# The Importance of Design Criteria Standards for the Construction of a Centralized Wastewater Collection System in the Florida Keys

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## ABSTRACT

Islamorada, Village of Islands, constructed a hybrid wastewater collection system from 2005-2007 and 2012-2016 consisting of vacuum sewers and low-pressure sewers. Village officials entered into an Interlocal Agreement with the Key Largo Wastewater Treatment District (KLWTD) in May 2012 to transfer all Islamorada wastewater flows from its centralized collection system to KLWTD's 2.3-mgd regional wastewater treatment facility for treatment and disposal. Construction of the Village-wide sewer collection system and execution of the KLWTD Interlocal Agreement prompted the Village to develop a new Village-wide Wastewater Utility Policy in November 2014. A key component of the Policy was development of a Village-wide Minimum Design and Construction Specifications and Standards for Wastewater. These standards proved to be critical to the success in constructing the collection system and reducing the potential for penalties specified in the KLWTD Interlocal Agreement.

**KEYWORDS:** Collection system, design standards, inflow, infiltration, low pressure sewers, vacuum sewers, water quality

## INTRODUCTION AND BACKGROUND

The Florida Keys are a chain of approximately 800 independent islands located off the southeastern tip of Florida, including the most southerly point of the continental United States. Home to a complex and dynamic marine ecosystem, the Keys include the world's third largest coral reef system and offer a natural beauty that attracts visitors from across the globe. Supporting major fishing and tourism industries, the reef and the entire marine ecosystem are the lifeblood of the Keys; protecting their existence and vitality is critical to the economic and environmental future of the islands. Without proper planning and regulations development, population growth, and tourists threaten the Keys' very health and future existence.

Extensive scientific study of the deterioration of the reef and the entire marine ecosystem has revealed that one of the principal causes of the Keys' unhealthy state is the elevated level of human-derived nutrients in the surrounding canals and near shore waters. Nutrients, comprised of nitrogen and phosphorus, are found in high levels in raw sewage and secondary treated wastewater discharged to the ocean. To improve the water quality of near shore water and the coral reefs in the Keys, the Florida lawmakers passed legislation (Chapter 99-395, Laws of Florida, and subsequent amendments thereto, and Senate Bill 550) that mandated higher wastewater treatment and disposal standards for the entirety of the Florida Keys. These regulations generally require that all wastewater treatment systems in the Florida Keys be upgraded and/or replaced to meet Advanced Wastewater Treatment (AWT) or Best Available

Technology (BAT) capabilities. The legislation established a mandatory compliance date of December 31, 2015. Monroe County and the utility districts and municipalities within Monroe County have undertaken initiatives to comply with these regulations. In several locations within the Keys, compliance was achieved by creating a centralized collection and treatment system where none previously existed.

Islamorada, Village of Islands, located in the upper Florida Keys has a full-time residential population of roughly 7,100 that fluctuates seasonally, as well as a variety of hotels, resorts, and marinas. Historically, Islamorada's wastewater infrastructure was privately owned. Most homeowners and small public/private facilities discharged wastewater to septic tanks, while large facilities discharged to onsite, privately-owned and permitted wastewater treatment package plants. Islamorada consists of six (6) wastewater service areas that extend a total of 18 miles with a land area of approximately 3,900 acres. The six wastewater service areas within Islamorada, Village of Islands (herein referred to as the Village) are known as:

- North Plantation Key,
- Middle Plantation Key,
- South Plantation Key,
- Windley Key,
- Upper Matecumbe Key, and
- Lower Matecumbe Key.

The Village boundaries extend from Mile Markers (MM) 90.939 to 72.658. A significant increase in population occurs within the service area during peak tourism season from late November through April. At build-out, the Village centralized wastewater system is estimated to service approximately 9,700 equivalent dwelling units (EDUs) with both residential and non-residential connections as shown in **Table 1**. Total wastewater flow for the combined service area is estimated to equal 1.4 mgd.

**Table 1. Residential and Commercial EDUs in Village Wastewater Service Areas[1]**

| Wastewater Service Area | Residential EDUs | Commercial EDUs | Total Estimated EDUs |
|---|---|---|---|
| North Plantation Key | 1,520 | 183 | 1,703 |
| Middle Plantation Key | 1,077 | 515 | 1,592 |
| South Plantation Key | 1,134 | 471 | 1,605 |
| Windley Key | 181 | 402 | 583 |
| Upper Matecumbe Key | 1,255 | 1,377 | 2,632 |
| Lower Matecumbe Key | 1,368 | 170 | 1,538 |
| | | **Totals** | **9,653** |

[1]Source: Islamorada Capacity Analysis Report, June 2011

## METHODOLOGY

### North Plantation Key Sewer Collection System

To comply with the legislative mandate, the Village constructed its first central sewer system in the North Plantation Key (NPK) between 2006 and 2010. This wastewater service area is comprised of approximately 1,500 residential and commercial connections located along U.S. 1 and bordered by the Atlantic Ocean on the east and Florida Bay on the west. Construction of the wastewater collection system in the NPK service area was completed in two phases.

