WATER DISTRIBUTION SYSTEMS & HYDRAULIC MODELING

McGoodwin, Williams & Yates is a leader in Arkansas in the field of hydraulic modeling, using the most up-to-date hydraulic software that operates seamlessly with AutoCAD. This approach allows base maps to be integrated into the modeling which results in easy visualization of the system and enables the model to be demonstrated in a presentable manner.

Since the early 1980s MWY has utilized computerized modeling software to simulate the dynamics of a water distribution system. The computerized modeling software has the ability to solve the complex mathematical equations associated with the distribution system quickly and accurately. The modeling can be used to identify potential weak areas of the system, perform fire flow analysis, and develop long range planning studies as well as facility sizing. Our experience with modeling software has included several different versions over the years. Since 1999, MWY has utilized H_2ONET modeling software to develop and model water distribution systems. MWY uses the hydraulic modeling software developed by MW Soft located in Pasadena, California. This software enables MWY to input and evaluate the following:

- Model pipes, tanks, pumps and control valves
- Input existing and future customer demands at the location in the system where they occur based on the city's billing records.
- Model diurnal demand (how the demands fluctuate over a 24-hour period) and examine what happens over a 72-hour period to analyze how the system responds to existing and future demands.
- Use real world dimensions to produce a map of the water system.
- Make changes to the system to determine most cost-effective solution to problems found during analysis and check system response to the proposed changes.
- Vary operations of the system within the model to optimize system performance with existing or proposed infrastructure.

Examples of our water distribution system modeling projects are included in the following pages. All aspects related to water modeling and hydraulic analysis have been provided, including software evaluation, engineering design, demand projections and long range planning studies.

SPRINGDALE

Hydraulic modeling has been used extensively by MWY for the city of Springdale, Arkansas. A small portion of the distribution system was modeled in 1993 and updated in 1997 with the acquisition of the White River System. In 1997, the city of Springdale selected MWY to develop a detailed *Water System Master Plan*. A citywide hydraulic model was developed and was used as the basis for the recommendations in the report. This master plan was used to develop a long-range plan for the water system including necessary distribution system improvements, storage system recommendations, and pump station modifications.

In 1999, additional modeling was completed regarding the storage facilities located on Fitzgerald Mountain. The modeling was used to evaluate additional storage for the primary pressure plane and associated piping. As a result, a 10 million-gallon tank along with 48-inch and 36-inch connection was completed in 2000 at a cost of approximately $4 million.

In December 2004 the city of Springdale requested MWY to update the master plans for both water and sewer. The Water System Master Plan was adopted by the Springdale Water and Sewer Commission in 2006 and the Sewer Master Plan was adopted in 2007. (See also Master Planning.

FAYETTEVILLE

In 1988, the city of Fayetteville, Arkansas selected MWY to produce a detailed water system study. A hydraulic model was completed in 1989 and was used to develop the recommendations as set out in the report. This study included a complete water system analysis based on existing and projected conditions, preliminary design and cost estimates of need facilities, operation and maintenance evaluation, potential financing alternatives and a plan of action. Upon completion of the master plan, the city moved to implement the recommendations presented. The major construction components consisted of approximately 10 miles of 42-inch water main and 2 miles of 36-inch water main. These improvements were completed in 1994. In 1996, MWY completed an update of the master plan to include the prior improvements. This update included the White River System acquisition and associated necessary upgrades of the water facilities to serve that system. Construction of those recommendations was completed in 1999, and included a 750,000-gallon elevated water storage tank, 18-inch water line and a booster pump station. The cost of these improvements was approximately $2.1 million dollars.

In 2002, the city of Fayetteville selected MWY to update the water master plan that was completed in 1996. The *2002 Master Plan Update* included 5, 10 and 20-year projections for population and system usage for the city of Fayetteville and the customers of the city. MWY used H_2ONET modeling software to model the Fayetteville distribution system and make recommendations of infrastructure improvements to be constructed throughout the Fayetteville system to adequately supply water to the projected population for the aforementioned time periods. MWY is currently working with the city to update the plan as the city's needs continue to evolve.

