Sewer Sociology – The Days of Our (Sewer) Lives

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ABSTRACT

For centuries mankind has recorded life's events through hieroglyphics, stories, and books. In a similar fashion, hydrographs from sewer flow monitors record the daily rhythm of people's lives through water and sewer use. Differences in land use are apparent, as well as differences between weekdays, weekends, and holidays. Other distractions and disruptions of everyday life can also be seen as departures from these patterns.

An overview of sewer use patterns is provided for normal weekday and weekend periods. Variations are then discussed based on land use differences. Other events that depart from normal diurnal patterns are also presented – including holidays, religious observances, sporting events, the World Trade Center Attack, the Northeast Power Blackout, and others.

This paper is not a typical technical paper, but rather a collection of interesting observations of human behavior documented through sewer flow monitor data. The authors have performed engineering analysis on data from thousands of flow monitoring locations across the United States, and this paper will show those of general interest, including both serious and light-hearted material.

KEY WORDS Flow Monitoring, Diurnal Pattern, Land Use, Sliicer.com™

Introduction

For centuries, mankind has recorded routine and historic events through hieroglyphics, stories, and books. In a similar fashion, hydrographs from sewer flow monitors record the daily rhythm of people's lives through water and sewer use. Differences in land use are apparent, as well as differences between weekdays, weekends, and holidays. Other distractions and disruptions of everyday life can also be seen as departures from these patterns. This paper is not a typical technical paper, but rather a collection of interesting observations of human behavior documented by ADS flow monitors located throughout the country.

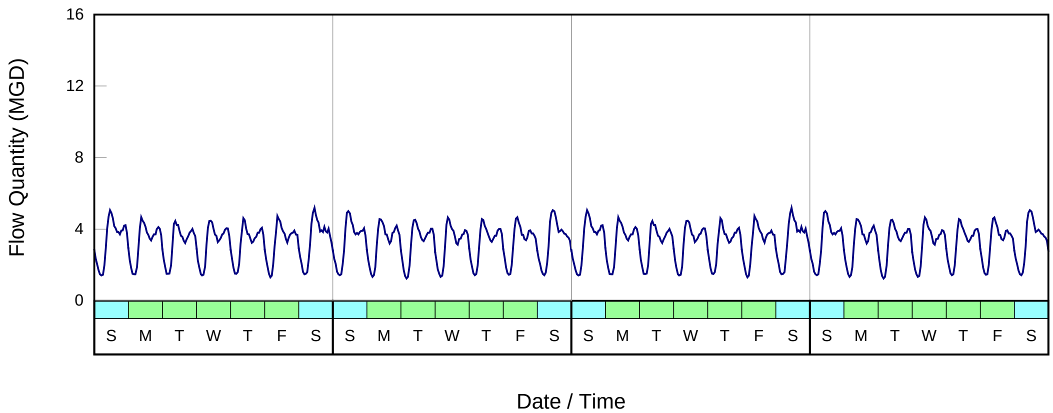
The Days of Our (Sewer) Lives

Sewers are an important part of our society. They serve to promote public health, protect the environment, and support economic growth within our communities. They also happen to provide a unique view into everyday life, and thus the connection between sewers and sociology. For this discussion, s*ewer sociology* is defined as:

> **sew´·ẽr sō·ci·ol´ō·gy**, *the science of society, social institutions, and social relationships viewed through the eyes of a sewer; specifically: the systematic study of the development, structure, interaction, and collective sewer use of organized groups of human beings.*[1]

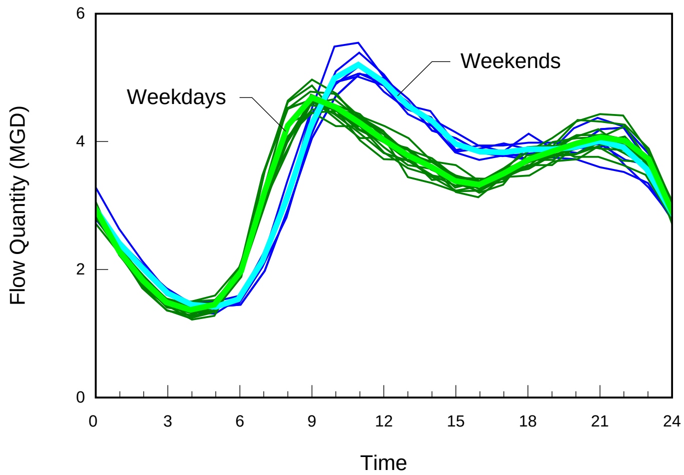
What would a sociologist have to say about all of this? Dr. Ron Akers, a Professor of Sociology at the University of Florida, was contacted in this regard. He stated that "there is definitely a social dimension and patterned social behavior that relates to the use of all public resources," including sewers.[2] Interesting observations into this social dimension can be revealed in a hydrograph of flow monitor data, as shown in Figure 1.

