CITY OF HIGH POINT
AGENDA ITEM

Title: NPDES Permitting Support for Future Expansion of the Eastside WWTP Tetra Tech

From: Terry Houk – Public Services Director
Derrick Boone – Public Services Asst. Director

Meeting Date: May 3, 2021

Public Hearing: N/A

Advertising Date: N/A
Advertised By: N/A

Attachments: Attachment A – Scope of Services for NPDES Permitting Support for the City of High Point Eastside WWTP (NPDES No. NC0024210)

PURPOSE:
To contract with Tetra Tech to provide monitoring and modeling services as part of the planning for the expansion of the Eastside wastewater treatment plant (WWTP) (NC0024210)

BACKGROUND:
The Public Services Department is currently evaluating a future expansion of the Eastside wastewater treatment plant. Tetra Tech will oversee monitoring and perform the necessary technical analyses to evaluate the planned expansion's impact on Randleman Lake such that the NCDENR-Division of Water Resources will have the necessary information to issue speculative limits to guide the facility expansion planning. Tetra Tech will perform the following tasks under the DWR approved monitoring plan: (See attached executive summary).

BUDGET IMPACT:
Funds for this are available in the adopted budget.

RECOMMENDATION / ACTION REQUESTED:
The Public Services Department recommends approval and asks for the Council to award the professional engineering services to Tetra Tech in the amount of $199,791.

Scope for NPDES Permitting Support for the City of High Point Eastside WWTP (NPDES No. NC0024210)

Phase 2 – Monitoring and Modeling

April 21, 2021

TO BE PERFORMED FOR

City of High Point
Public Services
211 S Hamilton Street
High Point, NC 27260

BY

Tetra Tech Engineering P.C.
1 Park Drive, Suite 200
P.O. Box 14409
RTP, NC 27709

P +1-919-485-2058
F +1-919-485-8280
tetratech.com

EXECUTIVE SUMMARY

Under this project scope, Tetra Tech will support NPDES wasteload allocation development for the City of High Point and it's facility planning engineering consultant, Hazen, for the planned expansion of the City's Eastside Wastewater Treatment Plant (WWTP). The Eastside WWTP discharges to the Deep River arm of Randleman Lake, a water supply for the region that is managed by the Piedmont Triad Regional Water Authority (PTRWA). In order for the City to be permitted for the expansion, it must demonstrate to the satisfaction of the North Carolina Division of Water Resources (DWR, NPDES permitting authority in NC) that water quality standards for the lake can be met with the expanded Eastside discharge. Tetra Tech will oversee monitoring and perform the necessary technical analyses to evaluate the planned expansion's impact on Randleman Lake such that DWR will have the necessary information to issue speculative limits to guide the facility expansion planning.

Tetra Tech, City staff, and Hazen representatives met with DWR to review Tetra Tech's Monitoring and Modeling Plan (Tetra Tech, 3/2/2021) on April 7, 2021. DWR approved of the Plan which will involve the following components:

Task 1. Monitoring: to support model setup, calibration, and corroboration

Task 2. QUAL2K model development and application to support speculative limits development for oxygen-demanding waste parameters (QUAL2K is a receiving water model, developed collaboratively between academia and the U.S. EPA, that has been tested and applied extensively in simulating fate and transport of oxygen-demanding substances including those in municipal wastewater treatment facility discharges)

Task 3. CORMIX model development and application to develop mixing zones for the effluent as the basis for establishing toxic pollutant and whole effluent toxicity limits and requirements (CORMIX was developed collaboratively between academia, U.S. EPA, and MixZon Inc. and is a recommended tool for predicting how discharges mix with receiving waters in order to estimate dilution for development of effluent limits for toxic substances including those in the Eastside facility effluent)

Task 4. BATHTUB model development and application to support evaluation of the expanded discharge volume impact on trophic levels of Randleman Lake (BATHTUB was developed by the U.S. Army Corps of Engineers and is a well-accepted tool by U.S. EPA and others for predicting eutrophication response of reservoirs to inputs of nutrients from point and nonpoint sources)

Task 5. Facilitation of interaction with DWR to address technical concerns regarding the modeling and speculative limits request

Task 6. Contract and project management to ensure that the project is completed on time and on budget with successful results for the City

To meet the City's timeline for the Eastside facility expansion planning and permitting, it is imperative that this project begin immediately after Council approval and contract execution. The monitoring required must be performed between May and October of this year or the project risks losing a year of time until monitoring can be completed the following year.

The cost to the City for conducting this project will be $199,791 with anticipated completion by March 2022 assuming weather conditions are appropriate for sampling this summer and timely response from DWR in its review of the modeling results and issuance of speculative limits.

BACKGROUND

The purpose of the scope is to support City of High Point in planning for the expansion of its Eastside wastewater treatment plant (WWTP) (NC0024210) which discharges to a Deep River tributary arm of Randleman Lake within the Cape Fear River Basin. The facility is currently permitted to discharge 26 million gallons per day (MGD) and the City is seeking to expand the discharge to 32 MGD. The North Carolina Division of Water Resources (DWR) has indicated that such an expansion will require an environmental assessment including speculative limits to be subject to public review and comment. DWR has indicated that a wasteload allocation (WLA) modeling analysis should be performed by the City and coordinated with agency staff.