**Phase I.** A vacuum sewer collection system was constructed to serve approximately 500 residential connections in a development known as Plantation Key Colony. Approximately 210 vacuum collection chambers manufactured by Roevac Vacuum Sewer Systems (Roediger, Germany) were installed as illustrated in **Figure 1**. The side-by-side chamber design consisted of the collection sump next to the vacuum chamber with a connecting pipe at the bottom allowing for the influent waste to be discharged into the vacuum collection system. The individual vacuum chamber sewage sump holds up to 10 to 13 gallons of wastewater. This design is problematic since a typical residence can produce 5 to 10 gpm or more of wastewater during peak usage. As a result, the chamber can easily overfill in a few minutes, a loss of vacuum can occur, and the vacuum valve will not operate.

**Figure 1. Roevac Sump**

The startup history of the Phase I North Plantation Key collection system was challenging. This service area experienced multiple system failures, wastewater backups in residences, and spillages when the system was commissioned in August 2006. The problems were well documented and appeared in the local media. Residents and the Village Council lost confidence in the project and the vacuum system manufacturer. The most common problem experienced with the Phase I project was failure of the Roevac controller to open the vacuum valve due to extraneous water (i.e. stormwater) entering the controller. This issue was addressed by replacing leaking chamber lids and faulty controllers. Additionally, many joints and connections installed on the system were not water tight and allowed groundwater infiltration into the system.

**Phase II.** This phase of construction consisted of installing vacuum sewers to serve the remaining 1,000 residential connections and all commercial connections in North Plantation Key communities. Phase II construction was completed using approximately 400 valve pits manufactured by Roediger Pittsburgh. *(Note: Roediger Pittsburgh was a Roediger U.S. affiliate and allowed to sell Roevac vacuum sewer equipment in the U.S. Several years later, the two companies parted ways and Roediger Pittsburgh is no longer in business).*

Like Phase I, a number of system failures occurred as a result of the Phase II construction. For example, the Roediger Pittsburgh valve pit was a top and bottom design (two pieces) consisting of a lower influent basin and an upper basin housing the vacuum valve and components. The joint between the upper and lower sections was not well constructed and would easily separate allowing for infiltration into the basin. Additionally, infiltration into the basin would overcome the discharge capacity, flooding the controller and rendering the pit useless.

Other factors that contributed to system failures include:

- The absence of vacuum sewer design standards that led to undersized vacuum mains, excessive number of connections on a single valve pit, etc.
- The lack of testing procedures for placing the vacuum collection system into operation
- Improper construction methods used for installing vacuum mains, e.g. horizontal directional drilling

**AIRVAC Material Selection**

The Village took corrective actions to address system reliability issues by re-evaluating the selection of a sole vacuum sewer component manufacturer using four primary factors:

(1) vacuum systems currently in operation throughout the U.S.;

(2) vacuum sewer components manufactured in the U.S.;

(3) technical comparative results of the vacuum sewer products used in the marketplace; and

(4) using a procurement process.

**U.S. Vacuum Sewer Installations.** Vacuum sewers have been used as an alternative wastewater collection system throughout the U.S. since the mid-1970s. By 2009, the majority of vacuum systems installed within the U.S. were AIRVAC systems including municipal systems that had been in operation for more than 30 years. Over 280 AIRVAC vacuum sewer systems were installed in the U.S. between 1969 and 2009 completing more than 115,000 sewer connections.

In comparison, Roediger operated its vacuum sewer business under the trade name Roevac. Its affiliate, Roediger-Pittsburgh, was active in the U.S. market from 1990 through 2004. In 2005, AIRVAC was purchased by Bilfinger-Berger which owned Roediger. After this ownership change, Bilfinger-Berger sold the Roediger-Pittsburgh operation but continued to market the Roevac product in the U.S. Between 1995 and 2006, only 14 Roediger vacuum systems were installed and operating inside the U.S. completing approximately 3,000 sewer connections (less than 3% of all vacuum connections throughout the U.S).

**American Manufacturing.** Another key component in the selection of a vacuum system provider for the Village was implementation of the “Buy American” provisions of Public Law 111-5, the American Recovery and Reinvestment Act of 2009 (ARRA). The ARRA provided significant state funding for high priority infrastructure projects needed to ensure clean water and safe drinking water. The Act also included “Buy American” provisions that required Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DDWSRF) recipients of ARRA funds to use domestic iron, steel and manufacturer goods produced in the U.S.. Since the Village intended to use CWSRF funds to finance wastewater projects in the remaining service areas, the Village was required to comply with the Buy American provisions which AIRVAC qualified under.

**Technical Comparisons.** A variety of testing comparisons of AIRVAC and Roediger vacuum sewer components were conducted prior to 2005. Test comparisons included controller timing, flood testing, leak testing, solid object testing, and minimum operating vacuum testing.

