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EDITORIAL FOCUS: COMPUTERS & AUTOMATION TECHNOLOGY

Modeling System Helps Limit Rehab Costs

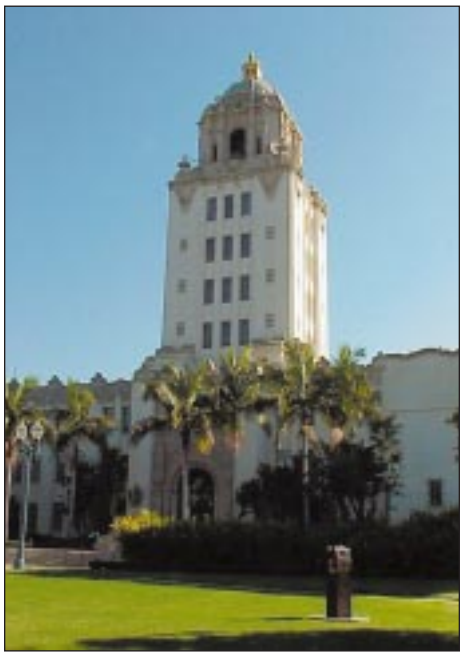
By NOAH WALKER, P.E., and ROB BESTE, P.E.

The city of Beverly Hills, Calif., used computer-based mapping, metering and modeling to help develop its Sanitary Sewer Collection System Master Plan. As a result, the city was able to identify areas of the system that suffered from inflow and infiltration, and limited its rehabilitation costs.

Like many other cities, the city of Beverly Hills maintained a single paper sewer atlas as the repository of all collection system information. This sewer atlas in turn referenced individual design and as-built drawings for details of pipe construction, such as materials, installation dates, and final inverts. Deriving responses to "will-serve" questions related to the hydraulic capacity of the system required multiple cross referencing to locate and extract system characteristics. While the information collected provided some information related to the "design capacity", it did not address the current availability of capacity.

The creation and calibration of a computerized model of the collection system was a central component of the Master Plan process and development of the Capital Improvements Program (CIP). The project team chose Hydra™, a GIS-based hydraulic modeling software product by Pizer Inc.

A model, in its simplest terms, represents the conveyance system and the flows imposed on that system. It was decided early in the project that the hydraulic model developed for the planning process should include the entire collection system rather than only the large diameter pipes. By creating such a model, the city would have a complete computerized source for all collection system information, automated for rapid retrieval and response to capacity inquiries. The model would be used not only for hydraulic analysis as part of the master planning process, but also as a collection system management tool.



City Hall of Beverly Hills, California.

The mapping of the conveyance system was performed using the Los Angeles County GIS maps as the base map to assure consistent geo-referencing with other municipalities in the county. The graphical entities were entered in an AutoCAD drawing that contained the Los Angeles County GIS double line street map layer.

Concurrently with the creation of a digital map of the collection system, the non-graphical attributes of the collection system were entered into a database. This included data such as pipe diameter, length, and slope. This non-graphical information for the collection system was derived from traditional sources but was entered into a database.

The database of non-graphical attributes was connected to the map through the Hydra interface. The GIS tools included with Hydra integrated these two work products to provide a basis for the conveyance model and all available collection system hydraulic data. The modeling software's graphical interface provided a tool for "visual queries" to enhance the engineering staff's understanding of system operations. Now all of the conveyance system information, previously located in many paper files, was rapidly accessible in a single data collection.

Model Calibration

The model was calibrated with data from an extensive flow metering program. Questions of quantity and location relating to system flows were answered by performing flow metering of the entire system in both the wet and dry seasons. There were 39 depth and velocity flow meters installed in 504,000 feet of pipe. These flow meters were used to establish the performance of individual sub-basins. The

results of the flow metering analysis located and quantified average dry weather flows and wet weather flows, providing information on inflow and infiltration.

The amount of rainfall in a given storm event was concurrently recorded by three rain gauges located throughout the system. Five storm events occurred and were evaluated during the metering period.

