Hazen and Sawyer
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August 23, 2022

Mr. Adam Steurer, PE
City of Hendersonville
305 Williams Street
Hendersonville, NC 8792

Re: Water Master Plan Update

Dear Mr. Steurer:

Hazen is pleased to provide this preliminary scope and fee proposal for the City of Hendersonville's Water Master Plan Update.

Project Background

The City of Hendersonville selected Hazen to provide engineering services described in a June 17, 2022, Request for Qualifications for the City of Hendersonville Water Distribution System Master Plan Update. This proposal outlines the scope of services and preliminary fee estimates.

The preliminary scope in this proposal is a summary of discussions with city staff on July 26, 2022, including optional tasks of interest to the city staff but not included in the scope described in the RFQ. Some tasks are presented in different levels of detail for fee comparisons, as requested by city staff.

Water System Overview

Hendersonville's distribution system provides drinking water to retail customers in the City of Hendersonville and surrounding areas. Hendersonville average day water production for 2021 was 7.78 mgd with a maximum day of 9.82 mgd.

Hendersonville's water system supplies a year-round population of approximately 72,000. The distribution system includes about 640 miles of main ranging from 2-inch pipes to 24-inch transmission mains. Some parts of the system were installed prior to 1950; consequently, a significant number of water mains are unlined cast iron pipes.

A 12 mgd water treatment plant about 8 miles northwest of the city supplies the system from the Mills River and two other sources in the Pisgah National Forest. The city upgraded the original 1963 plant in 2010 and plans to replace the high service pumps in the near future. Pumped water flows to the central part of the distribution system through two transmission mains, a 16-inch pipe installed in the 1920s and a 24-inch pipe installed in the 1960s.

Scope of Work

Hazen (Engineer) proposes the following scope for the City of Hendersonville (Owner) Water Master Plan Update:

Task 1: Project Administration

This task includes project administration such as developing the scope and fee, bi-weekly calls, invoicing, and providing quality assurance by senior level staff throughout the duration of the project. Engineer will also prepare final presentations for both the City Council and the Water / Sewer Advisory Council.

Task 2 – Update Existing Hydraulic Model

The Engineer will **update the pipe network** by importing water system data in the most recent version of the City's Geographic Information System (GIS) into the modeling software. The Engineer will compare the current GIS pipe network to the network in the existing model and add any missing pipes, simplifying where needed to improve software performance. C-factors will be assigned to reflect typical values for new pipes. New nodes will be defined at new hydrants and pipe intersections, and elevations will be assigned using digital topographic data.

Task 3 - Conduct Field Tests

This task will **develop a field test plan** based on study of GIS data, field inspections and discussions with city staff. A **workshop** will be held using Teams to review the field test plan with city staff. Hazen will deliver the plan at least 30 days before testing begins.

The Engineer will **conduct one hydraulic grade line (HGL) test** that measures flows and pressures along the transmission mains from the WTP through the new Northside BPS to the new Northside Tank. Hazen will provide all test equipment. The Owner will make accessible existing taps or air valves for flow measurements using pitot tubes, or install new taps, if needed. Measured pressures will be added to gauge elevations to plot hydraulic grade lines (HGLs) against distance. This test will study the performance of improvements that have been installed since the last master plan.

Hazen will **conduct 10 fire flow tests** with assistance from the Owner. The tests will consist of flow and pressure measurements that assess the strength or weakness of the system in specific areas. Tests will be located for geographic coverage and in problem areas identified by city staff and or the fire department. Hazen will provide test equipment and the Owner will provide transportation and staff to operate hydrants and control traffic.

Test WTP and pump station master meters. Hazen will provide pitot tubes and field engineers to test the master meters that measure finished water entering the distribution system at the Owner's water plant, as well as district meters at pump stations that supply the Northside (McCrometer's insertion meters) and Eastside (McCrometer's insertion meters), Kenmure Greenleaf (McCrometer's insertion meters) pressure zones, and wholesale meter to Saluda (coordination with Saluda will be required). Pitot flow measurements in pipes near each meter will be compared to meter totalizer registration. The tests will encompass the primary metering device, the secondary instrumentation, and data handling in the SCADA system. Tests for the WTP will cover a 24-hour period at the normal range of flow rates to determine any under or over registration and the

appropriate flow-weighted correction factors for the City's water audit. For the pump stations and wholesale meter, varying pump operations will be tested to determine correct factors. Pitot tubes will be inserted into water mains near each tested meter using taps installed or made accessible by the Owner. Hazen will assist in planning new 1-inch tap locations if needed using available drawings.

