

March 13, 2015

Mr. Mike Borchers  
Mr. Barry Parsons  
Greensboro Water Resources Department  
P.O. Box 3136  
Greensboro, NC 28088

RE: Proposal for Updating Model, Mapping Fire  
Flows and Revising Master Plan

Gentlemen:

Hazen and Sawyer is pleased to submit this proposal for updating Greensboro's hydraulic model, mapping available fire flows and revising the water system master plan. This project will help the city improve its Insurance Services Office (ISO) fire suppression rating, update water demand projections and adjust capital improvements planning.

### **Background Information**

Hazen and Sawyer updated Greensboro's hydraulic model in the 2008-09 water system master plan. Subsequent projects updated certain parts of the model, but some information in the model, such as customer water demands, is out of date. Many changes have affected the water system since 2008, or will soon affect it. The city began purchasing water from Piedmont Triad Regional Water Authority (PTRWA) in 2010. Clifton Road Pump Station was placed in service; the city is in the process of upgrading the New Garden Pump Station; and the Jessup Grove Pump Station will be relocated in the near future. New pumps at Battleground Standpipe soon will replace Westridge Pump Station, and nearby pressure zone changes and installation of a 24-inch transmission main will affect operations. The city's model and capital improvements plan need to reflect these changes, in addition to updated water demands.

Hydraulic models periodically need re-calibration to ensure that they accurately represent the existing distribution system. The last master plan included checking model calibration system-wide using field tests. The proposed project includes limited calibration focusing on new facilities such as the transmission mains carrying water from the Piedmont Triad Regional Water Authority to Clifton Road Pump Station.

The proposed project includes using the updated model to map available fire flows at every hydrant, including privately owned hydrants. The fire flow map will provide information for updating the city's ISO fire suppression rating. ISO periodically conducts field surveys to evaluate fire departments. The distribution system is one of four major areas taken into consideration. In lieu of a comprehensive fire-flow testing program, ISO now allows using calibrated computer models for predicting and mapping available flows. This saves the Fire Department a significant amount of field testing.

To facilitate modeling for the ISO, we propose creating a node at every hydrant, including the private hydrants that are in the city's GIS. Some of the private hydrants are supplied by private water mains that are not included in GIS, such as those on the UNCG campus and at the Koury Convention Center. Our proposal includes adding private water mains that are available in shapefiles provided by city staff based on record drawings.

The last master plan projected water demands and planned capital improvements using planning data from 2007 and 2008, before the economic recession. Demand projections were based on meter installation records that showed a steady 25-year trend of about 1,800 new meters per year. The recession broke this trend. In addition, water use per customer has declined due to rate increases, reduced irrigation, more efficient appliances and water conservation. Annual average water demands have remained flat, even though the supplied population has increased. Consequently, water demand projections from the last master plan need to be updated to match water demand trends. The proposed project will develop new projections through 2040 for updating the capital improvements plan and the city's water supply plan.

### **Scope of Work for Part 1: Model Update and Fire Flow Map**

- 1. Add new pipes to the model.** Hazen and Sawyer will update the city's hydraulic model so that it includes all 6-inch and larger water mains that currently are in the city's GIS, both public and private. The city will provide the most recent GIS data for the water system. We also will add to the model additional private water mains that are provided by the city in shapefile format.
- 2. Create nodes at every hydrant.** This task will involve creating a model node at the location where each hydrant lateral connects to a water main. The city will provide shapefiles showing the location of all hydrants, both public and private. The updated model will include the same hydrant identification labels used by the fire department.
- 3. Update model demands.** Node demands in the model will be updated using recent customer billing records. The city will provide 12 months of billing data for each customer, including wholesale and municipal use, but excluding sewer-only accounts. Model demands will be adjusted for non-revenue water, the difference between the total amount of water supplied to the system and the total billed to customers. Large customers and wholesale users will be excluded from this adjustment. The city also will provide daily records of the water supplied by the water treatment plants and purchased from other sources for the same 12-month period as the billing records.
- 4. Check fire flow calibration.** Hazen and Sawyer will work with city staff to select 10 locations for field tests to document model calibration. City staff will conduct two-hydrant tests at these locations, using ISO testing procedures. At least one test will be located in each pressure zone, focusing on locations where needed fire flows are highest or available flows are lowest. The updated model will simulate each test and the available flow at 20 psi will be calculated for comparison with available flows calculated from field test results. A comparison between model and field test results will be tabulated to document model calibration. Hazen and Sawyer will identify any tests showing discrepancies that indicate closed valves or other problems for subsequent investigations by city staff.
- 5. Provide support for field investigations.** This task will include providing up to 40 hours of support for investigating calibration discrepancies between model predictions and field tests.

6. **Map Available Fire Flows.** The updated model will predict the available flow at 20 psi residual pressure for each hydrant in the system, based on a simulation of maximum day demand with the elevated tanks at the lower limit of their normal operating range. The results will be tabulated and mapped using the color scheme required by ISO.
7. **Present results and prepare technical memo.** Hazen and Sawyer will present preliminary results to city staff summarizing the model update, calibration and fire flow predictions. We will prepare a technical memo that details the model update, documents its calibration and includes a large-format paper map showing available fire flows. Deliverables also will include electronic versions of the report and model data files, as well as maps in pdf format and shapefiles that can be imported into the city's GIS.

