

ANALYSIS OF RAINFALL AND ITS INFLOW INTO THREE MILE CREEK SEWER SHED SYSTEM IN MOBILE, ALABAMA

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Sewage is something that is present in every city. Sewage can present several problems in a community. One such problem is sanitary sewer overflows (SSO's). Not many people are aware that heavy rainfall events can cause sanitary sewer overflows. When a heavy rainfall event occurs, water can infiltrate the sewer system and cause the sewer system to reach and then exceed its capacity. Infiltration occurs in areas where the sewer pipes are weak or just weathered due to extreme age. Not only do overflows by rainwater decrease system capacity to collect and treat raw sewage, it also degrades water quality in the water shed by overflowing into storm drain systems, yards, homes and businesses. This study utilized rainfall and system flow data collected by Mobile Area Water and Sewer System as well as data from the National Weather Service. The rainfall and flow data was compared and evaluated with National Weather Service Doppler radar rainfall estimates to gauge how much water due to infiltration enters the Three Mile Creek sewer shed. A sewer shed, defined similarly to a watershed, collects sewage from a delineated area and concentrates it into a main line to flow eventually reaching treatment plants. Although metering and rainfall data have been collected for several years, it is difficult to relate this data as to what will cause an overflow.

Keywords: Infiltration, Sanitary Sewer Overflows, Alabama

Introduction

Water quality within the Dog River Watershed has been something that the Dog River Clear Water Revival has monitored for many years. They have observed many changes in the quality of the water over the last several years. All members in the community are dependent upon the water and any negative changes in the quality of the water could heavily affect all dependents of that watershed. The city of Mobile has multiple needs pertaining to the improvement of water quality. One such need is the ability to reduce sanitary sewer overflows (SSO's) in the City of Mobile sewage system caused by heavy rain (MAWSS, 2008). An SSO is an event that is defined as an overflow of untreated sewage into the environment (Fig. 1). SSO events are hazardous to health, cause damage to buildings and businesses, threaten the

environment and are also illegal by the Clean Water Act (Irving 2007). There are several factors that affect overflows from the sewage systems themselves. The two main factors that contribute to overflows are grease backup and rainwater infiltration. Rainwater infiltration is the leading cause of overflows, but grease backups cause twenty-one percent of overflows (Raleigh 2009).



Figure 1: Sanitary Sewer Overflow
Photo courtesy of The Clean Waterways Program of Frankfort and Franklin County
Kentucky

Rainwater infiltration into the sewer system is a known problem in the city of Mobile. There are several possible causes of infiltration into a sewer system. Such possible causes include: breaks in old pipes, settling of pipes causing joint expansion, and connections with building water runoff catchments (MAWSS defects 2010). From 1995 to 1999 alone, the United States Environmental Protection Agency has noted unpermitted overflows averaging from 2.1 to 4.1 million gallons per year in Mobile (EPA 2002). During a heavy rainfall event in Mobile on

February 4th and 5th, an estimated 175,000 gallons overflowed in the area (MCHD 2010). In 2010, Jerrod Frederking did an analysis of rainwater infiltration for the Eslava sewer shed in Mobile. He found that every flow meter location showed an increase in flow during a heavy rainfall event (Frederking, 2010). Analyzing the flow within the Mobile sanitary sewer system will help the Mobile Area Water and Sewer System (MAWSS) identify areas where rainwater infiltration is occurring. Identifying these problem areas will pinpoint locations where there is an increased risk for SSO's to occur and also help MAWSS plan for improvements to the sewer system in Mobile.

Study Area

The project will focus on analyzing the sewer system flow in the Three Mile Creek sewer shed (Fig. 2). Although only a small portion of the Three Mile Creek sewer shed falls within the Dog River watershed, rainwater infiltration and SSO's could still affect the Dog River watershed. The Three Mile Creek sewer shed does include a portion of downtown Mobile and The University of South Alabama campus.

