Sewer Sociology – San Diego Metropolitan Area

Kevin L. Enfinger, P.E. and Paul S. Mitchell, P.E.

ADS Environmental Services
1300 Meridian Street, Suite 3000 • Huntsville, Alabama 35801 • www.adsenv.com/sewersociology

ABSTRACT

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.

This paper provides a tour of the City of San Diego and its surrounding metropolitan area through the eyes of a sewer, as revealed through hydrographs of sewer flow data. 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, shopping, conventions, wildfire evacuations, and even a Madonna concert.

This paper is not a typical technical paper, but rather a collection of interesting observations of human behavior documented by flow monitors located throughout the San Diego area. Practical applications include sewer design, infiltration and inflow evaluation, hydraulic modeling, and real-time alarming.

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

Introduction

How often do you think about the sewers beneath your feet? Wastewater professionals think about them for a living, but most people never think about them at all. However, a community and its sewers are inextricably linked, and as a result, the flow of wastewater in the sewers below provides some remarkable insights into the life of the community above.

This paper provides a tour of the City of San Diego and its surrounding metropolitan area through the eyes of a sewer, as revealed through hydrographs of sewer flow data. This paper is not a typical technical paper, but rather a collection of interesting observations of human behavior documented by flow monitors located throughout the San Diego area. Practical applications include sewer design, infiltration and inflow evaluation, hydraulic modeling, and real-time alarming.

Overview

San Diego is a diverse, thriving community located in Southern California and is nicknamed *America's Finest City*. The area is well known for its entertaining beaches, enjoyable weather, and long-standing Naval and Marine Corps presence. The location of San Diego is depicted in Figure 1.

FIGURE 1: San Diego Location Map

San Diego has a population of about 1.2 million and about 2.8 million including the surrounding metropolitan area.[1] The hustle and bustle of daily life generate about 170 MGD of wastewater from the City of San Diego and 16 other Participating Agencies. Most of the wastewater is conveyed to the Point Loma Wastewater Treatment Plant for subsequent treatment and discharge to the Pacific Ocean, while the remaining wastewater is conveyed to two water reclamation plants for water reuse applications throughout the area.[2] As the wastewater moves through the sewer system, it is measured and recorded by a network of over 150 flow monitors installed in sewers from 8 inches to 108 inches in diameter.

Sewer Sociology

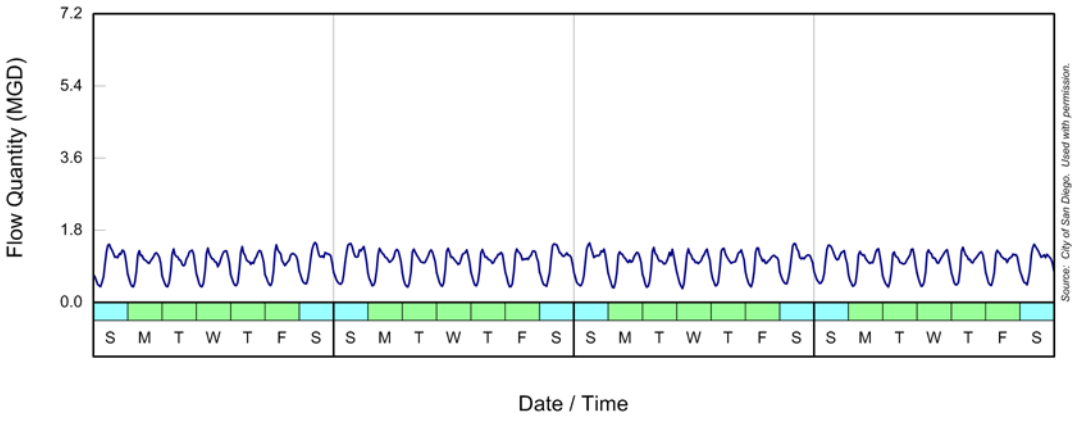
Sewers are an important part of society, and they serve to promote public health, protect the environment, and support economic growth throughout the San Diego area. They also happen to provide a unique view into everyday life within the community, and thus the connection between sewers and sociology.[3]

For this discussion, s*ewer sociology* is defined as:

> **sew´·ĕr 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.*[4]