In 2004, AIRVAC conducted testing by comparing the Roediger 3-inch vacuum valve against the AIRVAC 3-inch valve. This testing evaluated the time required to remove 10 gallons of water from the vacuum valve sump which provided a comparison of cycle times and flow rates for each valve. A range of vacuum settings from 22" Hg down to 6" Hg were tested to simulate actual field conditions. A comparison of testing results shown in **Table 2** proved that the AIRVAC 3-inch vacuum valve was capable of moving water from the sump 3 to 9 times faster than the Roediger 3-inch valve as shown by the flow data. This demonstration was key to understanding the technical capabilities of each vacuum valve manufacturer.

**Table 2. AIRVAC and Roediger Vacuum Valve Testing**

| 10-Gallon Flow Test Comparison | | | | | |
|---|---|---|---|---|---|
| AIRVAC 3" Valve | | | Roediger 3" Valve[1] | | |
| Vacuum (Hg) | Cycle Time (sec) | Flow (gpm) | Vacuum (Hg) | Cycle Time (sec) | Flow (gpm) |
| 6.5 | 3.25 | 184.6 | 6 | 120 | 5.00 |
| 8 | 3.03 | 198.0 | 8 | 36.6 | 16.4 |
| 10 | 2.40 | 250.0 | 10 | 8.41 | 71.3 |
| 12 | 2.31 | 259.7 | 12 | 6.44 | 93.2 |
| 14 | 2.16 | 277.8 | 13.5 | 6.00 | 100.0 |
| 16 | 1.97 | 304.6 | 16 | 5.28 | 113.6 |
| 17.5 | 1.69 | 355.0 | 16.5 | 5.72 | 104.9 |
| 19.5 | 1.47 | 408.2 | 19 | 5.59 | 107.3 |
| 22 | 1.66 | 361.4 | 22 | 5.20 | 115.4 |

**Procurement Process.** In the fall of 2009, the Village determined that a procurement process was necessary for selecting a sole source provider of vacuum sewer system parts, equipment, and services. To implement this process, the Village and its Program Manager consultant developed a Request for Proposals (RFP) that enabled the Village to select a vendor based on qualifications and experience with vacuum sewer systems. The RFP required responders to submit information on experience, system products, support services, personnel, and pricing components for valve pit packages (valve pits and valves), vacuum skids, spare parts, and support services. Additionally, all vendor submittals were required to comply with the Buy American provisions of Public Law 111-5 as previously described. Proposals were evaluated based on the quality of system products, cost of system components and support services, corporate experience, and the quality and responsiveness of support services and personnel. Based on submittals received, the Village Utility Department selected and executed an agreement with AIRVAC as its sole supplier for vacuum sewer system parts, equipment, and services in December 2009.

**Progression to a Village-Wide Central Sewer System**

The Village realized that immediate efforts were needed to complete the design and construction required to sewer the remaining service areas by the State's mandated deadline of December 2013. Acknowledging the complexity of the task, the Village issued a Request for Proposals (RFP) in 2007 to hire a Program Manager that would administer the program, including the hiring and oversight of engineers needed to design and construct the collection and treatment facilities to serve the remaining service areas in the Village. From 2008 to 2009, the Village moved forward with a design/bid/build program to complete the sewering of the remaining wastewater service areas. Recognizing the complexity of construction, the Village and Program Manager negotiated an extended project deadline of December 2015 with the Florida Department of Environmental Protection (FDEP). However, the Village's concern over the estimated total program costs ($130M) led to the examination of other alternatives for constructing both collection and wastewater treatment facilities needed to sewer the Village's remaining service areas. By 2010, the Village elected to use the design-build delivery method to expedite project delivery with the goal of establishing a lower construction price so that project costs would be known for its ratepayers. Concurrently, the Village investigated the option of entering into an interlocal agreement with the Key Largo Wastewater Treatment District (KLWTD), located north of Islamorada, to pump all wastewater generated within the Village service areas to the KLWTD facilities for treatment and disposal.

**Interlocal Agreement**

The Village of Islamorada was undecided on whether to construct treatment plants on each island to treat wastewater locally for each service area, to construct a single treatment plant at a central location in Islamorada to treat wastewater from all five service areas, or to collect and send all wastewater flows to the KLWTD for treatment and disposal. After many months of debate and discussion, the Village decided that the cost of sending flows to the KLWTD outweighed the cost and social impacts of constructing treatment facilities locally. More importantly, sending flows to the Key Largo treatment facility allowed Islamorada to complete construction of its central wastewater system within the required timeline mandated by the State of Florida.

Islamorada became the KLWTD's largest customer with the development and signing of the Key Largo Islamorada Interlocal Agreement on May 22, 2012 whereby a capacity allocation of 1.104 million gallons of annual average daily flow (AADF) was agreed upon. The Interlocal Agreement established upgrades necessary at the treatment plant, financial responsibilities for these upgrades, cost per gallon of flow, standards for the wastewater, and penalties for unacceptable sewage. Penalty surcharges included:

- High Strength Waste,
- Salinity, and
- Excessive Inflow and Infiltration (I/I).

