

Keyword: Dynamic

Dynamic sewer modeling, more accurate than steady-state modeling, can save sewer system capital improvement costs.

By Craig Close

Dynamic” is the word for the latest trend in sewer modeling technology. Dynamic sewer modeling opens a whole new realm of design alternatives and solutions for maintaining sewer assets than were previously possible through steady-state sewer modeling alone. By realistically analyzing available sewer capacity, dynamic sewer modeling pinpoints the need for system expansion. Utilities and public works operators can decide not only what, but when to make improvements.

An accurate picture of a sewer system saves time and capital improvement costs, as it did for the cities of San Diego and nearby Chula Vista in Southern California. Recent growth left these communities with two undesirable choices: a building moratorium or large capital expenditures.

A moratorium would prohibit the construction of homes, commercial businesses, and public facilities such as schools, libraries, and fire stations. Tax revenues would be lost, and the job market would stagnate. At the same time, building and maintaining facilities to meet a need projected for the next decade was financially irresponsible.

Both cities decided to reevaluate their master planning methods. They used dynamic sewer modeling to determine if existing sanitary sewer systems had reached capacity and to create a solid stance from which to make decisions.

Consulting firm PBS&J (www.pbsj.com) used its expertise in both hydraulic modeling and master planning to assist the cities.

Other communities can experience similar financial benefits using dynamic sewer modeling. In addition, collected dynamic sewer modeling data are the basis for use in required CMOM and GASB 34 compliance programs.

An Accurate Picture

Dynamic sewer modeling is more accurate than other models because it improves the hydraulic wave effects of

observed in the field in dry and wet weather and over weekdays, weekends, and holidays.

Basic data requirements for a dynamic model include:

- Flow monitoring data, ideally for a minimum two-week period during both wet and dry weather conditions
- Rainfall records for use in RDII (Rainfall Dependant Inflow and Infiltration) analysis
- Diurnal curve development for various land use classifications
- Demographic and land use projections
- Sewer network information, e.g., pipe diameter, invert elevations, and material/age, manhole floor and rim elevations
- GIS coverages such as parcel and census tract data, drainage basin boundaries, and service area boundaries.

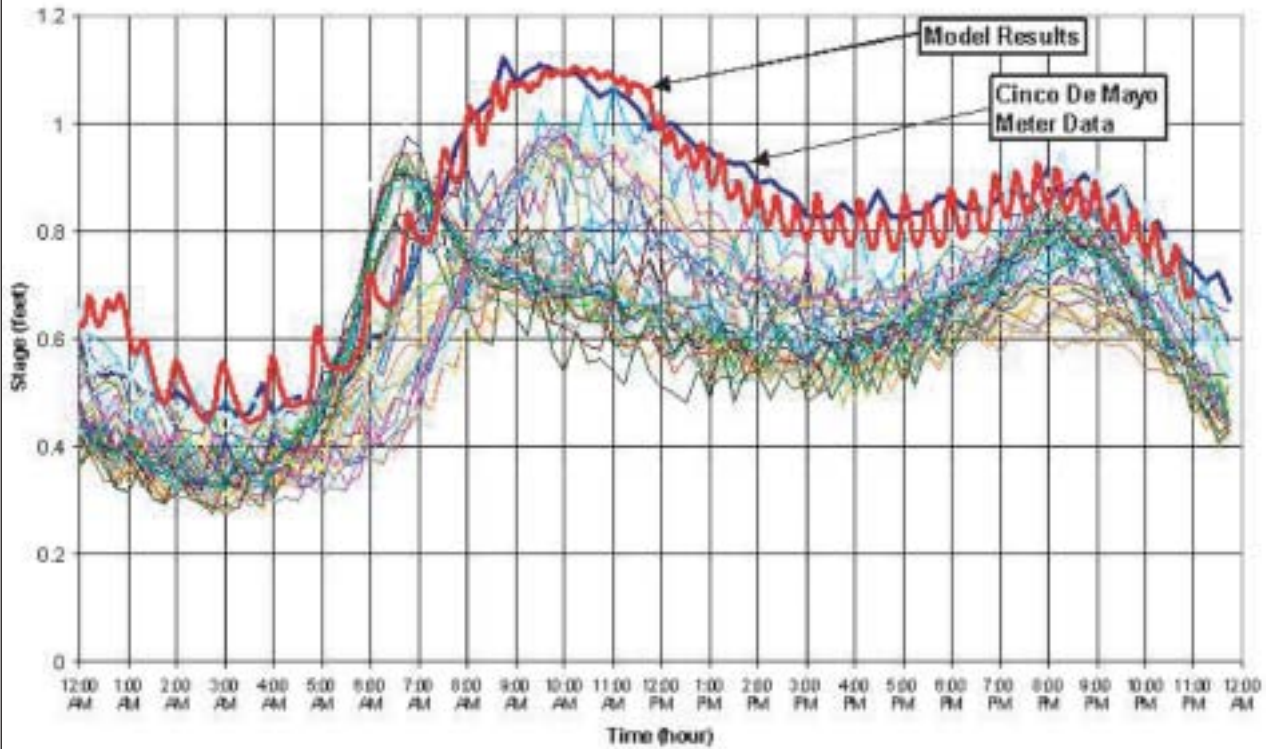
By creating a graphical illustration of collection system flow variations, dynamic sewer modeling indicates two key conditions: system capacity and potential choke points. This information can be used to specifically identify lengths of pipe that may need to be replaced or upgraded.