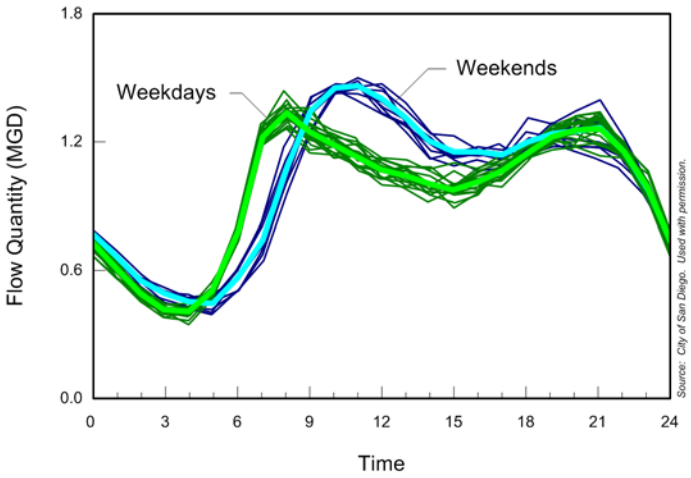
What would a sociologist have to say about all of this? Dr. Ron Akers, a Professor of Sociology at the University of Florida, was contacted in this regard. He stated that "there is definitely a social dimension and patterned social behavior that relates to the use of all public resources," including sewers.[5] Interesting observations into this social dimension can be revealed in a hydrograph of flow monitor data, as shown in Figure 2.

FIGURE 2: Hydrograph of Sewer Flow Monitor Data



This hydrograph displays flow monitor data from a residential area in San Diego 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 3. The distinctive patterns of weekday and weekend residential flows are readily apparent.

FIGURE 3: Weekday and Weekend Diurnal Patterns

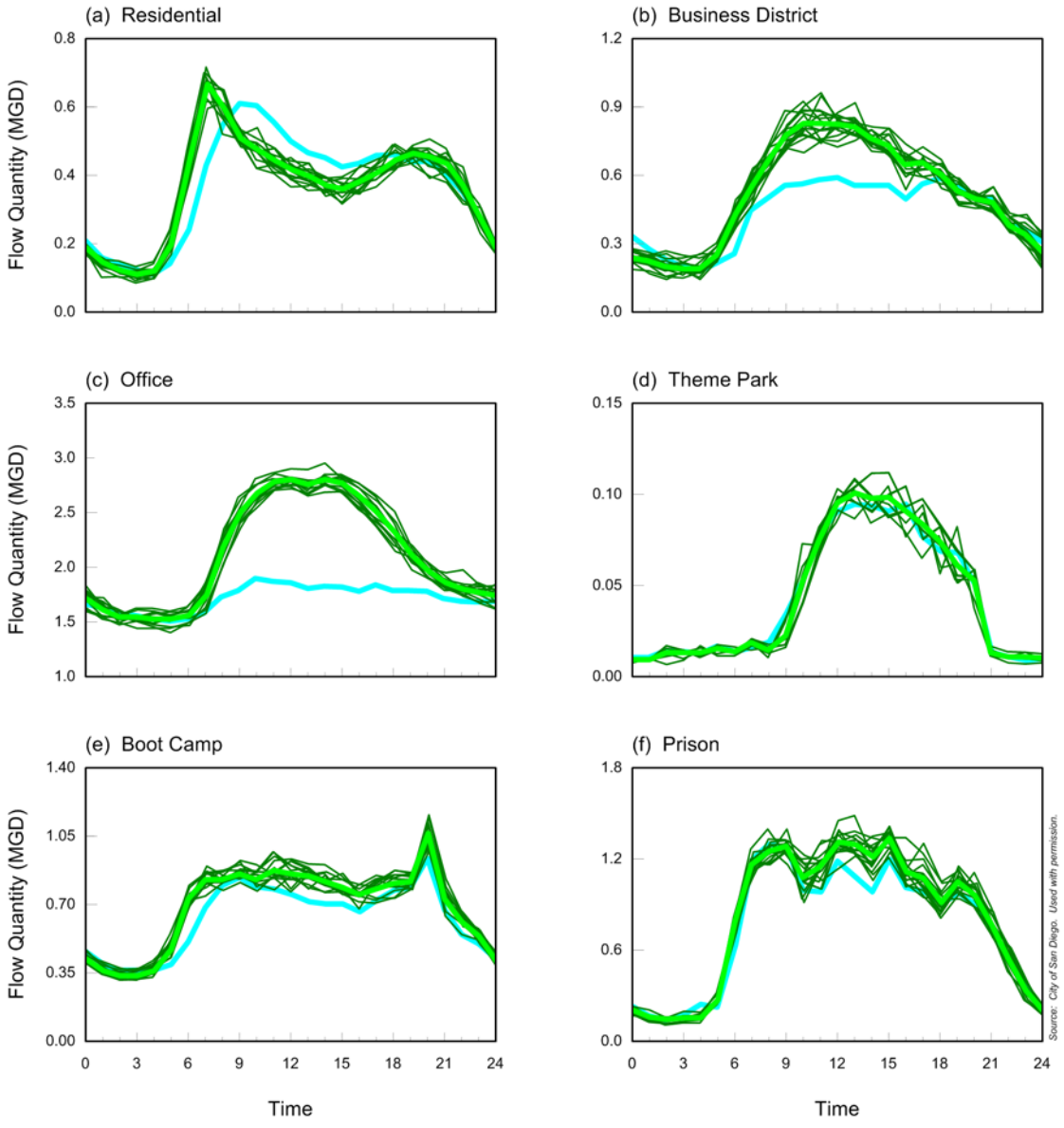


The light green curve and the light blue curve shown in Figure 3 are the average daily flow patterns observed on weekdays and weekends, respectively. The dark green curves and the dark blue curves are the individual weekday and weekend traces used to determine each average. These curves provide an indication 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.[3]