**High Strength Waste Surcharge.** The Village is required to limit the biological oxygen demand (BOD) content of the wastewater being discharged into the KLWTD's treatment facility to protect against nutrient overloading possibly leading to non-compliant effluent. The high strength waste surcharge is placed on the Village if wastewater exceeds a maximum BOD of 375 mg/L for each day out of compliance.

**Salinity Surcharge.** The most crucial of the penalties is the salinity surcharge. The Village is required to limit the amount of salinity or saltwater in the wastewater collection system that would ultimately discharge into the KLWTD's treatment facility. The Interlocal Agreement states that once salinity levels exceed 3.0 parts per thousand for more than 120 days in any rolling consecutive 12-month period, the Village has 30 calendar days thereafter to remedy the problem. If the Village fails to reduce its salinity levels below 3.0 ppt after the 120-day period, the KLWTD can act to reduce salinity levels in the Village's wastewater at the Village's expense. Additionally, a surcharge fee can be applied to the base flow charge after the salinity exceeds 4.0 ppt for 30 days in a rolling consecutive 12-month period. The multiplier (M) is calculated as shown in Equation 1.

$$M = (1+(N_s/35))^3 \quad (1)$$

Where,

M = Multiplier, and
$N_s$ = Salinity (ppt)

During the early transition of flow to KLWTD, salinities on the average 10 ppt were not uncommon and Equation 1 would yield a multiplier of 2.13. During the month of May, the Village sent an average daily flow of 670,000 gpd equaling a salinity daily surcharge of $3,520 with a salinity of 10 ppt.

**Excessive Inflow and Infiltration Surcharge.** Under the Agreement, the Village agreed to design and maintain its collection system from excessive inflow and infiltration (I/I) that would ultimately discharge into the KLWTD's treatment facility. The Agreement states that if wastewater flow exceeds 125% of the capacity allocation of 1.104 mgd AADF for more than 120 days in any rolling 12-month period, the KLWTD is not required to accept the flow. If the KLWTD decides to treat the flow, a surcharge can be imposed. The Agreement also grants KLWTD the right to limit the flow through installation of regulation devices, assess the Village for additional capacity, and withhold capacity allocation permit approvals.

## RESULTS

### Adoption of a New Village Utility Policy (2014)

The original Village Wastewater Utility Policy was antiquated and did not provide detailed information necessary to maintain a functioning wastewater system. The update to the Policy detailed the requirements for all customers to comply with the Interlocal Agreement, all applicable County, State, Federal, and Village laws and regulations, and referenced the Minimum Design and Construction Standards and Specifications for Wastewater (also referred to as the Minimum Design Standards). Specifics of violations are discussed along with the procedures to restore a property's compliance. Policy guidelines detail the provisions of service, construction, installation, maintenance, connection, metering, service, rates, fees and charges of wastewater service. The Policy regulates the sources, types, and characteristics of allowable discharge. Banned discharges are summarized below.

- Prohibited sources of wastewater discharge include trucked or hauled pollutants, storm water or surface water, ground water, pool discharge, condensate, non-contact cooling water, industrial waste, medical waste, septage from pump trucks, boats or RV holding tanks.
- Prohibited types of wastewater discharge include petroleum products, dyes or vegetable tanning solutions, deionized water, detergents or surface-active agents, and fats oils or grease.
- Regulated characteristics of wastewater discharge include fire or explosion hazards, extreme pH values, solid or viscous properties posing a blockage risk, pollutants, high temperature, ability to produce toxic fumes, noxious or malodorous, radioactive or isotopes, toxic, high salinity, or high CBOD.
- Miscellaneous prohibited discharges include any discharge causing KLWTD to violate its NPDES permits, any substance defined to be prohibited under 62-604 F.A.C, or any waste defined as hazardous in rules published by the State of Florida.

To help customers avoid the common infractions above, the Policy sets forth specific pretreatment standards and requirements. The Village infrastructure does not include any pretreatment facilities and, as such, may require any nonresidential property to demonstrate their discharge does not require pretreatment. Automotive-related discharge facilities such as repair shops and car washes are required to have an oil/water separator. To prevent cooking oil, grease or sand from entering the system, a grease interceptor policy was included and expanded upon in the Minimum Design Standards.

**Development of Village-Wide Minimum Design Standards (2014)**

The Policy is paired with the Village-Wide Minimum Design Standards represented in **Figure 2** to provide the approved guidelines, practices, and methods of collection system infrastructure. To avoid repeating the failures experienced with the North Plantation Key system, the Minimum Design Standards restrict the use of vacuum sewer system components, specify design requirements for all types of collection systems, and require the testing and reporting of installed systems. Testing of all components to be connected with the Village wastewater collection system verifies that all portions of the connected system will function properly and prevent I/I. Guidelines for all testing and reporting are provided in the Minimum Design Standards within subsections for vacuum, gravity or low-pressure collection systems. Unlike the Utility Policy that requires a Village Council resolution and approval to update, the Minimum Design Standards can be updated or revised as necessary by the Village Utility Director. Updates and revisions focus on technologies, manufacturers, and/or engineering guidelines. Since 2014, the Minimum Design Standards has been updated several times with the most recent revision in 2019.