FIGURE 1: Hydrograph of Sewer Flow Monitoring Data



This hydrograph displays flow monitor data from a residential area recorded over a four week period during normal dry weather conditions. Note that a repeatable daily or *diurnal* pattern is observed. A more detailed view is obtained by plotting each day on top of the other in a composite 24-hour hydrograph as shown in Figure 2. The distinctive patterns of weekday and weekend residential flows are readily apparent.

FIGURE 2: Weekday and Weekend Diurnal Patterns

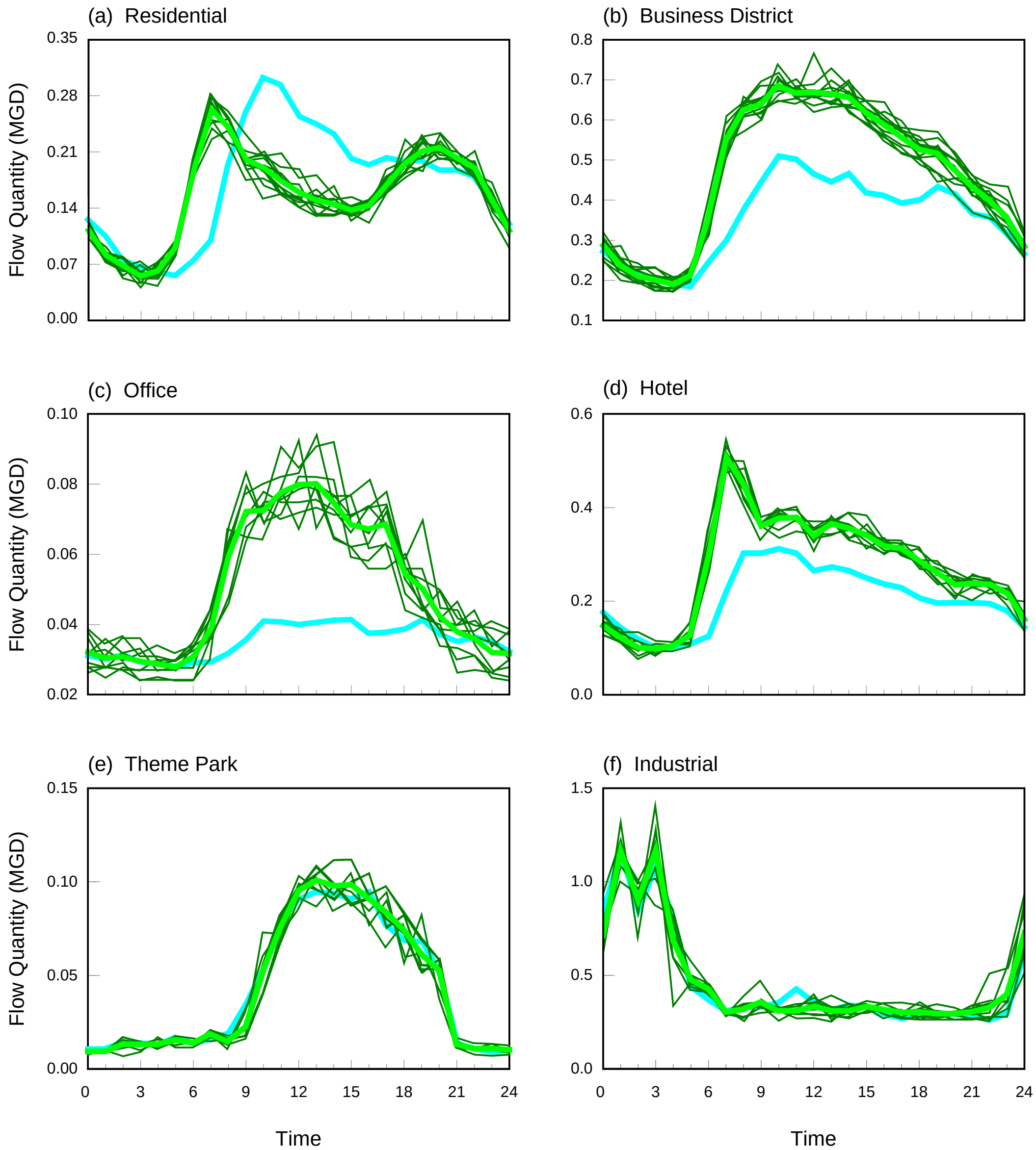


The light green curve and the light blue curve shown in Figure 2 are the average daily flow patterns observed on weekdays and weekends, respectively. The dark green curves and the dark blue curves are the individual weekday and weekend traces used to determine each average. These curves provide an indication of the normal variation in flow that can be expected during normal dry weather conditions. Composite hydrographs are used throughout the following sections and serve as an important reference in the study of sewer sociology.

