod restoration, and ecological improvements through application of reclaimed water to natural hydrologically altered wetlands. Figure 5 shows the proposed flow path for CLNSR.

With the addition of these three significant infrastructure improvements, the operational strategy for managing the water within the system was changing rapidly and significantly. The county needed a useful tool to help predict system response and understand how to operate the system going forward; however, the in-house model the county had developed was not sophisticated enough to provide the information at the level of detail necessary to get the answers needed for the evolving system.

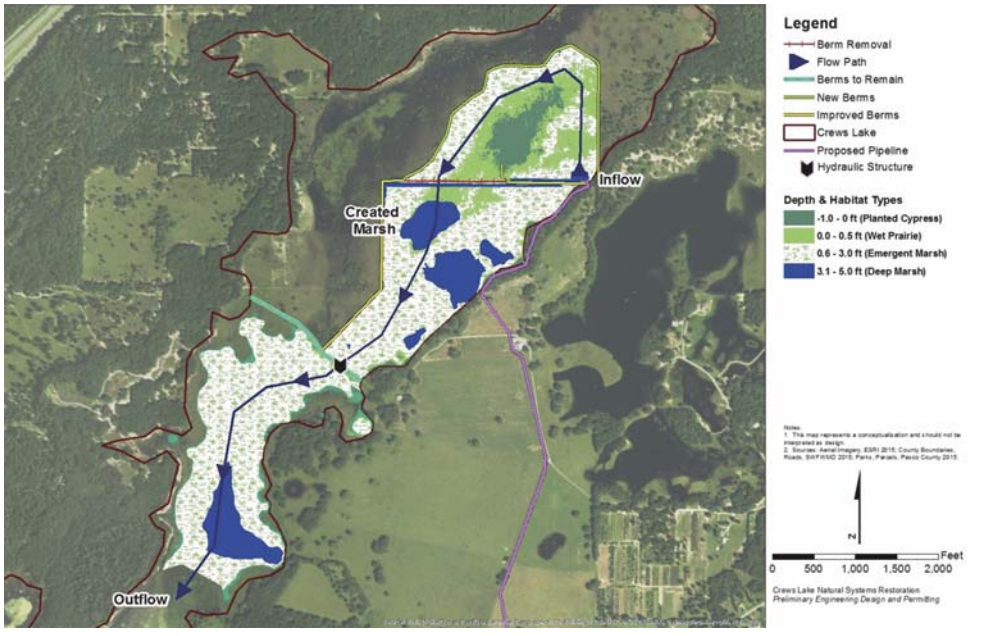

Figure 5. Planned flow path for Crews Lake rehydration project.