Under Phase 1 of the project, Tetra Tech met with representatives of the City, Hazen as the City's facility engineering consultant, and DWR to scope out study needs. Based upon study objectives and data review, Tetra Tech prepared a Monitoring and Modeling Plan that was approved April 7, 2021 during a coordination call to resolve any DWR questions and concerns regarding the Plan.

This scope of work is for Phase 2 of the project to implement the Monitoring and Modeling Plan. Tasks are separated out for field monitoring, QUAL2K modeling, CORMIX modeling, BATHTUB modeling, coordination with DWR, and project management.

2.0 SCOPE OF WORK

TASK 1: MONITORING

Tetra Tech will conduct monitoring to support model setup, calibration and corroboration. Initial field efforts will focus on reconnaissance to finalize sampling stations, flow monitoring sites, and to help plan to avoid any potential pitfalls (e.g., stream accessibility) when conducting the primary sampling events. Data collection for QUAL2K model calibration and corroboration will be performed during two separate trips. The goal will be to obtain information at or near critical conditions but different enough between the two sampling events to corroborate the model with one set that was calibrated with the other data set. The subtasks to plan and complete this work are outlined below.

1.1. CONDUCT RECONNAISSANCE AND LOGISTICS PLANNING

Logistically, Tetra Tech will need to coordinate with Meritech LLC, PTRWA, the City of High Point, and the NC DWR Winston Salem Regional Office. Tetra Tech will make arrangements for all sample collection and laboratory support services including field equipment rental. Reconnaissance will be performed on the lake to confirm station locations, constraints, and check the time for boat travel between stations and for the entire run. Lake depth measures will be taken at primary stations at the channel center point, and halfway between the center and each bank to corroborate bathemetry data or support adjustments of channel depth estimates for model development. Additionally, Tetra Tech will work with Meritech to test the feasibility of attaching a data sonde for continuous monitoring to a Hwy 62 bridge piling on the lake causeway.

Tetra Tech will also locate physical access points for measuring flow in the primary tributaries entering the Deep River arm and Hickory Creek arm of Randleman Lake. Currently, it is anticipated that this will include measurements in Richland Creek, Deep River, Reddicks Creek, and Hickory Creek. Arrangements will be made for rental of a flow meter with sufficient sensitivity to accurately measure very low velocities and a YSI meter to obtain physical information with the flow measurements.

Tetra Tech will also work out logistics for tracking conditions at appropriate precipitation and flow monitoring stations that will be used to make determinations of adequate conditions for sampling (i.e., steady-state, limited to no significant precipitation). A tracking protocol and go/no-go criteria will be set up to decrease risk of having to re-sample due to unacceptable receiving stream conditions.

1.2. PREPARE HEALTH AND SAFETY PLAN (HASP)

Based on the Monitoring Plan and additional knowledge obtained by the reconnaissance, Tetra Tech will develop a Health and Safety Plan (HASP) to ensure that the field team is aware of risks it will face, takes appropriate precautionary safety measures, has a communication plan to ensure others know where the team will be, and knowledge of closest urgent care and hospital facilities in case of an emergency. Tetra Tech's Health and Safety Officer will review the HASP and provide feedback before it is employed in the field.

1.3. PERFORM FLOW MEASUREMENTS

Tetra Tech personnel will make flow measurements at the Randleman Lake tributary locations defined during the reconnaissance. Field records will be maintained, quality-assured, and relayed to the modeling team for use in model calibration and corroboration.

1.4. CONDUCT WATER QUALITY SAMPLING

Water quality sampling will be conducted on two separate days approximately one or two months apart to provide appropriate datasets for conducting QUAL2K model calibration and corroboration. The two sampling events will be targeted to be performed sometime between June 1 and October 31, 2021. On each sampling day, two sets of sample runs will be performed, one in the morning, and one in the afternoon.

Sampling will be dependent on weather and flow conditions. Precipitation and flow will be monitored online at nearby gages to ensure that there is no appreciable precipitation seven days prior to sampling and longer if gages indicate that runoff has not receded to approximately baseflow (steady state) levels. Field sampling teams and laboratory services will be on-call for these periods and sampling go/no-go decisions will be made approximately 24 hours prior to scheduled deployment. City of High Point and PTRWA project contacts will be notified of sampling "go" decisions to be aware that the sampling teams will be on the lake during these two sampling days and to get appropriate access to boat launches as needed.

The sampling team will conduct sampling using a boat crew of at least two passengers: a driver and a field person. The field person(s) will be responsible for collecting, documenting, and storing the background samples.

Sampling techniques will be conducted using approved methodologies endorsed by NCDEQ for surface waters. Detection limits and quantification levels need to be appropriate for the applicable North Carolina surface water quality standards. The associated Standard Operating Procedures (SOPs) are to be followed. Samples must be collected with new, verified, and certified-clean equipment. Filtering and/or acid preservation using clean hands and equipment will be conducted onsite as required by the analytical method.