### **Scope of Work for Part 2: Water Demand Projections and Master Plan Update**

1. **Review scope of work and meet with City staff.** This task will include an initial meeting to review the scope of work and request information; two progress meetings at project milestones; and a final meeting to present preliminary recommendations for the capital improvements plan.
2. **Update general information.** Hazen and Sawyer will review with city staff the current status and planned changes for pressure zone boundaries, tank operation, control valves and pump stations. The pump curves and operational controls in the model will be reviewed to ensure they accurately represent existing conditions and planned upgrades.
3. **Review population projections.** We will review and compare population projections for Greensboro and Guilford County prepared by the NC Office of State Budget and Management, the Piedmont Authority for Regional Transportation (PART), and any other available projections from the city planning department or the chamber of commerce. The PART population projections for traffic analysis zones (TAZs) will be mapped to identify growth areas. Population estimates will be developed for each pressure zone through 2040, considering recent changes to water and sewer service areas approved by the City Council.
4. **Develop water requirements.** This task will include studying water supply and billing records to identify current trends for per capita use and peaking factors. Average day demand projections will be based on expected population growth and per capita demand, with allowances for industrial use, including the Greensboro-Randolph megasite, and non-revenue water. Maximum day projections will consider recent peaking factor trends. This task also will include evaluating storage requirements for equalizing demands, sustaining fire flows and meeting state guidelines for emergency storage. Storage requirements in each pressure zone will be compared with existing tank capacities to identify zones with inadequate storage. Maximum day demand projections will be compared to firm pump capacities to identify zones with inadequate pump capacity. We will present preliminary projections to city staff to obtain their input and prepare a technical memo summarizing population projections and water requirements before modeling future demands.

- 5. Conduct distribution system tests.** Hazen and Sawyer's field engineers will conduct flow and pressure measurements to trace the hydraulic grade line (HGL) along the transmission mains from the PTRWA transfer station on NC 62 to Clifton Pump Station, continuing to the Regional Road pump station and elevated tank. In addition, diurnal demand curves will be developed for each pressure zone using the city's SCADA records and flow measurements conducted by Hazen and Sawyer.
- 6. Check computer model calibration.** The updated model will be checked by comparing predicted flows and HGLs to test results along the PTRWA transmission mains. In addition, predicted tank levels will be compared to SCADA records to ensure the model correctly simulates tank performance. Calibration results will be presented to city staff with recommendations for resolving any discrepancies.
- 7. Propose improvements to eliminate deficiencies.** This task includes estimating needed fire flows at the ten locations where field tests were conducted and modeling to identify improvements that eliminate deficiencies. Additional modeling will simulate future demand conditions. Predicted pressures with existing infrastructure will be compared with design criteria agreed upon with city staff. After identifying deficiencies, the model will test improvement alternatives, including recommendations from the previous master plan and proposed transmission mains to serve the Greensboro-Randolph megasite. Modeling will identify cost-effective methods of supplying future demands and maintaining water quality. Costs will be minimized by taking full advantage of the existing system. Hazen and Sawyer will present preliminary improvement recommendations to city staff for their review and comments.
- 8. Update program of construction.** The existing program of construction will be reviewed and adjusted based on the modeling results and discussions with city staff. The updated CIP will include demand triggers and links to other projects where appropriate. Improvements will be reviewed for constructability and coordinated with paving schedules and other planning information made available by city staff. A color-coded map will summarize each phase of the updated CIP. A tabulated version of the CIP will be summarized by pressure zone with planning level cost estimates.
- 9. Prepare final report.** At the conclusion of the project, we will prepare a draft report that includes the technical memo summarizing demand projections, descriptions of the field test results and documentation of model calibration. The report will describe the modeling results for future conditions and present the CIP in tables and maps. Hazen and Sawyer will respond to review comments by city staff and prepare five paper copies of the final report, as well as an electronic version in pdf format. Deliverables also will include the CIP in spreadsheet format and model data files with scenarios that activate future demands and proposed improvements.

**Proposed Fee**

We propose a lump sum fee of ONE HUNDRED SEVENTY FOUR THOUSAND NINE HUNDRED DOLLARS (\$174,900.00).

The fee is based on the following estimates per task:

<b>Task</b>	<b>Description</b>	<b>Fee</b>
<b>Part 1: Model Update and ISO Fire Flow Map</b>		
101	Add new pipes including private pipes	\$8,100
102	Create nodes at every hydrant	\$5,100
103	Update model demands	\$5,700
104	Check fire flow calibration for 10 tests run by the city	\$6,700
105	Check calibration discrepancies	\$4,500
106	Map available fire flows	\$2,700
107	Present results and prepare tech memo	\$4,700
<b>Part 2: Master Plan</b>		
201	Meetings: initial, 2 progress, final	\$9,700
202	Update pump curves and general information	\$2,300
203	Project population by zones & WSAs	\$9,500
204	Water demand projections, pump & tank evaluation, tech memo	\$16,000
205	Field tests: PTRWA/Clifton/Regional HGL, diurnal curves	\$13,800
206	Computer model calibration: HGL & SCADA calibration	\$15,700
207	Identify proposed improvements	\$33,300
208	Program of Construction tables and maps	\$10,800
209	Final Report	\$26,300
<b>Project Totals</b>		<b>\$174,900</b>

**Schedule**

We propose scheduling this project to begin in the second quarter of 2015 and estimate completion by June 30, 2016.

Please call if you have any questions about our proposal. We look forward to working with you.

Very truly yours,  
HAZEN AND SAWYER, P.C.



Jeffrey R. Cruickshank, PE  
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