Land Use

Land use within a particular area can impact the shape of the diurnal pattern. The examples shown in Figure 3 represent diurnal sewer use patterns from six different land use areas.

FIGURE 3: Sewer Use Patterns for Various Land Uses



The residential pattern is the most common. Combinations and variations of these patterns are often observed in mixed land use areas. Industrial patterns are industry-specific and come in many varieties. The industrial example provided here is from a meat processing facility that performs cleaning operations on the third shift.

Holidays

Holidays are welcome diversions from everyday life and provide time to celebrate and relax with family and friends. These diversions are reflected in sewer use patterns, as shown in Figure 4. Flow monitor data from several familiar holidays are displayed in comparison with normal weekday and weekend sewer use patterns. To a sewer sociologist, a holiday looks much like a weekend. However, characteristic differences are observed that make each holiday unique. See what differences you can find and how they compare with your holiday traditions.

These composite hydrographs are interpreted by noting differences between the average weekend curve and the holiday of interest. Several interesting observations are noted:

- Higher sewer flows are observed early on New Year's Day as people celebrate the arrival of the New Year. The morning rise also occurs later in the day as people recover from the night before.

- Martin Luther King, Jr. Day and President's Day are government holidays. However, many businesses in the private sector remain open. As a result, the morning rise occurs earlier than a typical weekend as a certain percentage of residents wake at their normal weekday time and prepare for work.

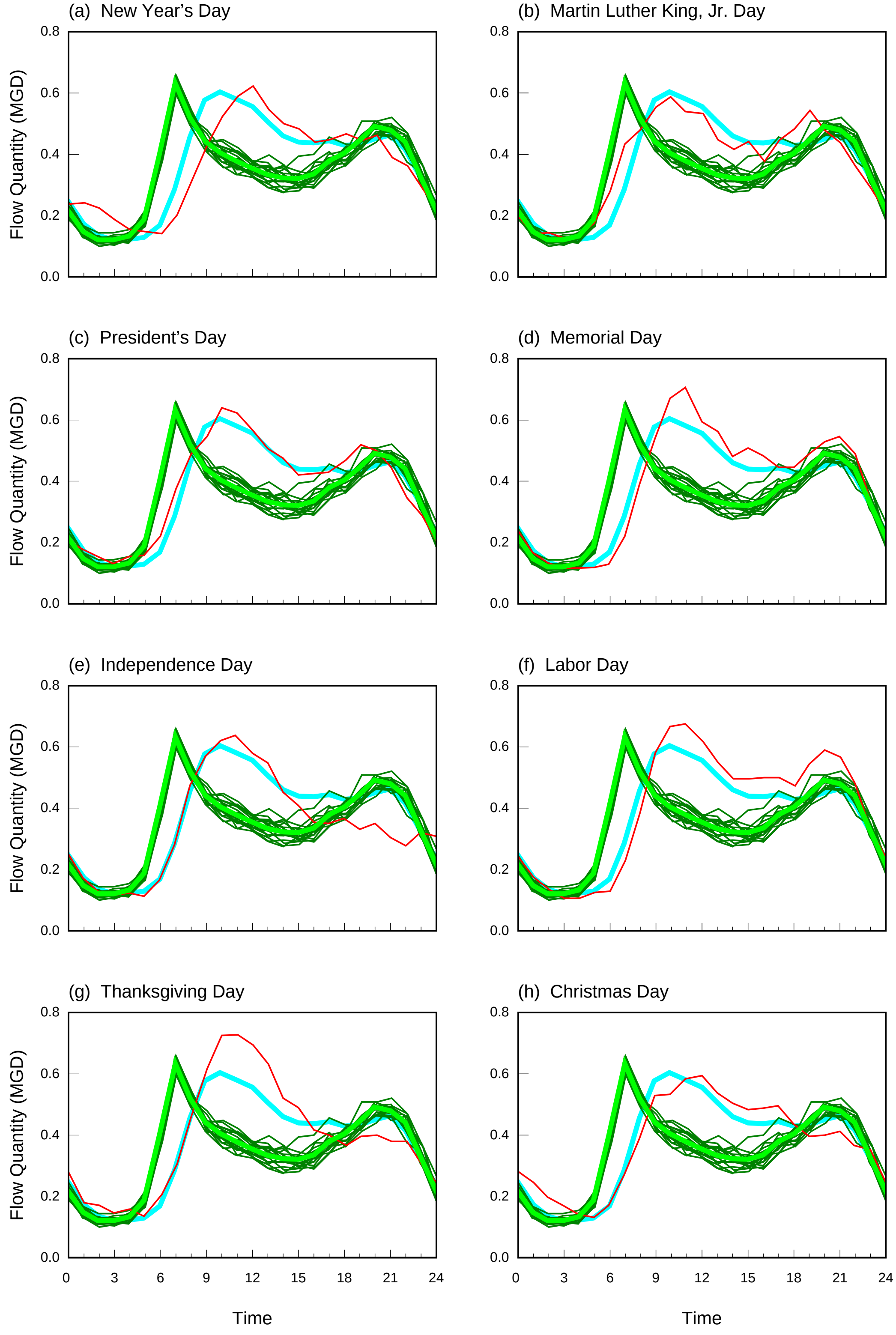
- Memorial Day and Labor Day are quite similar, both with higher sewer flows during the late morning and early afternoon as people enjoy the holidays.