Land Use

Land use within a particular area can impact the shape of the diurnal pattern. The examples shown in Figure 4 represent diurnal sewer use patterns from six different land use areas within the San Diego area.

FIGURE 4: 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. The boot camp example provides a glimpse into the life of a Marine Corps recruit – *Reveille* at 5:00 AM and *lights out* at 9:00 PM.

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 5. Flow monitor data obtained from Chula Vista during 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 remain open. As a result, the morning rise occurs earlier than a typical weekend as some residents wake at their normal weekday time and depart for work.

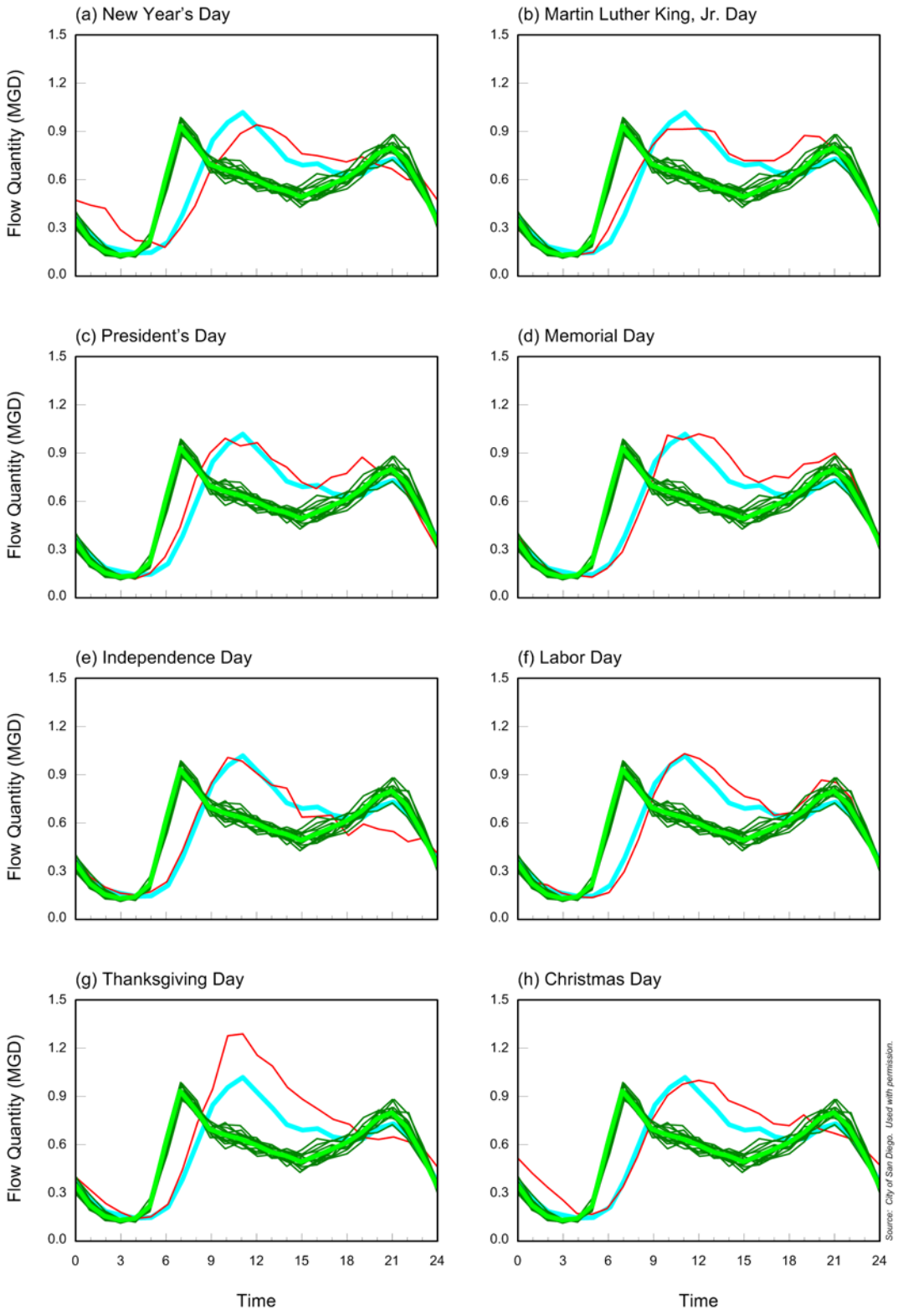
- Memorial Day and Labor Day are quite similar, both with sewer flows comparable to a typical weekend.