The rainfall and flow information was statistically analyzed to determine the ranking of the individual basins based on normalized defect flows. The normalization routines allowed the relative "leakiness" of a basin to be established, despite the differences in sub-system length and rainfall amounts. The flow metering data was incorporated with the conveyance data and used to calibrate the hydraulic model. Flows were distributed over the system on a sub-basin basis.

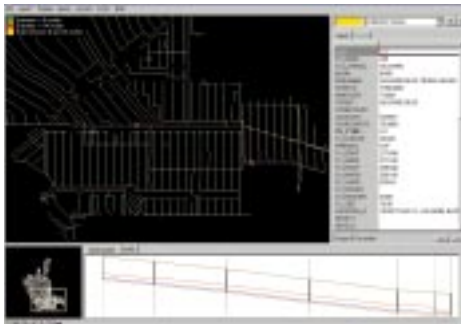
While the Hydra modeling software provides flow loading based on the location of individual parcels and the closest associated pipe, parcel data for the city of Beverly Hills was not available when the model was being created. Instead, an alternative approach using the point loading technique and a customized distribution technique was employed. The 25 largest flow contributors were modeled as individual point flows to assure realistic local loadings. The remainder of the flows in each sub-basin then were distributed over each individual pipe segment based on its length, excluding large diameter pipes. This technique eliminated dry pipes in the model and provided a reasonable flow distribution.

To determine the overall hydraulic capacity of the system, the model was calibrated for both dry weather and wet weather conditions. A feature of the Hydra modeling software allows separate accounting for defect flows, so that dry weather flows and wet weather flows were easily modified throughout the system. Following the dry weather calibration, wet weather defect flows were calibrated to data from the storm events from the rain and flow metering program. These events again provided the basis for understanding the location and severity of defect flows and the relationship to rainfall amount and intensity. By identifying reaches that were hydraulically overloaded, capital improvement program projects were developed.

Capital Improvement

Traditionally, master planning and CIP development projects have addressed the restoration of hydraulic capacity only by replacement. However, 3-Waters Technical Services and the city of Beverly Hills also decided to consider the effects of rehabilitation on the system as an alternative approach to capacity restoration. This especially was appropriate in Beverly Hills because of the sensitivity of community relations issues related to pipeline replacements and its almost "built-out" condition.

Several separate flow reduction strategies were evaluated to determine the potential effectiveness of the CIP projects. The ability of the modeling software to individually track the components of flow helped to locate areas where rehabilitation efforts would result in the greatest reduction of replacement piping. Note that these flow reductions were predicted in three separate levels depending on the defect flow type in the system. The flow reductions were not based on any defects identification and location that had occurred at that time. As a result, the Master Plan recommendations included physical inspection of the system, to identify and further isolate the type of defects and rehabilitation with post-rehab flow metering to assess the impacts of the flow reductions in the system.



A visual query of pipe diameters in Pizer's Hydra™ Hydraulic Modeling Software, used in the city of Beverly Hills Sanitary Sewer Collection System Master Plan.

The Results

In order to address immediate defect flow concerns in sensitive areas, the city of Beverly Hills has embarked on a series of limited physical inspections, and several trenchless lining projects. The city is performing pre- and post-rehabilitation flow metering in order to determine the overall effect of the CIP projects on the system flow. Depending on the observed results, it is possible that the replacements recommended as a part of the master plan may not be required — a direct result of the aggressive rehabilitation programs. This would be a direct benefit to the citizens by minimizing the traffic disruption and would also represent a tremendous capital savings.

The completed hydraulic model of the city developed for the master planning process also has been useful to the city for system management. The model allows a quick response to system capacity questions as they come up. The management of the collection system has been enhanced by utilizing the model, which provides access to the central collection of data on the collection system and its operating conditions.

In conclusion, the incorporation of computer based, GIS mapping, flow metering and the creation of a hydraulic model has greatly enhanced the ability to determine the most cost-effective method of efficient wastewater collection in the city of Beverly Hills.

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About the Authors: *Noah Walker, P.E., is Chief Technical Officer of 3-Waters Technical Services. Rob Beste, P.E., is Assistant City Engineer for the city of Beverly Hills, California.*