- Lower sewer flows are observed during the evening on Independence Day as many people depart to watch local fireworks displays.

- Thanksgiving Day provides the most noticeable deviation from typical flows, with peak flows occurring around the time of the traditional Thanksgiving meal.

- Peak flows on Christmas Day are less than those observed on Thanksgiving. However, increases are observed around afternoon and evening meal times. Note also that higher sewer flows are observed during the early morning hours, a traditional time when Santa Claus is known to be busy delivering gifts.

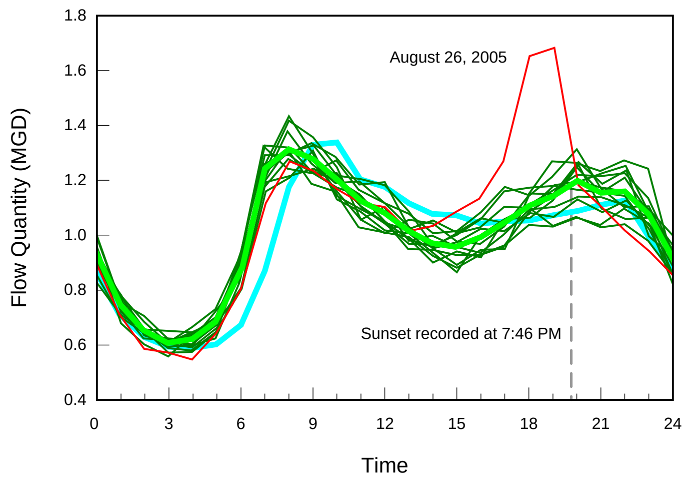
FIGURE 4: Sewer Use Patterns for Various Holidays



Religious Observances

Certain religious practices can also be observed in sewer use patterns. Figure 5 provides a composite hydrograph from a flow monitor located in a region with a prominent Orthodox Jewish population. The sewer use pattern observed on Friday, August 26, 2005 is shown for comparison.