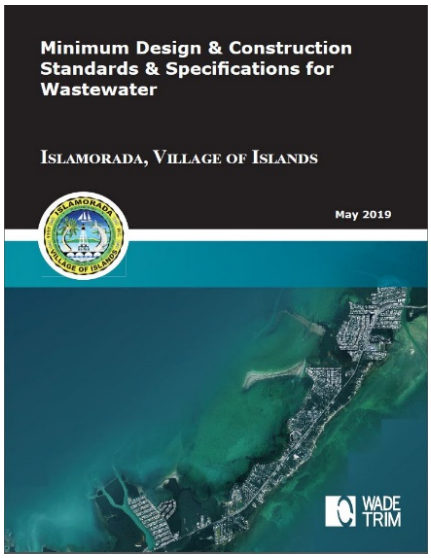


**Figure 2. Minimum Design Standards**

**Vacuum Systems**. Vacuum systems consist of an AIRVAC vacuum pit or buffer tank with associated gravity stub-outs and a vacuum main. The Minimum Design Standards require testing of each component of this system based on established AIRVAC standards as follows:

- Vacuum pit sumps and gravity laterals, including a dedicated breather, must pass a leak test at 40" water gauge pressure for a period of 1 minute with a leakage value of less than 5";
- Buffer tanks are required to pass both infiltration and exfiltration tests. For the infiltration test, the buffer tank is drained of all water and allowed a maximum infiltration of 2" per hour in the sump area, then the tank is immediately filled to the lid and allowed an exfiltration of 2" per hour; and
- Vacuum mains are tested at a minimum vacuum of 22" Hg for 4 hours with an allowable loss of less than 1% per hour (approximately 1" Hg)

**Gravity Systems**. Gravity system testing consist of laterals from the house or structure, manholes, and mains from manhole to manhole or lift station. The Minimum Design Standards specifies the following required tests for each section of the system as follows:

- The lateral from the house or structure to a manhole or lift station must pass a hydrostatic test based on the Florida Building Code requirements. Additional video testing was required to prevent debris from entering the vacuum system;
- Manholes are required to pass both infiltration and exfiltration tests similar to buffer tanks; and
- Gravity mains are required to undergo visual inspections, including lamping, leakage testing, and deflection testing for new systems only.

**Pressure Systems.** Testing relates only to the force main as the lift station is considered a manhole for the testing requirements. All pressure mains must first be flushed of all debris and air pockets removed before testing at a pressure of 150 psi. The testing requirements depend on the material. For PVC and ductile iron, testing is conducted per AWWA C-600 with a formula to calculate the allowable leakage rate. For HDPE main, the pipe must first undergo an expansion period of no less than 4 hours prior to the 2 to 3-hour test and the allowable leakage is indicated in tabular form based on the pipe diameter.

**NPK Collection System Transfer to the Key Largo WWTP**

In July 2014, the Village transferred wastewater flows from the North Plantation Key service area to the KLWTD for treatment and disposal. During the initial 30 days of flow, the KLWTD observed salinity readings ranging from 3.0 to 6.0 ppt in the Village influent stream, consistently exceeding the threshold value of 3.0 ppt allowed in the Interlocal Agreement (**Figure 1**). By December 2014, the Minimum Design Standards Manual officially became effective and a systematic approach to locate and correct sources of I/I was implemented for the Village's wastewater collection system.

The primary source of I/I in the North Plantation Key wastewater service area was the residential service area of the Phase I service connections in Plantation Key Colony. Initial investigations

indicated a system-wide failure with the outdated, failing Roediger/Roevac valve pits and prompted the Village to convert all failing vacuum valve pits to AIRVAC components. Recognizing the expense associated with this task, the Village developed a phased approach to identify sources of I/I that was based on using salinity readings taken in the field by operations staff as described below.

- Identify all existing Roediger/Roevac valve pits that exhibit salinity readings exceeding 6.0 ppt;
- Replace these identified valve pits, valves, and controllers with new AIRVAC valve pits, valves, controllers and appurtenances purchased and installed by the Village;
- Complete testing in accordance with the requirements specified in the Village's Minimum Design Standards;
- Measure salinity levels at each new installed vacuum pit at high tide to verify and confirm proper installation (water tightness) and to confirm the absence of I/I with connecting laterals;
- Identify existing Roediger and Roevac valves pits that exhibit salinity readings ranging between 2.0 and 6.0 ppt for continued monitoring and future replacement.

A complete assessment of all North Plantation Key vacuum valve pits was completed by August 2015. Each year the Village issued a work authorization that allowed for replacing approximately 100 Roediger/Roevac valve pits with new AIRVAC vacuum valve pits, valves, controllers and appurtenances. As of this date, all NPK Phase I valve pits have been replaced and a total of 90 remaining Phase II pits will be replaced by the end of 2020.