One or more waterproof field logbooks must be maintained for recording data collection activities performed during the study. The general principle of information recording is that all entries be sufficient to reconstruct the site investigation without reliance on memory. All field measurements from samples collected will be recorded. Wherever a sample is collected, at a minimum, the following will be recorded:

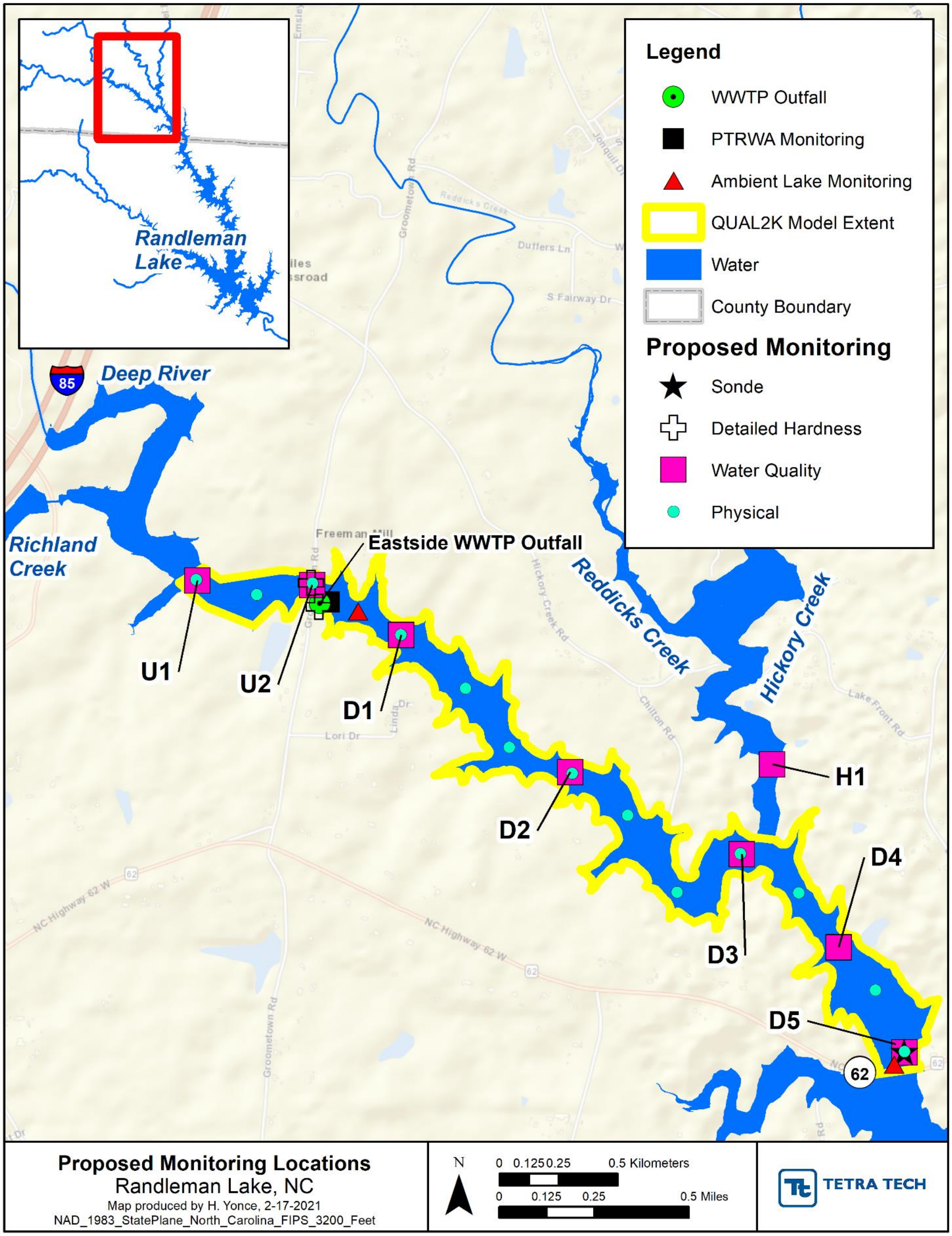
- Sample collection location (i.e., coordinates)
- Field observations (e.g., weather conditions, treefalls)
- Date and time
- Sampling challenges or quality assurance issues
- Sample depth
- Sampling team member names

To ensure consistency, a standardized form will be developed by the monitoring team prior to the sampling effort and applied throughout the project duration. Each section of the form will be completed with an ink pen. Any information not applicable to a certain site will be flagged as "NA". Additionally, digital photographs documenting the sampling locations (i.e., showing the orientation to the surrounding area and nearby objects) should be taken and included in the documentation. Each photograph documentation in the logbook should include the assigned photograph number, field date, and subject.

Physical parameters (water temperature, pH, DO, conductivity, and Secchi depth) will be measured in the field using a sonde and Secchi disk every 1000 feet throughout the QUAL2K modeling extent. These measurements will be conducted at one-meter vertical intervals for the entire depth of the water column at each primary sampling location (see table and map below). For physical parameter measurement at the 1000 foot intervals between primary stations, physical parameters will be measured at ½ Secchi depth, 1 foot off of the bottom, and halfway between the bottom and surface. Additionally, a sonde will be deployed at Highway 62 to measure continuous physical parameters at that location, approximately one foot below the water surface for the duration of each sampling event.

