By Hubert Fleming, Ph.D., and David Slack

Trends in Sewer Overflow Management

In this era of environmental stewardship, large cities and counties are faced with increasing pressure not only to deliver safe potable water supplies but also to treat combined and stormwater flows. The regulations for Combined Sewer Overflows (CSOs) and Stormwater Overflows (SWOs) are becoming more stringent as awareness of the effects of water pollution increase. Not long ago, wastewater operators were primarily concerned with removal of Total Suspended Solids (TSS), Biological Oxygen Demand (BOD) and Ammonia (NH_3). Now, standards must be met for Total Nitrogen (TN), Total Phosphorus (TP) and Oils and Greases (O&G). There are nutrient-sensitive rivers and bodies of water in half our states. Several states in the Midwest and Upper Midwest are developing limits for CSO requirements and now there are Federal Phase I and Phase II stormwater regulations. Recent start-up performance tests and pilot work suggest that deep bed filters can provide a reliable, flexible solution that will meet all of these present and future standards.

Combined Sewer Overflows

Communities often built sewer systems that would collect both stormwater runoff and sanitary sewage in the same pipe. During dry weather, these "combined sewer systems" transport wastewater directly to the sewage treatment plant. However, during wet weather the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to occasionally overflow and discharge excess wastewater directly to nearby streams, rivers, lakes or estuaries.

Combined sewer overflows (CSOs) contain stormwater but also untreated human and industrial waste, toxic materials and debris. CSOs cause beach closings, shellfishing restrictions and other water body impairments. Because of these problems, they have become a lightning rod for regulators.

Combined sewer systems serve roughly 950 communities with about 40 million people. Most communities with CSOs are located in the Northeast and Great Lakes Regions. *(Source:* EPA's CSO Control Policy—An Innovative Approach To Controlling Raw Sewage Discharges, *U.S. EPA Office of Wastewater Management, June 1998.)*

Stormwater Overflows

A high concentration of pollutants is found in SWO discharges, particularly in urban areas. Pollutants from concentrated human activity settle on impervious surfaces such as city streets, driveways, parking lots and sidewalks until a storm event washes them into nearby storm drains. Stormwater runoff transports pollutants such as pesticides, fertilizers, oils, litter and other debris and sediment—untreated—to waterways via storm sewer systems. Most Sanitary Sewer Overflows (SSOs) occur when stormwater flows overextend the system's capability to handle the overload.

SWO pollution is a major source of water impairment. According to the 1996 National Water Quality Inventory, a biennial summary of state surveys of water quality, "13 percent of impaired rivers, 21 percent of impaired lake acres and 45 percent of impaired estuaries are affected by urban/suburban stormwater runoff."

Utoy Creek Water Pollution Control Facility (WPCF). *(Photo courtesy of Aerial Innovations of Georgia.)*

Table 1: Atlanta's Three Major Water Reclamation Plants

WPCF Plant	Average Daily Flow (mgd)	Peak Daily Flow (mgd)	Consultant	Performance Test Date
Utoy Creek	48	95	Brown & Caldwell	7/99
South River	54	110	CH2M Hill	8/99
R.M. Clayton	122	240	Camp, Dresser & McKee	12/00

(Source: Stormwater Phase II Final Rule: An Overview, *U.S. EPA, January 2000.)*

Results

CSOs discharge a mixture of raw sewage, industrial/commercial wastewater, polluted runoff and scoured materials. These discharges contain a variety of pollutants that may adversely affect the receiving water body, including pathogenic microorganisms, viruses, cysts, chemicals and floatable materials. Health risks associated with bacteria-laden water may result through dermal contact or through ingestion of contaminated water or shellfish. *(Source:* Combined Sewer Overflow Technology Fact Sheet, *U.S. EPA, September 1999.)*

R.M. Clayton WPCF.
(Photo courtesy of Aerial Innovations of Georgia.)

South River WPCF.
(Photo courtesy of Aerial Innovations of Georgia.)

In addition to human health risks, reduced water quality also harms the ecosystem. When sewage enters a lake or stream, organic materials begin to decompose. Oxygen is consumed as microorganisms use it in their metabolism, depleting available oxygen and thus harming the marine habitat. When left uncontrolled, CSO and SWO discharges can result in fish kills, the destruction of spawning and wildlife habitats and a loss in the land's aesthetic value.

Existing and threatened legislation has left cities and counties scrambling to identify alternatives to combat the problem.

Regulations

In 1990, Phase I of the U.S. EPA's stormwater program was initiated under the Clean Water Act. It addresses stormwater runoff for medium and large municipal separate storm sewer systems (called MS4s) generally serving 100,000 or more people.

Phase II Final Rule, published on December 8, 1999, is the next step in EPA's efforts to address stormwater overflow problems. It expands the Phase I program by requiring additional operators of MS4s in urbanized areas to implement programs and practices to control polluted stormwater runoffs. Operators of regulated small MS4s must fully implement their stormwater management programs typically within a five-year period.