Planners can find opportunities to defer and phase pipeline improvements by analyzing flow projections and available capacity in existing systems. The service life of the existing collection system is prolonged by identifying triggers for expansion or replacement rather than calling for improvements before they are needed.



real system features such as pumps and control structures, backwater effects, and inflow and infiltration using data such as meter records and SCADA inputs. The model is calibrated through comparison to actual flow conditions

MH 75 Meter Data and Model Calibration Results



This calibration curve demonstrates that the model results, indicated in a red line, mirror the actual field monitoring data at a specific manhole both from flow and time of day response. The model in this example included a pump station operation that accurately reflects the start/stop cycling of an existing pump station.

San Diego Keeps Pace with Growth

The San Diego Metropolitan Wastewater Department (MWW) set out to determine if its Otay Mesa Trunk Sewer could handle future development in the southern portion of the county. The trunk sewer, now conveying sewer flows of one mgd, is projected to reach 34 mgd at build-out. To avoid overbuilding, planners wanted to learn when the maximum flow would be reached based on growth.

Both near-term and longer-range flows were considered along with capacity constraints in the existing system and realistic development patterns. Dynamic sewer modeling indicated that the system had available capacity for the next five to ten years, depending on the pace of development growth.

The modeling effort established that a reasonable growth rate could be accommodated by constructing seven facility improvement phases over the

next 50 years. By phasing the improvements just ahead of growth, the construction cost over the next ten years is about \$36 million compared with a complete build-out cost of approximately \$128 million. The phased implementation approach also benefited the environment. By only building facilities needed for the near term, initial construction-related impacts are minimized.

Interceptors that would convey Otay Mesa flows to a wastewater treatment plant were evaluated for existing capacity and flow thresholds. As a result, Otay Mesa's flow was diverted to two interceptors to use available capacity in both. Using either interceptor individually would have required immediate replacement of the utilized line. By splitting the flow, interceptor replacement was deferred for ten or more years saving the city an estimated \$28 million.

Say No to Overflows

In Chula Vista, a major trunk sewer

had been determined, through conservative steady-state modeling, to be at or near capacity and at risk for overflow during wet weather conditions. However, the dynamic model indicated flow rates were considerably lower than estimated due to increased water conservation.

Model results were used to analyze mitigation alternatives, such as managed pumping operations and use of storage, that would allow continued development. Additional development thresholds were established using future condition simulations.

Based on modeling study findings, the city implemented an improvement plan calling for much less replacement pipe than previously recommended. Development could continue, infrastructure costs were saved, and the city could realize fee and tax revenues all without the threat of sewer overflows.

Steady state models provide a snapshot, usually the estimated peak flow, of conditions at one instant. A steady state

model can only project the peak sewer flow and translate it downstream where it is added to peak flows gathered from other collection system branches, adding the worst case on top of each branch's worst case. This approach is conservative, but not realistic. In short, non-dynamic models lack the ability to accurately model the non-steady state hydraulic conditions found in complex sewer networks.

In general terms, a dynamic model can account for the time duration required for sewage to flow through the piping system from various points of entry as well as the actual time-of-day flow generation patterns of different types of users. Further, the model can account for the damping of the peak sewer flows within the piping routing system that allows a 15-minute peak flow event to be spread out in the collection system.

