# Inflow and Infiltration Affecting the Water Reclamation Facility #2 in Ocala, Florida

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## Abstract

The Water Reclamation Facility #2 (WRF #2) of the city of Ocala, Florida, is receiving high influent flows on heavy rain events. The hypothesis is that stormwater inflow and infiltration is coming into the sewer system and some possible combined systems may still be in service. Since September 2017, WRF #2 has received high influent flows over the design capacity five times. Hurricane Irma brought more than 10 inches of rainfall over 24 hours, the worst storm over the last three years. The analysis includes registered rainfall, registered flows on heavy rain events and design capacity of the lift stations and the plant. The average sewer flows can be correlated with the received flows during a heavy rain event to confirm the possibility of an inflow and infiltration situation. This correlation showed that sewer flow received after heavy rain events are greater than average, which confirmed the inflow and infiltration hypothesis. Ocala has started a smoke test project throughout the city, and they have found numerous cases of it, including combined systems. This project has been developed understanding the existing conditions and analyzing the best available data in order to identify possible opportunities to minimize the incoming of the inflow and infiltration into the sewer system to help the infrastructure.

## Introduction & Background

The city of Ocala is located in central Florida and is part of Marion County. It's a 45-square miles city with an estimated population of 60,000, but the utility service area reaches outside the city limits up to 64 m2.

The city of Ocala currently has two water reclamation facilities to service the entire city. WRF #2 was designed to receive the majority of the city's flow. The design capacity of the plant is 6.5 MGD; average daily flow is 4.2 MGD. This water reclamation facility serves approximately 25,000 ERUs in the city. Figure 1 shows the service area, including the lift station locations.

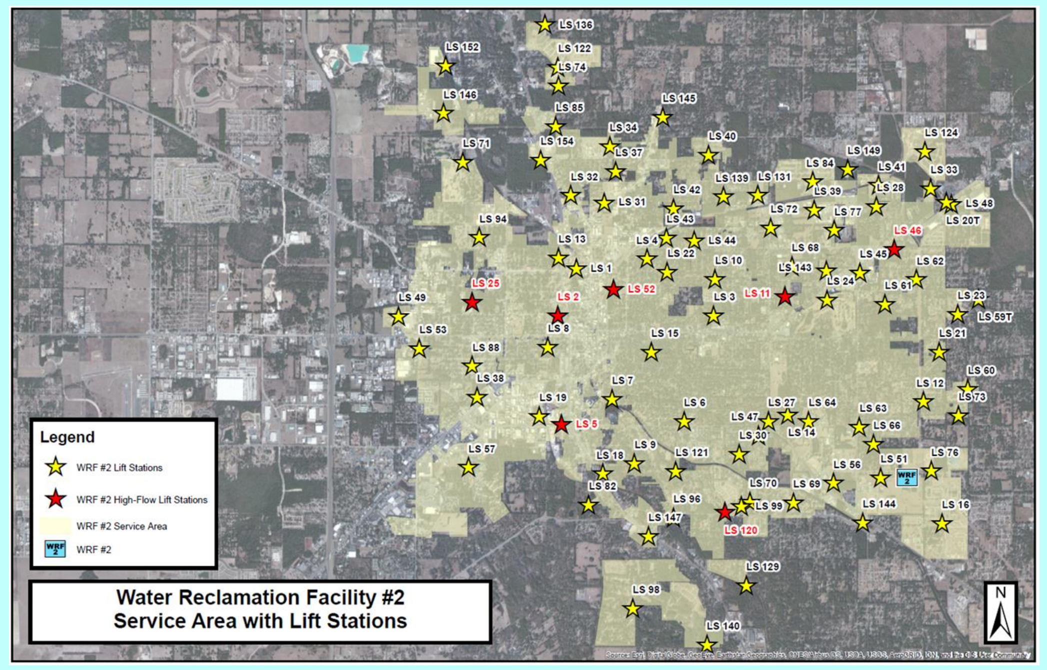


Figure 1: WRF #2 Service Area

## Problem

WRF #2 is having inflow and infiltration problems during every heavy rain event in the city. During those rain events, the influent flow overpassed the plant's design capacity. If the flow keeps increasing during the rain events, not only will they affect treatment, but it may also affect the infrastructure (lift stations, manholes, piping, etc.) and, eventually, citizens and the environment.

## Methodology

The methodology for the analysis is to relate storm rain events with influent flows at the wastewater plant. The starting date of the analysis is August 1st, 2017 to February 28th, 2020.