The Engineer will **calculate demand patterns for Laurel Park, Etowah, Northside, and Eastside, Kenmure-Greenleaf pressure zones as well as an overall system curve for the remaining pressure zones.** These calculations will use AMI district meters, SCADA records provided by the Owner showing hourly flows from water plants and pump stations, as well as hourly changes in recorded tank levels. These diurnal patterns will be used as input data for extended period simulation (EPS) modeling and for determining minimum night rates that indicate leakage potential.

Task 4 - Calibrate the Model

The Engineer will first **calibrate the model using the HGL test** by plotting and comparing measured and predicted HGLs. These plots will show where the model needs adjustments, or locations where unusual conditions are suspected, such as closed valves. Major discrepancies that cannot be resolved with reasonable model adjustments will be reviewed with Owner to develop a plan for further investigations. This task will check macro calibration for the most important parts of the distribution system.

Next the Engineer will **calibrate the model using fire flow tests**. This task will check micro calibration of the model in areas where fire flow tests were performed. After checking predicted static pressures, the model will simulate the measured flow from each test. Predicted residual pressures will be compared to the measured residual pressures and reasonable model adjustments will be applied to eliminate discrepancies. Major discrepancies that cannot be resolved with reasonable model adjustments will be reviewed with the Owner to develop a plan for further investigations.

The Engineer will then **calibrate the EPS model using SCADA records** by comparing recorded tank water levels to predicted tank water levels. This task will ensure that the model accurately simulates tank performance, which has a significant impact on water age calculations.

Workshop – An on-line Teams meeting will be held to review the mode updated, field test and calibration results.

Task 5 – Identify Existing Deficiencies

The Engineer will use the model to **evaluate pressure zone boundaries** by identifying areas where pressures are outside design criteria agreed upon with city staff. These areas will be taken into consideration when subsequently testing improvements.

Fire flow analysis will be performed by calculating at each hydrant connection the flow available at a 20 psi residual pressure to identify areas with deficient fire flows. The Engineer will identify any general areas with low fire flows, and these areas will be taken into consideration when subsequently testing improvements.

The Engineer will use the model to **map water age** for existing operation of the system. The model will predict water age based on a 30-day simulation of existing average daily demand using current pump controls and operating procedures. The map will highlight areas where water age is excessive. Additional modeling will **test operational changes,** including evaluating current flushing locations that reduce water age in problem areas.

Pump and storage deficiencies will be identified by comparing existing pump and tank capacity in each pressure zone to existing maximum day demands and requirements for equalizing and fire storage.

Engineer will use the hydraulic model to develop recommendations for eliminating existing deficiencies. Hazen will **conduct a Workshop** with city staff to review the existing system analysis.

Task 6 – Plan Uni-Directional Flushing (UDF) Program for Laural Park

The Engineer will use the hydraulic model to develop plans for uni-directional flushing (UDF) the Laural Park Pressure Zone (approximately 35 miles of water main). This method of flushing uses flowing hydrants and valve operations that induce high velocities in water mains for thorough scouring.

Task 7 – Forecast Future Water Demand

The Engineer will **review population projections for Traffic Analysis Zones** (TAZs) within the future water system service area agreed upon with the Owner. Hazen will **conduct a workshop** with city staff to review the TAZ projections as well as other planning information made available by the Owner. The TAZ projections will be adjusted if needed based on input from city staff.

The engineer will **forecast water demands to 2050** in five-year increments out to 2040 and then for 2050 based on the population projections for the service area. This task will include an evaluation of peaking factors and diurnal patterns to estimate future average day, maximum day and peak hour demands in each pressure zone. Demand forecasts will consider:

- historical water production records
- the Owner's billing records and meter installation trends
- information provided by city staff, planning department, and county staff about new industrial use and its most likely location
- wholesale supply to other systems considering contractual agreements and input from city staff
- per capita usage trends identified from number of meters to production records
- projected population growth

The Engineer will present s**ummarize demand projections and supporting data sources** to the city staff in a **Workshop** and then develop a technical memo. The demand projections will be agreed upon with the Owner before modeling any future demand scenarios.

