Development of a Cost Effective Centralized Wastewater System for Small Rural Communities

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Making the switch from on-site septic tank systems to a centralized wastewater system is challenging in itself. Add high groundwater tables, flooding and environmental issues, and coordination with regulatory agencies, several utility companies, two counties, and thousands of concerned citizens, and you have a truly challenging project.

The Astor-Astor Park Water Association (AAPWA) wastewater service planning area is along the St. Johns River just south of Lake George in northern Lake and Volusia counties. Within the area were seven privately owned utility systems considered as possible providers of wastewater service to the residents and businesses. However, none of the systems was capable of providing service outside of its existing certificated service areas because of limited collection, treatment, and effluent disposal capacities. Most of the systems were experiencing operational problems and permitting difficulties with regulatory agencies and could handle no additional flows. Since neither county was capable of providing wastewater service in the area, AAPWA appeared to be in the best position to provide the service, although its only experience was in providing potable water service to the area. The need to understand the requirements and demands of a wastewater system soon became evident to the AAPWA staff.

The project, which actually began in the late 1980s and early 1990s, didn't take hold until the late 1990s. The early problems with the project were twofold: the first being the development of a plan that was environmentally sensitive and acceptable to the citizens, and the second being development of a program that was financially feasible. What happened in the late 1990s that was different from the earlier attempts was that there was a greater push to obtain funds from a variety of sources.

Service Area

The AAPWA wastewater service planning area occupies a total landmass of approximately 23 square miles with a total population of about 3,700. In addition, the population density of the wastewater service area is spread out, with most of the customers located along State Road 40 west of the St. Johns River. While that figure is anticipated to increase due to the proximity of surrounding cities and direct access to the St. Johns River, an important aspect of the planning area is that the surrounding lands of the Ocala National Forest prohibit extreme growth.

Land characteristics range from a 0.5- to 1-mile wide strip of relatively level, rich soil along the St. Johns River basin to a 1.5-mile-wide upslope area with an elevation of 10 to 25 feet above mean sea level (MSL). The upslope area is followed by a relatively flat plain, about 25 to 30 feet above MSL, that extends to the Astor Park community about four miles west of the river, where sand hills begin. The sand hills slope up in a range of about 1 to 2 miles to elevations of about 60 to 70 feet above MSL. However, over 30% of the wastewater service area is located within the 100-year flood plain, which includes over 65% of the customer base of the proposed system. Furthermore, the majority of the soils that are encountered in the area are relatively poorly drained.

The area has long been noted as an environmentally sensitive area with outstanding fishing and water sports along the river and surrounding water bodies. Over time, residential and commercial development, particularly along the waterfront, had resulted in saturation of the individual septic tank drainfields and periodic overflow that reportedly has degraded water quality in the canals and portions of the river and caused potential health hazards.

System Evaluation

Because of the size and customer distribution within the proposed wastewater service area, it was decided to divide the program into three distinct phases. Phase I would encompass an area along State Road 40, involving about 550 customers, and would connect a majority of the single-family residential units and commercial customers. Phase II, connecting some of the private wastewater systems and a majority of the remaining residential customers in the central area of the planning area, would add about 750 customers. Phase III would address about 250 remote customers, primarily residential and private-utility systems in the outlying reaches of the service area. The total centralized wastewater program would connect more than 1,500 onsite septic tank/drainfield systems, and most of the private wastewater treatment systems in the area, to the AAPWA regional WWTP.

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The program examined and evaluated various wastewater collection and transmission systems, including the following:

1. Conventional gravity sewers.
2. Low-pressure grinder pump systems.
3. Septic tank effluent pumping (STEP) systems.
4. Vacuum sewer systems.
5. Small diameter gravity (SDG) systems.

Preliminary routing and design for each alternative wastewater collection and transmission systems were done for each of the three phases, and O&M costs, along with the advantages and disadvantages of each system, were addressed and evaluated.. The SDG system was eliminated from further consideration during the evaluation phase because of its limited use in the U.S.

As a starting point for the evaluation, preliminary engineering and designs quantified the components of each alternative wastewater systems. Summarized in the accompanying table are the capital and O&M costs for the alternative systems that will provide service to the customers in the first five years of the program (Phases I and II).

It was determined that the grinder low-pressure wastewater system was the most cost effective alternative for collecting wastewater within the service area. Moreover, the advantages of the three alternative wastewater collection systems, when compared to the conventional system, were similar in nature and included such items as lower construction costs, negligible impacts from I/I, and lower O&M costs. Also, the topography within the service area required that the conventional system incorporate a significant number of regional lift stations to transport the wastewater to the WWTP.