Research Question

Does rainwater infiltrate the Three Mile Creek sewer system and increase the flow rate contributing to Sanitary Sewer Overflows (SSO's)

Methodology

The main portion of this project dealt with analyzing flow data and rainfall data within the Three Mile Creek sewer shed. The flow data and rain gauge for this area was obtained from the Mobile Area Water and Sewer System (MAWSS). The flow data and accompanying rain

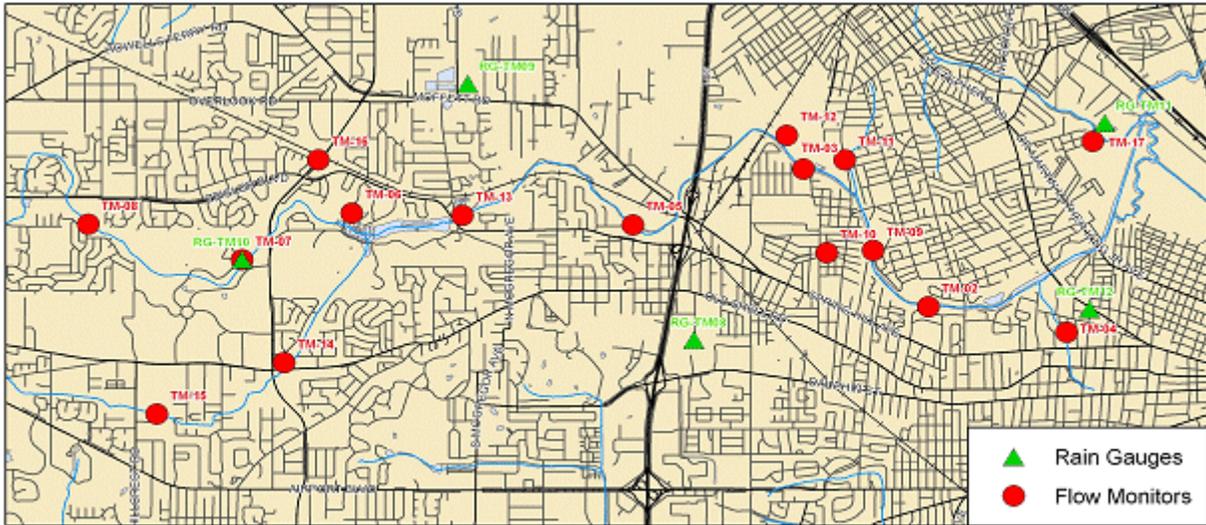


Figure 2: Map showing the flow meter and rain gauge locations within the Three Mile Creek Sewer Shed

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auge data came in Microsoft Excel spreadsheets. There are sixteen flow monitors and five rain gauges dispersed throughout the Three Mile Creek sewer shed. After the data was downloaded, it was checked for erroneous data. Both the flow data and rain gauge data were given in fifteen minute increments.

The first part of the project was to manipulate the data to get it in the appropriate units for this project. The flow data was given in millions of gallons per day (mgd). For this project the data needed to be in gallons per hour (gph). The following formula was used to convert the flow data from mgd to gph: $1 \text{ MGD} = 41666.6 \text{ gallon/hour [US]}$. Since the rain gauge data is given in fifteen minute increments, the data was summed up for each hour to show hourly rainfall amounts.

After the data was in the appropriate units for this project, the data was analyzed. First a dry flow day and a wet flow day were determined. The criterion for a dry flow day was a day that had no rainfall during the 24-hour period and there was no rainfall during the previous seven

days. The criterion for a wet flow day was a day that had at least an inch of rainfall in a 24-hour period. After the dry and wet flow days were determined, the data was separated into separate sheets to make the analysis easier. Once the separate sheets were created, graphs were made to show the flow pattern over the 24-hour period. The final step was to combine the two dates into one sheet and create a graph showing both flow dates on one graph.

The second part of this project took archived radar data and analyzed the amount of rainfall that occurred over the Three Mile Creek sewer shed during the chosen heavy rainfall event. The data was downloaded from the National Climatic Data Center (www.ncdc.noaa.gov). The data was then brought in to the GRLevel3 software for analysis. One hour precipitation totals were pulled up for each hour of the rainfall event and in the end, the totals for each hour were summed up to get the total amount of rainfall for the day. This was done to verify the rainfall totals given by the rain gauges throughout the Three Mile Creek Sewer Shed.