BATESVILLE

Hydraulic modeling has been used extensively by MWY for the city of Batesville, Arkansas. The hydraulic model was created in 1988 and was used to develop a detailed *Water Master Plan* for the city. This master plan was used to develop a long-range plan for the water system including necessary distribution system improvements, storage system recommendations, and pump station modifications. One concern which became readily apparent during the course of the analysis was the need to increase the capacity of the city's water treatment plant. Hydraulic modeling was used to simulate the addition to the high service pumping capacity and additional water transmission lines. The plant was then expanded in 1991 to a capacity of 12-MGD and the cost of the project was approximately $3 million dollars.

In 1993, additional modeling was completed regarding several distribution system improvements including the removal of the St. Louis Street tank, moving the College Heights tank, and the addition of several water transmission mains. In 1994, a citywide fire flow analysis was completed using the hydraulic model. This fire flow analysis was used to determine the amount of water available in the event of a fire. It was also used to evaluate the system at the fire flows and identify potential weak links. In 1996, the construction of a 1.5 million-gallon elevated water storage tank and water booster station was completed at a cost of $1.5 million dollars. Extensive modeling was completed regarding the booster station, tank and associated piping prior to construction.

In 1997, MWY completed an updated water and sewer master plan. Hydraulic modeling was used to assess the water distribution system and evaluate different alternatives. Recommended in the plan were both a 5.5 million-gallon tank and a 24-inch transmission line for an estimated cost of $3.5 million dollars. Several other water mains 12-inch and larger were modeled and construction of those lines was completed in 1998 and 1999.

In 2001, the model was updated from the TDHNet software to H_2ONET software. The model was also updated to include all new construction that has occurred to date. The model was then used to determine causes of and possible solution for low pressures at the White River Medical Center as well as low fire flow pressures at the facility.

CARROLL-BOONE

The Carroll-Boone Regional Water System provides treated water to the cities of Eureka Springs, Green Forest, Berryville and Harrison. The hydraulic model was developed in 1996 and covers approximately 47 miles of 30-inch and 24-inch transmission mains. The model was used to evaluate the transmission mains, an expansion of the water treatment plant, and the Pine Mountain Booster Station. A recent master plan updated the model in 2008.

JONESBORO

In 1990, MWY completed a *Water Distribution System Study* for the city of Jonesboro, Arkansas. The study included developing a hydraulic model of the distribution system based on existing and projected conditions, preliminary design and cost estimates. In 1991, the model was used to evaluate the effect of outages at Craighead Park supply. Later that same year, it was used to evaluate serving the city of Cash with municipal treated water.

GRAVETTE

In 1994, MWY performed a detailed water system study for the city of Gravette, Arkansas. A hydraulic model was developed and used to determine necessary distribution system improvements. Water transmission lines were constructed in 1995, 1997 and 1998 as a result of the modeling.

SILOAM SPRINGS

In 1999, MWY was selected to provide engineering services for a new elevated water storage tank. The services included building a complete hydraulic model of the city of Siloam Springs from an AutoCAD map of the water distribution system. The model represented over 100 miles of transmission lines and consisted of approximately 900 pipes. In addition, fire flow analysis was performed at over 1,200 fire hydrants located through the city. Projected demands were also developed as well as future storage system requirements. The study recommended building an elevated storage tank and associated water transmission mains at an estimated cost of $4.8 million dollars.

YELL COUNTY

In 1998, Northeast Yell County Water Association selected MWY to perform a detailed hydraulic analysis of the water distribution system. This associated is located south of Russellville, Arkansas and serves approximately 2,000 customers. The hydraulic analysis resulted in the construction of approximately 12 miles of 8-inch water transmission line and a 1 million-gallon ground storage tank.

CLIENT:
Rogers, Arkansas

PROJECT SCOPE:
Analysis of the Eastern Section of the Distribution System

COMPLETION:
September 2000

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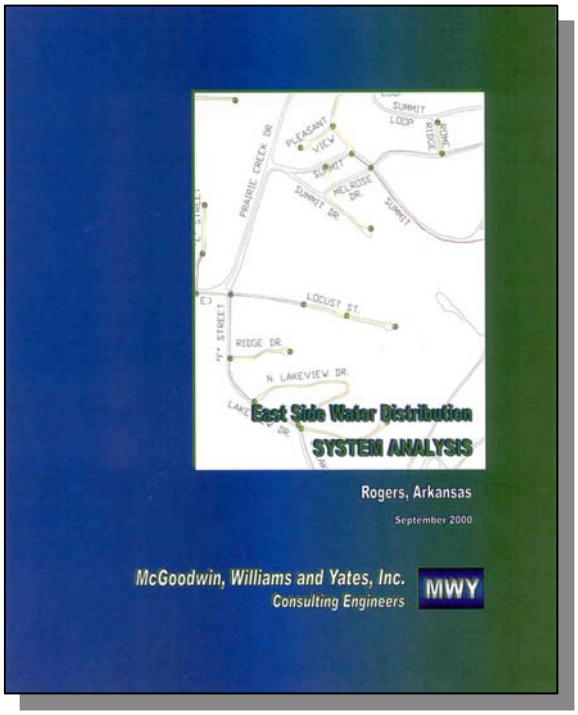

