

Cleaning up the Keys

Vacuum sewers reduce wastewater problems that threaten the islands' aquatic environment and economy.

By Steve Gibbs

Project

Florida Keys wastewater collection

Participants

- Key Largo Wastewater Treatment District, Key Largo, Fla.
- Eckler Engineering, Coral Springs, Fla.
- Weiler Engineering, Marathon, Fla.
- GlobeTec Construction, Deerfield, Fla.
- City of Marathon, Fla.

Product application

AIRVAC vacuum sewer systems overcome Florida Keys wastewater collection challenges with shallower trenches, fewer electrical connections, closed systems, and easier installation.



Ernest Hemingway, the most famous former resident of the Florida Keys, knew he was living in paradise when he wrote, “It’s the best place I’ve ever been anytime, anywhere — flowers, tamarind trees, guava trees, coconut palms ...” Today, more than 3 million visitors come to the Keys each year to enjoy that beauty and the lifestyle that Hemingway found so appealing. Tourism is the No. 1 industry on the archipelago, and many who come to visit end up living there year round.

But, the influx of people and burgeoning economy has come at a price for the Keys. In the 1980s, pollution, largely from wastewater, reached dangerous levels. The magnificent coral reefs and marine life, which are the foundation of the region’s tourism

industry, were in jeopardy. Tropical and game fish were endangered, and some bodies of water became unsafe for swimming. Residents, as well as local and state officials, began to realize that a great natural resource was dying unless they addressed the need for proper wastewater management. In 2000, the Florida legislature mandated that by mid-2010, the Keys have in place a suitable sewer system and treatment facilities, including nitrogen and phosphorous removal.

“The reefs here are incredible,” said Chuck Fishburn, general manager of the Key Largo Wastewater Treatment District. “Virtually everyone who is here came here because of the water — the fishing, diving, and boating. We understood that if we didn’t get central sewers, we would eventually kill off the

Densely populated areas surrounding numerous canals in the Florida Keys present significant obstacles for sewer construction. Additional problems are the underlying coral rock and high groundwater.

reason we’re here.”

The Florida Keys encompass approximately 137 square miles covering 17,000 islands, of which 35 are considered “major” islands. More than 80,000 people live year-round in the Keys and an estimated 4 million tourists visit the islands each year. Providing sewer service to such a large area and involving several entities presented a sizable challenge for project planners.

Civic and public works officials began the task by getting organized in their own areas. They prioritized the work, reviewed various proposals, and sought funding. After conducting a significant

amount of research, initial projects were constructed at the Ocean Reef Club in the Upper Keys, the Little Venice area of Marathon in the Middle Keys, and Stock Island in the Lower Keys. In each case, they installed vacuum sewer collection systems.

“The circumstances we face here in the Keys led us to select vacuum sewer technology,” said Fishburn. “We went through the installation process and then saw how the system worked and we were very pleased with the outcome. Based on those initial projects, we decided to utilize vacuum sewers wherever we could.”

Having made the decision to install vacuum sewers, both the Key Largo Wastewater Treatment District (KLWTD) and the city of Marathon began advertising for engineers who had experience with the technology. Eckler Engineering of Coral Springs, Fla., and Weiler Engineering of Marathon had both designed vacuum systems throughout South Florida and were an obvious fit. They were two of several engineering firms that were involved with this enormous effort. GlobeTec Construction of Deerfield, Fla., was one of several regional construction companies selected to do the installation.

“We were part of the team that installed the first vacuum system in the Florida Keys in 2001 and 2002,” said Jorge Fonte, vice president of GlobeTec. “We probably have installed more than 1,300 valve pits and 200,000 linear feet of vacuum lines.”

AIRVAC, headquartered in Rochester, Ind., was selected to provide the components and design support for the project. “AIRVAC developed most of the specifications used in vacuum system design so it’s always good to have their expertise for a job as big as this one,” said Don Eckler, P.E., president of Eckler Engineering. “They have worked well with us to create a fail-safe

functioning system that will experience minimal problems in the future.”

Master plan

There is an enormous amount of sewer construction work going on throughout the Keys right now, and it all started more than 10 years ago with a master plan. In 1999, Monroe County, which comprises 95 percent of the Keys, developed its Year 2010 Comprehensive Plan. The study cited the scope of the problem: 246 small wastewater treatment plants operating on the islands along with approximately 7,200 cesspool and cesspit systems,



Shallow trenches and lightweight PVC pipe made installation of a vacuum sewer system fast and less disruptive to residents and tourists.

many of them illegal. Combined, they contributed more than 7 million gallons per day (mgd) of wastewater, most of it containing pollutants that are detrimental to ocean life.

At the heart of the problem were the thousands of cesspools across the islands. Cesspools in the Keys provided poor wastewater treatment because most of the islands sit on a layer of coral rock, which is hard yet porous. The rocky soil did little to remove the pollutants in the wastewater, allowing it to seep into the groundwater and eventually into the canals and ocean surround-

ing the islands. Studies showed traces of fecal coliform bacteria on the reefs in amounts that would damage the reef and the surrounding marine life.

