Private Building Sewer Rehabilitation Pilot Program

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Sarasota has taken a proactive approach to avoiding the increasingly aggressive enforcement actions implemented by EPA and DEP towards municipalities that routinely experience sanitary sewer overflows (SSOs) and other compliance violations of the Clean Water Act. The proactive approach is evidenced by the city's continuing efforts to maintain and improve its infrastructure and level of service.

For over 20 years the city has expended considerable effort and funds to improve its sanitary sewer infrastructure in an attempt to provide adequate capacity and reduce significantly the amount of I/I into the sewage collection system and ultimately the wastewater treatment facility. The improvements, focusing generally on the sewer main lines, manholes, lift stations, and force mains within the public right-of-way, included new and larger facilities to accommodate growth and increase the overall capacity of the collection and transmission system. Because of the Sarasota's coastal location, chloride studies were performed to identify and eliminate sources of saltwater intrusion. Smoke testing and other conventional survey methods have been used to identify and eliminate sources of inflow and infiltration. The defects identified during these types of investigations have been documented and repaired on an ongoing basis.

In January 1996 the city and the engineering consulting firm of PBS&J performed a sanitary sewer evaluation survey (SSES) on the Southwest Collection System, which consists of approximately one-third of the city's entire collection system and includes barrier islands and low-lying coastal neighborhoods, as well as residential and commercial property on the mainland. While much of the area had been previously studied, it was still prone to the influence of extreme wet weather.

The purpose of the SSES was to decrease the amount of I/I in the city's sewage collection system. This was accomplished by identifying defects in the collection system, prioritizing the defects for repair based on their severity, recommending repair alternatives, and repairing the defects.

Standard SSES methods were employed, beginning with the smoke-testing of nearly 260,000 feet of gravity sewers and the connecting service laterals and building sewers. Once the smoke-testing was completed, the areas that were prone to the influence of wet weather were flow-isolated in an attempt to identify the sections that were likely to have the significant defects. If abnormal evening flows were present during the flow isolation, the sewer lines were scheduled for cleaning and TV inspection.

Chloride testing to determine whether salt water was present in the collection system was performed during spring tides in the early morning hours. The results verified that previous efforts to eliminate salt water I/I had been successful.

The TV inspection revealed the greatest amount of information about the condition of the sewage collection system. Cracked pipes, root intrusion, mineral stains, broken or dislodged joint gaskets, and offset joints were easily identified, even though infiltration may not have been present at the time of the inspection.

The sewer defects were prioritized based on severity and locations. Defects were rated from one to five, with five being the most severe. The highest priority was given to defects rated three or above and that were located beneath heavily traveled roadways. High priority was also given to defects rated four or above within any part of the collection system. Once the defects were prioritized, a construction contract was prepared and bid and the work was performed.

Defect Rating	Description
1. Minor defect —	no sign of infiltration
2. Minor defect —	signs of infiltration
3. Medium defect —	signs of infiltration and/or structural integrity questionable
4. Major Defect —	structural integrity in jeopardy
5. Major defect —	structural failure, collapsed pipe

It was estimated that approximately 90,000 gpd of extraneous flow existed in the southwest collection system during the 1996 SSES under typical wet weather conditions.

During the SSES coastal Sarasota experienced a storm surge generated by Tropical Storm Josephine. More than a foot of seawater covered much of the barrier islands. Relentless efforts by the city's staff to continuously monitor the groundwater elevation in the few areas not submerged by the storm surge provided the data that launched the first of several studies.

All of the manholes in the area had rain dishes with tar-sealed manhole covers installed prior to the storm surge. The surge caused two of three lift station service areas on north Siesta Key to surcharge and overflow. Lift Station No.18, for reasons unknown at the time, did not experience flooding or overflows despite being covered with more than a foot of water. As the storm surge began to recede, Lift Station No. 18 was immediately investigated for clues as to why its collection system weathered the storm.

The evidence revealed only one condition that differed from the other failed systems. The majority of the homes in the Lift Station No.18 service area had been recently renovated or reconstructed, and a majority had new PVC building sewers between the homes and the public rights-of-way lines.

Later that same month, during a flow-isolation study in the same area, a single sewer run between two manholes revealed a 31 gpm flow increase during a rain event - half of the total quantity estimated for the entire southwest collection during the 1996 SSES. The groundwater had risen over 12 inches. Flow at the city's treatment plant jumped from 6.7 MGD just before the rain to approximately 8.6 MGD, and peaked at over 9 MGD just after the rain. During the TV inspection conducted shortly after the event, it was observed that nearly 50 percent of the laterals were steadily running, while the water meters to the property were not.

It was now evident that the conventional methods used during the 1996 SSES did not reveal the real I/I problem, and that the quantity of I/I (90,000 gpd) estimated in the southwest collection system under typical wet weather conditions was radically insufficient and was not representative of extreme wet weather I/I problems. These discoveries triggered further investigation in other areas of the city.

Lift Station No. 5 Pilot Study

Improvements to the city's collection system continued throughout the next year. The defects identified on north Siesta Key were repaired, and the majority of the remaining improvements for the project were nearly completed. The city's focus turned to Lift Station No. 5, primarily because of its location. Situated on Bay Island, a part of north Siesta Key, a barrier island to mainland Sarasota, the collection system for Lift Station No. 5 is surrounded by the waters of Sarasota Bay and receives no additional wastewater flow from other service areas or mini-systems, which made it an ideal setting for evaluating I/I. Also, the location relative to Sarasota Bay should make any tidally influenced I/I easily identifiable. The system has several different types of service lateral pipe materials varying in age from 40 years to recently installed, and there was a minimal amount of residential traffic to interfere with the field evaluations and the rehabilitation.

A data recorder was installed in the lift station to monitor inflow and pumping volume. City staff took groundwater measurements manually, and rainfall was measured by a nearby rain gauge at another pumping station.

On September 27, 1997, after a summer of little rain and low groundwater levels, Sarasota experienced a storm that produced over three inches of rain. It was the first of nine significant storm events between September 1997 and March 1998. Although this first event increased the flow in the lift station to nearly double the average, the lift station was able to keep up, and the sewage flow and groundwater level returned quickly to normal as the storm passed. Over the next six months, when nearly 25 inches of rain fell on Sarasota, Lift Station No. 5 and other areas within the city experienced backups and overflows with almost every storm.

The final major storm of the 1997-1998 winter on March 18, 1998, produced nearly 4.5 inches of rain. Although that was not the largest rain event during the winter, it produced the largest flows to the city's treatment plant - in excess of twice the normal wet weather flow.

Groundwater readings taken before, during, and after the storm showed the highest peak of groundwater encountered during the winter. During these conditions, the groundwater levels within the study area were observed and recorded within inches of the surface. Several areas were completely saturated for days after the storm, as evidenced by the groundwater seeping from elevated properties onto the streets and drives. With the groundwater levels that close to the surface, the privately-owned building sewers from the public right-of-way to the houses became partially or wholly submerged.