- ***First Analysis***
  - Daily rainfall data
  - High influent flow dates

  This first analysis is to prove the correlation between the heavy rain events and the high influent flow at WRF #2.
- ***Second Analysis***
  - Average daily flow at lift stations
  - Design capacity of lift stations
  - Registered daily flow at lift stations

  The second analysis is to verify the flow from the lift stations that pump directly to the WRF #2 and compare it to the influent flow.
- ***Third Analysis***

  The third analysis is to prove the correlation between the heavy rain events and lift station flows, comparing the average daily flow, design capacity and the flow registered during the rain events.
- ***Fourth Analysis***
  - *Infiltration* can be estimated from the difference between the high groundwater level season average flow and the low groundwater level season average flow. These average flows must be measured in a dry weather period. During the low groundwater level season, the infiltration is assumed zero and that's the average flow of the lift station.
  - *Inflow* can be estimated from the difference between the high groundwater level season average flow and registered sewage flow during the rain event.
- ***Fifth Analysis***

  The fifth analysis is to verify whether the provided smoke test reports have any identified combined system..

## Results and Discussion

***First Analysis:***

Figure 2 shows five high influent flow events during heavy rain events have been registered during the past three years.

- September 10, 2017: Hurricane Irma
- December 14 - 21, 2018: 2nd storm (2nd & 3rd rain events)
- July 25, 2019: 3rd storm
- August 15, 2019: 4th storm

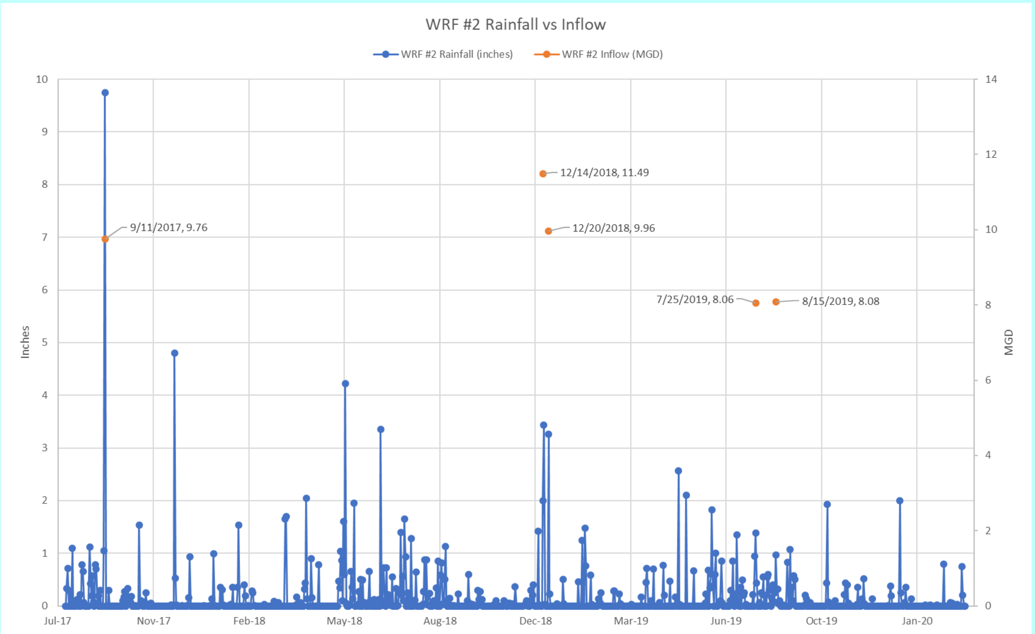


Figure 2: WRF #2 Rainfall vs Influent Flow

## Results and Discussion (cont.)

***Second Analysis:***

A total of 91 lift stations are in the WRF #2 sewer basin. Nine of these lift stations were pumping to the plant with recorded flows. The total flows of these stations, assuming that they were pumping at the same time, confirmed that WRF #2 was receiving flow over capacity during the identified heavy rain events.

***Third Analysis:***

Seven lift stations were identified as they triggered the high flow alarm in one occasion. Figure 3 shows an example of this correlation. Notice how the sewer flow overpassed the design capacity on the same day as the heavy rain event. After analyzing all the stations, the tendency of sewer flow increase during every rain event is confirmed.