“Twenty years ago, the canals were clean enough to swim in. They had tropical fish in them,” said Fishburn. “Today, the water is so murky you can’t see through it anymore.”

The Keys present several significant geographic challenges that could have made a sewer construction project extremely difficult and prohibitively expensive. “In the Keys, you have flat terrain, high groundwater, developed neighborhoods, and difficult soil conditions; all of these create problems when designing and installing sewers,” said Eckler. “Then there is the added difficulty of maintaining traffic on U.S. Highway 1 while installing a sewer system. Highway 1 is the only road in and out of the Keys, so it is always busy and must remain open. Plus, the side streets are narrow, which presents the challenge of keeping them open for emergency vehicles during the construction process.”

Gravity sewers, low-pressure systems, and vacuum technology all were considered, but a life-cycle cost analysis revealed that vacuum sewers would be the best option. The prospect of digging through coral rock with high groundwater was considered an enormous obstacle. A gravity system would have required trenches as deep as 10 to 15 feet to achieve the grade necessary to move sewage from homes to the treatment plant. Cutting through rock and constant dewatering, while trying to maintain traffic flow, would make the project incredibly expensive, time consuming, and disruptive for Keys residents.

Engineers also considered the number of lift stations that would have been required to transport wastewater in such flat topography. Key Largo alone would

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have needed 50 or more lift stations. In a place such as the Keys where land is so valuable, the property costs would have made the project extremely expensive.

Low-pressure sewers offered many of the same advantages as vacuum sewers in terms of pipe size, trench depth, and limited traffic disruption, but the life-cycle costs were higher than those of vacuum sewers. This was mainly because of the number of grinder pumps that would be required for the Keys project and the associated maintenance costs. Each dwelling would require a grinder pump and electrical connection to the dwelling. For many of the small homes in the Keys, this would have required an upgrade to their electrical systems. Furthermore, power outages, which are common in this region, would have shut down the system unless each grinder pump had its own generator, which is not practical.

“The analysis done by the engineers in 2000 clearly showed the advantages of installing vacuum sewers,” said Fishburn. “Simply stated, vacuum lines require only half the slope of gravity mains and can transport wastewater uphill by means of a saw-tooth profile. That means shallower trenches and less digging. There also was the fact that one vacuum station could do the job of several pumping stations, and there were fewer electrical requirements. In this situation, the decision to install vacuum sewers was an easy one.”

Vacuum power

Vacuum sewer technology solved many of the problems that are inherent in the Keys. The shallower trenches needed for vacuum lines helped avoid many of the cost and labor issues that deep trenching would have required. The trenches for the vacuum lines were typically 4 to 6 feet deep. Little dewatering was needed, there was less disruption to the established neighborhoods, and because the vacuum mains were made of smaller-diameter PVC pipe, the installers could use less and smaller equipment.

“The footprint required for construction is significantly smaller,” said GlobeTec’s Fonte. “Fuel consumption also is much less (than a comparable gravity sewer installation). I would estimate we used about 30 percent less fuel than we would have on a gravity sewer job. The technology is also faster to install than gravity or low-pressure systems. Crews installed 300 to 800 linear feet of collection lines per day.”

The design engineers and installation crews also received the benefit of AIRVAC’s years of vacuum sewer experience. Fonte noted that underground infrastructure projects can be unpredictable, so experience and flexibility are critical during installation. “There are always a lot of unknowns in an underground construction project,” he said. “It was extremely helpful to have AIRVAC there to make suggestions and provide advice when we encountered unexpected problems.”

Bonus benefits

Ease of installation was a significant factor in choosing vacuum technology for the Keys’ sewer system, but there were other benefits that made vacuum sewers a perfect fit for this situation. Hurricanes, an annual threat along the Southeast and Gulf Coasts, can damage or destroy pumping stations, dump tons of sand into the treatment system, and disrupt electrical power, knocking out a city’s sanitary sewer collection system.

Vacuum sewers are less vulnerable to electrical power loss for several reasons. In an AIRVAC system, sewage from houses and businesses flows by gravity to a valve pit, which is usually buried near the street. When the wastewater in the pit reaches a predetermined level, the valve opens pneumatically to release the sewage into the collection line. No electricity is needed to operate the valve pit.

Each of the six vacuum stations on



For future reference, crews mapped the vacuum collection lines and valve pits precisely with GPS technology.

Key Largo is equipped with a backup generator, so there will be no loss of sanitary sewer service even if the power is out. A gravity system would have required five or six times as many pumping stations to serve the 14,000 residents and tens of thousands of tourists, and each station would need electricity and daily attention to remain functional during a disaster.

Also, because vacuum sewers are a closed system, there is no infiltration or exfiltration, and any breach of the collection line is detected almost immediately. Salt water and groundwater are kept out of the treatment plant, and that reduces treatment costs and equipment degradation.

In designing the system, engineers came up with some extremely innovative ideas that paid some immediate benefits and will help utility workers for years to come. Because vacuum collection lines are water tight, they can be laid in the same trench with stormwater collection lines and reuse water lines, saving installation time and valuable space. Additionally, during daily inspection of line installation, inspectors mark coordinates with a GPS device. This will help public

works personnel create a detailed map of the buried infrastructure.