When the groundwater table is low, flows to the city's treatment plant average about 6.0 MGD. Typical wet-weather flows average around 8.0 MGD. During a moderately heavy rainfall event, the average flow to the plant may rise to as high as 10 MGD.

Normal high groundwater elevations alone contribute some extraneous flows into the collection system, specifically the sewer main lines and service laterals within the right-of-way. However, data collected throughout the pilot study suggested that the major flow increases into the Lift Station No. 5 collection system, such as the one that occurred on March 18, 1998, do not occur until the groundwater rises to an elevation high enough, or until the rain saturates the ground enough, to partially or wholly submerge private building sewers.

In years past, the focus of rehabilitation and I/I reduction had been in the sewer main lines with measurable but limited success. Though I/I reduction has been accomplished over the past several years, the city still experienced, and continues to experience, hydraulic overloads during extreme wet weather events.

Based on recent flow data and design calculation estimates, the normal sewage flow range for Lift Station No. 5 is between 10 and 30 gpm. The collection system's maximum capacity, as restricted by pipe sizes and pumping capability, is approximately 90 gpm. SSOs would occur when the flows to the collection system exceed the maximum capacity of the collection system.

From the time the sewer main line repairs were completed in mid-December 1997, flows from two to over four times the monthly average have been experienced during extreme wet weather conditions. Therefore, it was concluded that the remaining sources of I/I into the Lift Station No. 5 collection system could only stem from the service laterals, specifically, the building sewers that are located on the private property. Therefore, Sarasota turned the focus of its rehabilitation efforts to a private building sewer rehabilitation program.

Private Building Sewer Rehabilitation

City personnel decided to include the Lift Station No. 1 service area, a low-lying coastal area with mostly older homes and sewers on the mainland side of the north bridge to Siesta Key, in addition to the Lift Station No. 5 service area. The pilot program includes 511 private building sewers that require being located, inspected, and rehabilitated (if needed). It was also decided that the program would be broken into two phases.

Phase 1 would include locating the service lateral at the right-of-way line, exposing the pipe, installing a clean-out, and performing a TV inspection. At the time of the TV inspection, the condition of both the private building sewer (the clean-out at right-of-way line to the house), and the service lateral (from the clean-out at the right-of-way to the connection at the sewer main line) would be observed for defects.

Phase 2 would include the rehabilitation or replacement of the private building sewers.

The collection systems for Lift Stations No. 1 and No. 5 have several different types of service lateral pipe materials that vary in age from over 40 years to recently installed. As houses are remodeled, the service laterals are seldom replaced. New house plumbing is usually tied into the existing service lateral pipe, regardless of the condition. Unfortunately, no current ordinance exists that requires homeowners to upgrade or replace building sewers during renovations.

The most common materials found for service lateral pipe are Orangeburg, cast iron, vitrified clay, and PVC. Orangeburg and cast iron are two materials that, if given enough time under typical sewer conditions, will fail and should be replaced or rehabilitated regardless of condition. Vitrified clay pipe, though very brittle, will not corrode or deteriorate, but it commonly has two or three foot joints that give way to tree and plant roots. Past experience indicates that these should also be replaced or rehabilitated.

PVC pipe is the most common of new materials used for building sewers. Existing PVC building sewers should be relatively new and in good condition, but should also be inspected and replaced or rehabilitated if defects are found.

There are several important considerations in providing an effective and feasible solution to the I/I problem from private building sewers, including identifying which building sewers are contributing to the I/I problem, convincing the property owner that there is a problem needing fixing, accessing the private property, determining alternative methods of rehabilitation, and funding the rehabilitation.

Phase 1 of the pilot program, during which the building sewers would be inspected for defects, would identify which of the building sewers are contributing to the I/I problem.

Convincing a property owner with the I/I problem that there was indeed a problem, and that the problem needed to be fixed, posed a significant challenge. Funds for a public information program had been set aside to inform the community of the problems that the city has with the collection system during extreme wet weather. The program targeted the pilot program area via a neighborhood meeting and addressed items such as: identifying the problem, alternative construction methods, property impacts, financial concerns, and the benefits received by both the city and the community from rehabilitating private building sewers. The residents in attendance were receptive to the city's efforts and goals to resolve the I/I problem.

The city also implemented a new resolution and ordinance to provide the authority to eliminate I/I on private property. The

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Peace River Supply Interconnections

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The coastal area of west-central Florida has long been a major attraction to families on the move from colder regions of the country. The attractiveness has led to increased stress on the very systems that have attracted people. As populations have grown, the finite amounts of drinking water have become more and more precious, particularly in view of the disparity between the location of the heavy demands for water and the location of the major supplies.

Before the 1960s, local well water supplies along the Gulf coast were capable of serving the population. After the heavy influx of new residents began, the supplies were increasingly stressed by saltwater intrusion and other quality degradation. Reverse osmosis treatment systems were the norm for the small utilities that were prevalent in the Manatee-Sarasota-Charlotte Harbor area.

Inland rivers, including the Peace River, are capable of producing copious volumes of water, but they are remote from the the major demands of the coastal areas. For many years water managers in the area have sought ways in which the Peace River could become part of the potable water resources for the region. An interconnection of utilities would reduce dependence on groundwater in an area of critical concern and provide integrated regional management of water supplies to minimize the potential for localized environmental impact of the water resource. The interconnection of utilities would also provide the ability to transfer water among entities on an emergency basis in event of natural disasters or system failures.

In 1982 a group of far-seeing leaders in the counties of Manatee, Sarasota, DeSoto and Charlotte formed a special district, known as the Peace River/Manasota Regional Water Supply Authority, to develop and supply water for public purposes in a manner to reduce adverse environmental effects from improper withdrawals from concentrated areas, particularly groundwater. An underlying reason for the authority's continuing support by its members is a growing awareness that individual counties and cities are going to encounter greater difficulty meeting public water supply demands in the future. As competition among agriculture, public supply, and industrial users for limited water resources continues to escalate, local governments are finding partnerships can be more effective, and sometimes essential, in attaining water supply objectives.

Existing Authority Facilities

In 1991, as a first major step in accomplishing its mission, the authority acquired the water facilities of the General Development Corporation. The facilities, constructed in the late 1970s to provide potable water to GDC's North Port and Port Charlotte development areas, consist of a 12-MGD water treatment plant on the Peace River in DeSoto County, a seven-mile-long, 36-inch transmission main adjacent to a railroad grade, and a 12-inch transmission main to feed the developed southwest portion of DeSoto County.

The water treatment plant employs alum coagulation, filtration, and chloramine disinfection. The facility incorporates multi-source water resource management, which includes river withdrawal for raw water source, off-stream reservoir for raw water storage, and ASR for treated water storage.

The Peace River is the largest flowing surface water body in the southern region of the Southwest Florida Water Management District. During periods of high river flows, raw water from the river is harvested and stored in the off-stream reservoir. Treated water in excess of the demand during periods of high river flow is stored in the nine-well ASR system.