- 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 weekday 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, note that higher sewer flows are observed during the early morning hours, a traditional time when Santa Claus is known to be busy delivering gifts.

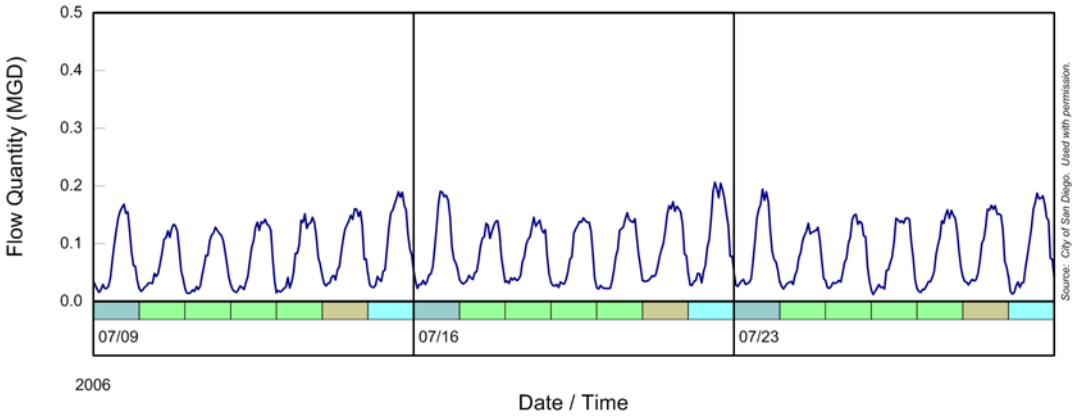
FIGURE 5: Sewer Use Patterns for Various Holidays



Shopping

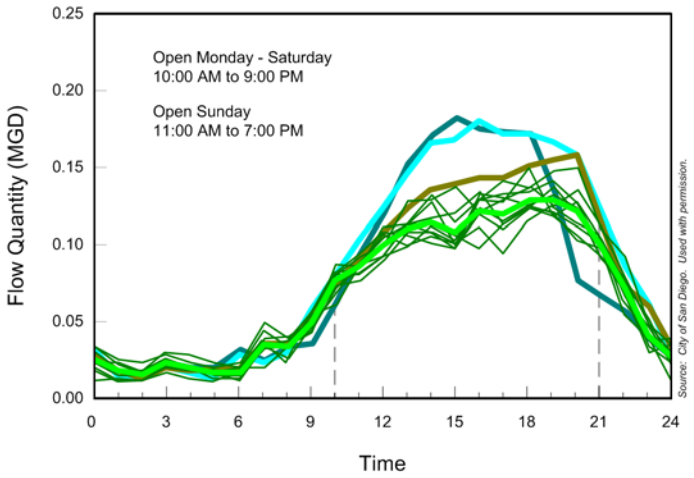
Shopping is as much a part of American life as baseball and apple pie, and sewer sociology offers insight into the shopping habits of American consumers from its own unique perspective. A hydrograph of sewer flow monitor data from a shopping mall located in the San Diego area is provided in Figure 6.