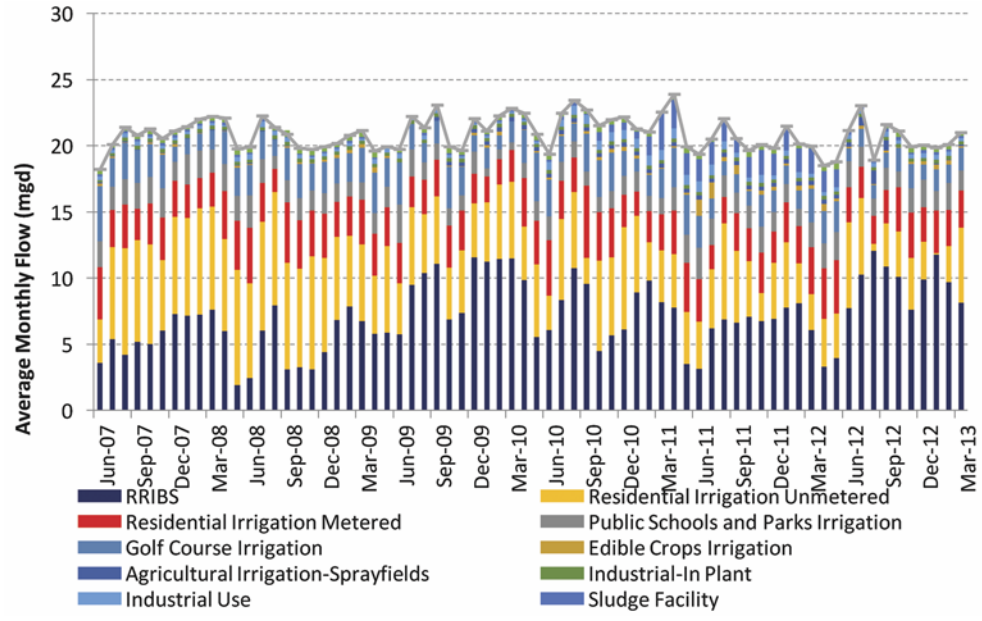

Figure 6. Current Pasco County Master Reuse System water balance.

Infrastructure Application to Meet Changing Demand

As the county's infrastructure evolved to meet both the growing population and the growing reuse supply, it became apparent that its operational strategy had to evolve with its infrastructure. This evolution was achieved through the use of water balance, field monitoring, and ultimately, the migration of the existing static model to a fully dynamic hydraulic model.

Current Conditions Water Balance

A water balance describing current conditions was developed in 2013, drawing from information contained within the annual reuse report and the PCMRS discharge monitoring report (DMR) for usage data. Supply data were taken from DMR data for the WWTF. Both metered and unmetered customers within PCMRS were used to accounting for all of the water produced by the six WWTF. To account for all of the water produced, the metered customers were

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compared to the total water produced; the remaining water was assumed to have been reused by the unmetered customers. Losses in the Land O' Lakes Reservoir and Lake Rita were included in the existing water balance. Because the Land O' Lakes Reservoir is lined, only evapotranspiration (ET) losses were included; for Lake Rita, both seepage losses and ET were included. In 2013, the Boyette Reservoir was not yet online, so it was not accounted for in the water balance.

Figure 6 presents monthly reuse within PCMRS from June 2007 through March 2013. For the period of the study, an average of approximately 39 percent of the total water reused within the PCMRS was reused by metered and unmetered Part III, with unrestricted access for residential customers. Approximately 34 percent of the total water reused within PCMRS was reused via Part IV RRIBS.

In Figure 6, other reuse costumers included golf course Part III reuse (10 percent), school and parks irrigation Part III reuse (8 percent), the sludge facility and the resource recovery facility Part VII industrial reuse (6 percent), crops/agriculture Part III reuse (1 percent), losses at storage facilities at the Land O' Lakes Reservoir and Lake Rita (1 percent), and in-plant reuse (1 percent). Figure 6 represents the total supply to PCMRS over this time period (green line at the top) and the breakout between the types of reuse (bars in mgd).

Table 1. Assumptions for projected demand data.
Pasco County Master Reuse System master plan update.

User Type	Basis for Growth Projections
Residential Users	
High Growth	Additional 200 customers first 2 years, 500 customers next 4 years, 800 customers years after
Average Growth	Additional 200 customers first 2 years, 500 customers years after
Low Growth	Additional 200 customers all the years
Public School and Park Irrigation	
High Growth	Additional 2 percent first 2 years, 5 percent next 4 years, and 8 percent years after
Average Growth	Additional 2 percent first 2 years, 5 percent years after
Low Growth	Additional 2 percent all the years
Golf Courses	No growth, monthly average values based on average of last five years of historic data
Edible Crops Irrigation	No growth, monthly average values based on average of last five years of historic data
Agricultural Irrigation	No growth, monthly average values based on average of last five years of historic data
Industrial In-Plant Use	No growth, monthly average values based on average of last five years of historic data
Industrial Use	No growth, monthly average values based on average of last five years of historic data
Sludge Facility	No growth, monthly average values based on average of last five years of historic data

