Comprehensive Program Approach to Wastewater Collection System Improvements in the City of Fort Lauderdale

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The city of Fort Lauderdale is committed to enhancing the quality of life in the community by providing modern, reliable wastewater service to all customers, improving the quality and reliability of drinking water, reducing adverse environmental impacts and leaving in place a sustainable infrastructure for the future.

The capital improvements needed to meet these goals were outlined in a 20-year master plan (*CH2M Hill/Hazen and Sawyer, December 2000*), developed and adopted in early 2001; however, a decision was made by the city commission to condense the time frame from 20 years to fewer than 10 years, so that all improvements would be completed prior to the city's centennial in 2011. The commission also established a firm budget of $550 million for completing the improvements developed in the master plan.

There are four major components to the goal of providing modern, reliable wastewater service to all city residents:

1. Adequate wastewater treatment plant capacity to meet the needs of the new service area.
2. Construction of new sewers in the 40 percent of the city currently served by onsite disposal systems.
3. Removal of infiltration and inflow to reduce wastewater flows to the plant and the cost of treatment.
4. A reliable wastewater conveyance system with adequate capacity to serve the new areas to be serviced, as well as those areas being redeveloped to a more intensive use.

Upgrading the wastewater conveyance system, specifically the pump stations and force mains, is the focus of this article. The gravity collection system currently consists of approximately 340 miles of pipeline. Over the course of the next eight years, more than 120 miles of additional gravity sewers will be extended to areas currently not served by the system.

The gravity sewer system is supported by 144 existing pump stations, which will be expanded by an additional 30-35 pump stations as new service areas come on line. The stations, in turn, rely on a 110-mile network of force mains, ranging in size from four to 54 inches, located throughout the city's service area.

In addition to the local pump stations, there are three "in-line" re-pump facilities that collect pumped effluent from three of the five major sub-basins and direct the flow to a single wastewater treatment facility located in the southeast corner of the city. The conveyance system also provides four connection points for large users, including the cities of Oakland Park, Wilton Manors, Tamarac, and the Port Everglades facility.

In recent years, most of the city's capital improvement funds allocated to the conveyance system were spent on increasing the system capacity in localized areas to meet growth and redevelopment demands and to address the most serious deficiencies identified by various studies and master plans. Little attention was paid to the overall network and to the interaction of the various components. There were a number of major problems occurring throughout the system:

- Aging Infrastructure—Leaking mains under waterways, several of which had been closed and the flows rerouted. Older, deteriorated force mains in other locations experienced failures and subsequent discharges.
- Insufficient Capacity—Increased back pressures in the system from increases in flow, undersized force main and new pump stations, both city owned and privately developed. Pumps at many stations could not keep up with flows under even normal conditions, with extended run times and periodic overflows. The city was also facing a potential building moratorium in some areas if capacity issues were not addressed.
- Excessive Inventory—Pump stations of various designs and as many as 20 different pump manufacturers were difficult to maintain.
- System Reliability—There were no relief mains between the sub-basins to provide back-up or redundancy under emergency conditions.

These deficiencies had created environmental and reliability problems that in turn had attracted the attention of the regional permitting authorities. In the face of a lack of capacity, accidental discharges, regulatory compliance, the threat of a building moratorium, and excessive maintenance demands, it was time to take a comprehensive approach to system renewal, rehabilitation, and expansion.

Prior to the completion of the master plan, a wastewater conveyance system capacity analysis (*CH2M Hill, October 1998*) was completed to evaluate both the capacity and condition of the conveyance system components. This analysis, which included a Cybernet hydraulic model, identified over $135 million in improvements required with various priorities:

- Immediate Action Required—Force main leaking or in imminent danger of failure or with excessively high flows. Pump stations not able to meet normal flow conditions on a regular basis or with serious electrical, mechanical, or structural deficiencies that could result in immediate failure. Estimated cost: $6.8 million.
- Action Required in the next Three to Five Years—Projects needed to meet the current growth and flow requirements. Estimated cost: $13.6 million.
- Long-Term Improvements Required—Projects required to meet planned growth and additional service needs. Estimated cost: $114.6 million.

While the conveyance analysis was eventually rolled into the master plan, many of the immediate action projects were acted on quickly to avoid serious service or environmental problems. It was apparent that the magnitude of the required conveyance improvements and the relationship to other infrastructure improvement projects, along with the other goals of the master plan and the city's desire to complete the improvements in a shorter time frame, would require a different approach to project implementation that extended the capabilities of the city's traditional procurement strategies.

Historically, the city would bid approximately $10 million a year in capital utility improvement projects. The accelerated program would require bidding an average of $5 million per month. The increase in volume would strain resources in planning, design management, inspection, and finance and would result in widespread construction activity throughout Fort Lauderdale that must be coordinated.