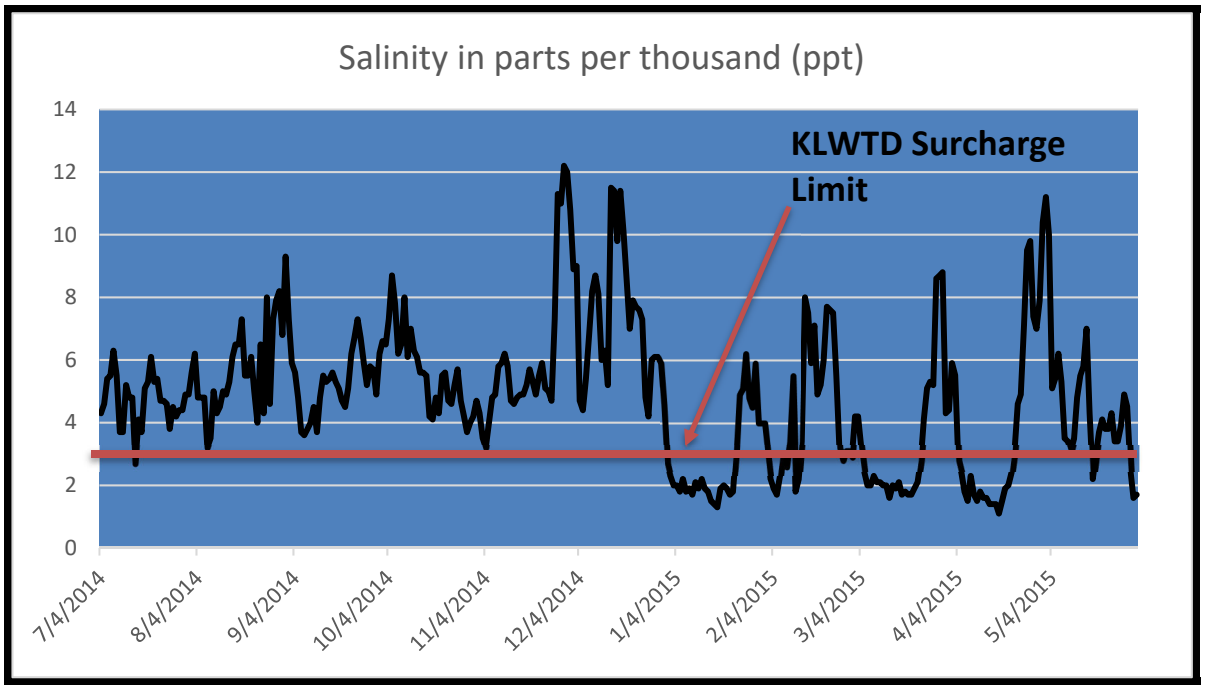


**Figure 1. Salinity levels of discharge to KLWTD before new service areas**

**New Residential Service Area Connections**

The remaining five service areas were designed and constructed as part of the Design-Build-Operate (DBO) project in accordance with the Minimum Design Standards under the oversight of the Village Owner's Representative. Service availability proceeded generally from north to south following the construction pattern of the infrastructure within the Village right-of-way. The Middle, Upper, and Lower Plantation Key service areas consisted of both vacuum sewer and low-pressure connections, while the Windley Key service area consisted of all low-pressure connections. Vacuum service connections in these service areas were available for customer connection in March 2015 while customers on low-pressure sewers under the residential grinder pump program were available for connection in November 2015. The Upper Matecumbe service area was available for service connections by March of 2016 and the Lower Matecumbe service area was available for service connections by late 2016. Wastewater flows from the new service areas had very little I/I and served to help dilute any saline infiltration that was still occurring in the NPK service area (**Figure 2**).