The facility is not permited to withdraw water from the Peace River during periods of low flow (river flow less than 130 cfs). During such periods stored water is withdrawn from either the reservoir or the ASR system. Diversion from the Peace River for treatment is designed to mimic the natural flow variation within the river over time and to preserve the low flows for the environmental preservation of the downstream riverine and estuarine systems.

The existing facilities provide the water supply to over 90,000 citizens in southwestern DeSoto County, northern Charlotte County, and southeastern Sarasota County.

The Peace River Option

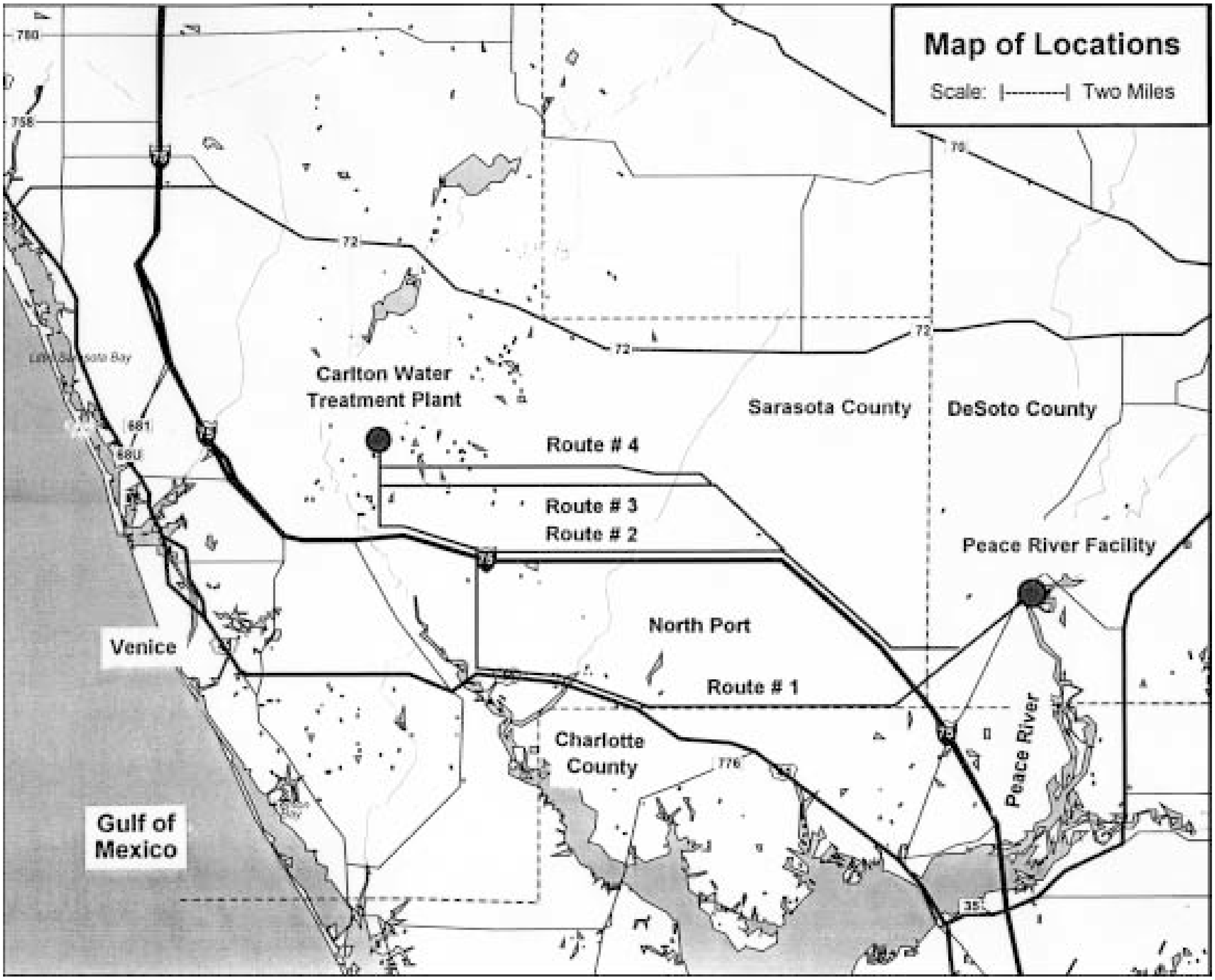
After the acquisition of the GDC properties in 1991, the authority undertook a study of the expansion facilities needed to meet future water needs. The resulting plan, completed in 1993, provided for expansions of the facility in approximately 6-MGD increments from 12 MGD to 44 MGD. The authority applied to SWFWMD for a water use permit renewal in 1994 for 44 MGD and a 30-year term. After filing of petitions by three intervening parties and entering into administrative proceedings, all parties agreed to the issuance of a 20-year permit providing for withdrawal of up to 33 MGD from the river. The permit was issued in March 1996.

The first-phase expansion, dubbed the "Peace River Option," provides for expansion of the facility to a firm 18 MGD, addition of 12 ASR wells, and expansion of the regional transmission system to provide an additional supply to DeSoto County and to interconnect the facility with Sarasota County's T. Mabry Carlton, Jr., Water Treatment Plant near the Myakka River at Venice. A 24-inch transmission pipeline for DeSoto County will also provide a second feed to the Port Charlotte system, thus completing a loop system for a backup supply line to that large development area.

The initial interlocal agreement under the Peace River Option included the authority and Sarasota and DeSoto counties. During the final negotiations for the permit, however, Charlotte County asked to participate in the expansion (the county was one of the three intervenors in the original permit application). The four-party-amended agreement was concluded in March 1996, and the Peace River Option development began in earnest.

The 42-inch Regional Transmission Pipeline

In addition to Sarasota County, the pipeline was originally slated in 1993 to serve Port Charlotte and the city of North Port; however, in the development of the interlocal agreements for the Peace River Option, Charlotte and North Port both chose not to take any of the capacity in the pipeline, although Charlotte County retains rights to a portion of the expansion capacity of the facility. With just one destination for the water



in the main, additional alternatives to the originally designed route became available.

PBS&J and the authority staff conducted an initial screening of potential routes for the transmission pipeline from the facility to the Carlton WTP, using the following factors to arrive at alternatives for further study:

- Ability to "co-locate" with an existing linear disturbance, such as alongside a road or power line.
- Availability of public lands on which to locate the pipeline.
- Length of route (length having a direct effect on the cost of construction and operation).

Four alternatives emerged from the screening, with lengths varying from nearly 29 miles for the original 1993 route to just over 23 miles for Route #4.

Five categories of criteria were used to evaluate each of the routes:

- Environmental elements, including wetlands (size, type and quality); uplands; critical water crossings; threatened and endangered species; potential for encountering petroleum-contaminated soils or groundwater; and permitting complexity.
- Property acquisition — the number and costs of easements.
- Long-range planning and consistency with comprehensive and future utility plans.
- Construction considerations, including geotechnical (soils, groundwater, and corrosivity); potential for encountering archeological or historic sites; effect on traffic; potential for utility conflicts; and safety.
- Comparative costs - the present worth of all program costs that are not reflected in the other categories of the evaluation.