FIGURE 6: Hydrograph of Sewer Flow Monitor Data from a Shopping Mall



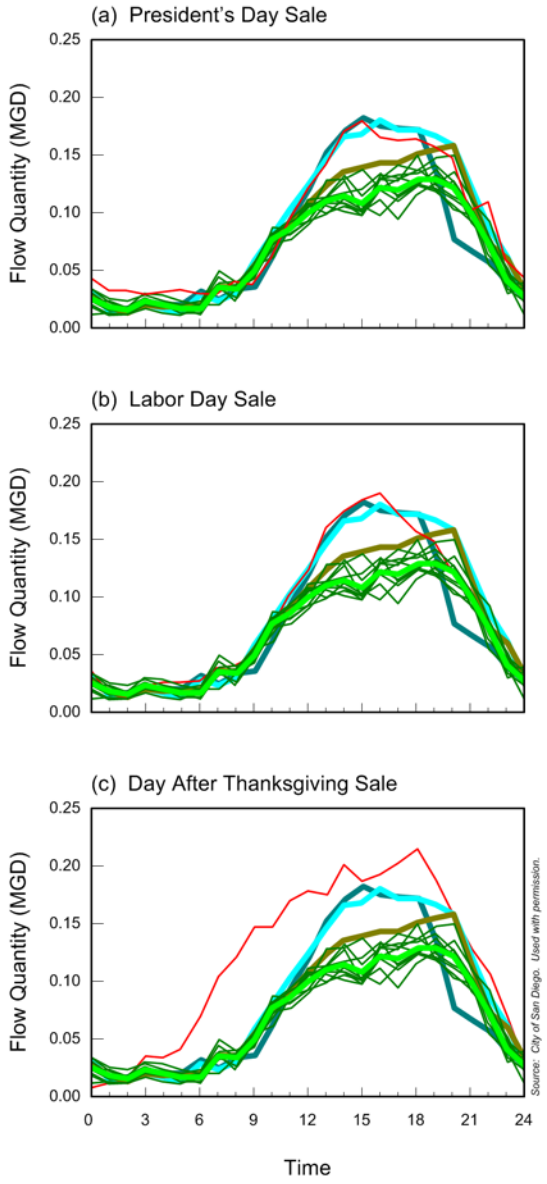
Note that wastewater flow increases during the week and is higher on weekends than weekdays. A closer look is provided in the composite hydrograph shown in Figure 7, revealing four distinct patterns: weekdays (Monday through Thursday) shown in green; Fridays, shown in brown; Saturdays, shown in light blue; and Sundays, shown in dark blue. These patterns are closely correlated with common retail operating hours and confirm that more people shop on weekends than on weekdays.

FIGURE 7: Sewer Use Pattern for a Shopping Mall



Many retail stores offer annual sales events on President's Day, Labor Day, and the day after Thanksgiving (often referred to as *Black Friday*). A composite hydrograph for each sale event is shown in Figure 8.

FIGURE 8: Various Retail Sale Events



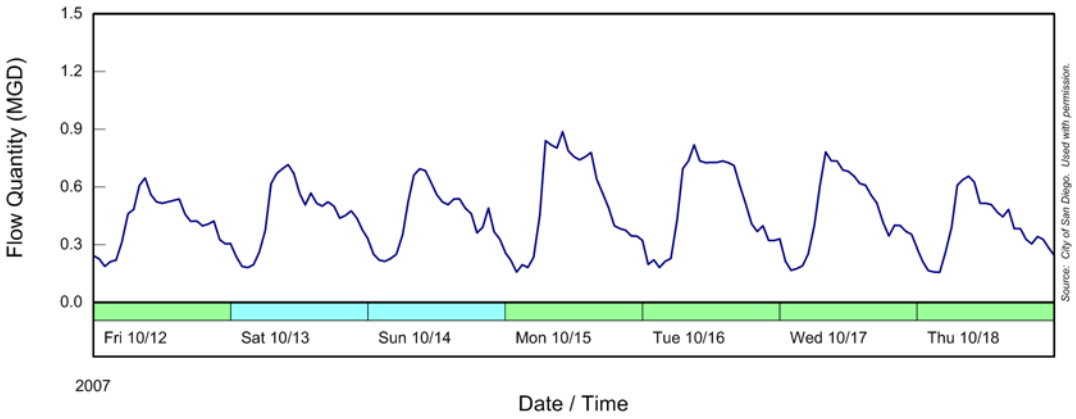
Although they occur on Mondays, the President's Day Sale and the Labor Day Sale bring shoppers out in numbers similar to a weekend. However, the biggest difference is observed on *Black Friday*, one of the busiest shopping days of the Christmas holiday season.

Conventions

WEFTEC is an annual convention sponsored each year by the Water Environment Federation, and is the largest such gathering in the United States designed for water and wastewater professionals. WEFTEC 2007 was held at the San Diego Convention Center and featured 19,929 attendees and 1,017 exhibitors occupying 268,405 ft^2 of exhibit space.[6]