“It’s great to know exactly where your utilities are buried, especially [during] a natural disaster like a hurricane. If a street is wiped out or buried in sand, we will know precisely where the collection lines and valve pits are buried,” said Dan Saus, wastewater project manager for Weiler Engineering in Marathon, Fla. “They also snapped photographs when they took the coordinates. So, when you go into their system and click on a data point, you’ll see a photo of what is buried there. It’s like having x-ray vision.”

Award winner

In 2009, the city of Marathon received the Pisces Award from the U.S. Environmental Protection Agency for projects that represent a commitment

to the state’s aim to achieve sustainable water quality. Marathon was the only city in Florida to receive the award.

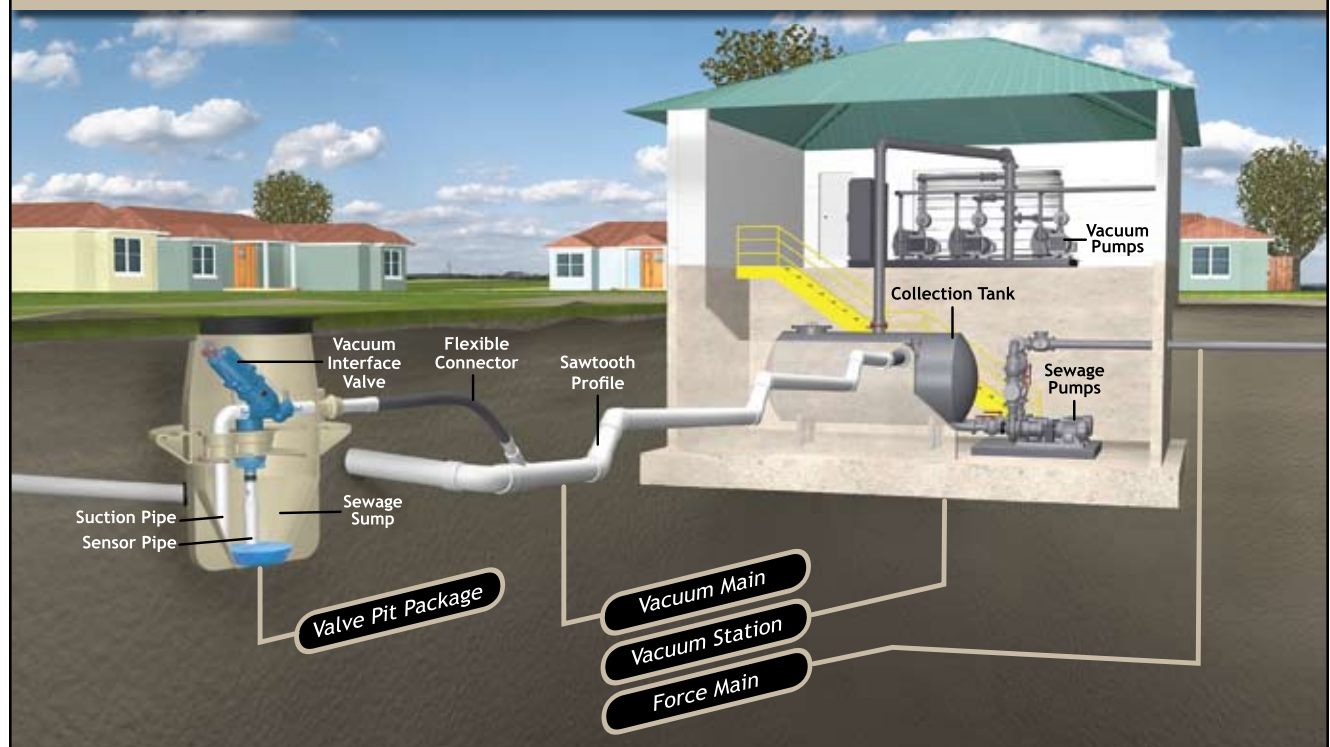
Marathon’s design won the award in part because of the one-trench design for installation — which includes both sewer and stormwater piping and was made possible because they installed a closed vacuum system — along with the GPS mapping work. They also were lauded for designing a system that produces reuse water, which will provide 1 mgd of water that can be used on golf courses, football fields, and public parks.

“I don’t think I’ve ever seen a team of public works professionals who were as progressive as this team was,” commented Susie Thomas, director of community services for the city of Marathon. “It’s really a tremendous honor and we’re very proud.”

Of course, the most important objective of the massive Keys project is a cleaner aquatic environment in and around the islands. When all of the communities throughout the Keys complete their sewer collection and treatment systems, then we will begin to see cleaner water throughout the area. The tourism industry will remain vibrant and the residents of the Florida Keys can again enjoy one of the most beautiful natural environments in the world. ■

Steve Gibbs is a freelance writer based in Memphis, Tenn., with 20 years of experience covering public works and construction projects for regional and national publications.

AIRVAC Vacuum Sewer System



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