THE DEVELOPMENT OF A COST EFFECTIVE CENTRALIZED WASTEWATER SYSTEM FOR SMALL RURAL COMMUNITIES

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Introduction

Making the switch from on-site septic tank systems to a centralized wastewater system is challenging in itself. However, add high groundwater tables and environmental issues, close coordination with the regulatory agencies, the Astor-Astor Park Water Association (AAPWA), several utility companies, Lake and Volusia Counties, and thousands of concerned citizens, and you have a truly unique and challenging project.

Located within the wastewater service area there were seven (7) privately owned utility systems that were currently in operation and were considered as possible providers of wastewater service to the residents and businesses. However, none of these systems were capable of providing service outside of their existing certificated services areas due to their somewhat limited available treatment capacities. In addition, most of these systems were experiencing operational and permitting problems with the regulatory agencies, and thus could not handle any additional flows. Moreover, since neither Lake nor Volusia Counties were capable of providing wastewater service in the area, AAPWA appeared to be in the best position to provide this service, since they were in the utility business, although their only experience is being the purveyor potable water service to the area. Understanding the requirements and demands of a wastewater system soon became evident to the AAPWA staff.

The project, which actually began in the late 1980's and early 1990's, did not take hold until the late 1990's, when Hartman & Associates, Inc. (HAI) was retained in 1997. The early problems with this project were 2-fold. The first being the development of a plan that was environmentally sensitive to the area and acceptable to the citizens in the area, and the second being development of a program that was financially feasible to implement. What happened in the late 1990's, that did not happen with the earlier attempts was that there was a greater push to obtain funds from a variety of sources for this program.

Service Area

To understand the overall wastewater program, one must have an understanding of the service area that this centralized system will serve. The AAPWA wastewater service planning area is located in the central portion of Florida along the St. Johns River just south of Lake George in northern Lake and Volusia Counties. The City of Daytona Beach is located approximately 30 miles to the east and the City of Ocala is located approximately 36 miles to the west of the service area. The AAPWA wastewater service planning area occupies a total landmass of approximately 23 square miles. 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. Presently, the service area has a population of approximately 3,700 people, but due to the

close proximity of surrounding cities and direct access to the St. Johns River, the population of the area is anticipated to increase. An important aspect of this planning area is that it is surrounded by Ocala National Forest Lands, and are therefore isolated and protected from unreasonable growth.

The land characteristics range from a strip of relatively level, rich soil along the St. Johns River that is about 0.5 to 1 mile wide, to an upslope from about elevation 10 to 25 feet above mean sea level (MSL) that is about 1.5 miles wide. From the upslope area, the area is followed by a plain at about 25 to 30 feet above MSL that extends to the Astor Park community about 4 miles west of the river, where the 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-percent of the wastewater service area is within the 100-year flood plain, which includes over 65-percent of the customer base of the system. The majority of the soils that are encountered in the area are relatively poorly drained.

This area has long been noted as an outstanding natural area with fishing and water sports along the St. Johns River and surrounding water bodies. Over time, the residential and commercial development, particularly along the waterfront, has resulted in saturation of the individual septic tank drainfield's and subsequently the periodic overflow of these systems that has been reported to degrade the water quality in the canals and portions the river throughout the area. The result of these problems were reported by the Counties to be a degradation of the conditions that make the community so attractive and potential health hazards as a result of pollution in areas traditionally used for water recreation.

Centralized Wastewater System Evaluation

Due to the size and customer distribution within the service area it was determined to divide the service area into three (3) distinct phases. Phase I would encompass an area that would connect a majority of the single family residential units and commercial customers along State Road 40. Phase II would connect some of the private wastewater systems, as well as a majority of the remaining residential customers in the central area of the planning ar□□ea. Phase III would address the remote customers, who primarily would be residential and private utility systems in the outlying reaches of the service area. Phase I will provide service to approximately 550 customers, Phase II will provide service to approximately 750 customers, and Phase III will ultimately pvide service to approximately 250 customers. In summary, when the entire centralized wastewater is constructed over 1,500 onsite septic tank/drainfield systems, and most of the private wastewater treatment systems in the area will be connected to the AAPWA regional WWTP.

The AAPWA requested HAI to examine and evaluate the various wastewater collection and transmission systems available. The five (5) alternative wastewater systems evaluated included 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.

The overall goal was to determine which of the above alternatives had the lowest life cycle cost. Each of the above wastewater collection and transmission systems were laid out for each of the three (3) phases proposed for the centralized wastewater system. In addition, the capital and operation and maintenance (O & M) costs, and advantages and disadvantages of each system were addressed and evaluated. During the evaluation phase of the program, the SDS system was eliminated from further consideration due to the limited use of this type of system in the United States. As a starting point for the evaluation, preliminary engineering was performed to quantify the components of each alternative system for the project areas. Summarized below are the capital and operating costs for the alternative systems that will provide service to the customers in Phases I and II.