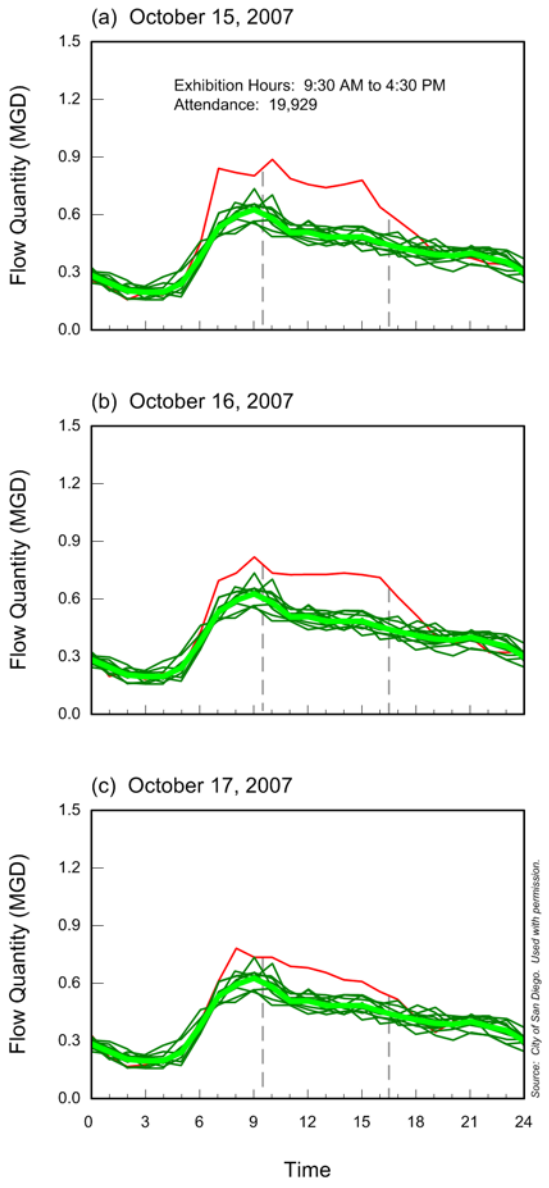
While attendees, exhibitors, and staff were hard at work, a sewer flow monitor quietly observed the event from a location downstream from the San Diego Convention Center. A hydrograph of sewer flow rates before, during, and after WEFTEC is provided in Figure 9.

FIGURE 9: Hydrograph of Sewer Flow Monitor Data — WEFTEC 2007



Note the increase in sewer flows on October 15th – the first day the exhibit hall was open. The flow rates observed during WEFTEC are compared to average dry day flows on the composite hydrographs shown in Figure 10.