Proposed primary sampling locations (upstream & downstream relative to Eastide Outfall)

Site ID	Site Description
U1	1500 feet upstream of SR1129, downstream of junction of Richland Creek and Deep River
U2	SR1129 crossing (Groometown Road)
D1	1500 feet downstream of SR1129
D2	Midpoint between D1 and D3
D3	7000 feet downstream of D1, upstream of junction with Hickory Creek
H1	Hickory Creek, 1000 feet upstream of junction with Deep River
D4	Midpoint between Hickory Creek junction and Highway 62 crossing
D5	Highway 62 crossing



Proposed monitoring locations near the Eastside WWTP discharge

Grab sampling of water quality constituents at the eight identified primary sampling locations will be conducted twice per day (morning and afternoon). Each water quality sample will be collected as a composite sample between the water surface and twice the Secchi depth for the given location.Additionally, the monitoring and lab team will coordinate with the City Eastside WWTP Superintendent to collect two effluent samples (one AM and one PM to coincide with the lake sampling) on the two primary sampling event days.

Parameters that will be collected for laboratory analysis are:

- BOD, 5 day
- CBOD, 5 day
- BOD, 20 day
- CBOD, 20 day
- Total Dissolved Solids
- Ammonia, Nitrogen
- TKN
- Nitrate/Nitrite, Nitrogen
- Phosphorus, total
- Ortho-Phosphate
- Dissolved Ortho
- Hardness, total
- TOC
- Turbidity
- Chlorophyll-a

Proposed Deliverables (schedule)

1. Lake reconnaissance (target within 30 days of NTP)
2. Stream reconnaissance for flow measurement stations (target within 30 days of NTP)
3. Updates to the monitoring plan based on reconnaissance and logistics planning (within 15 days of both lake and stream reconnaissance)
4. Primary lake water quality sampling day 1 (weather & flow dependent; target June)
5. Primary lake water quality sampling day 2 (weather & flow dependent; target between end of July and early September)
6. Lab analytical results (included with final report documentation)

TASK 2: QUAL2K MODELING

The second objective listed in the modeling plan is for Tetra Tech to "Simulate impacts of the expanded discharge on near-field DO dynamics and kinetics of the receiving waterbody to support development of speculative limits for biochemical oxygen demand (BOD) and ammonia nitrogen." This objective will be addressed with the application of the QUAL2K receiving water model that will developed under Task 2. QUAL2K was developed by staff from the Civil and Environmental Engineering Department at Tuft's University and the Washington State Department of Ecology, with collaborative engagement with the U.S. EPA.

QUAL2K has been applied extensively in simulating fate and transport of oxygen-demanding substances. This model is frequently used to simulate both existing and speculative conditions in receiving waters to support NPDES permitting decisions related to speculative limits. The QUAL2K model can simulate point source input based on a breadth of hydraulic and water quality parameters (flow rate, nitrogen and phosphorus species, dissolved oxygen concentration, BOD loading, etc.). The model will be setup based on existing conditions in the near-field around the Eastside WWTP outfall, calibrated and corroborated based on additional sampling that will be conducted in 2021, and applied under critical low flow warm summer conditions to ensure speculative permit limits result in simulation of Randleman Lake maintaining attainment of all key water quality criteria applicable.

The QUAL2K model simulates a single steadystate 24-hour period and predicts effluent impacts on a diel time scale. The latest release is QUAL2K v12b1, which will be applied in the near-field DO dynamics and kinetics study for High Point's Eastside WWTP.

Tetra Tech will develop a QUAL2K model to simulate the impact of modified permit limits on the upper portion of the Deep River arm of Randleman Lake. The QUAL2K model will be developed in accordance with the DWR approved modeling plan for the Eastside WWTP.

2.1. QUAL2K DATA COMPILATION & PRE-PROCESSING

QUAL2K requires information about receiving water hydraulic geometry, meteorological forcing data, and flow and water quality associated with point sources and boundary conditions (headwaters, tributaries, diffuse flows). With the additional field data that will be collected in 2021 documented in the DEQ-approved Monitoring and Modeling Plan, there will be sufficient data available to construct, calibrate, and corroborate a robust QUAL2K model. The existing available data for Randleman Lake, its tributaries, and the Eastside WWTP outfall can be found in Table 1 of the modeling plan, much of which will be employed for the QUAL2K model of the upper portion of the Deep River arm. Data compilation and pre-processing will involve analyzing and organizing all existing data, new data from multiple field sampling events, and data from multiple sources and types. For example, daily Discharge Monitoring Reports (DMRs) will be used to characterize effluent properties, while other data such as monthly grab sample data for chl-*a* will be processed for model calibration, hydraulic channel measurements will be converted into a format to inform the model (e.g. rating curve or Manning's formulae), sub-hourly sonde data will be processed for either model input and/or calibration, and hourly meteorological data will be processed for input. To the extent possible, inputs or calibration data processing that are appliable to the CORMIX and/or BATHTUB models, will be processed simultaneously to improve efficiencies.

As data are being compiled and processed for the QUAL2K model, the modeler(s) will maintain a quality assurance spreadsheet the documents data sources, processing procedures, assumptions made, and data file records. Quality assurance of the data used in the QUAL2K model will be conducted by a senior technical advisor. Issues found will be addressed prior to model set-up and analyses.