In August of 2000, the city of Rogers experienced an inability to deliver adequate amounts of water to the eastern most reaches of the water distribution system. Using the model, MWY was able to simulate the problems Rogers was experiencing in the field and make recommendations to alleviate these problems. The recommendations included three phases. Phases 1 and 2 consisted of the construction of transmission lines to the eastern section of the system. Phase 3 consisted of the construction of an elevated tank to help with the growth in this area.

CLIENT:
Batesville Water Utilities

PROJECT SCOPE:
Master Plan Update

PROJECT COST:
$ 70,000 (1990 Master Plan)
$ 26,000 (1997 Update)

COMPLETION:
March 1997
2001 Update

CONTACT PERSON:
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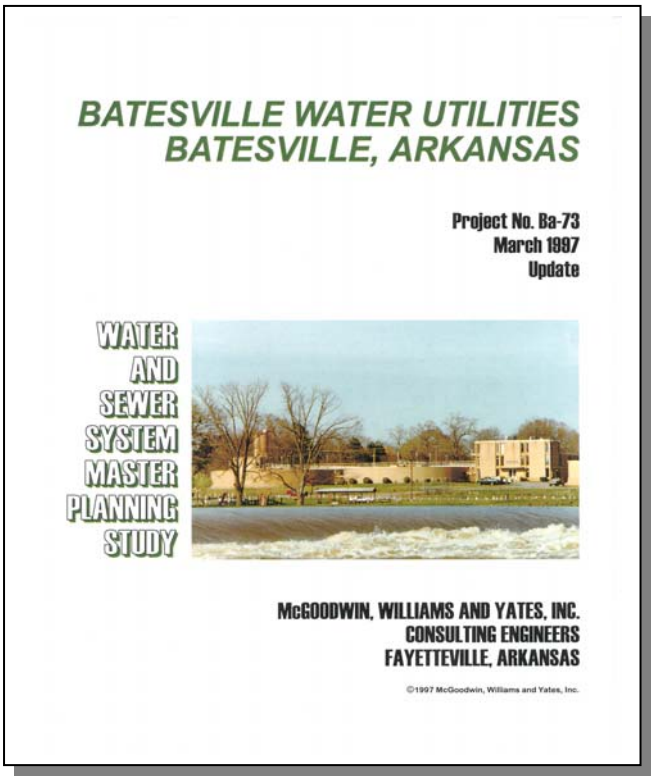

PROJECT DESCRIPTION:

In March of 1997, MWY submitted an update to the *Water and Sewer System Master Planning Study* originally presented to the Batesville Sewer Commission in 1990. The original 1990 master plan was also prepared by MWY.

The update outlined the status of items of work set forth in the original 1990 plan, and updated recommendations and schedules for water treatment plant and storage facilities. Recommendations for distribution system improvements were also made based upon a hydraulic analysis of the system utilizing a model created during the 1990 study and converted to TDH Net software during the update.

The Update also examined raw and finished water quality and the impact of amendments to the Safe Drinking Water Act (SDWA) and other proposed rules and regulations since the original study.

In 2001, the model was updated from the TDHNet software to H_2ONET software. The model was also updated to include all new construction that had occurred to date. The model was then used to determine causes of and a possible solution for low pressures at the White River Medical Center as well as low fire flow pressures at the facility.