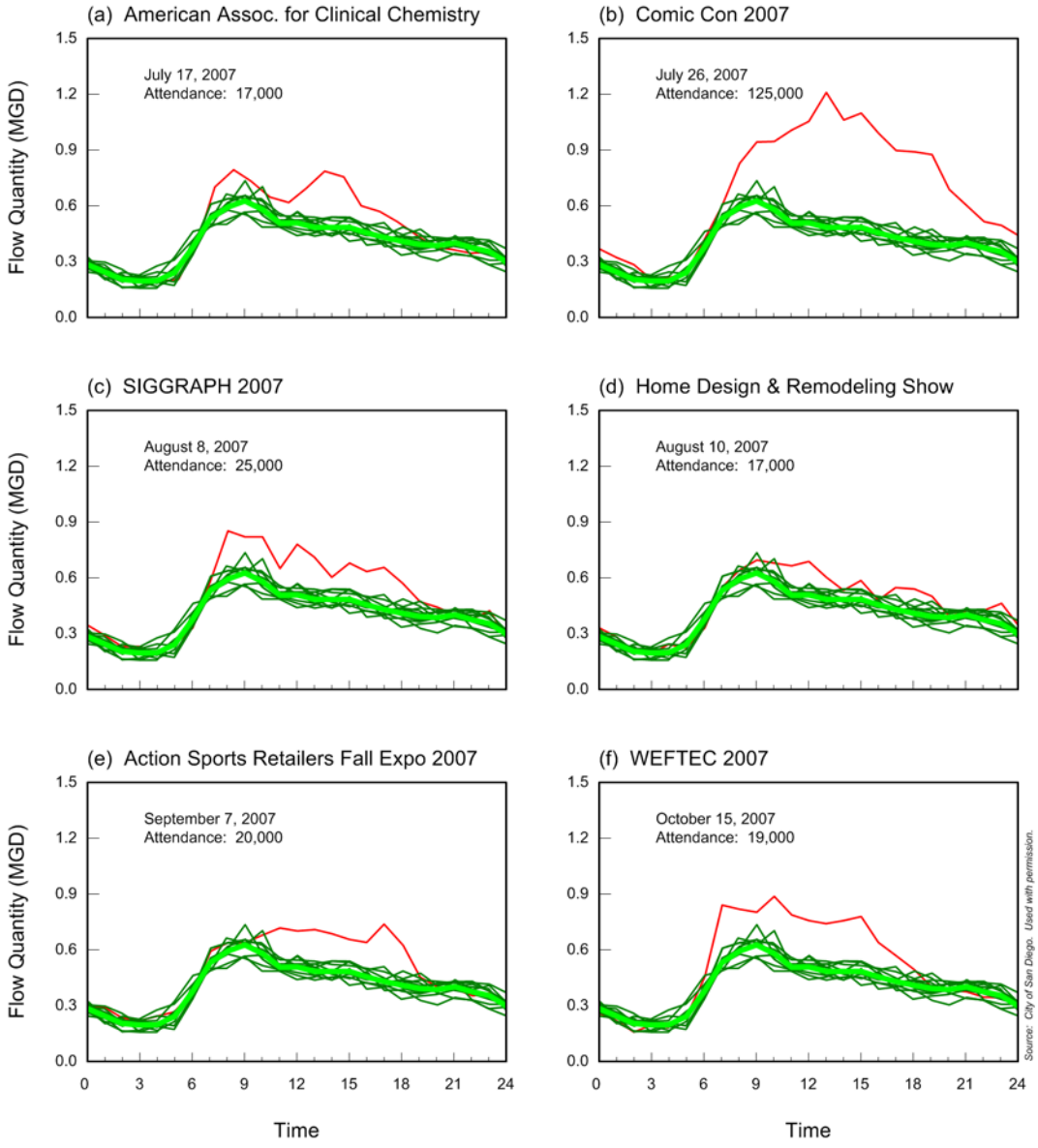
FIGURE 10: WEFTEC 2007



The average dry weather flow observed at the monitoring location on non-conference days is 407,000 gallons. The additional flows recorded during the three WEFTEC exhibit days were 109,000 gallons, 94,000 gallons, and 59,000 gallons, respectively, on October 15th -17th, and indicate that the number of attendees decreased from the opening day to the closing day of the conference. Based on reported attendance figures, the observed wastewater flow represents a sewer use rate of about 5.5 gallons/day/attendee on the opening day.

Sewer flows from several other major conferences held at the convention center were also observed, including a high-profile comic book convention that attracted more than 125,000 attendees. A comparison is provided in Figure 11.

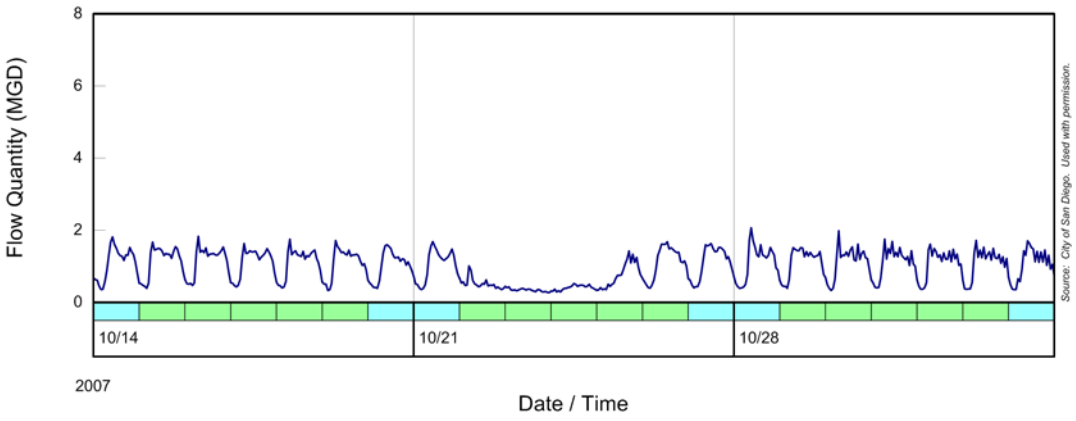
FIGURE 11: Sewer Use Patterns for Opening Exhibition Day of Various Conferences



Wildfire Evacuations

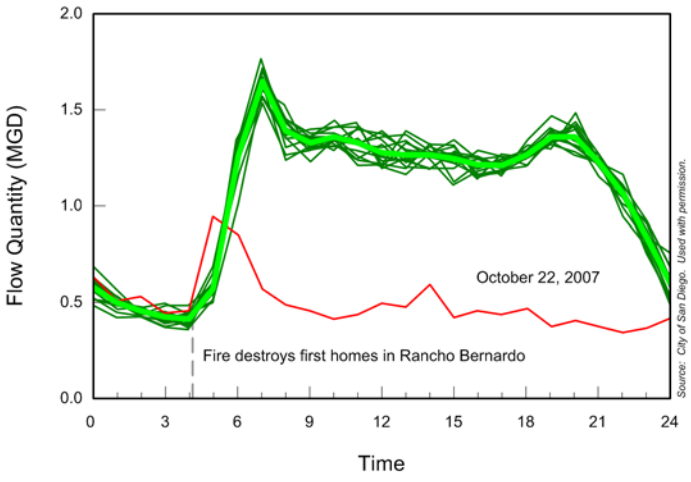
Several devastating wildfires raged through the San Diego area in October 2007, prompting the evacuation of over 500,000 residents as fire fighters fought to save lives and protect property. The Witch Creek Fire alone burned nearly 200,000 acres and threatened residents in Ramona, Rancho Bernardo, Poway, and other communities.[7] The data shown in Figure 12 were obtained from a flow monitor located in Rancho Bernardo, where flames reached the first homes at about 4:07 AM on October 22nd.