2.2. PERFORM QUAL2K MODEL SETUP

As described in the modeling plan, the spatial domain of the QUAL2K model application will include the upper portion of the Deep River arm of Randleman Lake, from approximately Groometown Rd (SR 1129) to NC-62. Data processed under Section 2.1 will be entered into the model using the QUAL2K Excel-based interface for simulation. Inputs are organized by separate sheets/tabs in Excel: QUAL2K (file details, calculation time step, simulation date), Headwater (flow and water chemistry of Deep River and Richland Creek headwaters), Reach (reach-specific inputs such as length, slope, hydraulics), meteorology tabs for hourly inputs (Air Temperature, Dew Point Temperature, Wind Speed, Cloud Cover, Shade), Rates (systemwide or reach-specific water chemistry kinetics and thermal properties (Rates, Reach Rates, Light and Heat), and inflows or outflows associated with groundwater exchanges, non-point sources, tributaries, and outfalls (Diffuse Sources, Point Sources). The QUAL2K model will be set-up to evaluate fate and transport of oxygen-demanding substances in the vicinity of the Eastside outfall based on four anticipated model setup conditions: calibration and corroboration periods based on one existing conditions captured during two unique field sampling trips undertaken in 2021, and simulated facility expansion under critical conditions for summer and winter low-flow periods (see Section 2.4). Many model inputs associated with water chemistry kinetics for example are anticipated to be maintained between calibration and corroboration model setups, however boundary conditions and meteorology forcing parameters will vary based on observations associated with the two different field sampling excursions.

Following model setup, the QUAL2K model will be checked for reasonableness prior to conducting sensitivity tests and application scenarios. During model set-up the quality assurance spreadsheet will be updated by the modeler(s) and reviewed by a senior technical advisor.

2.3. CONDUCT QUAL2K MODEL CALIBRATION & CORROBORATION

The QUAL2K model setup for the upper portion of the Deep River arm of Randleman Lake will be calibrated and corroborated based on two unique datasets observed and sampled in 2021. Observed data processed under Section 2.1 will be entered into the model using the QUAL2K Excel-based interface to compare to simulated output. Calibratrion and/or corroboration observation data are organized by separate sheets/tabs in Excel based on data type and can be located anywhere spatially within the model extent: Hydraulics Data (e.g. flow, depth, velocity), Diel Data (hourly water chemistry data typically from sondes), and minimum, maximum, and average values for water chemistry typically available from grab samples (Temperature Data, WQ Data, WQ Data Min, WQ Data Max),

The QUAL2K model will be calibrated to one field-sampled dataset which involves iterative tweaking of relevant model rates and parameterized within reasonable ranges to achieve the best fit of simulated output relative to observation. QUAL2K model calibration may be presented as relative error when comparing simulated output to observed data related to hydraulics, temperature, and key water quality parameters (e.g. dissolved oxygen, nutrients). Maintaining key calibrated model rates and parameterization, the QUAL2K model is corroborated by runnin the model under different conditions, and comparing simulated results to the uniquely different field sampling trip observations. Similarly, model corroboration may be presented as a relative error calculation as calculated beterween simulated output and observed data related to hydraulics, temperature, and key water quality parameters.

During model calibration and corroboration, the quality assurance spreadsheet will be updated by the modeler(s) and reviewed by a senior technical advisor.

2.4. PERFORM QUAL2K SENSITIVITY ANALYSIS & SCENARIO APPLICATION

Following development, calibration, and corroboration of the QUAL2K model, the model will be applied to conduct a fate and transport analysis for the near-field conditions of Randleman Lake by simulating waterbody response to speculative permit limits from the Eastside WWTP discharge, particularly related to nutrient and DO concentrations. These constituents are regularly monitored in Randleman Lake because of its water supply status, and there are numeric water quality criteria specified in regulation for these parameters that must be met (or at least not worsened if not currently met due to sources other than the WWTP) when the expanded discharge is in place. The calibrated and corroborated QUAL2K model will be used to simulate the fate and transport of oxygen-demanding substances in Randleman Lake under seasonal critical low flow (i.e., summer and winter 7Q10) and elevated temperature conditions. Results will be presented for both existing permit limits and proposed speculative limits. If existing water quality standards are not exceeded during critical conditions for the speculative limits, it can be assumed that water quality standards will also be met under more typical conditions.

For the QUAL2K model of the Deep River arm of Randleman Lake, critical conditions will be simulated during late summer when air temperatures are high, and water levels are low in the lake. The waterbody will be modeled with headwaters and tributaries simulated at the lowest 7-day average flow that occurs on average once every 10 years (7Q10) based on estimates provided by the U.S. Geological Survey in collaboration NCDWR. Results from the model application will be subject to review by a senior technical advisor, and provided in the modeling report.

The most critical model inputs/parameters for QUAL2K tend to include reaeration formula selection, channel slope, and boundary flow and DO conditions. Analyses will be conducted to examine model sensitivity relative to a number of critical inputs/parameters. Sensitivity tests will involve proportionally adjusting the value (e.g., by ±

20% or in the case of temperature ± 2 degrees) and quantifying the impacts on the ultimate end-point, which in this case is related to dissolved oxygen kinetics. Results from the sensitivity tests will be subject to review by a senior technical advisor, presented in the modeling report.

2.5. DOCUMENT QUAL2K MODELING RESULTS

Tetra Tech will develop a Fate and Transport Modeling Report for Hazen & Sawyer and High Point that summarizes the QUAL2K modeling work and details the speculative limits proposed for the Eastside WWTP NPDES discharge. The report will discuss the QUAL2K modeling software, summarize data used in the modeling analyses, describe model development, calibration, and corroboration, and include a summary of the scenarios completed and results. The draft report will be reviewed for quality and accuracy by a senior technical advisor at Tetra Tech then it will be provided to Hazen & Sawyer and High Point for review. The draft report will then be updated to address any comments prior to submittal to DWR.