The Engineer will **distribute new demands to model nodes** and develop future demand scenarios that agree with the demand projections for each pressure zones.

Task 8 – Simulate Future Demand Conditions

The Engineer will **identify future deficiencies** by simulating future supply and demand conditions and comparing predicted performance with design criteria agreed upon with the Owner.

Based on the demand projections, the Engineer will **evaluate pump and storage capacity** by pressure zone. This task will include evaluating storage requirements for equalizing diurnal demand, sustaining fire flows and meeting state regulations for emergencies. The Engineer will compare needed storage in each pressure zone with existing tank capacities and recommend new tanks in zones with inadequate storage. The Engineer will evaluate pump capacity by comparing maximum day demands with firm pumping capacity. New pumps will be proposed as needed.

Hazen modelers will **test improvements** that eliminate deficiencies. Viable alternatives will be compared to identify cost-effective methods of supplying future demands while meeting hydraulic design criteria and maintaining water quality. Improvements will take full advantage of the existing distribution system. Improvements will include adjustments to pressure zone boundaries, if needed. Hazen will **conduct a Workshop** to review the improvements, and final recommendations will be based on review comments from city staff.

Task 9 – Update the CIP

Hazen will **update the capital improvement plan** (CIP) from the previous master plan by mapping, prioritizing, and tabulating recommended pipes, tanks and pump stations. The CIP will include planning level cost including future estimates and detailed project sheets for each major improvement. Cost estimates will include construction, land acquisition, contingencies, engineering, legal and administrative costs. The CIP will be divided into 5-year planning periods out to 2040 and then for 2050 corresponding to a color-coded map. Project sheets will identify any demand benchmarks that trigger the need for proposed improvements.

To assist the City with SRF applications, the CIP for the next 10 years will be further prioritized. Prioritization of new projects will consider fire flow, water age and redundancy.

The Engineer will **review the new CIP with city staff** in a **Workshop** and make changes based on review comments.

Task 10 - Prepare Master Plan Report

The Engineer will **prepare a draft report** that:

- documents the process of updating the hydraulic model
- summarizes the field tests and model calibration
- identifies existing deficiencies
- maps water age and summarizes recommendations for improving operations and water quality
- summarizes the population and demand projections
- explains model results for future demand conditions
- tabulates proposed improvements, with planning level cost estimates
- UDF map books for Laural Park

Hazen will respond to review comments and **deliver a final report** that is signed and sealed by a Professional Engineer.

Optional Services

Our proposal includes optional tasks as follows:

Task 11 – Water Audit

Association (AWWA) for M36, the Manual of Practice for Water Audits and Loss Control Programs. The water audit will evaluate non-revenue water, the difference between the amount of water billed to customers and the amount of water supplied to the distribution system. The water audit report will include specific recommendations on how to decrease non-revenue water. Going forward, city staff will be able to track non-revenue water by updating the audit on an annual basis.

The Water Audit task will include the following subtasks:

a) **Kickoff conference.** Engineer will host a **workshop** call to review the billing summary from the master plan, request information for the audit and answer questions from city staff.
b) **Compile distribution system information**. This task includes entering required information describing the distribution system into the spreadsheet for the 4th Edition of M-36. This information includes statistical information about the distribution system and financial information, such as the total costs to operate the water supply system, billing rates, and marginal production costs. Hazen will work with city staff to compile this information.
c) **Perform water balance calculations and develop performance indicators.** Engineer will use M-36 software to calculate water balance components including water supplied, water exported, billed authorized consumption and non-revenue water, including apparent losses and real losses. This task also will include calculating performance metrics to track non- revenue water year to year and identifying operational benchmarks for comparison with other utilities.
d) **Prepare technical memo summarizing the water audit**. Hazen will prepare a technical memo summarizing the water audit, including the completed forms produced by the M-36 software. The summary also will include plotting monthly water production and billing for the last several years and calculating the difference as a 12-month moving average to identify trends. The technical memo also will compare water pumped to water billed in the Laurel Park, Etowah, Northside and Eastside pressure zones to help the Owner prioritize future leak detection efforts.