The project team developed a numeric matrix to help in evaluating the alternatives, based on each of the criteria. In addition, each of the criteria was assigned a weight to express the relative importance of one criterion over another. This analysis led to the adoption by the of Route #4 for the 42-inch pipeline. The recommended route scored highest in all of the evaluation criteria. It had minimal impacts to wetlands and to threatened and endangered species, permitting ease, an absence of contaminated sites, the fewest construction constraints, the least number of easements, and the shortest distance.

The 42-in pipeline will traverse only open-pasture and conservation lands, bypassing all of the development in the Port Charlotte-North Port area. It will be immediately adjacent to power lines owned by Florida Power & Light over about three-quarters of its more than 23-mile length. Through a consent agreement with FPL, the authority is using the power line patrol road for construction and later maintenance access to the pipeline. Four FPL timber bridges are being replaced on the patrol road as part of the construction activity.

The proximity of the pipeline to the patrol will allow most of the 84 wetlands that will be traversed to be restored to their pre-construction condition. That was an important aspect in the evaluation that led to the selection of the route. It also led to the successful environmental permitting through Sarasota County, SWFWMD, and the US Army Corps of Engineers. The restoration will be so high, in fact, that fewer than six acres of wetlands will be permanently impacted out of 74 acres that will be disturbed during construction.

During the final design of the pipeline, PBS&J engaged Corrpro Companies Inc. to prepare an analysis of the subsurface conditions expected to be encountered with respect to potential corrosion along the 42-inch pipeline, and to recommend appropriate measures for protection. The pipeline materials included in the design analysis, and later included in the bidding documents, were steel pipe, prestressed concrete cylinder pipe, and ductile pipe.

Soils testing was performed at pipeline depths on samples averaging 1600 feet apart over the 23 miles. Many of the samples showed pH values less than 5.0, the level below which soils are considered to be corrosive. Most of the samples showed resistivities of less than 10,000 ohm-cm, the level below which the soil is considered to be moderately corrosive, and nearly one-quarter of the samples showed resistivities of less than 2000 ohm-cm, the level below which the soil is considered to be severely corrosive.

What's worse is the fact that the corrosive soils are interspersed with less-corrosive soils along the entire route, with the possible exception of the last few miles. This interspersion creates a potential for corrosion.

The recommendations covered several aspects of the pipeline environment, and they are summarized as follows for the three pipeline materials:

Bonded joints will make the metallic components of the pipe electrically continuous, from one 20-foot or 40-foot section to the next, so that electrical currents induced by the adjacent FPL transmission lines can be discharged safely into the ground at grounding stations (the pipeline will be adjacent to a 240 KV line for over 70 percent of its length). The bonded joints will also provide the electrical continuity needed for the cathodic protection system for the ferrous materials, steel pipe, and DIP, and will provide the ability to monitor the state of passivation over the prestressing wires in the concrete pipe.

Steel pipe will be tape wrapped and a cathodic protection system will be provided. The tape wrap will be the principal line of defense against the corrosiveness of the surrounding soils. It is a tight-bonded system with additional layers of tape wrap protecting the tape that will be in contact with the pipe.

For prestressed concrete cylinder pipe, the exterior will be coated with a tight-bonded epoxy that prevents any contact between the groundwater and the surface of the pipe. The recommendations also include specifics as to the fabrication of the pipe's prestressing wire and mortar thickness.

The project cost for the facilities in the Peace River Option is estimated at about $55 million, including about $28 million for the 42-inch transmission main....

For ductile pipe, the exterior will be coated with a urethane material and a cathodic protection system will be provided. The urethane is a tight-bonded material that prevents any contact between the groundwater or soil and the surface of the pipe. The cathodic protection system, as for steel pipe, would protect the ductile iron where exposed through the inevitable "dings" that occur in pipelaying.

PBS&J also engaged two peer reviewers of the Corrpro report, Law Engineering, and Environmental Services, Inc. (Lakshman Santanam) and RUSTNOT Corrosion Control Services, Inc. (William S. Spickelmire). The peer reviewers were unanimous in the opinion that the pipeline will be exposed to significant corrosion conditions along its route, and concurred with the Corrpro recommendations.

Conclusion

Although the 23-mile-long, 42-inch transmission pipeline to the Carlton WTP, the longest continuous water pipeline on the west coast of Florida, is principally to transfer Peace River water westward to Sarasota County, it was also designed to allow water to flow east, in reverse direction, to the North Port-Port Charlotte-DeSoto areas. This will allow transfer of water from any of the water-producing members of the authority, including Manatee County (which is already interconnected to Sarasota County), to all authority members.

The project cost for the facilities in the Peace River Option is estimated at about $55 million, including about $28 million for the 42-inch transmission main, now under construction. The new facilities will extend the service area of the Facility to an estimated population of 240,000. SWFWMD is providing about $21 million in grant funds through its New Water Source Initiative, and the authority will recover the bonded debt service for the remainder from user fees charged to its member customers. ■

The Peace River Interconnect to Sarasota County:
A Study to Assess Blended Water Quality and Compare Blending Options

Steve Soltau, Mike McGee, and Jim Bradbury

Sarasota County Utilities provides potable water to a population of approximately 200,000 people living in the unincorporated area of Sarasota County on Florida's West Coast. To meet additional future potable water demands, Sarasota County Utilities has entered into a four-county agreement to secure additional potable water from the Peace River Manasota Regional Water Supply Authority (PR/MRWSA) water treatment plant in Desoto County. This interlocal agreement will provide 5.8 MGD of potable water until 2010 and an average of 3.8 MGD thereafter. The chloraminated finished water from PR/MRWSA will be transmitted via a 23-mile-long, 42-inch-diameter pipeline to Sarasota County's T. Mabry Carlton Jr.'s water treatment plant. At the Carlton WTP, finished surface water from the PR/MRWSA will be blended with finished groundwater produced by the WTP and pumped into the Sarasota County distribution system.

A two-part study evaluated water quality issues of blending the waters and four options for blending the PR/MRWSA water and Carlton WTP finished water at the Carlton WTP site. Part 1 of the study focused on chloramine demand and the disinfection by-products (DBP) of the PR/MRWSA water in the transit pipeline and also addressed threshold odor number (TON), pH, Geosmin, MIB, Langelier saturation index (LI) and calcium carbonate corrosion potential (CCCP) characteristics resulting from blending of the two waters. Part 2 evaluated four alternatives for blending the two waters.

Background

The PR/MRWSA WTP is a conventional surface water treatment plant consisting of chemical coagulation, flocculation, sedimentation, chloramination, filtration, and stabilization capability. It has three sources of raw water: the Peace River, ASR wells, and a reservoir.