FIGURE 5: Sewer Use Pattern for Jewish Sabbath

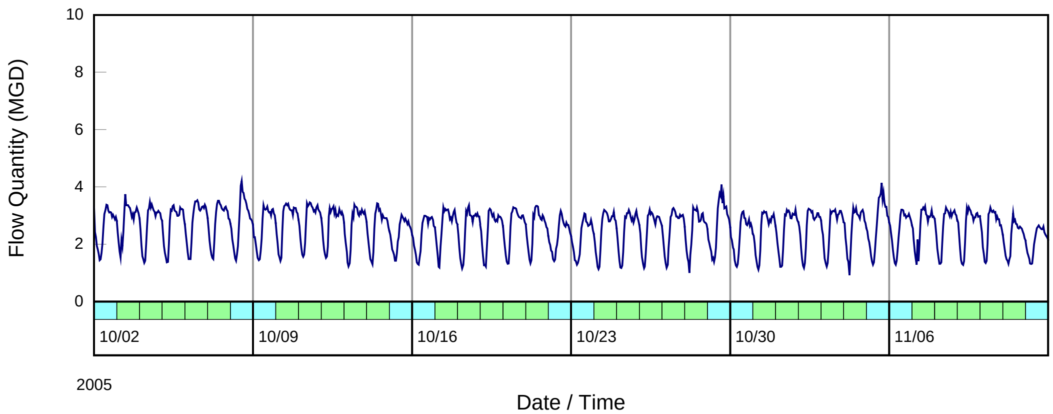


The Jewish Sabbath, or *Shabbat*, begins at dusk on Friday evening. However, preparations such as shopping, cooking, cleaning, and bathing start much earlier and must be completed by dusk. The Jewish Sabbath is a time of worship, reflection, and rest, and other activities are limited during this period.[3] Preparation for the Sabbath and the rest that follows are reflected in the sewer use pattern each Friday. These patterns are repeatable from week to week. However, peak flows do shift with changing sunset times.

College Football

College football games are big-time events in big-time college towns as students, alumni, and fans descend upon campus for a day of spirited festivities. Flow monitor data from Tallahassee, Florida – home to Florida State University (FSU) – are shown in Figure 6 and provide a glimpse into the world of college football.

FIGURE 6: Hydrograph of Sewer Flow Monitoring Data from Tallahassee, Florida



This data was obtained during a portion of the 2005 football season at a monitoring location downstream from the Florida State University campus. The FSU football schedule and the outcome of each regular season game are provided in Figure 7 for reference.[4] Please note the sound thumping FSU received on November 26th by the author's alma mater.

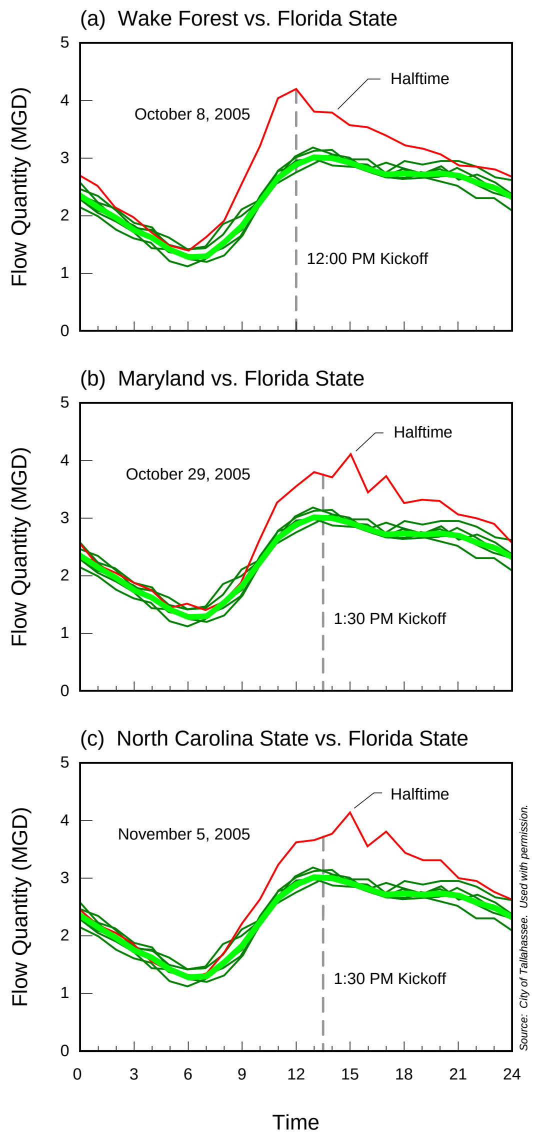
FIGURE 7: FSU 2005 Football Schedule

09/05	Home	Miami	W	10-7
09/10	Home	The Citadel	W	62-10
09/17	Away	Boston College	W	28-17
10/01	Home	Syracuse	W	38-14
10/08	Home	Wake Forest	W	41-24
10/15	Away	Virginia	L	26-21
10/22	Away	Duke	W	55-24
10/29	Home	Maryland	W	35-27
11/05	Home	NC State	L	20-15
11/12	Away	Clemson	L	35-14
11/26	Home	Florida	L	34-7

Flow rates at this location show a dramatic increase on three occasions which happen to correspond to three home football games at Doak Campbell Stadium. The flow rates observed during these three games are compared to average dry day flows on the composite hydrographs shown in Figure 8.

All three games began in the early afternoon, and as expected, sewer flows began to increase a few hours prior to kickoff. During the Maryland and North Carolina State games, two distinct flow increases were observed that coincide with halftime and the end of the game. Note, however, that the same pattern was not observed during the Wake Forest game. A review of the final score reveals that Wake Forest was routed 41-24 by FSU. The flow monitor data reveal that fans began to depart the stadium early in the game. The final scores from the other two games were much closer – resulting in one win and one loss for FSU.