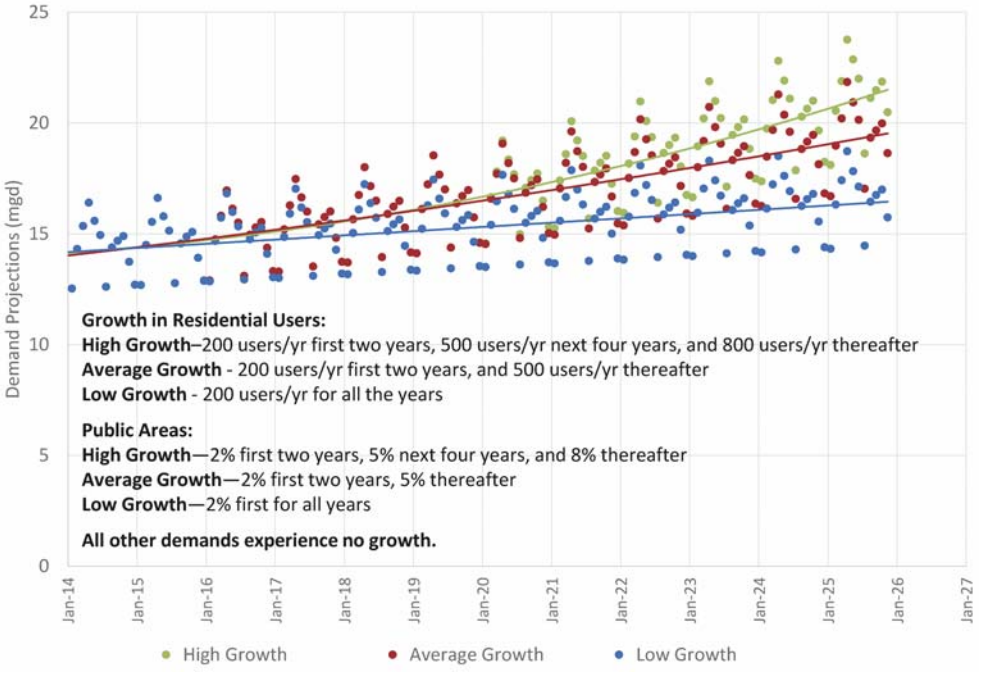

Figure 7. Reclaimed water demand projections.

Data Sources

Data used for the water balance from June 2007 through March 2013 were retrieved from monthly DMR and annual reuse reports. The DMR for the New Port Richey WWTF was provided by the county. The Land O' Lakes Reservoir storage was calculated from reservoir-stage data provided by the county. The Florida Department of Environmental Protection annual reuse inventory for 2012 was used as the base year for projecting reuse demands through 2025.

Projected Demand – 2014 Through 2025

To project the future water balance, three growth scenarios were evaluated: high, medium, and low. Residential and public areas were the only users that are projected to experience growth. Other user types are expected to remain with the same demand that has been experienced during the past five years. The assumptions for growth rates are based on past trends. Assumptions made for flow demand projections are listed in Table 1.

Figure 7 graphically presents the reclaimed water demand projections based on the assumptions previously presented.

Projected Supply – 2014 Through 2025

Water supply projections were completed from 2014 through 2025. Several assumptions were made, both for supply and demand. For the high-growth scenario on the supply side, available transportation analysis zone (TAZ) data were used, which were obtained from the county metropolitan planning organization. The TAZ data are a planning-level projection typically considered during the compilation of local and regional population projections, such as those used for state-required comprehensive planning. While this method achieves a conceptual level of agreement between planning populations and wastewater flow, such plans are typically somewhat aggressive in their growth rates. This could, in turn, lead to a higher projection than actually occurs; therefore, it is appropriate to use scaling methods to choose an appropriate "time zero" value and propagate the TAZ based projection through the analysis period.

Using the TAZ data, monthly flow projections were completed, and the trend-line slope derived from the projections were used for supply. For the average growth scenario, supply data were based on the trend-line slope of the last five years for historic flow data. For a low-growth scenario, supply data were calculated by subtracting the difference of high and average growth from the average growth flow data. All calculations were done on a monthly temporal scale, and seasonality was also taken into consideration.