The Carlton WTP, which treats brackish groundwater to potable water standards by the electrodialysis reversal (EDR) treatment process, has degasification, sedimentation, filtration, EDR, and disinfection by chloramination.

An earlier study considered impacts on general water quality and corrosivity from blending the two waters using historical data and bench scale testing. The previous bench scale study utilized samples collected when the WTP was treating ASR well water as its source water. Recommendations from the previous study included re-chlorination capability with a proposed new chlorine contact tank, pH adjustment provisions using sodium hydroxide, a new transfer pump station, and blending in the existing ground storage tank (GST).

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CH2M Hill conducted a follow-up study to further assess water quality issues, to evaluate aesthetic impacts of blending the two waters, and to evaluate options for blending PR/MRWSA water and Carlton WTP finished water. This article presents results from the follow-up study.

PART 1: ASSESS BLENDED WATER QUALITY

Finished water grab samples were collected on three separate events. PR/MRWSA grab samples from the first event were analyzed for evaluation of chloramine decay. PR/MRWSA grab samples from the second event were analyzed for disinfectant byproduct formation. PR/MRWSA finished water and Carlton WTP finished water grab samples from the third event were analyzed to assess the impact of blending waters on MIB, Geosmin, and TON, plus stability and corrosivity indices. All PR/MRWSA samples were held in the dark for 36 hours prior to commencement of laboratory analyses to account for pipeline residence time anticipated in the PR/MRWSA water supply header. The PR/MRWSA WTP's raw water source during the sample events was the Peace River. All samples were analyzed by Tampa's water department water quality laboratory in accordance with industry standard procedures.

Sample Event 1, Chloramine Decay

The first sampling event demonstrated a combined chlorine decay of 0.7 ppm following a 36-hour pipeline detention time and a 1.2-ppm decay following a 108- hour detention time. The initial combined chlorine level at the PR/MRWSA WTP was 4.4 ppm. The 36-hour detention time corresponds to the detention time in the pipeline from a flow of 5.8 MGD. The 108-hour detention time corresponds to the detention time in the interconnect pipeline from a flow of 3.8 MGD plus two days in Sarasota County's distribution system. Chloramine decay is presented in the accompanying graph, which shows disinfection byproduct levels (DBP) and chloramine decay in the PR/MRWSA finished water.

Sample Event 2, Disinfection Byproducts

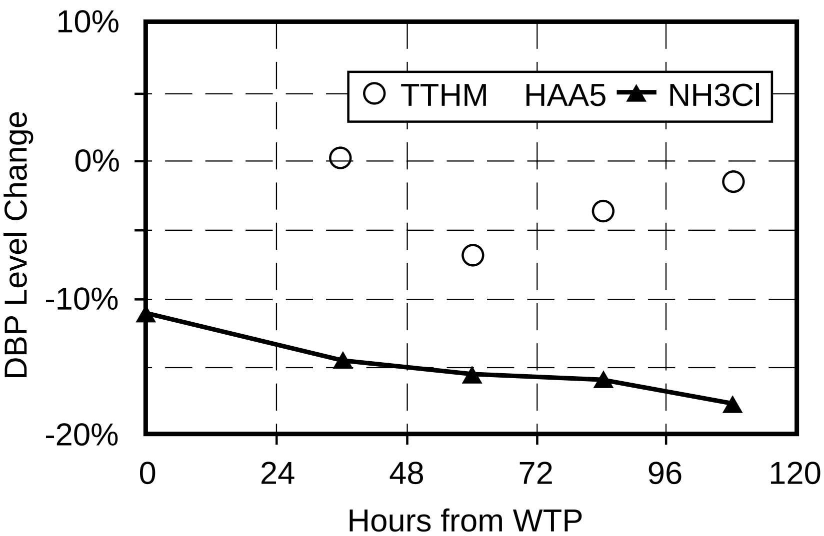
The second sample event examined the PR/MRWSA water for changes in disinfection byproduct levels for total trihalomethanes (TTHM) and haloacetic acids (HAA5) at four detention times. Results from this event are presented in the accompanying graph..

Examination of the graph demonstrates that the TTHM levels decreased slightly for the second sample event, while HAA5 levels increased by approximately 10% throughout the simulated distribution system detention period (108 hours). The study did not measure DBP levels at the PR/MRWSA WTP site. The Carlton WTP has reported TTHM and HAA5 levels over a 48-hour contact period at less than the proposed Disinfectants/Disinfection Byproducts Rule (D/DBPR) Stage 2 limits. The PR/MRWSA WTP has also reported DBP concentrations in its finished water consistently below the D/DBPR Stage 1 limits. Therefore, the blended water is expected to be well within compliance of the Stage 1 limits of the D/DBPR.

Assessing probable compliance with the proposed Stage 2 D/DBPR MCLs is difficult because the rule is not required to be

Table 1. Summary of Water Quality Parameters

	Finished Water Blend Ratios, (PR/MRWSA WTP Water) : (Carlton WTP Water)				
	100:0	75:25	50:50	25:75	0:100
pH	8.19	8.18	8.21	8.24	8.24
Temp. °C	24.8	25.8	26	26.6	28.7
TDS mg/L	284	322	327	344	373
Fluoride mg/L	0.46	0.61	0.91	1.16	1.38
Ca Hardness mg/L as CaCO3	97	92	89	92	98
Total Hardness mg/L as CaCO3	187	162	151	124	105
Total Alkalinity mg/L as CaCO3	54	52	46	40	37
Odor, TON	3	2	2	2	3
MIB, ppb	1.58	< 1	< 1	< 1	< 1
Geosmin, ppb	< 1	< 1	< 1	< 1	< 1



promulgated until May 2002, and various components of the rule are somewhat fluid at this time. However, the Federal Advisory Committee met in July 2000 and chose the Stage 2 D/DBPR MCLs for HAA5/TTHM as 60/80 ug/L based on running annual averages for each sampling location. This was a significant departure from the extremely low system-wide annual average MCLs for HAA5/TTHM of 30/40 ug/L that had been discussed previously. Although the rule will not be final until promulgation, based upon the most current Stage 2 MCLs described above there should be no difficulty for compliance with any possible blend ratio of water from the PR/MRWSA WTP and the T. Mabry Carlton WTP.

Sample Event 3, Impact of Blended Water on Taste and Odor Compounds and Indices for Stability and Corrosion

MIB and Geosmin test results are well below the generally accepted levels of 5 ppb. TON values for both 100% waters are 3 and for blended waters are 2. A TON value of 2 is considered acceptable as an average value, while 3 is considered acceptable as an intermittent peak value.

Other parameters presented in Table 1 are within current EPA primary drinking water standards.

Table 2 summarizes calculated stability and corrosion indices - calcium carbonate precipitation potential (CCPP) - and LI for each blended water ratio. The first set is calculated using measured blended water quality parameters, the second set presents the calculated effect of an addition of 0.50 mg/L sodium hydroxide, and the third set presents the calculated effect of adding sufficient sodium hydroxide for initiation of calcium carbonate precipitation.