Next to be evaluated was the method of effluent disposal, because WWTP design is always dictated by the method of effluent disposal and the effluent limits it imposes on the treatment process. Several methods of effluent disposal were considered, including surface water disposal and a number of land application techniques. The idea of surface water

	Estimated Construction Cost		*Estimated Annual O&M Cost*	
System Alternative	**Phase I**	**Phase II**	**Phase I**	**Phase II**
Conventional System	$7,857,000	$9,997,000	$100,800	$71,900
Grinder Pump System	$5,155,000	$5,935,000	$31,500	$30,900
STEP System	$5,675,000	$7,419,000	$36,000	$36,800
Vacuum System	$5,238,000	$6,825,000	$44,100	$42,300

Notes:

1.Each of the alternatives included a major wastewater transmission system to transport the wastewater to the proposed WWTP.

2.The estimated annual O&M cost for Phase II includes the additional costs only attributed to the new facilities.

disposal was quickly discarded, primarily because it would be extremely difficult to permit and would contradict the overall goal of improving water quality in the St. Johns River.

Land application methods of effluent disposal evaluated for the AAPWA facility included the following:

1. Rapid infiltration basins.
2. Public access and restricted access spray irrigation.
3. Drip irrigation.
4. Subsurface irrigation.
5. Overland flow.
6. Natural and/or manmade wetland systems.

Capital costs for effluent disposal ranged from $340,000 to more than $890,000. Although spray irrigation was the least costly, it did not provide sufficient disposal capacity for the facility. Rapid infiltration basins were the next least costly option at approximately $510,000. It was determined that rapid infiltration basins were capable of disposing of the entire flow treated during the first two phases of the program.

The final area evaluated included the method of wastewater treatment and effluent disposal proposed. Based on the projected growth within the service area, a facility to treat 0.5 MGD was proposed for the initial phase of the program. Alternative treatment methods included the following:

1. Package WWTP.
2. Separate unit process tankage WWTP.
3. Sequential batch reactor (SBR) type WWTP.

Estimated costs for the three alternative treatment methods, inclusive of residuals management and effluent disposal facilities, ranged from $2,744,000 to $3,240,000. As expected, the package WWTP and the SBR systems were the determined to have the lowest cost and were within 5% of each other. The SBR system offered a number of advantages over the package type of facility, including a high tolerance for peak flows and shock loadings, process flexibility to control filamentous bulking, and the fact that all of the treatment is contained in one tank. Based on our experience, along with consideration of future construction issues and future expansion requirements of the facility, it was determined that the SBR was the most appropriate system.

In addition, provisions were incorporated into the design of the WWTP to treat the wastewater to a higher level and thus meet the requirements for public access reclaimed water reuse. Located adjacent to the WWTP site is a cemetery and fernery, both of which were determined to be viable options for the development of a reclaimed water reuse program as the system expands in the future.

In summary, the proposed system for the centralized wastewater system will consist of the following components:

1. Wastewater collection will be accomplished using a low-pressure grinder pump system discharging into a regional lift station that will convey the wastewater to the WWTP. The first phase will consist of more than 18 miles of low-pressure mains, the necessary number of grinder pump stations, and two regional pump stations. The second phase of the program will consist of more than 14 miles of low-pressure mains, the necessary grinder pump stations, and seven regional lift stations.
2. The wastewater generated within the service area will be treated with a sequential batch reactor process and basic disinfection process to meet secondary standards. Provisions have been incorporated into the facility to construct the necessary facilities to provide a higher degree of effluent treatment, or meet public access reclaimed water standards.
3. The effluent from the WWTP will be disposed of into three rapid infiltration basins.

The total estimated capital cost of Phase I of the AAPWA centralized wastewater system, inclusive of collection, treatment and disposal was estimated to be approximately $8,037,000.

Funding

Construction of the centralized wastewater facilities would require some type of funding assistance. Most of the individuals in this area are either retired or on limited incomes, and could not afford this service. Therefore, the goal of the development of a funding program was to maximize the grants received to develop a final average rate for wastewater service in the range of $30 to $40 per month for 5,000 gallons.

Based on preliminary investigations of the various grants available for the project, it was determined, based on average income, the area would fall within the poverty category for obtaining grants and loans through state and/or federal agencies. Moreover, during our discussions with funding agencies, it was determined that due to overall cost of the project, it would be best to divide the project into phases, which resulted in the program being divided into two primary phases.