Figure 8 graphically presents the reclaimed water supply projections based on the assumptions previously presented.

Future Water Balance

For the future water balance, the RRIBS operations located in the western county area were modeled by maintaining a constant average annual daily flow (AADF) throughout each projection year. This operational approach was selected to simplify day-to-day activities by leveraging the storage capacity of the reservoirs, as suggested by the county. Reservoir storage operating parameters were taken into account when determining what annual flow to convey to the RRIBS. In order to keep two weeks of PCMRS capacity stored at any given time, a minimum reservoir storage of 200 MG was used. In anticipation of a heavy rain event over a short period of time, such as a hurricane or tropical storm, a reservoir storage availability of 100 MG at any given time was used.

The PCMRS is supply-rich, meaning that there is sufficient supply for all of its projected customers. Because of this ample supply, wet years are the most concerning for the county. With the Boyette Reservoir now operational, storage of excess water for brief periods is not a problem. Figure 9 represents an average growth scenario water balance for PCMRS.

As shown in Figure 9, successful management of PCMRS will require understanding of how to leverage storage options during wet weather conditions, while maximizing beneficial reuse throughout all seasons.

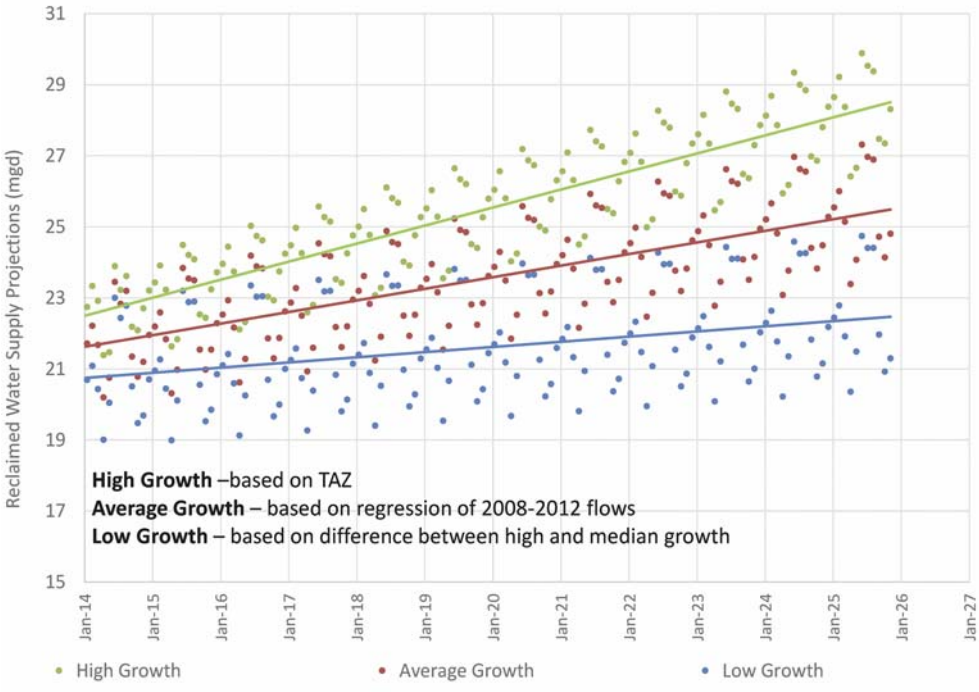

Figure 8. Reclaimed water supply projections based on transportation analysis zone data.