Blending of the waters resulted in decreased levels of CCPP and LI. Given the calcium levels and total alkalinity levels in Table 1, pH adjustment by sodium hydroxide addition is a potential means for stability and corrosion control.

Table 2 presents calculated results of adding sodium hydroxide. Adding 0.5 mg/L of sodium hydroxide results in a slight pH increase and positive values for CCPP and LI. Further addition to increase CCPP and LI to a level sufficient to initiate calcium carbonate precipitation2 could raise the pH level above the National Secondary Drinking Water Standard of 8.5. Exceeding this secondary level could lead to an increase in customer issues or pipeline plugging and require a DEP waiver for exceeding a pH of 8.5. Table 2 indicates that a low-dose NaOH feed system may be suitable to control corrosion indices levels.

Evaluation of PR/MRWSA WTP Alternate Sources

Seasonal variations of measured parameters were not determined in this study. It was recommended that sample events 2 and 3 be repeated on treated PR/MRWSA water when the PR/MRWSA WTP is being supplied from the ASR well field and the reservoir.

Table 2. Summary of Sample and pH Adjusted Stability and Corrosion Indices

	Finished Water Blend Ratios, (PR/MRWSA WTP Water) : (Carlton WTP Water)				
	100:0	**75:25**	**50:50**	**25:75**	**0:100**
	Bench Test Results				
Sample pH	8.19	8.18	8.21	8.24	8.24
CCPP, mg/l as CaCO3	0.27	0.05	-0.13	-0.16	-0.08
LI	0.03	-0.01	-0.05	-0.06	-0.04
	Calculated Adjusted Indices				
NaOH added, mg/L	0.5	0.5	0.5	0.5	0.5
pH	8.25	8.25	8.44	8.44	8.44
CCPP, mg/l as CaCO3	0.6	0.5	1.1	0.8	0.88
LI	0.1	0.1	0.2	0.14	0.16
NaOH added, mg/L	1.05	1.25	1.25	1.30	1.30
pH	8.58	8.63	8.63	8.72	8.72
CCPP, mg/l as CaCO3	2.8	3.0	2.4	2.7	2.8
LI	0.4	0.4	0.4	0.4	0.4

Note: Conditions for calcium carbonate precipitation defined as CCPP 4-10 mg/L as CaCO3 and LI greater than 0.

PART 2: EVALUATION OF OPTIONS FOR BLENDING

All developed blending options include provisions to "top up" residual disinfectant levels, adjust pH, control blend ratio, and mix the two waters prior to entry into the distribution system. Each of the alternatives presented will meet these objectives.

Table 3, Order of Magnitude Costs for Blending Option

	Option 1	Option 2	Option 3	Option 4
Order of Magnitude Estimates	$3,030,000	$2,360,000	$3,300,000	$5,700,000

Note: Order of Magnitude Estimate is +50% -30% of actual costs.

Disinfection Requirements

PR/MRWSA is obligated to meet all federal and state regulations at the agreement's defined water transfer point. Consequently, primary disinfection of the PR/MRWSA water is completed at the PR/MRWSA WTP site. Therefore, additional provisions for a disinfectant contact time at the Carlton WTP are not required for the PR/MRWSA water.

Unusual circumstances resulting in unexpected chloramine demand may result in a requirement to occasionally boost the PR/MRWSA water residual chloramine level at the Carlton WTP. To satisfy this need, it was recommended that provisions be made for boosting the chloramine level in the PR/MRWSA water transit pipeline at or near the Carlton WTP site.

All of the blending options considered in the study will require provisions for boosting the chloramine residual. CH2M Hill recommended in-line injection of ammonia followed by chlorine into the PR/MRWSA water supply pipeline. The new chloramination equipment could draw from the existing chlorine and ammonia supplies and be injected into the PR/MRWSA supply pipeline. In-line static mixers would be utilized to ensure sufficient mixing prior to blending. The fourth blending option, although not recommended for further consideration, consists of routing the PR/MRWSA water to an additional or a modified existing Carlton WTP chlorine contact chamber for disinfectant adjustment.

NaOH Provisions

Each of the blending options considered in the study would require provisions for adjusting the pH with sodium hydroxide. This chemical feed system would utilize the existing NaOH supply at the Carlton WTP with the addition of dedicated feed pumps and control system for in-line pH adjustment of the PR/MRWSA water prior to blending. Consequently, each water stream would be independently pH-adjusted.

Blending Options

CH2M Hill considered four options for finished water blending at the Carlton WTP site, as follows:

- Option 1, direct into distribution line via a new booster pump station,
- Option 2, blend in existing GST and potential upgrade high service pump station,
- Option 3, new ground storage tank and blend in high service pump station suction line,
- Option 4, new GST, blend in chlorine contact chamber intake.

The first three options would require provisions for in-line chloramination and NaOH injection. The fourth option would require either modifications to the existing Carlton WTP chlorine contact chamber or construction of an additional contact chamber.

Order of magnitude estimates for the options are summarized in Table 3 (note pump station upgrades are included).

Option 1

Option 1 would require an in-line chloramination system and NaOH addition capability for the PR/MRWSA water, followed by a VFD-controlled booster pump station to inject PR/MRWSA water directly into the distribution system supply line. The Carlton WTP high service pump station may require upgrading due to hydraulic impacts of increased flows and resulting pressures in the supply pipeline to the distribution system. The proposed booster pump station will require a VFD control to regulate downstream pressure levels. Experience has shown that it is difficult to eliminate downstream pressure fluctuations resulting from upstream pressure changes. Mixing blend ratio in this option is not controlled because the Carlton WTP flow rate will vary hourly with system demands, while the PR/MRWSA water will flow at a constant hourly rate. The key disadvantage of Option 1 is the lack of control over blend ratio: PR/MRWSA flow is expected to be constant while flow from the high service pump station will vary to meet demands. Option 1 was not preferred and not recommended.

Option 2

Option 2 requires an in-line chloramination system, NaOH addition capability upstream of the GST, modifications to the GST (addition of baffles for blending and mixing), and potential upgrades to the existing high service pump station. The blend ratio in this option is accurately controlled since both the Carlton WTP flow and the PR/MRWSA flow may be kept at a constant ratio. Option 2 was the preferred alternative when combined with the design or confirmation of sufficient downstream storage and high service pumping requirements.

Option 3

Option 3 requires an in-line chloramination system, NaOH addition capability, a new on-site ground storage tank, and modifications to the existing high service pump station. The high service pump station is expected to require modifications to pump the increased average and peak flows. This option offers the most precise control over the blend ratio by use of flow meters and modulating flow valves on each ground storage tank supply line to the modified high service pump suction line. The flow meters would feed individual flow rates back to the controller, which would compare the rates to set values and modulate the ball valves as required to maintain blend ratio and ensure sufficient NPSHA is maintained for the high service pumps. Additional downstream storage capacity would not be required with this option. This option was not preferred due to high costs required.