Solutions

After having evaluated a number of process options, the leading candidate for addressing both SWO and CSO has become deep bed filtration. Deep bed filtration gives the user greater solids loading, higher filter rates and longer filter runs before backwashing. The approach is simple but robust and offers a wide range of treatment flexibility. Tetra Process Technologies, a Severn Trent Services, Inc., company, has been supplying deep bed filters for wastewater applications for more than 50 years and is responsible for bringing air and water backwashing to the United States. The deep bed filter offers the advantage of handling shock loads and using less backwash water than any other filter manufacturer. It also can be used as a bioreactor simultaneously without removing the filter from service, reducing nutrients such as total phosphorus and nitrate-nitrogen.

Deep Bed Filtration and CSOs

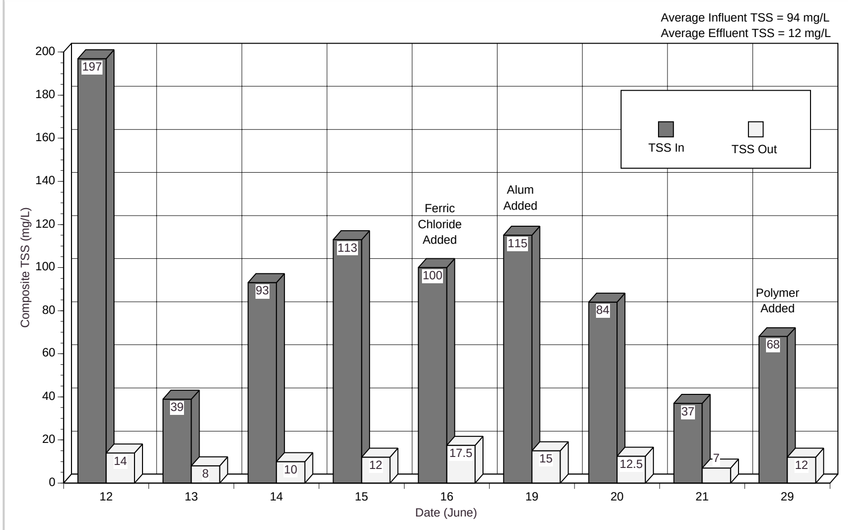
The City of Atlanta has three major wastewater reclamation plants (Table 1) that have the ability to treat a maximum peak flow of 400 million gallons per day. In the early 1990s it was determined that these plants would have to meet new stringent TP standards in the treated wastewater discharged to the Chattahoochee River. Georgia Environmental Protection Division (GAEPD) initially set TP limits at 0.75 ppm and now, ten years later, they are 0.64 ppm. The city engineering staff retained professional engineers to analyze how reduction demands would be met. Engineers designed a Biological Phosphorus Removal (BPR) process for each site, selecting a deep bed filter for the complete treatment. They also required that stringent guaranteed performance criteria be met in 30-day-average and 5-day-peak-flow tests on filter rates (avg. 3.75 gpm/sf, peak 7.5 gpm/sf), percent of forward flow for backwash (<5 percent) and effluent quality (<2 NTU).

All three performance tests comfortably exceeded the average and peak filter rates and were well under the turbidity (<1 NTU) and backwash requirements (1.5 and 1.6 percent).

Deep Bed Filtration and SWOs

A major Southeastern U.S. County has entered into a Consent Decree with the U.S. EPA to improve its SWO flows by decreasing BOD and TSS levels at a site that experiences peak flows of 360 mgd with inlet concentrations exceeding 100 ppm BOD and TSS. Data from a 30-day pilot test show that with inlet screening and direct deep bed filtration, the BOD and TSS limits can be met. Additionally, the deep bed filter also offers the flexibility to handle first flush (oils, greases, twigs and larger debris) conditions and to simultaneously act as a bioreactor to reduce soluble BOD. (See Figures 1 and 2.)

Figure 1: TSS Removal at 10 gpm/sf



Conclusions

The National Water Quality Inventory reported that "approximately 40 percent of surveyed U.S. waterbodies are still impaired by pollution and do not meet water quality standards." Much of this pollution is attributable to CSOs and SWOs. Concern for the environment and increasing EPA regulations demand that we attend to these problems. Deep bed filtration is a cost-effective method for treating wastewater because it combines a filtration step and a bioreactor step, capable of BOD and nutrient removal, into a one-unit process and is ideal for large tertiary applications. Direct filtration of CSO and SWO flows can be achieved at high rates often without chemical addition. As treatment becomes a regulatory requirement in more cities, deep bed filtration has become a suitable solution to these problems.

About the Authors:
Dr. Hubert Fleming is the vice president of Water Purification Solutions at Severn Trent Services.

David Slack is the general manager of Tetra Process Technologies, Inc.

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Figure 2: CBOD Removal at 10 gpm/sf