Proposed Deliverables (schedule)

1. Draft QUAL2K Modeling Report for Hazen and City staff review (approximately 60 days from receipt of all field monitoring results including long-term BOD samples)
2. Revised QUAL2K Modeling Report for inclusion with consolidated Modeling Report that will be submitted to DWR under (within 7 - 10 days from receipt of all review comments)
3. QUAL2K modeling files for submittal to DWR (at time of submittal for Consolidated Report)

TASK 3: CORMIX MODELING

The first objective listed in the modeling plan includes “Simulate mixing and quantify the dilution ratio for the expanded effluent discharge in the receiving waterbody to support development of acute and chronic permit limits for metals and other analytes, as well as whole effluent toxicity testing requirements.” This objective will be addressed with an application of the Cornell Mixing Zone Expert System (CORMIX) model that will be developed under Task 3. CORMIX was collaboratively developed by the U.S. EPA, U.S. Bureau of Reclamation, Cornell University, Oregon Graduate Institute (OGI), University of Karlsruhe, Portland State University, and MixZon Inc., the latter of which manages and distributes CORMIX software.

CORMIX is a recommended tool for predicting dilution of discharges to receiving waters to support permit decisions and development of effluent requirements. The CORMIX model can simulate single and multi-port diffusers and surface discharges under steady-state ambient conditions or under tidal conditions; the former of which is applicable to the Eastside WWTP that discharges to an arm of Randleman Lake. CORMIX has the capability to predict the characteristics of the geometry and dilution of the initial mixing zone to ensure compliance with the water quality regulatory constraints. The program can also be used to study and predict the response of the plumes from the effluent discharges at larger distances. CORMIX has been extensively verified by the developers, has undergone extensive peer review, and is often applied for dilution analyses. The latest release is CORMIX v11.0, which will be applied in the mixing zone study for High Point’s Eastside WWTP.

Tetra Tech will develop a hydrodynamic CORMIX model to simulate mixing and dilution of the facility’s effluent within the receiving water body. The CORMIX model will be developed in accordance with the DWR approved modeling plan for the Eastside WWTP.

3.1. CORMIX DATA COMPILATION & PRE-PROCESSING

CORMIX requires information about the receiving channel geometry, ambient conditions in the receiving waterbody, outfall design, and effluent properties. Sufficient data are available to construct a CORMIX dilution analysis model for the Eastside WWTP; additional information about sources of available data that may inform the development of the CORMIX model can be found in Table 1 of the modeling plan. For example, Discharge

Monitoring Reports (DMRs) will be used to characterize the effluent properties. Some data (e.g., ambient conditions) used in the CORMIX model will also be appliable to the QUAL2K and/or BATHTUB models, thus, will be processed simultaneously to the extent feasible to improve efficiencies. Applicable information from the monitoring effort will be applied (e.g., ambient water temperature). Information on the outfall design and discharge will need to be (or has been) provided by High Point for the CORMIX model, including outfall location, port diameter, port deflection/angle, port depth, effluent flow/velocity, and effluent density.

As data are being compiled and processed for the CORMIX model, the modeler(s) will maintain a quality assurance spreadsheet the documents data sources, processing procedures, assumptions made, and data file records. Quality assurance of the data used in the CORMIX model will be conducted by a senior technical advisor. Issues found will be addressed prior to model set-up and the analyses.

3.2. PERFORM CORMIX MODEL SETUP

As described in the modeling plan, the spatial domain of the CORMIX model application will include the mixing zone in the vicinity of the WWTP outfall that captures the lateral and vertical mixing of the effluent plume. Data processed under Section 3.1 will be entered into the model using the CORMIX Graphical User Interface (GUI) for simulation. Information includes effluent flow rate (or velocity), effluent temperature (or density), depth and channel geometry information, roughness (Manning's n), wind, ambient velocity (or flow), ambient temperature (or density), port design (i.e., angle, diameter, etc.), and information about the mixing zone. The CORMIX model will be set-up to evaluate mixing and dilution for the facility expansion to 32 MGD at the current primary outfall location on Randleman Lake under critical conditions being applied in the QUAL2K model (e.g., 7Q10 streamflow). Following model set-up the CORMIX model will be checked for reasonableness prior to conducting sensitivity tests and dilution scenarios.

During model set-up the quality assurance spreadsheet will be updated by the modeler(s) and reviewed by a senior technical advisor.

3.3. PERFORM CORMIX SENSITIVITY ANALYSIS & SCENARIO

Following development of the CORMIX model, the model will be applied to simulate mixing and dilution of the effluent in the Deep River arm of Randleman Lake. The concept of dilution is used to quantify the degree of mixing and the transport of the effluent discharge in the system. The dilution of the effluent discharge can be determined by the following equation:

$$D = \frac{C_e}{C}$$

where, D is the dilution ratio,

C_e is the concentration of the effluent, and

C is the instream concentration.

For this assessment, a conservative tracer with a concentration of C_e will be introduced into the discharge. Background levels of the conservative tracer will be set to zero. The mixing model will then be used to simulate the geometry of the plume and distribution of the tracer in the system such that a quasi-steady state is achieved.

Instream concentrations along the plume centerline will be used to evaluate dilution ratios at multiple distances with respect to the outfall location. The effluent flow rate will be equivalent to the expanded design flow rate, which provides the dilution ratios for the expected highest discharge from the facility. Results will be proved in the modeling report.