FIGURE 8: College Football Games

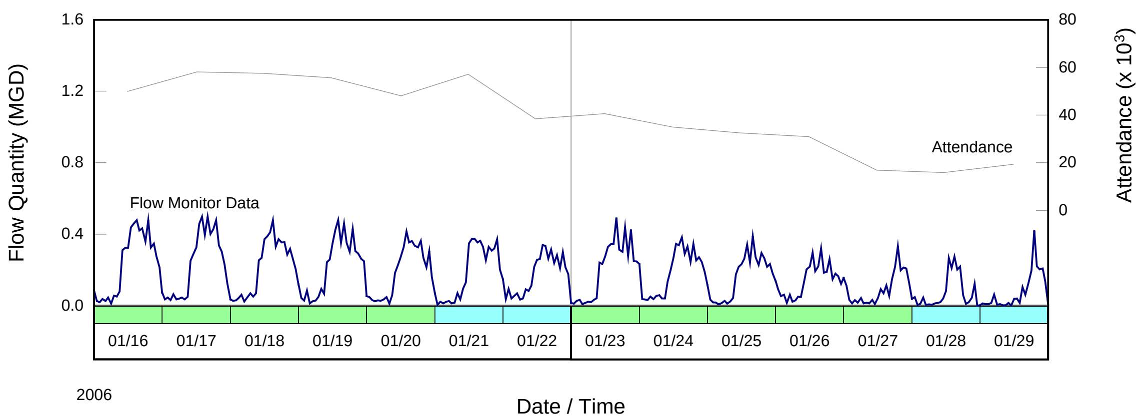


Flows directly associated with the stadium are determined by subtracting each game day flow from the average weekend flow. The Maryland and North Carolina State games generated an additional 304,000 gallons of flow. With a stadium capacity of 82,300, this results in a sewer use rate of 3.7 gallons/day/seat, comparable to the 4 gallons/day/seat sewer use estimates recently used for other stadium development projects.[5]

Australian Open

The Australian Open is held each year in Melbourne, Australia and is one of four Grand Slam tennis tournaments, attracting top-ranked professional and junior players from around the world. Flow monitor data from the 2006 Australian Open are provided in Figure 9 and provide a recap of the tournament from a sewer's perspective. Attendance figures for each day of the tournament are provided for comparison.[6]

FIGURE 9: Hydrograph of Sewer Flow Monitoring Data from the 2006 Australian Open



This data was obtained from a flow monitor located just downstream from Melbourne Park – home to the Australian Open. Melbourne Park provides a world-class venue for competitive tennis, and key features of the venue are summarized in Figure 10.[7]

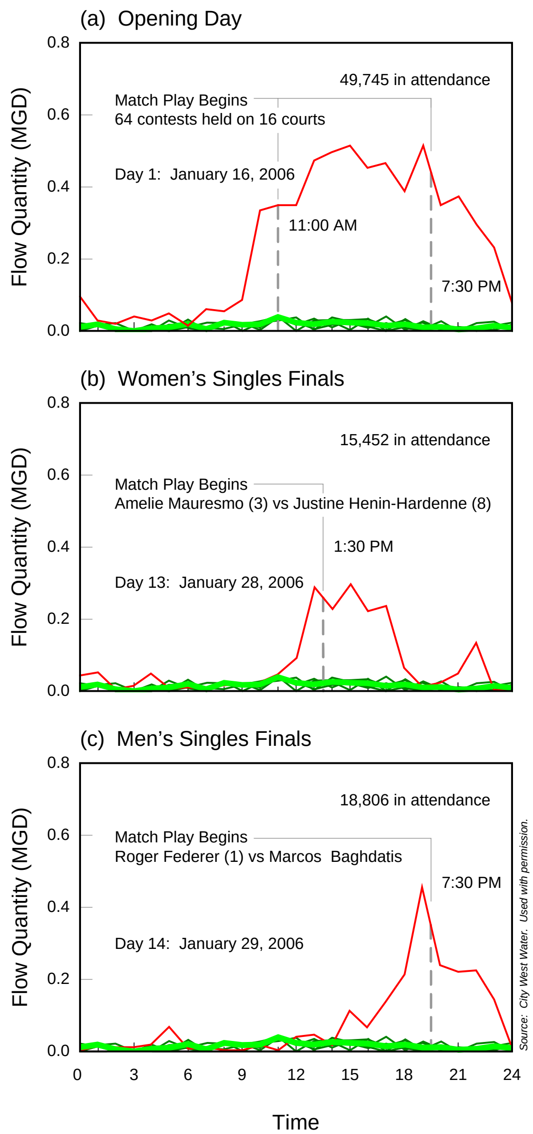
FIGURE 10: World Class Facilities at Melbourne Park