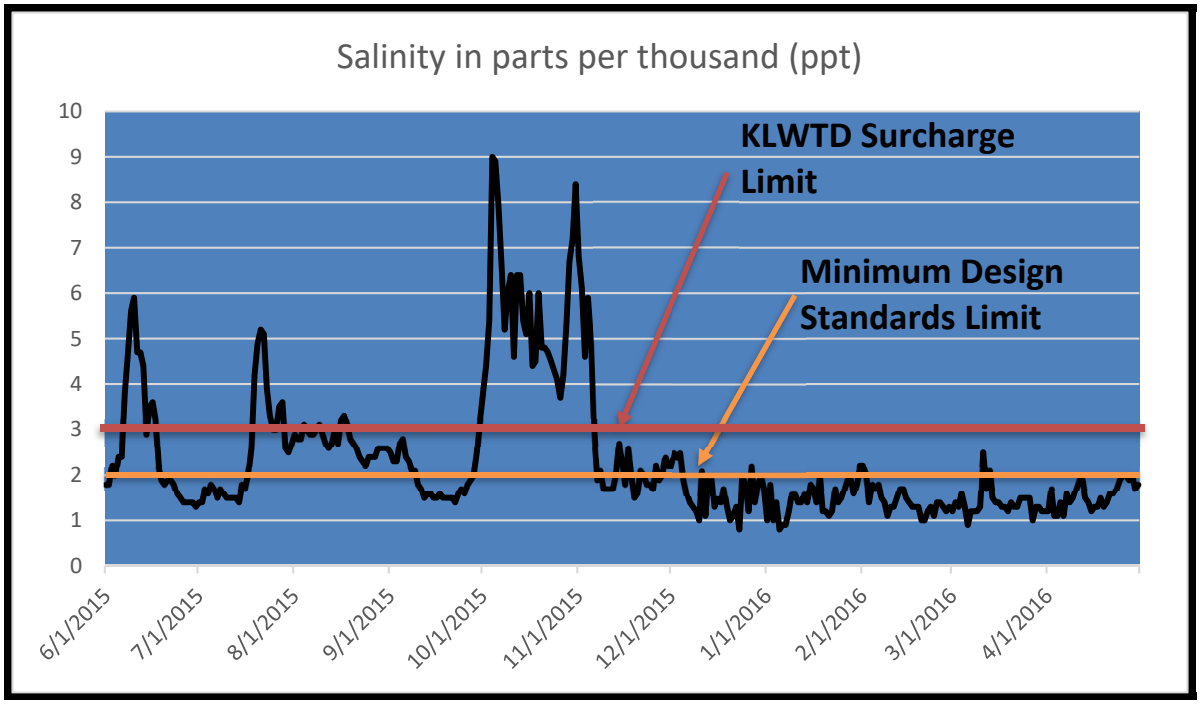


**Figure 2. Salinity levels of discharge to KLWTD after new service areas connected**

Under the Minimum Design Standards, every new residential connection was required to undergo leak testing and visual inspection prior to connecting with the Village central sewer system. With the system being a hybrid collection system, residential connections fell into four possible testing categories which are described below

**Vacuum Sewer/Gravity Connection**–This connection type consists of a licensed plumber installing the required gravity lateral, hydrostatic testing, video inspection, and final connection under supervision of operations staff. Material for the lateral is specified as green SDR 26 PVC pipe, or where a minimum of 3 feet of cover cannot be maintained, AWWA C-900 or C-905 green PVC DR-25, Class 100 per the Minimum Design Standards. Hydrostatic testing was

completed per the Florida Building Code requirement of a 10-foot pressure head with no visual signs of leaks for 1 hour. Prior to final connection, the line is video inspected as a precaution to prevent rocks and debris from entering the vacuum system.

**Residential Grinder Pump Program/Gravity Connection** – This connection follows the same procedures as described above except that the resident would be connecting with a 6-inch gravity lateral to the stub out from the grinder pump basin that has already been installed, tested, and undergone start-up procedures by Village-selected contractors under the inspection of Village staff.

**Low Pressure Connection/Non-Grinder Pump Program Participant** – This is a residential connection where the homeowner is not participating in the Village-wide grinder pump program and has elected to purchase, install, and maintain their own grinder pump. The homeowner is required to submit shop drawings for the grinder pump and basin proposed for the system when obtaining a sewer connection permit with the Village Building Department. The Minimum Design Standards require an E-One progressive cavity type grinder pump or approved equal. After receiving approval, the homeowner can install the approved grinder pump system. The low-pressure service lateral must undergo a leakage test at a minimum of 150 psi for a duration of 2 hours allowing for a change in pressure of less than 5 psi. This test must be performed under the inspection of a Village Building Department inspector or authorized representative.

**Low Pressure Connection to a Vacuum Valve Pit** – This connection method is only allowed upon a case by case review. A minimum of 35 linear feet of 6-inch gravity lateral must be installed prior to the final connection point with the Village system to transition pressure flow (from grinder pump) to gravity flow (into valve pit). The gravity portion of the system must undergo the same required testing as any other gravity connection and the pressure main section must undergo the same testing as stated in the sections above.

**New FDEP Permitted Commercial Connections**

Commercial properties located within Islamorada are connected with the Village's wastewater collection system in two ways – with vacuum sewer or with low-pressure sewer. Properties with two or more buildings connecting into a common service connection are considered a private collection system and must obtain an FDEP construction permit and a Village building permit. These facilities also require a Monroe County Department of Health (DOH) permit for decommissioning or an FDEP permit for abandoning an existing onsite sewage treatment disposal system.

**FDEP Construction Permit –** Prior to submitting an FDEP construction permit, all commercial permit applications and construction plans are forwarded to the Village Wastewater Department through the Owner's Representative for review and approval. Permit submittals are reviewed for service connection compatibility with the Village's vacuum or low-pressure sewer system, and compliance with the Minimum Design Standards, provisions of the Islamorada and KLWTD Interlocal Agreement, and local plumbing and building codes. Upon approval, the Owner's Representative forwards the permit application and construction plans to the KLWTD for final review and signature. Once approved, the Owner's engineer-of-record submits the permit application to FDEP for approval. Upon receipt of the FDEP permit, the Owner's engineer-of-

record submits the FDEP permit and construction plans to the Village Building Department to obtain the required building permit to initiate construction of the onsite collection system. This building permit also initiates the inspection process by which both the Village Building Department and a representative from the KLWTD witness all required video inspection, leakage and hydrostatic testing of the constructed sewer laterals and mains, manholes, pump stations, grease interceptors, and appurtenances on the project site. This process is specified in the Interlocal Agreement to prevent I/I into the Village wastewater collection system. Salinity testing must also be conducted at the pump station wet well during high tide events to identify any tidal infiltration. Acceptable salinity concentrations must be less than 1 part per thousand (1 ppt).