Results

The rain gauge analysis was performed for two main purposes: to determine dry flow days and wet flow day and to determine when and how long the rainfall occurred within the Three Mile Creek sewer shed. The dry flow day examined in this project was November 11, 2010. The wet flow day that was examined in this project was November 15, 2010. The rain began around 7:30 am and continued on and off until shortly before midnight. The heaviest rainfall occurred at 11:30 am for rain gauges RG-TM08 and RG-TM10 and 11:45 am for rain gauges RG-TM09, RG-TM11, and RG-TM12.

The analysis of the Three Mile Creek sewer shed flow data showed uniform results. Every flow meter showed that there was an increase in flow during a heavy rainfall event (Fig. 3). This graph shows that meters TM-02 and TM-03 had relatively higher flow than the other meters. On dry flow days, these meters had higher flow rates than the other meters as well. These meters are located extremely close to Three Mile Creek as well as in neighborhoods. These two factors could contribute to higher flow when compared to the other meters. The graph also shows that after the rainfall decreased and eventually stopped, the flow rate would gradually come back down, but still remained higher than normal flow for several hours. Some flow meters showed a greater increase in flow than others. For example, the flow rate in meter TM-02 showed an increase of more than three times its normal flow. Meter TM-04 normally has a low and fairly constant flow rate, but during the rainfall event on November 15, 2010, the flow rate increased by more than five times its normal flow rate (Fig. 4).

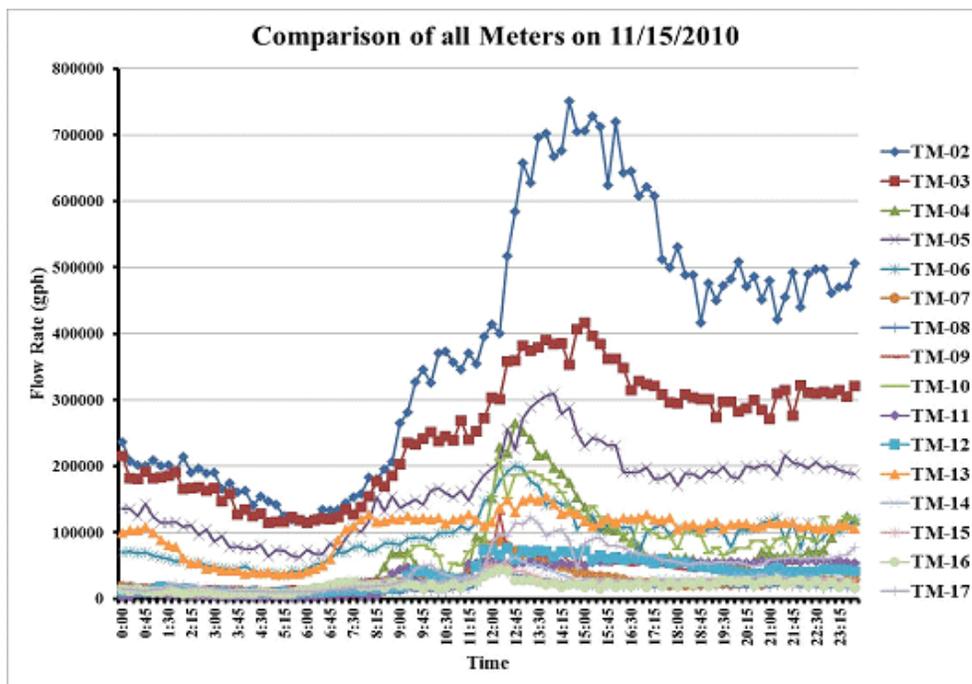


Figure 3: Comparison of all flow meters during the November 15, 2010 rainfall event

The data showed a lag in the flow rate increase from when the rainfall started. For all the rain gauges the heaviest rainfall occurred during the 11:00 am hour. The peak flow for all meters showed up during the 12:00 pm hour.