Option 4

Option 4 requires the highest level of construction activity involving a new contact basin or modifications to the existing chamber, upgrade to the existing transfer pump station (extra pumping costs), and disruption to operation and production of the Carlton WTP. This option was not preferred due to high costs and complexity of implementation.

References:

1. Boyle Engineering. 1998. *Peace River Option: Carlton Plant Water Quality Compatibility Evaluation*. Sarasota, Florida.

2. EPA. 1992. *Lead and Copper Rule Guidance Manual Volume II: Corrosion Control Treatment*, Appendix A. EPA, Washington D.C. ■

Sanitary Sewer Overflow Reduction Plan - Criticality Review Matrix

Stephen H. Riley and Scott D. Kelly

In late 1996 JEA entered in to Administrative Order No. 96-013 with EPA regarding sanitary sewer overflows within the JEA sewer system. One of the requirements of the administrative order was the preparation of a plan to reduce SSOs. One of the first tasks faced by JEA was sorting through the massive amount of data that JEA had gathered over the years on SSOs. Together with JEA, CH2M Hill developed an approach to organizing the data and producing a prioritized plan for correcting the SSO-prone components of the sanitary sewer system. The prioritized plan was developed by a criticality review process.

Information Gathering

An initial information gathering and review effort was initiated to document and categorize the SSO events. The goal was to categorize causes, frequency, and locations. The primary sources of information were site visits and staff interviews, pump station runtime/downtime reports, and system GIS maps and FEMA flood maps.

Current practice at JEA is to prepare a monthly SSO report compiled from individual field reports filed by maintenance staff. The following is a summary list of the reasons for sanitary sewer overflows in the JEA system:

- Power failure
- Main breaker tripped
- Air pump failure
- Air relief leaking
- Blown fuse
- Broken air line
- Phase monitor failure
- Contractor new tie-in
- Discharge pipe
- Electrical control failure
- Broken force main
- Pumps not pumping properly
- Rain - Too much flow for station to pump
- Other

Based on the initial meetings with JEA maintenance managers, a preliminary list of 33 pump stations and 11 force mains was categorized as "critical" because they had either had an SSO incident or represented critical components in the collection system. After reviewing the list with additional JEA staff, site visits were performed to get an understanding of the pressure manifold system, observe the existing condition of the facilities, and make observations relative to potential solutions.

A pump station/area checklist was developed to consolidate the information gathering process during the site visits. The information was grouped into the following general categories:

- existing condition of facility
- condition of electrical/control equipment
- flow conditions in wet well
- manifold down stream conditions
- site data

Pump stations run time reports were also analyzed to identify pump stations at risk of SSO for the following reasons:

- Station influent piping and/or wet wells under capacity for the influent flow.

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- Station operating at lower pumping rates due to high back pressure or mechanical problems.
- Stations experiencing high flow volumes due to infiltration/inflow problems.
- Any combination of the above.

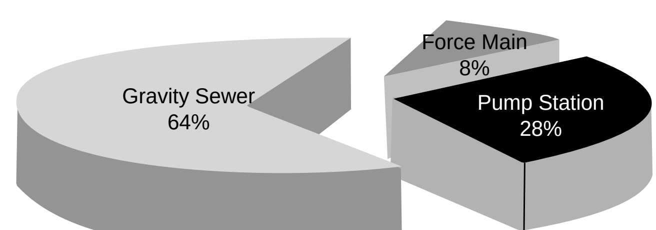
JEA compiles a list of total monthly run times, in hours, for the pumps in each pump station. An average daily pump station run time of 10 hours or more throughout the period was established as a threshold to be used as an indicator for a pump station that is potentially experiencing flows that exceed its capacity. Pump stations that had an average run time greater than 10 hours for a just a few months out of the year were also included in the list, because there was a possibility that those stations could be experiencing these periodic high run times due to I/I problems.

System GIS maps were reviewed to develop an understanding of the relation of individual pump stations to the entire network. Flood maps were used to identify if a particular pump station, or its service area, is within a flood zone.

Conclusions of Information Gathering

An analysis of the historical SSO records led to the following conclusions:

- The majority of recorded SSO problems were related to the gravity system in the downtown area of the city (Sewer District 1) which is the oldest part of the collection system.
- For the pressure manifold system, consisting of pump stations and force mains, the historical SSO records indicate a random geographical pattern.
- The majority of SSOs in the pressure manifold system were caused by random electrical control and/or power failures at pump stations.



Elements of the system that experienced SSOs.

Criticality Review

The process used to evaluate and rank the SSO risk elements was called the "criticality review." Specific components of the manifold system were considered critical to SSO reduction if they met the following criteria:

- Critical System Component - JEA personnel provided information on those components in the pressure manifold system deemed critical to the operation of the entire wastewater collection and treatment system. The list included specific pipelines and pump stations, typically those which were part of the trunk sewer system.
- High run time pump stations - Those stations that average ten hours or more average daily run time for any month, over the period examined.
- Pump Stations deemed at risk for an SSO event - Those stations considered at risk for an SSO incident by JEA personnel and/or CH2M Hill. They had either a history of SSOs, were considered weak links in the pressure manifold system, or had chronic maintenance requirements.

A total of 145 SSO-risk components were identified under the Criticality Review.

SSO Risk Analysis

After the criticality review, an SSO risk analysis process was developed to rank and prioritize each critical component based on individual potential SSO risk. The initial step in the ranking process was for JEA maintenance managers to give each component an overall high or low priority ranking. CH2M Hill further ranked those critical components given a high priority ranking by factors presented as important by the administrative order. The ranking factors considered were as follows:

- Potential to harm public health or cause property damage
- Potential to cause damage to the environment
- Potential overflow volume
- Difficulty of repair or other action to stop SSO

A numerical ranking system was developed with each critical component receiving a score of 1 to 5 based on its relative magnitude of impact within each of the ranking factors. This score was then multiplied by a weighting factor, which was based on the importance of the criteria in the administrative order. The following is a discussion on the ranking factors and their numerical point ranges.

Potential to Harm Public Health or Cause Property Damage

The relationship of pumping station or force main facilities to developed areas, existing infrastructure systems (such as roadways and other utilities), and land areas occupied and utilized by the public were considered in ranking critical sites and assigning points. The following criteria and point values were used:

- No development in the immediate vicinity of the facility. No health hazard or damage to public property would occur in the event of a failure. Point value = 1
- Limited development in the area of the facility. Potential for health hazard or property damage possible in the event of a failure. Point value = 2.
- Moderate to heavy development in the vicinity of the facility. Potential for health hazard or property damage likely in the event of a failure. Point value = 3.
- Heavy development in the vicinity of the facility. Failure results in discharge to residential or commercial properties. Potential for health hazard or property damage certain in the event of a failure. Point value = 4.
- Heavy development in the vicinity of the facility. Failure results in discharge to multiple locations with a higher potential for exposure to raw wastewater by persons. Potential for serious health hazard or property damage in the event of a failure. Point value = 5.