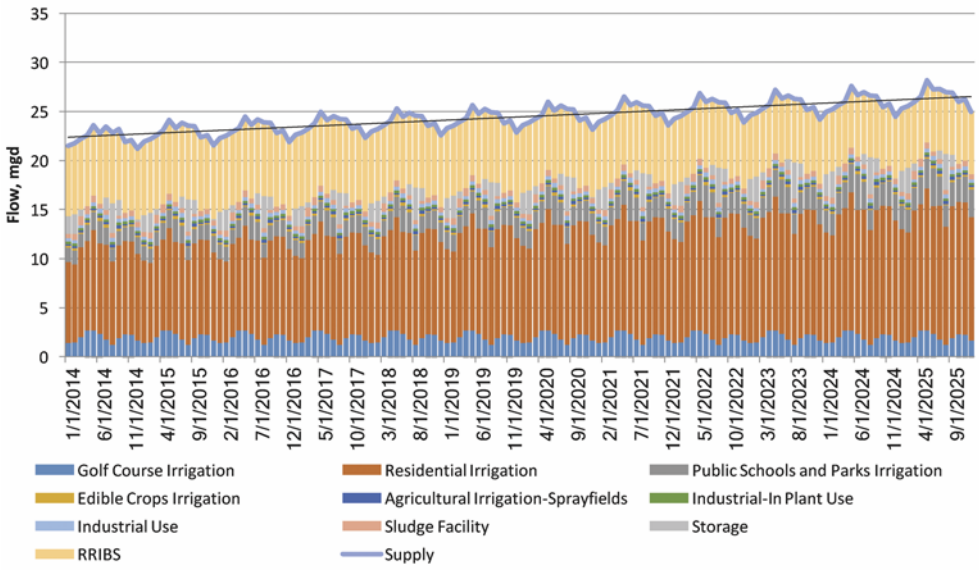

Figure 9. Water balance projection, average growth scenario.

Modeling

To provide the necessary answers to questions being asked by operations personnel on how to run the evolving system, the county needed an accurate, calibrated, and dynamic model. The goal was for the county to update the existing static model of PCMRS to a dynamic model. At the time, the county modeled PCMRS with a steady-state static diurnal model using Innovyze InfoWater. While the model was sufficient for long-term, lower-resolution planning tasks, it proved limited when the county looked to develop seasonal diurnal protocols with its new infrastructure, including the Boyette Reservoir. The calibrated model will help the county achieve the following critical success factors:

- Define operation protocol points for the PCMRS supervisory control and data acquisition (SCADA) system inclusive of the Boyette Reservoir and 4G
- Improve operational strategies
- Maintain reasonable pressure ranges within the system
- Improve the system to maintain reasonable flows
- Identify the ideal level of service for the system
- Improve disposal management
- Assure supply to new customers coming online now and in the future

To accomplish this task, the first hurdle was to overcome system data gaps.

The modeling task started with a data review and gap analysis. The result of the analysis was a desire to obtain more live-system data during operation, which would be necessary for the calibration of the dynamic hydraulic distribution model of PCMRS. In addition to data already being collected by the county, there was a temporary distribution system data collection effort. The proper calibration of this model is required to develop, run, and evaluate the scenarios necessary to view the system as a whole, make critical operational decisions, and perform future master planning.

The PCMRS monitoring program consisted of installing pressure and flow monitoring equip-

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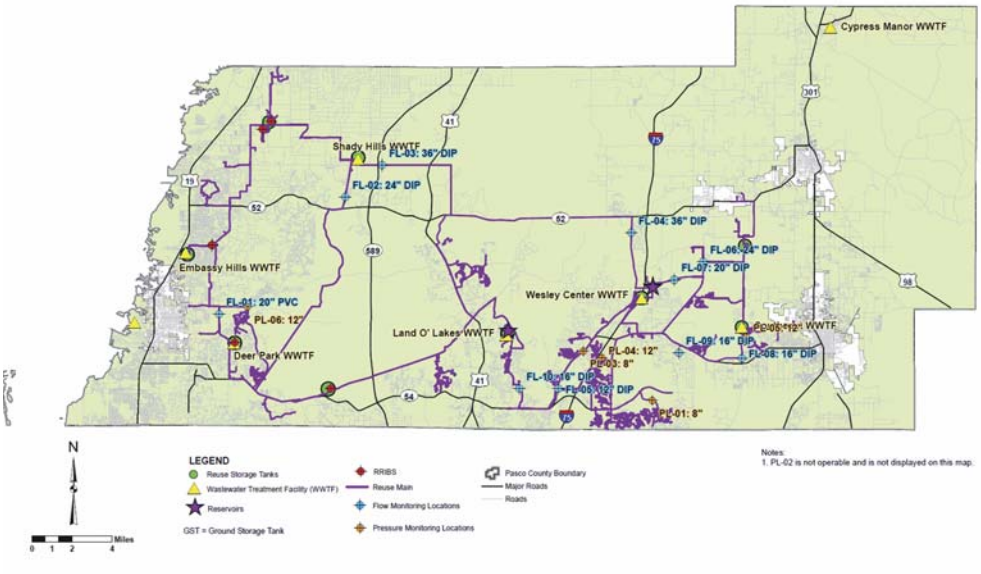