FIGURE 12: Hydrograph of Sewer Flow Monitor Data From Rancho Bernardo, California



The composite hydrograph shown in Figure 13 offers a closer look. Note the drastic reduction in flow after residents awoke and fled the approaching wildfire – a complete evacuation of this area.

FIGURE 13: Wildfire Evacuation in Rancho Bernardo

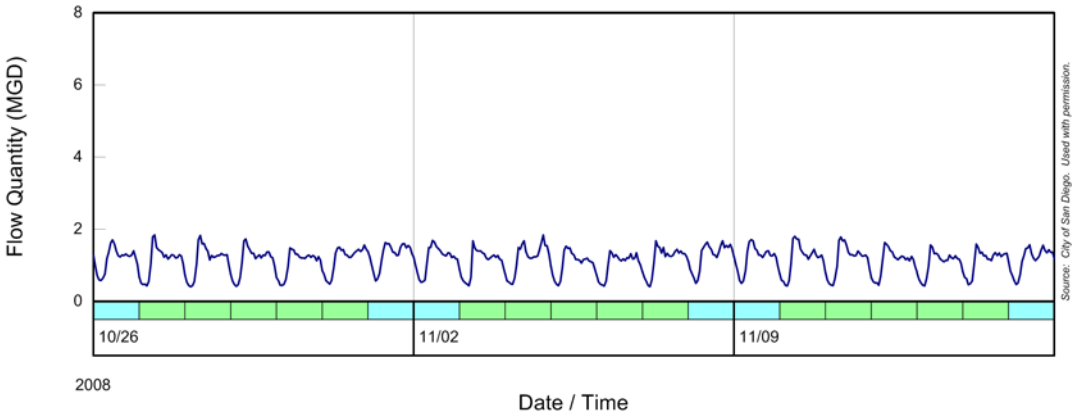


A total of 365 homes were destroyed within the City of San Diego, and an additional 79 homes were damaged as a result of the wildfires. However, it is estimated that fire fighters saved approximately 6,000 homes within the path of the fire.[7]

Madonna in Concert

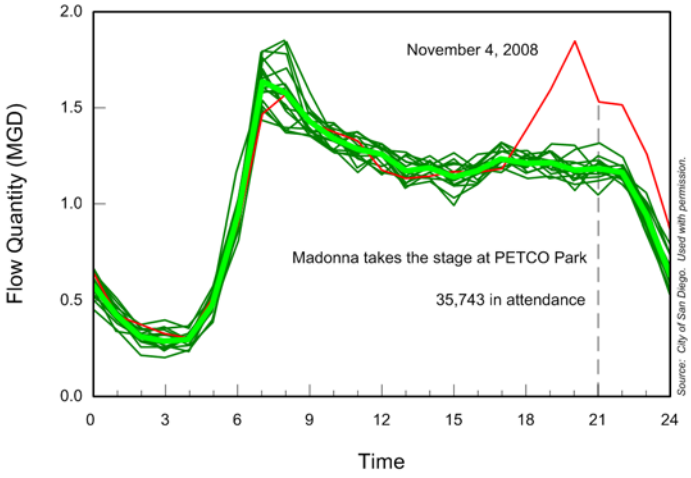
Pop superstar Madonna took San Diego by storm on November 4, 2008 when she performed in concert at PETCO Park before a sellout crowd of 35,743. The concert was part of her *Sticky and Sweet* tour promoting her studio album *Hard Candy*.[8] No sewer sociologists were in attendance, but a sewer flow monitor was conveniently located downstream from the concert venue and provided the data shown in Figure 14.

FIGURE 14: Hydrograph of Sewer Flow Monitor Data From Downtown San Diego, California



The composite hydrograph shown in Figure 15 offers a closer look. The concert began at 7:00 PM, and sewer flows peaked before Madonna took the stage.

FIGURE 15: Madonna Concert in Downtown San Diego



According to published accounts, the concert generated $5,097,515 in gross receipts and contributed over $200,000 to the City's general fund from stadium rent and concession sales.[8,9] According to the flow monitor, the concert also contributed 107,000 gallons of wastewater. Based on the reported attendance, this results in a sewer use rate of 3.0 gallons/concert/ticket.

Conclusion

Sewers are an important part of society, and they serve to promote public health, protect the environment, and support economic growth throughout the San Diego area. They also happen to provide a unique view into everyday life within the community as revealed through hydrographs of 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. Practical applications include sewer design, infiltration and inflow evaluation, hydraulic modeling, and real-time alarming.

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