The most critical model inputs/parameters for CORMIX tend to include ambient flow/velocity, ambient temperature/density, effluent flow/velocity, and effluent temperature/density. Sensitivity tests that involve proportionally adjusting the value (e.g., by ± 20% or in the case of temperature ± 2 degrees) and quantifying the impacts on the ultimate end-point, which in this case is the dilution ratio. Results from the sensitivity tests will be presented in the modeling report.

Dilution ratio calculations and results from the sensitivity tests will documented in the quality assurance spreadsheet by the modeler(s) and reviewed by a senior technical advisor.

3.4. DOCUMENATION OF CORMIX MODELING RESULTS

Tetra Tech will develop a Mixing Zone Analysis Report for Hazen & Sawyer and High Point that summarizes the CORMIX modeling work and generates near- and far-field dilution ratios for the Eastside WWTP NPDES discharge. The report will discuss the CORMIX modeling software, summarize data used in the modeling analyses, describe model development, and include a summary of the scenarios completed and dilution results. The draft report will be reviewed for quality and accuracy by a senior technical advisor at Tetra Tech then it will be provided to Hazen & Sawyer and High Point for review. The draft report will then be updated to address any comments prior to submittal to DWR.

Proposed Deliverables (schedule)

1. Draft CORMIX Modeling Report for Hazen and City staff review (approximately 90 days from receipt of all field monitoring results)
2. Revised CORMIX Modeling Report for inclusion with consolidated Modeling Report that will be submitted to DWR under (within 7 - 10 days from receipt of all review comments)
3. CORMIX modeling files for submittal to DWR (at time of submittal for Consolidated Report)

TASK 4: BATHTUB MODELING

Tetra Tech will use the BATHTUB model (currently distributed at https://wwwalker.net/bathtub/) to estimate eutrophication response within Randleman Lake with and without the proposed expansion. BATHTUB is a well-accepted tool for predicting growing season average chlorophyll a concentration in reservoirs that has been used in many EPA-approved nutrient TMDLs. It is a simplified tool, but that level of simplicity is appropriate to the amount and type of data that are available. BATHTUB will not provide detailed time series of chlorophyll a concentration, but can be used to predict the frequency of algal blooms above a target threshold such as 40 µg/L. Using BATHTUB to represent the reservoir as a series of linked segments will enable estimation of nutrient response at multiple locations within the lake consistent with available monitoring data. As incremental flow from the Eastside expansion is not expected to have a large impact on the phosphorus balance in the reservoir, use of BATHTUB rather than a detailed linked hydrodynamic and water quality model combination such as EFDC/WASP or CE-QUAL-W2, which would require a substantial investment and a year or more to develop and calibrated, is an appropriate and cost-effective choice.

4.1. BATHTUB DATA COMPILATION & PRE-PROCESSING

Information requirements and processing for BATHUB are relatively simple. BATHTUB requires as input information on lake morphometry and seasonal or annual flows and nutrient loads from tributaries and point sources. Other inputs include information on stratification depth and estimates of non-algal turbidity (for which the BATHTUB manual provides estimation methods). Bathymetric coverages are already available. Tributary inputs and loads can be estimated from flow gaging and monitoring data (with proration to ungaged areas) using tools such as FLUX or LOADEST. All data used to develop inputs will be reviewed for accuracy and usability as part of Tetra Tech's QA protocols.

4.2. PERFORM BATHTUB MODEL SETUP

BATHTUB can be set up in segmented form with multiple linked model areas. We will set up the Randleman model with segments that correspond to the four main monitoring stations from the Eastside discharge to the dam. Versions of the model will be set up separately for a range of available years to capture the natural variability of loading and nutrient response conditions. Initial values of model sedimentation and kinetic parameters as well as selection of options for representation of nutrient sedimentation and algal growth will be specified in accordance with the BATHTUB documentation. Final model setup will be checked by an experienced senior reviewer.

4.3. CONDUCT BATHTUB MODEL CALIBRATION & CORROBORATION

BATHTUB is calibrated by adjusting factors on the representation of net sedimentation loss for nitrogen and phosphorus species and algal growth. The intent of the calibration is to reproduce the growing season average concentrations of N, P, and chlorophyll *a,* while also approximating the within-year range. The BATHTUB guidance contains recommended acceptable ranges for adjusting these factors. If calibration cannot be achieved by adjustments within these ranges, alternative sedimentation formulations contained within BATHTUB will be evaluated.

Calibration is sequential, beginning with nutrients and proceeding to algae, and beginning in the upstream segment and proceeding downstream. We will initially calibrate to two different years (one wet and one dry). We will then seek corroboration of the model parameters through application to years other than those used to calibrate the model.

All steps in the calibration process will be documented in written form and checked by a senior reviewer.

4.4. PERFORM BATHTUB SENSITIVITY ANALYSIS & SCENARIO APPLICATION

As part of the calibration we will document model prediction sensitivity to parameter choices. We will also use the model to evaluate sensitivity to year-to-year variability in hydrology and use this to identify a critical year condition. For example, the algal response may be greatest for a year with high spring flows followed by a dry summer. An appropriate critical condition year will then be selected based on the historical gaging record.