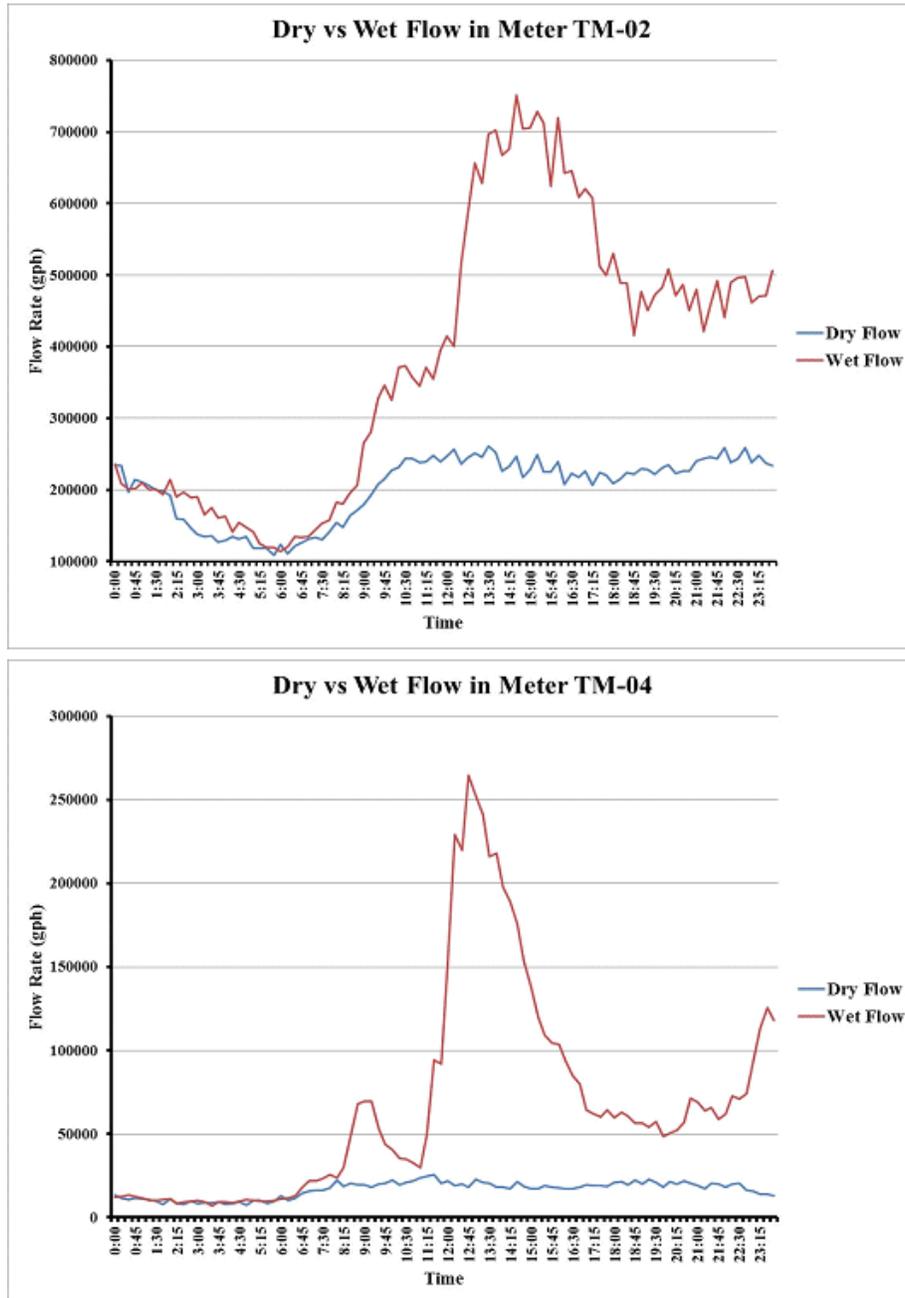


Figure 4: Top graph shows meter TM-02 dry/wet comparison and bottom graph shows meter TM-04 dry/wet comparison

Conclusion and Discussion

The results from the flow analysis most certainly show that there is a problem with rainwater infiltration throughout the Three Mile Creek sewer shed. With this problem established, MAWSS can take the proper steps to improving the sewer system in Mobile. This will drastically decrease the threat for SSO's and improve the water quality in the Dog River watershed and the Mobile area. Since the Three Mile Creek sewer shed contains many neighborhoods, several schools and universities, and numerous businesses, it would be beneficial to the community to see positive changes in the sewer system.

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