System Alternative[1,2]	Estimated Construction Cost		Estimated Annual O & M Cost[3]	
	Phase I	Phase II	Phase I	Phase II
Conventional System	$7,857,000	$9,997,000	$100,800	$71,900
Grinder Pump System	$6,155,000	$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 costs for Phase II includes the additional costs only attributed to the new facilities.

Based on the above, it was recommended that the grinder pump station system was the most cost effective alternative for the City to collect the wastewater within the service area. Moreover, the advantages of the three (3) 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 infiltration and inflow (I/I), and lower O & M costs. In addition, 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 wastewater treatment plant (WWTP) site. Based on results of this evaluation the grinder low-pressure wastewater system was determined to be the most cost effective and best alternative for the AAPWA.

The next 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 million gallons per day (MGD) was proposed for the initial phase of the program. Three (3) alternative methods of treating the wastewater generated within the service area were evaluated, which included:

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

The costs for the above methods of treating the wastewater generated within the AAPWA service area, inclusive of land residuals management ranged from approximately $2,744,000 to $3,240,000. As expected the package WWTP and the SBR systems were the determined to be the lowest cost alternatives and were within 5-percent of each other. However, the SBR system offered a number of advantages over the package type of facility. These advantages included 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 (1) tank. Based on our experience, future constructibility issues, and future expansion requirements of the facility it was determined that the SBR system was the most appropriate for this facility.

The final area evaluated included the method of effluent disposal. Although effluent disposal is the final component in a wastewater system, it is one (1) of the first component that must be considered when developing a wastewater program. This is due to the fact that the WWTP design is always dictated by the method of effluent disposal. Based on the method of effluent disposal utilized, the regulatory agencies have specified certain effluent limits for the treatment facility. These effluent limitations will then dictate the level of treatment required at the WWTP. Several methods of effluent disposal were considered, which included a number of land application techniques and surface water disposal. However, although surface water disposal was considered, it was quickly discarded. This was primarily due to the fact that the method would be extremely difficult to permit, and would contradict the overall goal of improving the water quality in the St. Johns River. The land application methods of effluent disposal evaluated for the AAPWA facility included:

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

The capital costs for the above five (5) methods of effluent disposal ranged from $340,000 to over $890,000. Although spray irrigation was the least costly, it did not provide sufficient disposal capacity for the facility. The RIB's were the next least costly option at approximately $510,000. The RIB's designed for this site were capable of disposing of the entire flow treated during the first two (2) phases of the program.

In addition, provisions were incorporated into the design of the facility to treat the wastewater to a higher level, and thus meet the requirements for public access reclaimed water reuse. Located adjacent to the WWTP is a cemetery and fernery, both of these sites are viable options for the development of a reclaimed water reuse program in the future as the system expands due to growth within the region.

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

1. Wastewater collection will be accomplished using a low-pressure grinder pump system that will discharge into a regional lift station that will convey the wastewater to the WWTP. The first phase will consist of over 18-miles of low-pressure mains, the necessary number of grinder pump stations, and two (2) regional pump stations. The second phase of the program will consist of over 14-miles of low pressure mains, the necessary grinder pump stations, and seven (7) regional lift stations
2. The wastewater generated within the service area will be treated using a sequential batch reactor process and basic disinfection process will treat the wastewater 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 a RIB system that consists of a total of three (3) RIB's.

The total estimated capital cost of the Phases I and II of the AAPWA centralized wastewater system, inclusive of collection, treatment and disposal was estimated to be approximately $12,090,000.

Funding

Based on the capital costs for the facilities, to construct the centralized wastewater facilities without the assistance of some type of funding would be cost prohibitive in this area. Most of the individuals that reside 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 the preliminary work that was conducted when investigating the various grants available for this project it was determined that based on the average income within the service the area would fall within the poverty category for obtaining grants and loans through the State and/or Federal agencies. Moreover, during our discussions with the funding agencies, it was determine 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 (2) primary phases.

A number of funding mechanisms were investigated, and our efforts resulted in obtaining grants in the amount of $4,000,000 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 include the following:

1. The United States Department of Agriculture (USDA)-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 the AAPWA a grant in the amount of $1-million.
3. The Department of Commerce Economic Development Association provided the AAPWA with 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.

Based on 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 AAPWA centralized wastewater program, which includes primarily the same sources that provided funds in the first phase. However, a higher grant request is being discussed from the state of Florida, which based on the preliminary discussions appear to be promising. The total anticipated cost of the first phase of the AAPWA centralized sewer system is anticipated to cost approximately $6,155,000, and the second phase is anticipated to cost approximately $5,935,000.

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 both environmental agencies in developing a centralized system to remove the on-site septic tank/drainfield systems and the 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 work with the State, Federal and local communities to develop a cost effective centralized wastewater system

Construction of the first phase of the AAPWA centralized wastewater is anticipated to begin in May 2000, and be completed within 18-months. The final design of the second phase of the centralized wastewater system is anticipated to be completed in October 2000, with construction completed within 12-months, thereafter, which will be concurrent with the completion of the first phase.