We will then run scenarios with and without the proposed expansion of the Eastiside discharge. We assume that the expansion will result in increased flow, but will most likely hold the line on nutrient loads. However, we will also conduct sensitivity analyses to examine the effects of ±10% changes in the load limits. As with the calibration, all steps in the scenario analysis process will be documented in written form and checked by a senior reviewer.

4.5. DOCUMENT BATHTUB MODELING RESULTS

Setup, calibration, corroboration, sensitivity analysis, and scenarios conducted with the BATHTUB model will be documented in a brief memorandum suitable for inclusion as a chapter in the consolidated modeling report. After internal review by Hazen and City staff, the report will be submitted to DWR for review. A revised version incorporating requested changes will be developed within 10 working days of receipt of comments.

Proposed Deliverables (schedule)

1. Draft BATHTUB Modeling Report for Hazen and City staff review (to be performed simultaneously with QUAL2K modeling schedule; may also be influenced by timing of the HSPF modeling for the Integrated Watershed Assessment Framework project)
2. Revised BATHTUB Modeling Report for inclusion with consolidated Modeling Report that will be submitted to DWR under (within 7 - 10 days from receipt of all review comments)
3. BATHTUB modeling files for submittal to DWR (at time of submittal for Consolidated Report)

TASK 5. FACILITATE DEQ COORDINATION

Upon completion of the modeling and draft modeling report, staff from DWR have requested a debriefing meeting to walk them through the model development steps and results. Tetra Tech will make arrangements for, prepare for, and facilitate this coordination meeting to kick off the review process.

It is anticipated that a second meeting with DWR will be conducted to go over the agency's comments on the models and draft modeling report. Tetra Tech will make arrangements for, prepare for, and facilitate this coordination meeting to identify any additional modeling and reporting requirements for obtaining DWR approval of the model as the basis for speculative limits for an expanded Eastside WWTP discharge.

Proposed Deliverables (schedule)

1. Facilitated Model Review Kickoff Meeting with DWR (TBD)
2. Facilitated Meeting to go over DWR comments and concerns (TBD)
3. Miscellaneous email and phone correspondence with DWR staff to set up meetings and prior to or in follow up to the meetings to address interim questions or clarify direction.

TASK 6. PROVIDE CONTRACT & PROJECT MANAGEMENT/COORDINATION

Tetra Tech will coordinate with the City of High Point to manage this contract and plan work under its provisions. This includes corresponding with City staff, planning work, estimating level of effort, tracking accounting, preparing work summaries to accompany billing invoices.

Proposed Deliverables (schedule)

1. Contract documents (as requested by City)
2. Work planning conference call and meeting summaries (via email within 1-5 days following calls/meetings as needed)
3. Invoices and progress reports (monthly or as invoiced)

3.0 CONTRACT AMOUNT

Phase 2 work will be performed for a total contract value of $199,791 with an estimated LOE of 958 hrs. The monitoring task involves extensive logistics planning, time in the field, equipment expense, and laboratory analysis accounting for approximately 47 percent of the total project cost. The remainder of the cost is for development and application of the three models (QUAL2K, BATHTUB, and CORMIX) and for interacting with DWR and the City to obtain speculative limits for the planned expansion of the Eastside discharge.

4.0 SCHEDULE

Estimated project schedule is as follows:

Task Description	Deliverable or Progress Goal	Projected Completion Date
Task 1.1 Conduct Reconnaissance and Logistics Planning	Lake Reconnaissance Stream Reconnaissance Updates to the Monitoring Plan	Target 30 days from NTP Target 30 days from NTP Within 15 days of completion of reconnaissance
Task 1.2 Prepare Health & Safety Plan	HASP	5 – 10 days prior to reconnaissance
Task 1.3 Perform Flow Measurements	Field notes processed for Model Report	Within 10 days of each primary sampling run
Task 1.4 Conduct Water Quality Sampling	Primary sampling event 1 Primary sampling event 2	Target June (weather dependent) Target end of July and before mid September (weather dependent)
Task 2 QUAL2K Modeling Report & Files	Draft for Hazen & City staff review Revised Draft for inclusion with consolidated Modeling Report QUAL2K modeling files	Within 60 days from receipt of all field monitoring results including long-term BOD samples Within 7-10 days of receipt of all review comments At time of submittal for Consolidated Report
Task 3 CORMIX Modeling Report & Files	Draft for Hazen & City staff review Revised Draft for inclusion with consolidated Modeling Report CORMIX modeling files	(Timing dependent on progress of QUAL2K and BATHTUB modeling because of limited terms for CORMIX license) Within 7-10 days of receipt of all review comments At time of submittal for Consolidated Report
Task 4 BATHTUB Modeling Report & Files	Draft for Hazen & City staff review Revised Draft for inclusion with consolidated Modeling Report BATHTUB modeling files	Simultaneously with QUAL2K modeling Within 7-10 days of receipt of all review comments At time of submittal for Consolidated Report
Task 5 Facilitate DEQ Coordination	Facilitated Model Review Kickoff Meeting with DWR	Timing depends on DEQ schedules

	Facilitated Meeting to go over DWR comments and concerns	Timing depends on DEQ schedules (target 30 days after model review kickoff meeting)
Task 6 Provide Contract & Project Management/Coordination	Contract documents Meeting Summaries Invoices w/ Progress Reports	As requested by City As needed to document key decisions Monthly

The overall period of performance for this work will be through March, 2022 unless there are delays outside of the City and project team's control such as extended wet weather conditions or delays in review and response from DWR.