Rod Laver Arena:	stadium with retractable roof and a seating capacity of 15,000
Vodafone Arena:	stadium with retractable roof and a seating capacity of 10,000
Margaret Court Arena:	seating capacity of 6,000
Show Court 2:	seating capacity of 3,000
Show Court 3:	seating capacity of 3,000
Outdoor match and practice courts:	19
Indoor practice courts:	5

The 2006 Australian Open encompassed a total of 631 matches contested on 17 different courts during 14 days of competition – including 12 day sessions, 11 night sessions, and two twilight sessions.[8]

Sewer flow rates observed during several days of the tournament are compared to average dry day flows on the composite hydrographs shown in Figure 11. Dry day flows were obtained after the tournament during February 2006 when no other events were scheduled at Melbourne Park. Flows directly associated with the Australian Open are determined by subtracting each tournament day flow from the average weekday or weekend flow. Note that peak sewer flows occur just before the start of major matches and are most pronounced for the men's singles finals.

FIGURE 11: Australian Open Highlights



According to tournament officials, patrons consumed more than 37,247 buckets of hot chips, 37,305 barbeque sausages, 5,500 pounds of curry, 164,416 ice creams, 200,821 bottles of water, and 110,685 espresso coffees.[7] According to the flow monitor, they also generated 2,204,000 gallons of wastewater. With a reported attendance of 550,550, this results in a sewer use rate of 4 gallons/day/person over the duration of the tournament – consistent with the sewer use rate observed at college football games in the United States.

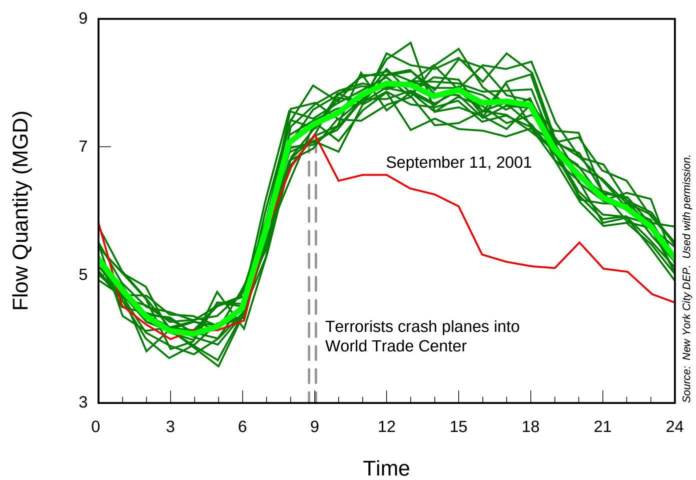
World Trade Center Attack

September 11, 2001 is a defining moment in U.S. history, and its memories and emotions echo through the words of the 9/11 Commission:[9]

> *At 8:46 on the morning of September 11, 2001, the United States became a nation transformed. An airliner traveling at hundreds of miles per hour and carrying some 10,000 gallons of jet fuel plowed into the North Tower of the World Trade Center in Lower Manhattan. At 9:03, a second airliner hit the South Tower. Fire and smoke billowed upward. Steel, glass, ash, and bodies fell below. The Twin Towers, where up to 50,000 people worked each day, both collapsed less than 90 minutes later . . . More than 2,600 people died at the World Trade Center . . .* [and] *the death toll surpassed that at Pearl Harbor in December 1941.*

The composite hydrograph shown in Figure 12 offers a unique perspective on the events of September 11th as observed by a flow monitor located north of the World Trade Center.