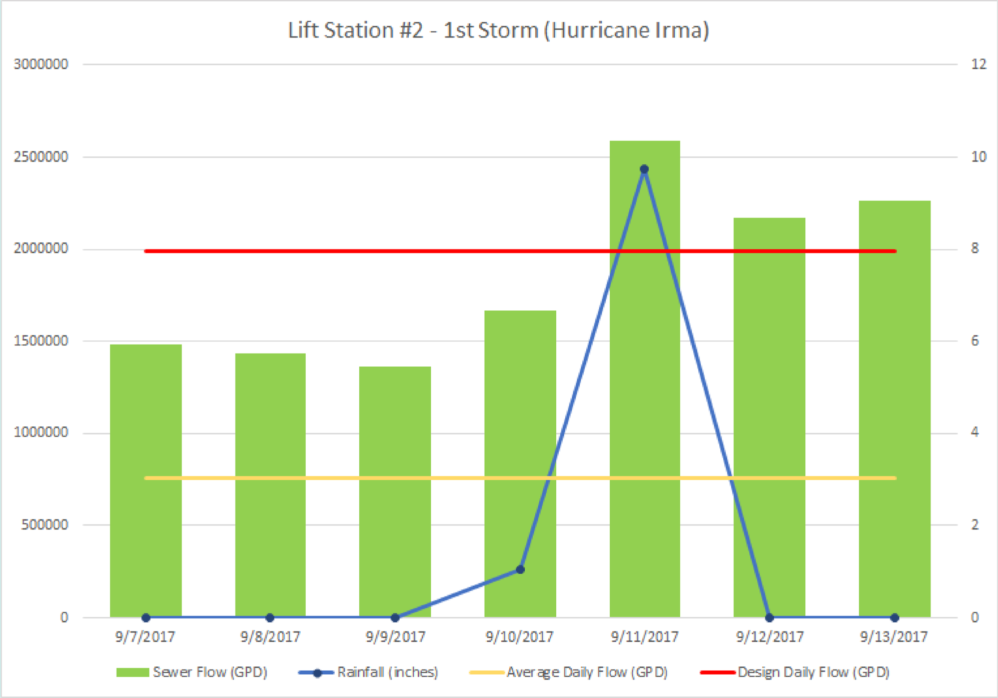


Figure 3: Lift Station #2 – Hurricane Irma Sewer Flow vs Rainfall

***Fourth Analysis:***

Inflow and infiltration was estimated [1]. The estimation depended on the following information:

- Specific location of the lift stations
- Sewer basin of the lift stations
- High/low groundwater table seasons
- Groundwater table heights

After the estimation, three of the seven high flow lift stations reflected infiltration, and six reflected inflow.

***Fifth Analysis:***

City of Ocala has performed smoke tests around the city. They have provided the reports for this analysis. After analyzing them, combined systems were found at different locations. Figure 4 shows how the smoke is coming out of a storm inlet.

Figure 4: Combined System Identified During Smoke Test [2]

## Conclusions

After the analysis, it can be confirmed that WRF #2 is receiving an extra influent flow during heavy rain events. The results proved that inflow, infiltration and combined systems are contributing to the problem. It's known that the city of Ocala has a very old infrastructure still in operation. Also, the smoke test reports revealed a lot of inflow cases and combined systems. The groundwater table level is also a contributor to the problem. When all these factors are combined, the problem could be worse than expected.

As a short-term solution, the recommendation to the city is to continue the smoke testing throughout the city. Next, they assess how old the infrastructure is, mostly in the Downtown area, and then start a program to fix or replace the damaged infrastructure. Some solutions may be lining the gravity sewer main, lining manholes, pipe bursting, manhole lid replacement and eliminating illegal connections and combined systems.

As a long-term solution, the recommendation to the city is to pursue the WRF #3 expansion project to double the capacity of the plant. Then, divert some flows to WRF #3 instead of WRF #2. Some upgrade projects will be needed to pursue this solution but will match city growth.

The city of Ocala is growing as a city and utility companies such as water and sewer should be considering future expansion and how to be on the frontline of this expansion.

## Recommendations

Most of the current big developments in the city of Ocala are in the west side of the city. New residential neighborhoods, all kinds of commercial projects, hospitals, etc. are some of the new developments. WRF #3 is the treatment plant designated to serve the west side of the city, with a capacity of 4 MGD. Considering these facts, the city of Ocala is planning to double the capacity of WRF #3 (to 8 MGD) during the following 5 to 10 years. Taking into consideration such plant expansion, the proposed solution to solve the high influent flows coming into WRF #2 during every heavy rain event is to divert some flows to WRF #3. For this solution to be effective, the city of Ocala must combine this solution with other alternatives such as minimizing the inflow-infiltration and eliminating the combined system throughout the city.

## References

[1] Quick Guide for Estimating Infiltration and Inflow, EPA, June 2014. [Online]. Available: https://www3.epa.gov/region1/sso/pdfs/QuickGuide4EstimatingInfiltrationInflow.pdf

[2] USSI, "Homepage." Accessed May 14, 2020. [Online]. Available: https://www.ussiusa.com/home.html