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To meet the city's goals, the *WaterWorks 2011* program was created and a program management team (PMT) was formed as a partnership between the city of Fort Lauderdale and CH2M Hill, supported by a team of design consultants. The PMT was established to oversee the planning, funding, design, and construction of over 300 projects during the next eight years with the assistance of the Fort Lauderdale Engineering Department and seven outside consulting firms. The PMT had the full support of city administration and the city commission, whose members were then included as active participants in the early planning and development workshops.

Program Development

While the master plan and related documents were developed in association with city utilities personnel, it was recognized early in the program that consensus must be attained with the extended program team to insure that projects proceeded on schedule and the ultimate results were as expected. There were a number of overall issues that had to be resolved prior to proceeding with projects, such as design standards, specifications, and details.

The city's *Bluebook—a* set of contract documents, specifications, and details—provided a basis for developing program standards, but the *Bluebook* had not been substantially revised since 1982 and did not contain any information relative to the design and construction of projects with mechanical and electrical equipment.

Design criteria for facilities such as wastewater pump stations were left up to the multiple designers involved in the projects, including the city engineering department, resulting in many different designs throughout the system and no standardization of components. In addition, there was no universal agreement between engineering and utility operations staff that the provisions of the Bluebook or related policies really provided the facilities desired for efficient operation and maintenance of the system.

The PMT includes CH2M Hill and subconsultant design, planning, project, and construction management staff, as well as administrative positions necessary to provide support to the program activities in the areas of finance, scheduling, document control, legal issues, grant procurement, quality assurance, and public outreach and communication.

One key to the success of the PMT is the co-location of CH2M Hill and city staff fully committed to the program. City staff in the PMT office include administrative, legal, design and construction management, as well as a complete design team dedicated to the design of capital improvement projects defined by the master plan. In this role, the city design team functions in a manner similar to the three design consultants that provide design support to a portion of the projects.

The city design team prepares designs for public bidding, as well as plans for pipelines to be installed by the city's in-house pipe crews. In addition, they legitimize the role of the PMT as an extension of city staff and provide an established communication link to utilities management, operations and maintenance staff that assisted in the development of standards for the upcoming projects.

The initial development of the program plan for wastewater conveyance was taken directly from the master plan and the conveyance analysis. Although the development of these documents involved the input from staff throughout the utilities organization, they did not necessarily include the key operations and maintenance staff that would end up "owning" the improvements made.

Program Planning

The first step was to finalize the projects defined by the master plan and develop an implementation plan. A series of workshops was held to discuss the conveyance system issues and establish the criteria for the program. Those invited to the workshops included city design staff (including those who had previously worked on utilities projects but who had decided not to join the PMT) consultant design staff, utilities administration, and operations staff. Although the conveyance analysis established project priority based on condition and capacity considerations, the projects were reprioritized according to the following criteria:

1. New pump stations and force mains required to serve the initial sewer area projects.
2. Pump stations and force mains with capacity or operational problems that would be impacted by flows from the initial sewer area projects.
3. Pump stations and force mains with existing structural or operational deficiencies—these stations were further ranked by subjective consideration of the severity of the problems.
4. Pump stations and force mains with existing hydraulic limitations.
5. Pump stations of inferior design or those difficult to maintain and repair.
6. Pump stations where hydraulic limitations will occur after other conveyance improvements are made or as additional flows are put into the system.

Similar projects were combined into groups based on the type and location of the construction. It was also recognized that priorities could change as a result of ongoing improvements and their impact on the system. Although the hydraulic model is a useful tool, the dynamics of a force main and pump station model are much more complex than a more static water main model, with the many pump stations operating at different times and under varying flow conditions. Major force main improvements and redirection of flow are expected to result in the need to modify pump stations that are not currently on the priority list.

The program delivery plan is structured to respond to changing priorities and to reallocate funding from less critical tasks. In addition, related projects are linked so that schedule deviations that affect another project are recognized and the appropriate measures can be taken.

The next step was to finalize design standards and criteria, specifications for equipment, material and construction activities, and standard details to be used for pipeline and pump station projects. The goals were to increase uniformity in the system, reduce maintenance costs, and improve the efficiency of operations staff. The workshop format was continued and the same staff was involved to insure buy-in to the recommendations.