FIGURE 12: World Trade Center Attack of 2001



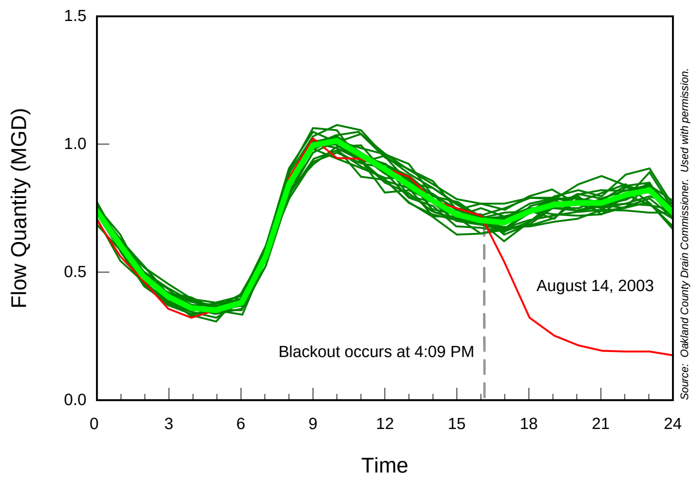
Note that this day, started out like any normal day. That all changed at 8:46 AM when terrorists flew American Airlines Flight 11 into the North Tower of the World Trade Center.[9] Much of Manhattan, including this area, was evacuated as rescue and recovery efforts began. This clearly was not a *normal* or *average* day. Instead, this flow monitor has documented its own account of a historic tragedy from a unique perspective. Although the perspective is different, the story remains compelling.

Northeast Power Blackout

Millions of people were left without power on August 14, 2003 at 4:09 PM when the largest blackout in the history of North America occurred. The blackout began when three transmission lines failed near Cleveland, Ohio. Within minutes, over 100 power plants in the United States and Canada were overwhelmed and knocked offline.[10]

The blackout affected several major metropolitan areas – including Detroit, Cleveland, Columbus, New York, Toronto, and Ottawa. Figure 13 displays a composite hydrograph of normal dry weather conditions from a flow monitor located in Oakland County, Michigan. Flow monitor data from August 14th are shown for comparison.

FIGURE 13: Northeast Power Blackout of 2003



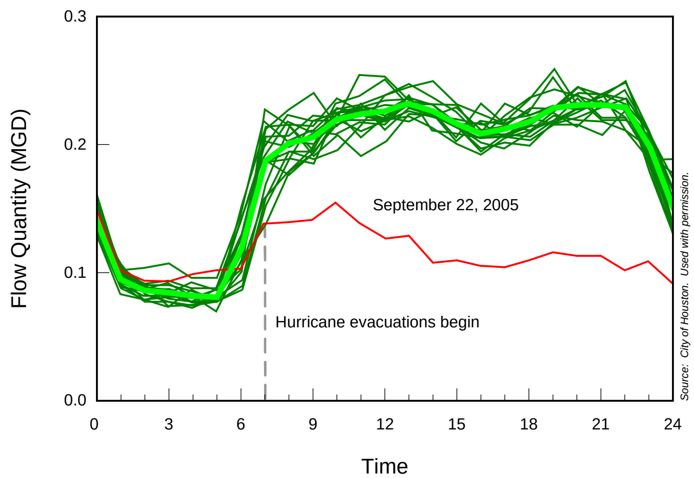
Note the dramatic drop in flow after the power failure. The minimum flow during the blackout was well below the normal night-time flow. This example illustrates how the disruption of one basic service can affect the use of another.

Hurricane Rita

Hurricane Rita entered the Gulf of Mexico on September 21, 2005 and strengthened to a powerful Category 5 hurricane. No less than a month before, Hurricane Katrina had devastated New Orleans and other surrounding coastal communities. This time, storm-weary residents were not taking any chances.[11]

Early forecasts for Hurricane Rita included the metropolitan Houston area – with a population in excess of five million – prompting one of the largest evacuations in U.S. history. Media reports indicate that the ensuing evacuation involved more that two million people in Texas alone.[12] Figure 14 displays a composite hydrograph of normal dry weather conditions from a flow monitor located in Houston prior to the evacuation. Flow monitor data from September 22nd, the evacuation day, are also provided.

FIGURE 14: Evacuations from Hurricane Rita



Assuming that the average dry day flow is directly related to population, approximately 36% of the residents fled this area within two days of landfall. After the evacuations, Hurricane Rita turned northward and made landfall as a Category 3 hurricane on September 24th near Sabine Pass along the Texas-Louisiana border. Ironically, National Weather Service data from the George Bush Intercontinental Airport indicate that this area received sustained winds of only 40 mph and rainfall totals less than one inch.[12] Houston had been spared. Sewer flows within this area returned to normal within a few days as residents returned home.

Conclusion

Sewers are an important part of our society. They serve to promote public health, protect the environment, and support economic growth within our communities. They also happen to provide a unique view into everyday life that is revealed through sewer flow monitor data.

Most sewer flows are characterized by a repeatable daily or *diurnal* pattern that is best examined using a composite hydrograph. These patterns vary between normal weekday and weekend periods. Variations are also observed based on land use differences. Other distractions and disruptions of everyday life can also be seen as departures from these patterns, and the magnitude of their impact can be investigated.

Acknowledgement

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