Potential for Damage to the Environment

The relationship of pumping station and force main facilities to natural water bodies such as rivers, lakes and streams, primary drainage facilities leading to natural water bodies, wetland areas, and environmentally sensitive areas were considered in ranking critical sites and assigning points.

- No natural water courses, drainage ditches, or wetland areas in the vicinity of the facility. No environmental damage would occur in the event of a failure. Point value = 1.
- Facility is located in proximity to limited natural watercourses, drainage ditches, or wetland areas. (One or two locations in proximity of facility.) Potential for environmental damage limited in the event of a failure. Point value = 2.
- Facility is located in proximity to several natural watercourses, drainage ditches, or wetland areas. (More than two locations or parallels such facilities.) Potential for environmental damage likely in the event of a failure. Point value = 3.
- Facility is located in proximity to many natural watercourses, drainage ditches, or wetland areas. Potential for environmental damage certain in the event of a failure. Point value = 4.
- Facility is located in proximity to many major natural watercourses, drainage ditches, or wetland areas. Potential for significant environmental damage certain in the event of a failure. Point value = 5.

Potential Overflow Volume

The potential overflow volume, which could result from the failure of a facility, was considered under this criterion. The potential volume of discharge is a function of many variables. Some of these may include: the operating capacity of the facility, the ability to isolate or shut down the facility in the event of a failure, and the location of the facility within the collection system. The following ranking criteria and point values were used:

- No potential for overflow. If a failure occurred, the facility could be removed from service without any discharge of wastewater. Point value = 1.
- Overflow volume would be limited and, when detected, could be managed by containment and tank truck clean up activities. Point value = 2.
- Overflow volume would be high in the event of a failure. Failure of medium sized pumping stations and force mains up to 14 inches in diameter are included in this category. Potential overflow volume would most likely not be easily contained due to the inability to shut down flows. A substan-

The Numerical Ranking System

Ranking Factor	Point Range	Weighting Factor	Critical Ranking Points Possible
Potential to harm public health or cause property damage	1 - 5	8	40
Potential to cause damage to the environment	1 - 5	6	30
Potential overflow volume	1 - 5	4	20
Difficulty of repair to stop SSO	1 - 5	2	10
Critical Ranking Minimum/Maximum Score		20	100

tial volume of wastewater will most likely be discharged and not recovered. Point value = 3.
- Overflow volume would be substantial in the event of a failure and very difficult to control or limit. Failures of medium to large pumping stations and/or 16- to 18-inch diameter force mains are included in this category. Potential overflow volume would most likely be significant, and failure would affect the operation of several other pumping stations and force main systems, making the continued operation of the regional system and potential for residual SSO events highly likely. Point value = 4.
- Overflow volume could be catastrophic in the event of a failure. Failure of master pumping stations and force mains greater than 20 inches in diameter would be included in this category. Failure of system component would likely result in uncontrollable discharge of a high volume of wastewater for a significant period of time. The shutdown of the system component is not possible due to the critical link, which the component represents in the system. Point value = 5.

Difficulty of Repair

The location, size, and construction characteristics of pumping station and force main facilities in relation to difficulty of repair was evaluated. A more difficult repair would increase the potential for SSO impacts.

- Force main located in rural area with open space adjoining most of the route. No development in the immediate vicinity of the facility. Small pumping station includes components that should be readily available for replacement. Point value = 1.
- Force main located in rural area with minor development along most of the route. Small to medium sized pumping station includes components that should be readily available for replacement. Point value = 2.
- Force main located in moderately developed area requiring pavement repair. Medium sized pump station includes components that should be readily available for replacement. Point value = 3.
- Force main located under major roadway, in tight right-of-way, or under waterway. Repair would be difficult. Large pumping station with specialty electrical and mechanical components. Point value = 4.
- Force main located under river or major roadway system. Repair would require special equipment, excavation and dewatering. Master pumping station with specialty electrical and mechanical components. Point value = 5.

Criticality Review Matrix

The list of critical components was further developed by combining the risk ranking with the criticality review. This resulted in the criticality review matrix, which ranked and prioritized the 145 at-risk components. The matrix includes an action planning component as described in the following.

Short Term Action Plan

The short term action plan has three major categories:

- Capital Projects that can be implemented relatively quickly. These projects consist of actions such as installing a SCADA system at the listed site, installing a standby engine driven pump, and/or upgrading the equipment at a pump station.
- Investigation tasks needed to define scope of project. These tasks consist of actions such as pipe integrity testing, pump station performance testing, network alternatives modeling, and site specific evaluations.
- Operation and Maintenance Planning tasks that should be implemented. These tasks consist of planning activities such as establishing an enhanced maintenance program and preparing an emergency response plan.

Of the 145 critical components identified, 43 were deemed to be of the highest priority and placed on the Short Term Action Plan list.

Long Term Action Plan

A long term action plan was also developed, consisting of three specific actions, as follows:

- Replacement or upgrade of facility.
- Construction of parallel or alternative, redundant piping.
- Rehabilitation or modification of existing facility.

Conclusions

JEA is currently implementing the short term action plan for the highest priority components. Upon the resolution of those items, JEA will continue working through the remaining components in the matrix. The criticality review matrix is a living document and is periodically updated to reflect progress, changing action plan tasks, and new additions to the critical components list.

JEA's responsiveness to the EPA administration order, including the SSO reduction plan as developed from the criticality review, was responsible for EPA closing the administration order in 1998. ■

Private Building Sewer Rehabilitation *from Page 30*

resolution identified the pilot program area as being prone to I/I and gave the authority to have the problem corrected. Access to the property would be granted through individual agreements with the homeowners.

Determining alternative methods of rehabilitation was one of the primary goals of the pilot program. Demonstrations were used to verify the rehabilitation techniques. Some methods proved to be successful while others were not; this provided a base for the rehabilitation techniques to be used. As the rehabilitation projects progress, so will the technology and competition, offering a larger variety of rehabilitation methods and costs.

Determining how to fund the rehabilitation was addressed by answering one question - Is there a benefit to the public? The answer was undoubtedly "yes." As seen during the severe weather winter months of 1997-1998, the flow increases due to I/I in the wastewater collection system have had significant effects on the operation of the facilities. These conditions require extraordinary effort and costly preventative maintenance measures to reduce the potential for overflows and public health hazards. Through persistent efforts, the city was able to establish the need to spend public funds on private property in order to correct the problem.

As of September 2000, Phase 1 of the Pilot Program was nearly 95% complete. Clean-outs have been installed in most cases, and TV inspections have revealed more defects than originally anticipated. Thanks to the public information program, homeowners' awareness and cooperation throughout the first phase of the program have been exceptional.

Furthermore, on September 17, 2000, Tropical Storm Gordon passed by the Sarasota coast creating conditions nearly identical to Tropical Storm Josephine in October 1996. The collection systems on the north end of Siesta Key reacted similarly to the 1996 storm, thus reinforcing the principal theories leading to the pilot program and the need for rehabilitation of the private building sewers. ■