Design criteria, specifications and standards discussed and agreed to included the following:

- New and rehabilitated pump stations would be wet-pit submersible facilities with a separate valve vault. All new wet wells would be provided with a corrosion-resistant internal lining system.
- Substandard existing pump stations would be converted to wet- or dry-pit submersible facilities.
- All wastewater pumps would be provided by no more than four manufacturers based on performance history and availability of local service. Pump vendors would be periodically evaluated and substitutions would be made as necessary.
- All level control in new and rehabilitated pump stations would be provided by the use of submersible pressure transducers. Several units were evaluated on a trial basis and were found to be more reliable and require less maintenance than the bubbler, float or ultrasonic systems previously used.
- Two-, three-, and four-pump control panel schematics based on a previous design used and accepted by the city were refined and made into standards to be used for all new pump stations.
- Force main piping would be epoxy-lined, ductile iron with external coatings or corrosion protection as required by the specific site conditions. Force mains installed by directional drilling would be HDPE.
- Where required, joint restraint is to be provided using manufacturer's restrained joints. Mechanical joint restraint is to be used only where field-cut joints are necessary. Restraining gaskets are allowed for use only on mains less than 12 inches in diameter.
- Specific manufacturers and products were

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approved for use in control panels to reduce training requirements and reduce the cost of spare parts inventory. Named items included relays, motor starters, time-delays, pump controllers, level control, and breakers.

• Control valves, check valves, and air and vacuum relief valves would be procured only from named, specific manufacturers based on performance and service history.

The design criteria and standards were put into master specification and standard detail format to be utilized by the design consultants and the city design team. Inspectors and construction management staff were provided with training on the new standards to insure that they were implemented during the construction phase. Eventually these standards will be incorporated into an updated city standard specification to be applied to all city projects requiring a municipal standard.

The final step in preparation for design and construction was to open a dialogue with the residents in areas affected by specific projects. The concern initially was that the many concurrent projects would result in disruption and traffic impacts throughout the city that would have to coordinated and planned in advance. Also, as the first few projects initiated construction, it was realized that the compression of project schedules to fit the overall program schedules also resulted in more severe impacts within each project area.

The public outreach program is initiated prior to or early in the design phase to provide adequate opportunity for input into the design process. The outreach program includes mailings, articles in newsletters, a program Web site, and public meetings to present the proposed project at various stages. The public outreach continues during construction in the form of weekly plans of anticipated construction activities and updates of traffic routing plans.

The public outreach program also includes forming a partnership with regional regulatory agencies responsible for approval of the proposed projects. In the early stages of the program, this involved presenting the overall program plan and including agency representatives in the planning and development workshops.

As stand-alone projects, there were several that may have been delayed due to the perception that inadequate capacity existed in a related part of the system. It was important to demonstrate the relationship between projects and the time of completion to assure the approving authority that concurrent projects would be completed in the proper sequence to eliminate concerns. This approach maintained the program's ability to manage the overall schedule, rather than have project schedules mandated by others.

Project Execution

The early start for critical projects, advance planning, and cooperation between designers and operations have helped reduce the time it takes to get projects from planning to completion. The PMT has been in full operation since early 2002, with a significant increase in the number of projects in design, under construction, or completed than what might have been expected using traditional project delivery methods:

• Two major (2000 and 550 gpm) pump stations have been reconstructed.

• Phase I of a 24-inch force main in the heavily developed beach area, including a 900 LF direction drill under a waterway, has been installed.

• A second 24-inch force main, including two directionally drilled crossings, is under construction.

• Two new pump stations with connecting force mains have been constructed in areas being provided with new gravity sewers.

• A new 20- and 16-inch force main with a directionally drilled highway crossing is being advertised for bidding.

• Ten additional pump station rehabilitations will be advertised for bid by the first quarter of 2004 with an additional 10 stations in the early stages of design.

• The contract for rehabilitation of the three re-pump stations will be advertised for bidding at the end of the year, with the schedule dictated to complete one station per year.

• A major new east/west force main ranging in size from 20 to 54 inches is under design to provide relief to the existing network and provide additional capacity for the new service areas in the western part of the city. The project includes interconnects with major north/south force mains and will cross under two railroad right-of-ways, a major waterway, and Interstate Highway 95.

• Thirteen additional new pump stations and their connecting force mains for new sewer service areas are currently under design.

The estimated construction value of the conveyance improvements over the three-year period covered by these projects is over $21 million. This work is concurrent with the water and wastewater plant projects, the sewer area developments, the sewer rehabilitation, and the water main improvements being undertaken by the same program team.

The hydraulic model originally done as part of the 1998 study has been updated and further calibrated for use as a tool by the project designers. The model will be used to evaluate the need to modify existing facilities as the new improvements are brought on line and as a basis for design. Older force mains will be examined for potential corrosion failures or other damage and worked into the program as required. The original financing model included sufficient funding to account for unexpected conditions and changes during the course of the program.

Success Factors

The success of the program, and in particular the upgrading of the conveyance system and the ability to execute the work in a relatively short period of time, is due to a number of important changes in how the city typically completed projects:

• Integrating city and consultant staff into a unified team.

• Planning project development and implementation schedules based on input by the end users.

• Utilizing public outreach to advise affected residents of what to expect during the construction period.

• Developing design and construction standards with consensus from operators of the systems.

• Holding advance discussions with regulatory agencies to facilitate project approvals and avoid mandated project schedules.

• Managing construction of all projects to provide consistency in inspection, submittal review, and overall coordination of construction projects.