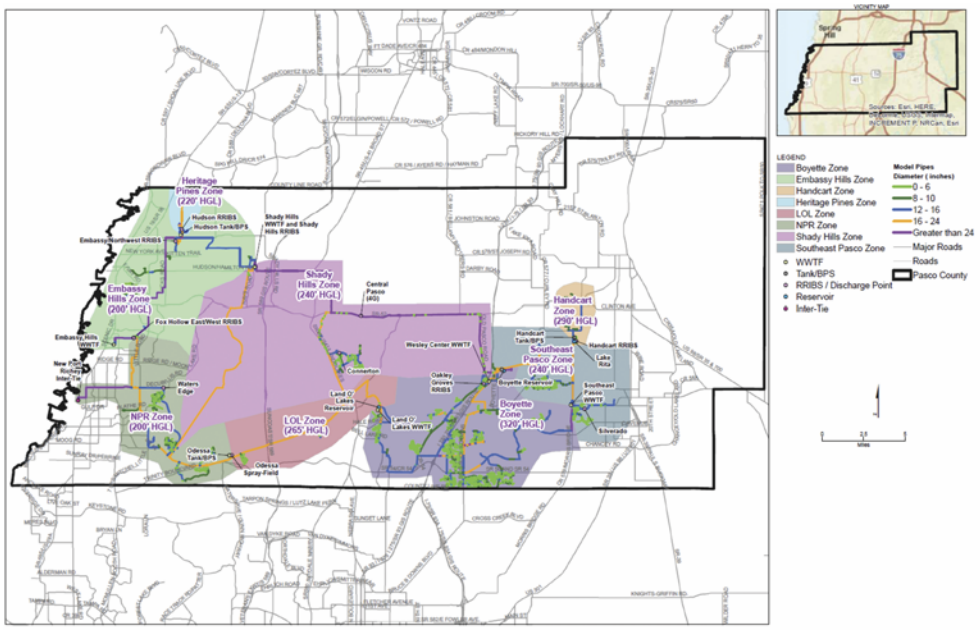

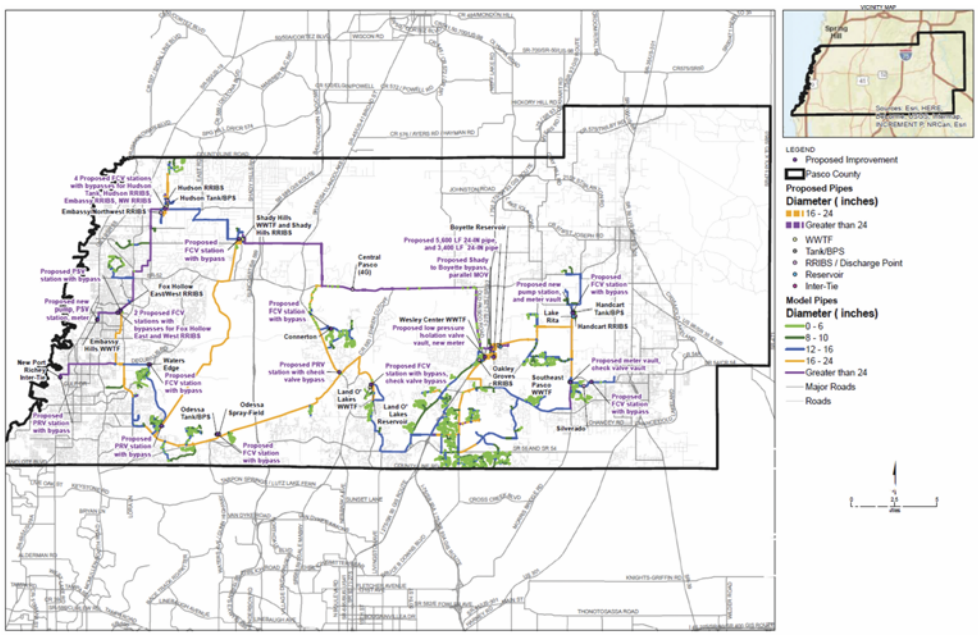

Figure 12. Proposed improvements.

and to collect field data during the monitoring period that will complement SCADA data (Figure 10). The goal of the field monitoring was to collect hydraulic performance data in PCMRS for a period of eight weeks. These data will be used for calibration of the dynamic hydraulic distribution model of PCMRS. The temporary flow and pressure monitoring equipment chosen was Hydreka HydrlNS 2™, which includes electromagnetic insertion rod flowmeters with varying insertion rod lengths, depending on the physical constraints of the flow monitoring sites. County staff installed 10 insertion meters (flow and pressure) that were previously described, with field observation and support. The insertion meters were located inside manholes installed by the county.

Field monitoring was conducted for 55 days, from Sept. 25 through Nov. 19, 2015; however, Oct. 5, 2015, marked the start of complete field data collection. Figure 10 shows the field monitoring site names and locations. The 10 flow and pressure monitoring loggers transmitted data wirelessly using short message service cellular technology. The meters monitored these data remotely, on a daily basis, and the data team took corrective action if data interruptions occurred.

Modeling Results

After the field data collection campaign, the model was calibrated for wet and dry periods. Three scenarios were run: wet, dry, and average. The results of the modeling indicated that the county should shift its operational strategy from an overall strategy to managing the system in individual pressure zones, loosely tied to the reclaimed water sources in the system. Figure 11 outlines the proposed pressure zones.

This is a significant shift in thinking regarding the system operation; a shift that would not have been possible without the addition of the Boyette Reservoir, 4G, and Crews Lake projects. Previously, all of the wet weather reuse had to be moved to the northwestern corner of the county to reach the RRIBS. Adding the reservoir, co-located