



Ms. Melinda King, PE
Water Resources Department
City of Greensboro
2602 S. Elm-Eugene St.
Greensboro, NC 27406

Subject:

City of Greensboro, NC
Sewer Model Expansion and Recalibration Services
Proposal for Engineering Services

Dear Ms. King:

ARCADIS is pleased to submit this proposed scope of services for expanding and recalibrating the existing dynamic collection system model and providing the City with a comprehensive update of the City's Sanitary Sewer Master Plan (completed in 2011). As a result of this modeling the City will be able to:

- Use the dynamic collection system model as currently applied to support development and local sewer improvement project decisions
- Estimate the effectiveness of completed sewer rehabilitation projects
- Quantify inflow and infiltration and prioritize remaining improvement areas based on inflow/infiltration
- Re-evaluate the existing CIP projects, developed as part of the original Master Plan, to determine if they are still required to support growth or wet weather driven capacity needs
- Develop additional potential capital improvements to increase capacity, reduce I/I, and/or improve operation of the collection system.

The main tasks of this proposed scope of services are listed below. We understand that the City expects to convert existing InfoWorks CS model databases into InfoWorks ICM using City staff prior to the following scope.

- Expand the existing dynamic collection system to include any recently developed areas of the City's system.
- Update the existing model with revised water consumption data.
- Re-calibrate the expanded model to the newly collected flow monitoring data (from 2015 Winter/Spring monitoring period).
- Provide a summary report of the model update and calibration including assumptions used in calibrating the model and defining CIP projects
- Provide hands-on training to City staff on the use of the model

Imagine the result

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Our ref:
GRGRN050.R006

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NC Engineering License # C-1869
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ARCADIS will help the City meet these objectives through the scope of work provided below.

SCOPE OF WORK

Project Management

This task includes ongoing project management and project meetings (approximately four client meetings) and handling all aspects of the contract execution, including invoicing.

Model Conversion

The City staff will convert the hydrologic and hydraulic model from InfoWorks CS to InfoWorks ICM. The model conversion will consist of converting both the Existing Conditions model and the 2050 Future Conditions model.

After conversion into ICM, the City will run the ICM models for the existing and future conditions (both dry weather flow and 10-year storm) to verify the performance of the model for critical infrastructure locations (pump stations, major pipe networks). If necessary, selected model attributes will be corrected and adjusted as needed to ensure the proper operation of all modeled facilities and structures. These simulations will be performed as a confirmation of the model conversions and to ensure that upon conversion the City will have a working version of the model for continued day-to-day use until the re-calibrated model is completed.

Any support services by ARCADIS for the model conversion will be handled as additional services when requested.

Expand System-wide Model

This task identifies all steps required to update the previously developed model to reflect any changes and modifications to the system since the 2011 model calibration effort.

Update Structures for New Survey

Under this sub-task, ARCADIS will update existing hydraulic network (pipes and manholes) with survey data collected by the City or other contractors as available. These data will provide updated pipe inverts, diameters and/or manhole rim elevations based on recent surveys, construction or rehabilitation. It is anticipated that all data will be provided to ARCADIS by the City digitally, either through updated GIS databases, Excel spreadsheets or other formats readily imported into the modeling software.

This task will also provide a review of the new data and identify any potential questionable areas. These areas will be discussed with the City and a process for rectifying will be developed. The budget for this task assumes no additional field work by ARCADIS.

Model Expansion for New Development Areas

ARCADIS will expand the model to incorporate new areas developed since the 2011 model update as well as the area by Cardinal Lift Station that was not included in the original model. Preliminary data for the Eastern Area Sewer Improvements projects have been included in the model already, however, updated information and planned projects such as the proposed Megasite utilities will be included as part of this task assuming information is available on that infrastructure in time to incorporate them in this model update. New lift stations and force mains will be added as well. ARCADIS will collect all available data (pipe network, parcels, land use, water consumption, etc.) for additional areas to be added and convert them for use in the InfoWorks ICM model. This sub-task assumes all data will be provided by the City digitally and in a format readily imported into the modeling software.

Update for Known Changes to Lift Stations

ARCADIS will update all pump stations currently included in the model to incorporate any changes, upgrades or other operational modifications made to these stations since the original model development/calibration was completed. Lift station changes required for the model update but are not limited to:

- Changes to Lift station operations (on/off levels, new or upgraded pumps and associated pump curves, conversion from constant speed to variable speed or vice-versa).

- Changes to pump station physical configuration (wet well dimensions, force main size, etc.)

Model Re-Calibration

This task provides for the calibration update of the model for ultimate use as a master planning tool. Re-calibration services are included below.

Update Base Sanitary Flow Parameters

The development of base wastewater flow for input into the model will be conducted by using water consumption data provided by the City. Using updated water consumption information, estimated wastewater flows will be compared to flow monitoring data to (a) verify the meter data; (b) develop initial estimates for groundwater infiltration; (c) finalize model dry weather flow calibrations. Included in this task will be analysis of meter data from small, upstream basins to determine whether the current typical diurnal flow patterns included in the model need to be updated.