A number of funding mechanisms was investigated, and our efforts resulted in obtaining grants in the amount of $5,000,000 for the first phase of the program. The funds (grants and loans) that were received for the first phase of the AAPWA centralized wastewater system included the following:

1. The United States Department of Agriculture Rural Development provided the AAPWA a grant in the amount of $2 million and a low interest loan in the amount of $2 million.
2. The state of Florida provided a grant in the amount of $2.5 million.
3. The Department of Commerce Economic Development Association provided a grant in the amount of $1 million for the commercial development along State Road 40.
4. Connection charges that will be paid by the customers of the system that will receive wastewater service during the first phase of the AAPWA centralized wastewater system.

The capital costs and annual O&M costs for the system, coupled with the grants and low-interest loans, resulted in an average monthly rate of approximately $35.43 for 5,000 gallons of service.

Funding is currently being pursued for the second phase of the program, primarily from the same sources that provided funds in the first phase. However, a higher grant request is being discussed from the state, and it appears promising. The total anticipated cost of the first phase of the AAPWA centralized sewer system was anticipated to be approximately $8,037,000, and the second phase approximately $5,935,000.

The project was bid in November 2000.

A total of five bids were received, ranging from $7,048,283 to $10,576,000. The breakdown of the low bid was as follows:

1. Construction of the low pressure grinder pump stations wastewater collection and transmission system: $4,165,155.
2. Construction of the SBR WWTP and effluent disposal system: $2,883,128.

Construction of the initial phase of the program began in February 2001. Final design of the second phase is anticipated to be completed in September 2001, with construction completed within 12 months, which will be concurrent with the completion of the first phase.

Conclusions

The AAPWA centralized wastewater system project was a unique application of alternative technologies from the collection of the wastewater to the treatment thereof, as well as the development of a funding program for a system that, on the surface, was not financially feasible. The program will ultimately satisfy the needs of environmental agencies in developing a centralized system to remove the on-site septic tank/drainfield systems and of homeowners, who were assisted in paying for the capital cost of the project.

The AAPWA experience illustrates that a small rural community with limited resources and funds can nevertheless work with the state, with federal officials, and with local communities to develop a cost effective centralized wastewater system. ■

Glossary of Common Terms Used in This Publication

ASR	aquifer storage and recovery
AWT	advanced water treatment
AWWT	advanced wastewater treatment
AWWA	American Water Works Association
BOD	5-day biochemical oxygen demand
BOD_x	BOD test based on other than 5 days
CBOD	5-day carbonaceous BOD
COD	chemical oxygen demand
cfm	cubic feet per minute
cfs	cubic feet per second
CWA	Clean Water Act
DEP	Florida Dept. of Environmental Protection
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FAC	Florida Administrative Code
fps	feet per second
FSAWWA	Florida Section of AWWA
FWEA	Florida Water Environment Association
FWPCOA	Fla. Water & Pollution Control Operators Assoc.
GIS	Geographic Information System
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
hp	horsepower
I/I	Infiltration/Inflow
MGD	million gallons per day
mg/L	milligrams per liter
MLSS	mixed liquor suspended solids
MLTSS	mixed liquor total suspended solids
NPDES	Nat. Pollutant Discharge Elimination System
NTU	nephelometric turbidity units
O&M	operation and maintenance
ORP	oxidation reduction potential
POTW	public-owned treatment works
ppm	parts per million
ppb	parts per billion
PSC	Public Service Commission
psi	pounds per square inch
PVC	polyvinyl chloride
RO	reverse osmosis
SCADA	supervisory control and data acquisition
SJRWMD	St. Johns River Water Mangement District
SFWMD	South Florida Water Management District
SRWMD	Suwannee River Water Management District
SSO	sanitary sewer overflow
SWFWMD	Southwest Florida Water Management District
TDS	total dissolved solids
TMDL	total maximum daily load
TOC	total organic carbon
TSS	total suspended solids
USGS	United States Geological Survey
WEF	Water Environment Federation
WRF	water reclamation facility
WTP	water treatment plant
WWTP	wastewater treatment plant

Editorial Calendar

January	Advanced Treatment.
February	Water Supply. Wastewater Disposal.
March	Residuals Management.
April	Annual Conference Issue.
May	Treatment Technology & Operations.
June	FSAWW /FWEA Awards. Misc. technical articles.
July	Disinfection.
August	Conservation/Reuse.
September	Industrial Wastewater. Stormwater.
October	Water Resources Management; FWPCOA Awards.
November	FSAWWA Conference; Misc. technical articles.
December	Collection & Distribution.

Technical articles are usually scheduled several months in advance and are due 60 days before the issue month (for example, May 1 for the July issue).

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