CLIENT:
Beaver Water District

PROJECT SCOPE:
To Analyze and Determine Methods of Operation for Beaver Water District

COMPLETION:
June 2000

CONTACT PERSON:
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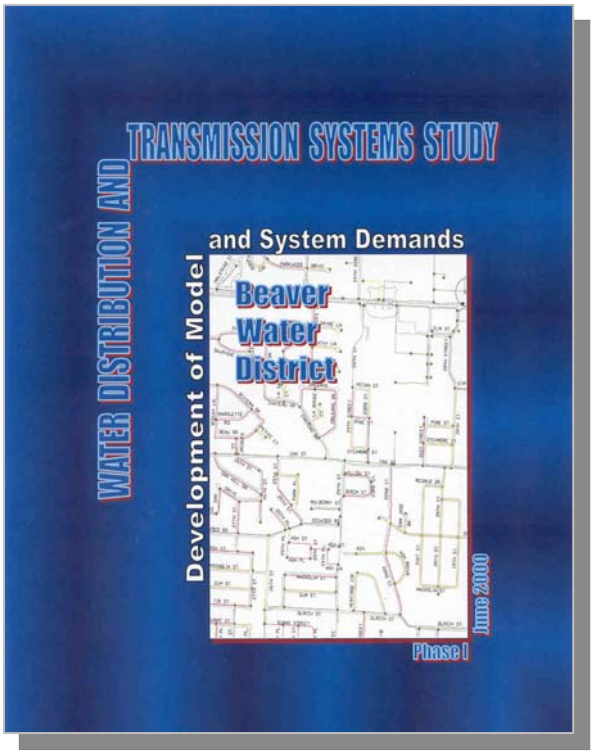

PROJECT DESCRIPTION:

In 1999, Beaver Water District selected MWY to create a hydraulic model of the transmission and distribution systems from the district's water treatment plant through the cities of the Rogers, Bentonville and Bella Vista. These three cities are served from a set of high service pumps at Beaver Water District. This model consisted of the following:

Rogers
- 2740 pipes
- 3 elevated tanks and 2 ground storage tanks
- 3 pumps stations

Bentonville
- 1296 pipes
- 2 elevated tanks and 2 ground storage tanks
- 2 pump stations
- 2 metering stations

Bella Vista
- 401 pipes
- 6 elevated tanks and 1 ground storage tank
- 2 metering stations

The Rogers/Bentonville/Bella Vista model totaled 4,437 pipes which represented 610 miles of water lines. The hydraulic model was used to identify deficiencies in the distribution system and evaluate various operating scenarios to determine the most efficient way to operate the combined system of these three cities.

CLIENT:
Bethesda Water Association

PROJECT SCOPE:
Recommend Improvements for the Distribution System

COMPLETION:
August 2002

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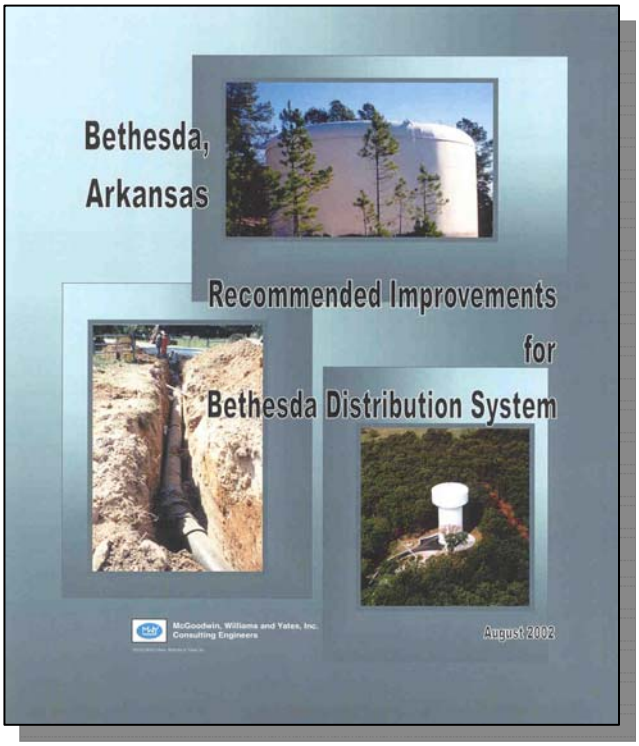

Bethesda Water asked MWY to analyze the distribution system and make recommendations for improvements. The system experiences low pressures in certain areas and does not have sufficient storage to help maintain the system pressure. MWY built a model of Bethesda's water distribution system using H2ONET. Using the model, MWY was able to determine the size of an elevated tank and location of a pump station to mitigate the aforementioned problems.