to the majority of the current and future customers, and adding 4G, which is hydraulically on the reservoir supply line, allows the county to consider a completely different system paradigm. This shift in operations will ultimately simplify the operation of the system, while also improving reliability of supply to all customers.

In addition, because the system is recommended to be run pressurized all of the time, it is recommended that the county add valving

and other infrastructure to maintain the pressure zones to better manage movement of the water within the system as well.

In concert, the changed operational strategy, the infrastructure additions, and the proposed system improvements will work together to simplify the operation of the system overall.

Conclusion

The vision of PCMRS is to continue operations without a surface water discharge and to grow the residential customer base. To achieve this, the county will need the Boyette Reservoir and other options, like 4G and CLNR, to manage wet weather flows; however, as the county continues to grow, the reservoir will eventually switch from a wet weather flow management tool to a residential user supply source that will allow PCMRS to grow well into the future. To understand how to do this in the most efficient manner, the county has evolved the static PCMRS model into a dynamic model that will help it understand how to best manage it to ensure that customers get the reclaimed water they need.

Over time, PCMRS has evolved, both to respond to changing customer demands and to respond to changing supply, with no surface water discharge available for wet weather flows. The county has adapted operations accordingly, incorporating pressure zones and continued growth, which will likely influence operational needs. With a new dynamic hydraulic model available to support system design and operation, decision making should be greatly simplified. What this evolutionary stage has brought to PCMRS is increased operational control and flexibility, and it has positioned the county for more effective reclaimed water management into the future.