I/I Abatement with Mass Metering

Alternative approach includes determining over ground flow patterns.

By David J. Saylor

South Haven Sewer Works is a mid-size private utility in Northwest Indiana. In 1995, the utility expanded its treatment plant to accommodate excess wet weather flows. However, SSOs did not vanish, rather, in the intervening years, their frequency and duration increased. In 2003, the utility entered into an EPA Consent Decree, which included provisions requiring the elimination of SSOs. In response, an alternative approach was developed whereby the collection system is inspected and repaired only at locations that exhibit both site-specific infiltration and deteriorated pipe conditions. Pivotal to this approach is a methodology that addresses the constraints of existing technologies and isolates both restrictions and I/I. This process consists of four basic steps: prepare, deploy, analyze, and decide.

Prepare

Though often overlooked, the development of a system for managing the collection and review of data is critical. Preparation before commencing on field studies yields the best results:

- Create a system-wide map of the sanitary collection system. A single document shows the design and organization of the entire pipe network.
- Include on the system map stormwater collection assets from catchments to discharge points.
- Enlist as many personnel as possible in the evaluation process. This includes all segments of the operations and maintenance staff. Discuss locations of customer complaints, high maintenance areas, areas prone to flooding, etc. Mark these sensitive areas on the system-wide map.
- Provide flow monitoring equipment at a fixed downstream location, such that upstream normal and wet weather flow rates can be compared over many months. Often for smaller systems, gauging the influent flow rate at the treatment plant is this downstream location. In addition, install a real-time precipitation monitor connected to a computer.
- Use inexpensive software (Global Mapper©, www.globalmapper.com, for less that $300) to determine the over ground flow patterns of stormwater for areas serviced by the sanitary system. Flow patterns are derived from empirical observations, the hydraulic organization of the stormwater collection system, and the topography of the affected area. With common functionality in GIS programs, the watershed information is combined using layers with the collection system map. Locations having both storm and sanitary flows are identified as "source/receiver" sites.

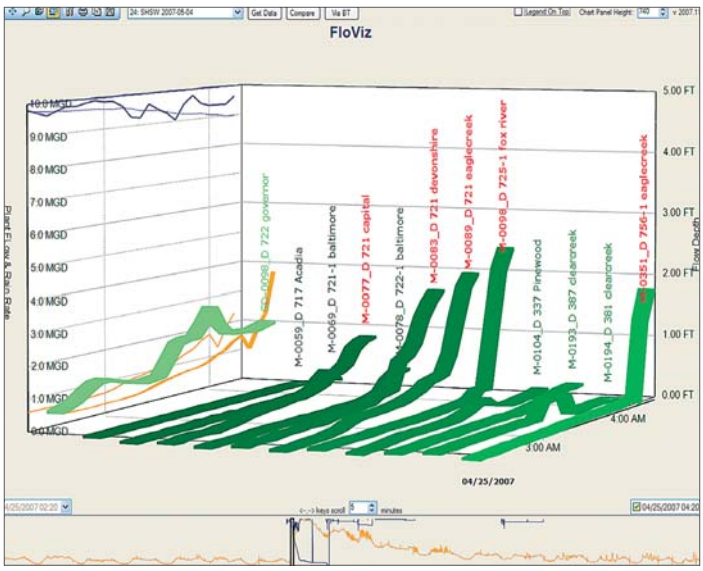

Figure 1. Unlike 3D charting shown here, two dimensional charting can obscure unique hydraulic behavior of a single manhole as a small section of the collection system's response.

Deploy

Based on watershed design and adjacent location of collection system assets, the utility staff selects sites with high potential for the delivery of stormwater to locations having gravity sanitary piping. Meters are positioned at a frequency of five to ten meters for every 100 manholes, a placement rate defined as "mass metering." After a number of meter deployments, the meters are moved away from unaffected areas and clustered about areas that exhibit greatest variability during wet weather. A unique metering device was developed with sufficient resolution and sampling frequency to identify those pipe sections that are candidates for subsequent field inspections.

Analyze

Harvest the meter data after significant precipitation events with a handheld computer or PDA. These files are then processed and stored in an SQL database. Thus organized, the data is queried and evaluated with 3D visualization software.

The concurrent evaluation of data from many meters using a spreadsheet has limitations. With two dimensional charting, any more than a few hydrographic curves can obscure unique hydraulic behavior of a single manhole as a small section of the collection system response to the in-rush of infiltration (Figure 1). An extended metering period may have a number of separate wet weather events. Shifting the chart focus area within the spreadsheet data was cumbersome and time consuming. Furthermore, when mass metering, the shear amount of data handled by a spreadsheet made the program lethargic and unstable.