Included in this task will be importing all flow and rainfall data into the model for use during the model re-calibration tasks.

Recalibrate Model

This sub-task covers the re-calibration of the system-wide model to new monitoring data collected during the 2015 Winter/Spring flow and rainfall monitoring period, as well as available M800 data from lift stations. Re-calibration will include the following:

- Dry weather re-calibration. Calibration of the model to dry weather flows or inter-wet weather events, including diurnal patterns. The following will be compared:
 - o Verify that the model is routing dry-weather flows correctly. If the modeled flow data does not closely match the monitored flow data the system will be reviewed for possible connectivity errors.
 - o Compare the measured and modeled flow depths, adjusting Manning's n as needed, or identifying the cause of discrepancies (e.g., downstream blockage, local flow effect, etc.).
 - o Interviews with key collection system operation staff to find known capacity problems as well as locations of other service-related problems, such as roots and grease.

Wet weather re-calibration.

- o Re-calibration of the model will be completed for up to four storm events at up to 64 locations (combination of flow meters and lift stations) throughout the City's collection system. These events will cover a range of events from smaller storms to significant storm events.
 - o Available lift station flow data ("Mission" data) will also be evaluated and used where necessary to augment the re-calibration.
 - o Wet weather parameters will be adjusted as needed to generate volume and peak flow. Surge depth and flow will be calibrated in order to develop a robust tool for future flow projections and system analyses.
- Wet weather verification
 - o After completion of model calibration, up to two historical storms will be simulated to confirm the model hydrologic and hydraulic parameters.
 - o Customer complaint records and anecdotal information will be used along with available long term flow monitoring data to verify that the model suitably predicts the collection system response during conditions other than the calibration period.

Existing System Characterization

Using the re-calibrated model, ARCADIS will update the existing system characterization for the 10-year storm conditions. Prioritized thematic maps, tables and other summaries will be provided to show where within the City's system there may be capacity limitations or other service concerns that exist for current conditions.

Future (2050) System Characterization, CIP Update, and Documentation

This task will update the re-calibrated model to account for any changes in the future (2050) projected flows. The City will provide updated population and employment projections, if any. Using the re-calibrated model, ARCADIS will update the future (2050) system characterization for the 10-year storm conditions. Prioritized thematic maps, tables and other summaries will be provided to show where within the City's system there may be capacity limitations or other service concerns that exist for future conditions. A workshop will be held to review both existing system and future (2050) system characterization results, and to confirm the performance of the system with City staff.

ARCADIS will further take the conveyance improvements identified as part of the original master plan and that comprised current planned CIP projects and evaluate whether those projects, in light of the revised calibration and recently completed projects by the City, are still warranted. ARCADIS will also develop (in concert with the City) additional alternatives to address any issues identified during this master plan update that are not resolved by either recently completed projects or planned CIP projects. Up to two additional alternatives evaluating combinations of conveyance improvements, sewer rehabilitation, or system storage will be evaluated.

ARCADIS will document the model update, calibration and system characterization results, as well as any changes to the proposed CIP and original master plan. This report will provide a description of the model expansion, re-calibration, necessary dry and wet weather parameter changes, and quality assurance procedures that were used to create a calibrated and verified model of City's sanitary sewer system. ARCADIS will also provide updated project cost opinions for identified CIP projects.

Model Training

ARCADIS will transfer the re-calibrated sewer model to the City after the Model Recalibration is complete. ARCADIS will provide up to four days training for City staff on use of the InfoWorks ICM sewer model. This task will also provide access to ARCADIS staff to answer questions that may arise as the Water Resources staff continues to use the model.

FEE PROPOSAL

Based upon the scope of work and level of effort defined above, ARCADIS proposes to perform these services according to the terms of the existing On-Call Services agreement on a time and materials fee basis with a 3.2 multiplier on direct labor, plus reimbursable expenses at a 1.0 multiplier, for the maximum estimated fee of \$415,000. The contract maximum fee will not be exceeded without prior authorization by the City.

The table below summarizes the associated costs for each task. ARCADIS anticipates completing all tasks described in this scope within approximately twelve (12) months of authorization to proceed.

Task Description	Fee
Project Management	\$15,000
Expand System-wide Model	\$40,000
Model Recalibration	\$274,000
Existing System Characterization	\$30,000
Future (2050) System Characterization, CIP Update, and Documentation	\$41,000
Model Training	<u>\$15,000</u>
Total	\$415,000

Reimbursable expenses are described as follows:

1. Mileage and associated travel costs for employees working on the project at current IRS-approved rate per mile. Lodging, rental car costs, and airfare associated with staff traveling to the project site from other offices as required.
2. Reproduction of project-related materials by outside vendors.
3. Postage and shipping charges associated with the project.

We appreciate the opportunity to provide these services for the City. If this proposal meets your approval, please provide a Supplemental Agreement to our existing Agreement for Professional Services for execution.

Sincerely,

ARCADIS G&M of North Carolina, Inc.



David A. Hamilton, PE
Project Manager

Copies:

Mike Borchers, PE (City of Greensboro)
Eric Harold, PE (ARCADIS)
Bill Barrack, PE (ARCADIS)