**FDEP Place Into Operation Permit –** Upon completion of all construction and testing, the commercial facility's engineer-of-record must submit a permitting package to the Village Wastewater Department and the KLWTD for approval. The permitting submittal consists of an FDEP Place into Operation permit, signed and sealed record drawings for the constructed facility, and a signed and sealed Condition Report that documents the results of testing conducted on the Owner's onsite collection system. Reporting of the salinity data is required with the submittal of each commercial facility's connection permit application and must be signed and sealed by a registered professional engineer in the state of Florida. Upon receipt of an approved FDEP permit, the Owner can connect with the Village wastewater collection system. A total of 87 commercial facilities in the Village have applied for FDEP construction permits with the Village's Wastewater Department since 2015. As of June 1, 2019, approximately 70 percent of these facilities have connected with the Village's wastewater collection system.

## DISCUSSION AND CONCLUSIONS

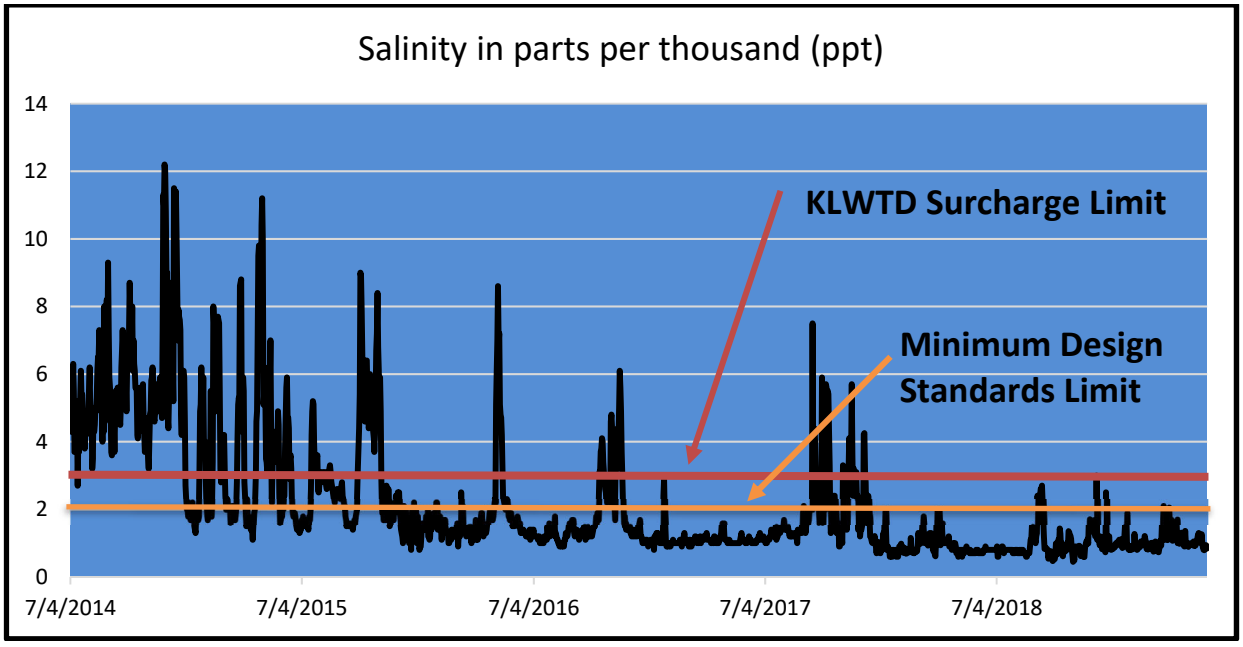


**Figure 3. Salinity levels of discharge to KLWTD from beginning to present**

Salinity monitoring (**Figures 1 and 2**) illustrates the impact of each phase of recovery while **Figure 3** provides the full history of salinity in the system through May 2019. The NPK system was constructed without oversight and experienced multiple system failures, wastewater backups in residential homes, and spillages. Once the effluent from the NPK system was transferred to the KLWTD for treatment and disposal, the extent of the problems in the NPK collection system were realized. Implementation of the Village Utility Policy, Minimum Design Standards, and NPK vacuum valve pit replacement program reduced the salinity levels below the surcharge limits with violations only occurring during monthly high tide events in the 2015 calendar year. New service areas that were designed and constructed in accordance with the Minimum Design Standards began providing measurable flow by late 2015. Violation events were all but eliminated during the 2016 calendar year. As of May 2019, more than 97 percent of properties have connected and the Village has not triggered a salinity surcharge since November 2016, even during the weeks following Hurricane Irma.

## REFERENCES

Wade Trim (2014). Minimum Design and Construction Standards and Specifications for Wastewater, Islamorada, Village of Islands.

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