Task 12 – Plan Uni-Directional Flushing (UDF) Program for Etowah and Northside

The Engineer will use the hydraulic model to develop plans for uni-directional flushing (UDF) the following pressure zones: Etowah, and Northside (approximately 100 miles of water main). This method of flushing uses flowing hydrants and valve operations that induce high velocities in water mains for thorough scouring.

Task 13 - Dashboard

The Engineer will meet with the City to determine how the dashboard will appear and to verify necessary data connections to facilitate functionality. The Engineer will **prepare a Power BI report with three pages** that:

1. Tracks existing demands with functionality to compare projected demands from the Master Plan. Existing demands will be stored in an Excel Workbook provided by Hazen to be updated by the City.
2. Tracks development projects to include development name, location, type, status, anticipated dwelling units, projected demands.
3. Revises the existing Power BI Dashboard to display location of CIP projects and prepopulated project information in coordination with the City Manager's office.

Task 14 – Conduct Valve Criticality Risk Assessment

The Engineer will use the hydraulic model to **assess valve criticality** within the main zone and several of the larger pressure zones. The model includes an automated vulnerability module that quantifies criticality by determining how many customers would have no service or deficient pressure if each pipe section was isolated for a repair using existing valves. The results will be used to rank valves or pipe sections by relative risk, considering the consequences of failure.

A technical memo will **make recommendations to reduce risk**, such as adding new valves or installing new connecting pipes or other improvements.

Compensation

The tasks described in the Scope of Work will be billed monthly on an hourly basis by employee classification, as shown in in Table 1. These rates will remain in effect through June 30, 2023, when they will be adjusted based on increases in the cost of labor. Reimbursable project expenses will be billed at cost, including vehicle mileage at the rate established by the Internal Revenue Service and sub-consultant fees.

Estimated hours and fees for each task are shown in Table 2.

For Tasks 1 through 12, compensation to Hazen and Sawyer shall not exceed TWO HUNDRED THOUSAND DOLLARS ($200,000.00) without further authorization from the City.

Table 2 also shows estimated fees for optional tasks not included in the limit above.

Table 1: Hourly Rates

Vice President	$260
Senior Associate	$220
Associate	$180
Senior Principal Engineer	$160
Senior Field Coordinator	$155
Principal Engineer	$140
Engineer	$130
Assistant Engineer	$125
Editor/Admin	$75
Technician	$50

Table 2: Estimated Hours and Fees

	Task	Est Hours	Task Fee
1	Conduct Project Admin	106	$22,300
2	Update Existing Hydraulic Model	12	$1,900
3	Conduct Field Tests	146	$22,800
4	Calibrate the Model	94	$15,600
5	Identify Existing Deficiencies	125	$19,800
6	UDF - Laurel Park Zone	64	$9,600
7	Forecast Future Water Demand	250	$39,000
8	Simulate Future Demand Conditions	188	$31,400
9	Update the CIP	94	$15,400
10	Prepare Master Plan Report	144	$22,200
SUB	TOTAL	1,223	$200,000
OPTIONAL TASKS			
11	Water Audit	193	$30,100
12	UDF - Etowah and Northside Zones	114	$17,200
13	Dashboard	150	$23,700
14	Conduct Valve Criticality Risk Assessment	254	$40,000

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Schedule

The chart below depicts the preliminary project schedule assuming a start date of September12, 2022.

Hendersonville Water Master Plan Update
Project Schedule

Task		Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23
1	Conduct Project Admin													
2	Update Existing Hydraulic Model													
3	Conduct Field Tests	★												
4	Calibrate the Model				★									
5	Identify Existing Deficiencies					★								
6	UDF - Laurel Park Zone													
7	Forecast Future Water Demand	★		★										
8	Simulate Future Demand Conditions								★					
9	Update the CIP										★			
10	Prepare Master Plan Report													★

★ Workshop