



# Modeling Water Distribution Systems

## Overview

Water distribution system models are the most comprehensive tool available for helping operators and managers perfect their system's performance. Model software compiles a system's entire infrastructure and operational conditions into a network that will simulate the behavior of the actual system. The model can then be used to predict the system's behavior when the existing system and/or operational conditions are modified. Schmueser Gordon Meyer (SGM) consistently uses Extended Period Simulations (EPS) to help our clients make decisions related to infrastructure operation optimization, design, solve problems associated with hydraulics and water quality, predict future system stresses and solutions, and prioritize capital project importance. While EPS-guided solutions may be applied to a wide range of challenges, several that SGM routinely encounters are described here.

## Design and Prioritize Capital Infrastructure Projects



As a distribution system service area grows, decision makers are faced with determining how best to bring new infrastructure online to meet ever-increasing water demands. Water distribution modeling assists system managers in analyzing:

- Sizing – Industry standard design criteria, such as maximum velocity in pipes, fire flow delivery requirements or water storage tank volumes, can be evaluated with a model. SGM uses EPS simulations, for example, to see how pipe velocities change with diurnal demands, pump on/off settings and seasonal water use variability, then recommends pipe sizes that are appropriate to minimize over or under-sized infrastructure.
- Location – With each new development, there are (in most cases) multiple tie-in options to consider. While pipe tie-in may appear to be a simple matter of shortest and minimum size to deliver demands, models can show if a single tie-in will deliver the required fire flow or if more locations are needed. Models also show if such an addition offers other benefits, such as improving conveyance capacity.
- Timing – System managers understand that the addition of a single development affects their distribution system's delivery. The key is determining the impact of the development singularly vs. the role it plays in the big picture. SGM often uses models to identify events that will trigger the need to make system-wide improvements. This enables decision-makers to determine the degree to which all anticipated developments contribute to the need for large-scale changes. In this way, all development or service area additions can be managed fairly and capital project funding allocated as necessary.

## Optimize System Control Setpoints



Affect of setpoints for a system's pumps and Pressure Reducing Valves (PRV) range from water quality and delivery availability to energy consumption cost evaluation.

Setpoints determine how much water will be available during a fire event or emergency production shutdown, how often stored water is allowed to turn over and even how much mixing is occurring in all tanks. Models are an ideal tool for understanding how setpoint manipulations affect these elements. For example, with goals in place for tank turnover time, a model will show when and how long pumps should turn on, how many pumps are needed and what the limitations are to best meet those goals with current infrastructure and demand conditions. This makes the model a low-capital tool to improve water quality in tanks and, in turn, the system.



Another example of setpoint evaluation relates to optimizing cost of energy consumption. Operating pumps during hours of peak energy consumption can be costly. System managers may want to consider how their system will perform when they prioritize off-peak pumping. Using a water model will help to answer: How low will the water level in my tanks go? How will this affect system pressure? Will my pumps be able to meet demands and fill tanks in the off-peak window? Will the system still be able to deliver adequate fire-flows under these conditions?

## Devise Hydraulic Imbalance Solutions



Public water distribution systems have water sources that are located based on the availability of surface or ground water. As a result, managers may struggle with water source locations that are far from high demand areas. In some cases, a significant length of pipe between a high demand area and the water source creates a system imbalance. A common symptom of such an imbalance is poor turnover in one water storage tank with excessive turnover in another. A well-working water model can predict such an imbalance and, once brought to light, SGM often uses the model to help optimize water system operation:

- Find places where new infrastructure (new piping or pipe size upgrades) helps move water across the system with greater ease.
- Devise specialty valve controls at tanks that manage flow into or out of the tank and moderate its turnover.
- Evaluate new tank locations, elevations, size and shape that provide the required volume, but also accommodate the imbalance.
- Consider changing how the existing tanks are used through seasonal shut-down, changes to source or pump station on/off settings or even assess the pros and cons of tank-abandonment.

## Focus Water Quality Improvements

Among the many challenges that distribution system managers face is that of maintaining high water quality throughout their system. Once chlorinated water leaves the disinfection station, degradation begins, forming disinfection byproducts (DBPs). Presence of residual chlorine and the concentration of DBPs is affected, in part, by time (water age) and source water quality (source contribution and mixing). EPS simulations can be used to identify locations in the distribution system where each of these elements may be problematic.

- Water age at any point in the system can be modeled to see if there are locations more prone to harboring old water. Model results also show if there are specific seasons which are more problematic based on demand fluctuations, pump setpoints and source utilization. This can guide managers in determining where to focus their system's water quality improvement efforts.
- Source contribution, in systems with multiple sources of varying water quality, can also be tracked to determine the degree to which mixing occurs. For example, managers can see if an area has a high percentage of good source water. Despite high water age, that area may not need flushing or chlorine boosting because of a high contribution of water from a source with slow degradation potential. The model can help streamline their water quality improvement efforts.



To learn more about water distribution system modeling and the benefits modeling will bring to your water system challenges, please contact **Shannon Ullmann** at Schmueser Gordon Meyer (970.384.9060).