FloViz is patent pending software that includes evaluation tools designed to address these limitations. Visualization is a chief feature of the software, which allows viewing of data from the entire collection system, based on placement of the flow monitors. Scrolling through the data at synchronized time intervals produces the affect of a time lapse movie. Using three dimensional viewing, one can quickly identify the manholes first responding to rain. Later, as the influence of infiltration subsides, some manholes will show elevated flow depths while the remainder of the collection system will return to normal flow levels. With respect to isolating I/I, "the unwelcome guest is one that arrives early and/or stays late."

Assessment of the data charts is within the framework of the system maps and watershed. Based on the hydraulic hierarchy of the collection system and the potential source/receiver sites, the migration of stormwater into the sanitary piping is gauged with flow meters. If during significant precipitation, where there is little or no impact in flows behavior, it is assumed that a given source/receiver site does not merit further evaluation. By contrast, when significant variability in flows is present at a metering point, the hydraulic mechanism that allows the migration is studied by assessing the condition of both source and receiver structures and flow characteristics during precipitation events.

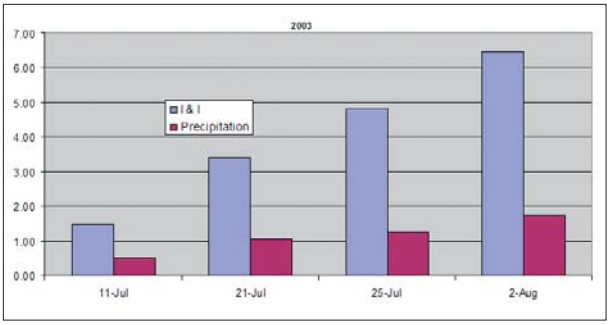

Figure 2. 2003 Rain Events.

Decide

Before committing resources to rehabilitate the sanitary and/or stormwater structure, more than one assessment method—CCTV, smoke testing, dye testing—is often used. This process both narrows the evaluation effort and concentrates on only problem areas. Once an I/I site is determined the selection of rehabilitation or replacement method should be tailored to prevent the cause or causes of the groundwater migration. Upon completion of the rehabilitation work, post-flow monitoring confirms whether the expected amount of I/I was removed.

Under this process, it is obvious that a greater burden rests on the utility personnel to manage and assimilate the data collected by the described methodology. However, the responsibility for cost-effective solutions now rests within the ranks of the utility staff, and not necessarily by outside consultants. This scenario is an incentive for utility staff members to thoroughly understand the wet weather behavior of the collection system. The process is iterative and therefore requires management personnel to stay focused to shift meters to affected areas combined with consistent evaluation of the flow data. As a consequence, rather than a singular construction project as found with "convey and treat," the "find and fix" solution for I/I becomes a process that compliments evaluation steps typically found in a preventive maintenance and capacity assurance program.

Evidence of Success

For four years the South Haven Sewer Works has been performing evaluations and rehabilitation work using this process to isolate specific sites of I/I. The assessment work, including flow monitoring, was performed by the local utility staff under the review of a licensed engineer. Evaluations and repair continue because the utility still has periodic wet weather SSOs. However, based on the comparison rain events shown in Figures 2 and 3, the methodology has realized significant I/I reductions at a cost-per-gallon well less than to convey and treat the stormwater flows.

Figures 2 and 3 compare the four largest pre-rehabilitation and wet weather events occurring from the months of June to August 2003, and the post-rehabilitation I/I flows during the same period in 2007. With respect to the total amount of precipitation, I/I flows are decreasing. Though the utility is yet to eliminate all SSOs, both frequency and duration are significantly reduced. GE

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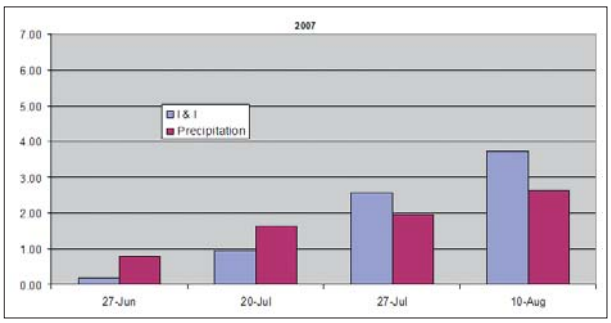

Figure 3. 2007 Rain Events.