Because steady state models do not produce time-varying simulation

results, the modeler has only one point for calibration, a factor that reduces confidence in the simulation's accuracy. Simulated peak flows may match metered flow rates and depths, but simulations based on future loading conditions, an expanded or improved sewer network, or the addition of design wet weather events may produce results with lesser accuracy. In contrast, dynamic simulations produce a continuous plot of flow or depth versus time.

Added Benefits

The San Diego and Chula Vista projects employed the InfoWorks (Wallingford Software, www.wallingfordsoftware.com) modeling platform. GIS data, describing the physical collection system, demographics, land uses, and future growth projections was used extensively. For both projects, InfoWorks provided GIS data management, inference, and validation.

An added bonus is that data sets com-

plied and manipulated in InfoNet can easily be exported to other hydraulic simulation platforms including standard industry models such as SEWERCAD, XPSWMM, MOUSE, and HYDRA. The InfoNet database can store video assessment data, age and condition data, and links to record drawings and technical reports. The software provides a component for CMOM reporting, and the available data sets prove useful in completing GASB 34 compliance reports.

Dynamic sewer modeling offers collection system operators a wealth of information for both system-wide planning and regulatory compliance. Just as the cities of San Diego and Chula Vista have enjoyed the benefits of this better modeling technology—from capital improvement savings to accurate master planning—so will other cities in the near future. GE

Mr. Close, P.E., DEE, is an associate vice president with PBS&J's San Diego office. He may be reached at cclose@pbsj.com.

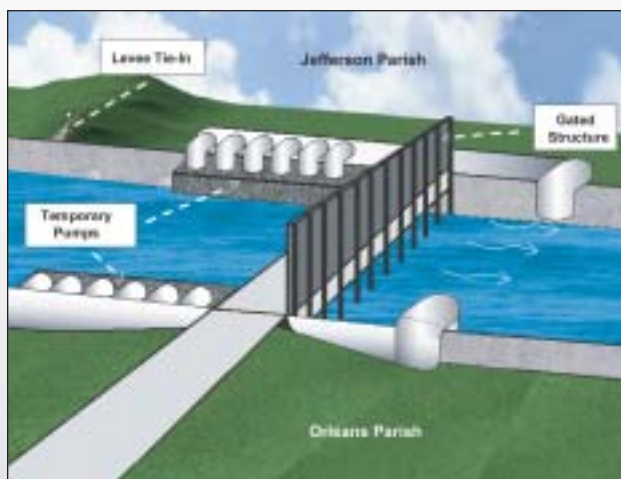
Outfall Canal Contracts Awarded

The Army Corps of Engineers has awarded contracts for construction of interim gated closure structures at the 17th Street and London Avenue outfall canals in New Orleans. The Corps also awarded a contract for 34 large temporary pumps to remove storm water from the canals when the interim gates are closed. An award for the contract for the interim gated closure structure at the Orleans Avenue canal was expected to follow. The Corps plans to complete construction of the interim structures at all three canals by June 1, 2006, in time for the start of the hurricane season.

The interim structures will prevent storm surge from entering the canals and breaching the levees as happened during Hurricane Katrina. They will remain open unless a storm surge in Lake Pontchartrain threatens the canals. Each interim structure will rise 16.5 ft above sea level; that matches the height of the hurricane protection levees at the lakefront.

"We've been working with the City of New Orleans and Jefferson Parish over the last several weeks to find a way to increase hurricane protection along the outfall canals before June," said Col. Lewis Setliff, III, the commander of the Corps' Task Force Guardian, the group responsible for restoring the damaged hurricane protection system.

"The people who live behind these levees need to have confidence in their hurricane protection system. Preventing storm surges from entering the canals is the



most prudent course of action right now," he said. "We know that the interim gated closure structures will do that. While we're still analyzing exactly why the levees failed, the interim structures are a significant step to restoring protection before the next hurricane season.

Contracts and amounts were awarded to: Boh Brothers Construction Company (www.bohbros.com), 17th Street Canal, Interim Gated Closure Structure, \$27,806,500; M. R. Pittman Group (Harahan, LA), London Avenue Canal, Interim Gated Closure Structure, \$25,504,250; and temporary pumps, MWI Corporation, \$26,606,383.