Vacuum Sewers Protect Keys and Everglades

Where wastewater treatment is a Catch-22.

By Jeff Gilbert and John Pantelis

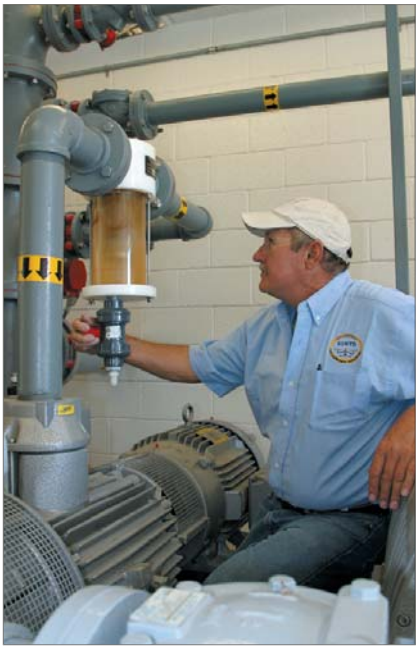
Wastewater treatment has been a catch-22 for Monroe County, FL—protecting the fragile ecosystems of the Everglades and the Keys from water pollution is a priority, but a flat topography and coral-based lime rock present in the bedrock have eliminated many cost-effective options. The result? A collection of ineffective, poorly-organized systems that fail to meet updated nutrient-removal requirements.

To streamline the entire system and reduce the amount of harmful nitrogen, ammonia, and phosphorous present in processed wastewater, the Florida State Legislature created a mandate for the county, requiring—among other things—that an alternative collection system be chosen and installed as the primary means of sewage collection by July 2010. Monroe County settled on the vacuum sewer system from Airvac (www.airvac.com), which has already been successfully implemented in various Keys jurisdictions as well as 300 other sites in the U.S.

A technology that remained under the radar for years due to a lack of involvement in engineering curricula, the vacuum sewer system was introduced to the U.S. in the 1960s. The lack of practical knowledge concerning this system in today's engineering field is the chief reason it hasn't been utilized elsewhere—in many cases, it is more economical than more traditional methods.

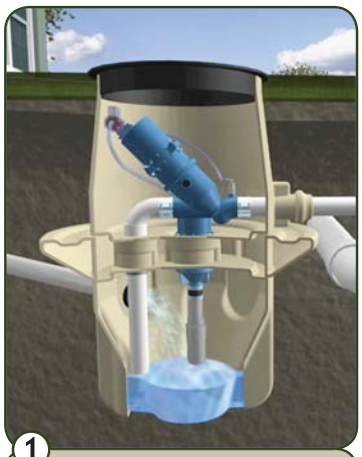
Vacuum sewers work on the principal of a pipe network under negative pressure, using the force of 16 in. to 20 in. of mercury to draw sewage from a valve pit at a residence into a vacuum main and then into a receiving tank at a vacuum station. Waste is then transferred from the receiving tank to a treatment plant via a force main by conventional sewage pumps located within the vacuum station.

A vacuum valve pit—established in the public right-of-way for access by



Vacuum stations are clean as well as operator friendly. Monitoring and maintenance are easy with a few gauges and charts checked daily and oil in the vacuum pumps changed regularly.

How AIRVAC Works:



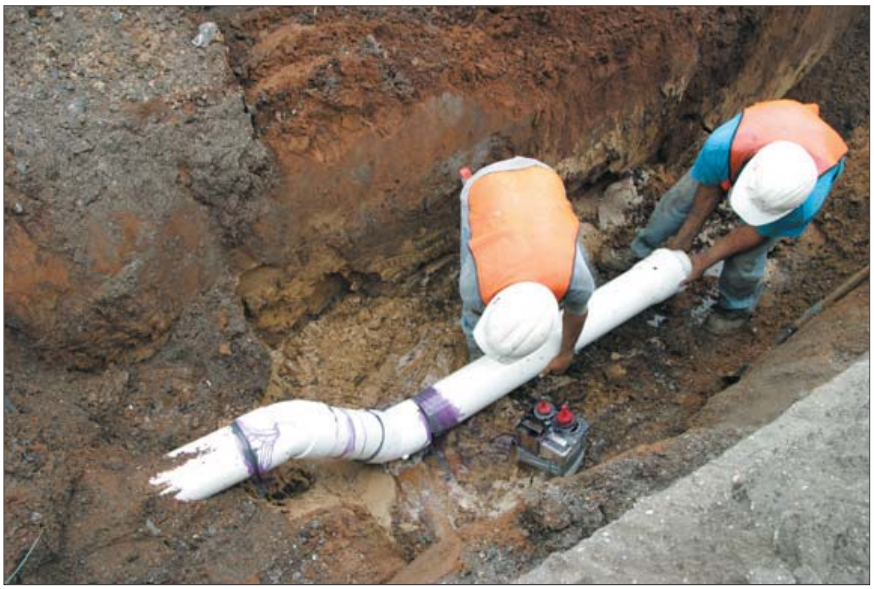
1 Traditional gravity lines carry wastewater from the customer to an AIRVAC valve pit package.

2 When 10 gallons of wastewater collects in the sump, the AIRVAC valve opens and differential pressure propels the contents into the vacuum main.

3 Wastewater travels at 15 to 18 fps in the vacuum main, which is laid in a sawtooth fashion to insure adequate vacuum levels at the end of each line.

4 At the vacuum station, vacuum pumps cycle on and off as needed to maintain a constant level of vacuum on the entire collection system.

Wastewater enters the collection tank. When the tank fills to a predetermined level, sewage pumps transfer the contents to the treatment plant via a force main.



Unlike conventional sewers, which require the force of gravity and a continual downward slope to transport the wastewater, vacuum sewers use a pressure differential and are installed in a saw-tooth fashion, resulting in much shallower trench depths.

maintenance personnel—is installed at the point of service and connected to the wastewater source by a gravity service lateral. This pit is a self-contained, at-grade unit with a sump at atmospheric pressure and a sealed compartment above that containing the vacuum valve. When sewage reaches a pre-set level in the sump, the rising sump pressure sends a pneumatic signal to open the vacuum valve and expose the contents to the negative pressure in the system, forcing an evacuation of the sewage and drawing air into the system before the valve closes.

To reduce the sewer line depths a series of suction lifts, or physical lifts, are used in the pipeline, created by 45-degree fittings necessary to adjust for grade differentials. Burying the sewer lines at a more shallow level can reduce excavation costs.

Given the alternative nature of this system, design requirements for vacuum sewers are somewhat unconventional. To operate properly, a certain air-to-liquid ratio in the pipe must be maintained. An insufficient air-to-liquid ratio can result in the system becoming "waterlogged" and conveyance efficiency will be reduced. In addition, each vacuum station must be designed for the requirements of the area it serves—the vacuum pump capacity must be sufficient to maintain the necessary level of vacuum in the piping network.

In most vacuum systems a typical vacuum pit serves two or three family homes (or Equivalent Dwelling Units). However, the small lots that exist in the Florida Keys coupled with the relatively low water consumption for a typical home allows for three to six single family homes to be served by a single valve pit on occasion. Serving more than three units per pit on a system-wide basis can put undue strain on the entire sewer system, which can include hundreds of vacuum pits.

The Florida Keys is a unique environment for the United States and the world, and implementing the vacuum sewer system is an excellent way to unify local communities in an effort to preserve it. By following this mandate and creating a sewer system that is unified and more efficient, the state of Florida, Monroe County, and local residents are taking steps toward preserving the health and well-being of the coral reefs, supporting the sustainability of the Keys' ecosystem for years to come. GE

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