CITY OF HIGH POINT
AGENDA ITEM

Title: Amendment 1– Watershed Assessment Framework Phase 2

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

Meeting Date: March 1, 2021

Public Hearing: N/A

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

Attachments: Attachment A – Amendment No. 1

PURPOSE:
This amendment modifies the original agreement entered on July 24, 2020 (PO Number 103547) with Tetra Tech for Phase I of the project. The purpose of Phase 2 is to begin developing a linked watershed-lake modeling system that will be used to support water-related regulatory compliance and water infrastructure planning for the City of High Point.

BACKGROUND:
The City of High Point is responsible to its citizens and businesses for managing water quantity and quality while maintaining compliance with state and federal regulations. This involves managing stormwater runoff, treating wastewater, protecting water quality, providing water supply for drinking water and a recreational destination for people interested in boating, fishing, golfing, camping, and other outdoor activities. Water is recognized as a lifeline for current citizens and businesses, and the projected growth of the community, and therefore maintaining an effective and efficient water management framework is essential for the City of High Point. Phase 1 was started in July 2020 and the team (Tetratech, Engineering Services, Parks and Recreation, and Public Services) established goals of assessment across the departments, specified objectives under each goal, identified water quantity and water quality indicators related to each objective. Phase 2 will initiate construction of the HSPF(Hydrological Simulation Program- Fortran) watershed models that will be used to support watershed planning and management (e.g., flow volume and pollutant loading under variable conditions as the City continues to grow; support for City comprehensive planning and infrastructure master planning; water supply watershed protection; compliance; and identification of critical areas for potential pollutant control measures). HSPF is a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic pollutants.

BUDGET IMPACT:
Funds for this are available in the FY 20-21 budget.

RECOMMENDATION / ACTION REQUESTED:
The Public Services Department recommends approval of Amendment No. 1 to Tetra Tech for $ 85,000.00.

Attachment A –

Amendment to Watershed Assessment Framework Project PO #103547 to support:

Watershed Model Development and Calibration Scope

February 18, 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

1.0 BACKGROUND

The purpose of this Scope of Work (SOW) is to begin developing the linked watershed-lake modeling system that will become the foundation for the technical assessment framework to support water-related regulatory compliance and water infrastructure planning for the City of High Point. This scope represents the first tasks to be performed under Phase 2 which begins to construct the framework elements that were defined by a City team representing multiple departments and the project consulting team under Phase 1 of the project.

Under Phase 1, the City team and project team established overarching goals of assessment across the departments, specified objectives under each goal, identified water quantity and water quality indicators related to each objective, selected models that would support the objectives and produce the indicators to support decision-making for capital projects or operations, reviewed the data available for developing the models and identified gaps, and produced a model development plan optimized for the City of High Point. The first tasks under Phase 2 will be to initiate construction of the HSPF watershed models that cover the full extent of City of High Point interests and that can be readily used to provide information on conventional parameters (i.e., flow, sediment, nutrients, temperature, BOD, DO, and algae) to support watershed planning and management (e.g., flow volume and pollutant loading under variable conditions as the City continues to grow; support for City comprehensive planning and infrastructure master planning; water supply watershed protection; compliance; and identification of critical areas for potential pollutant control measures). In addition, the HSPF watershed model can inform the development of other model applications for flood and hydraulic assessments (e.g., HEC-RAS), lake source water protection and NPDES permitting (e.g., CE-QUAL-W2, QUAL2Kw, BATHTUB), and urban stormwater conveyance system evaluations (e.g., SWMM), as discussed in the City of High Point Integrated Watershed Assessment Framework prepared by Tetra Tech in February 2021 (revised).

Future work to complete the framework would include completing the HSPF modeling, developing HEC-RAS and SWMM models in select portions of the watersheds, and developing lake response models for Oak Hollow Lake, City Lake, and Randleman Lake. Therefore, this scope represents a level of effort that is initiating the broader, multi-year model framework development process.

2.0 SCOPE OF WORK

This goal of this scope of work is to construct a HSPF watershed model for the City of High Point, it's planning area, and watersheds draining to the City's water supply lakes. The tasks herein focus on completing the hydrologic calibration and beginning the water quality calibration, which will be finalized under a subsequent scope of work for the 2021-22 fiscal period. Specific tasks under this include:

2.1 (TASK 1) SET UP HSPF MODEL

The first task will be to construct the HSPF watershed model for simulation of hydrology and water quality. This involves compiling and processing geospatial data, time series, and hydraulic data.

The HSPF model extent will cover the city limits and planning area; the model extent will also include upstream areas draining to/through the planning area (e.g., in the Tom-A-Lex Lake-Abbotts Creek watershed) and land downstream in the Cape Fear River Basin draining to Randleman Lake (Figure 1 and Figure 2). Separate models are planned for in-line lakes, including Oak Hollow, High Point City Lake, Randleman Lake (CE-QUAL-WQ, QUAL2K, and/or BATHTUB) and Deep River (HEC-RAS). Therefore, the watershed model will include all drainages to these waterbodies, including tributaries and direct flow pathways. Future plans include using the HSPF model outputs as inputs to separate models for these waterbodies. As such, these waterbodies will not be represented in this iteration of the HSPF model (Figure 2).

The pre-calibration model parameterization will be initialized based on the literature, other relevant HSPF (or LSPC) model applications, and best professional judgement. Under Task 2 the parameterization will be refined based on calibration to monitoring data.

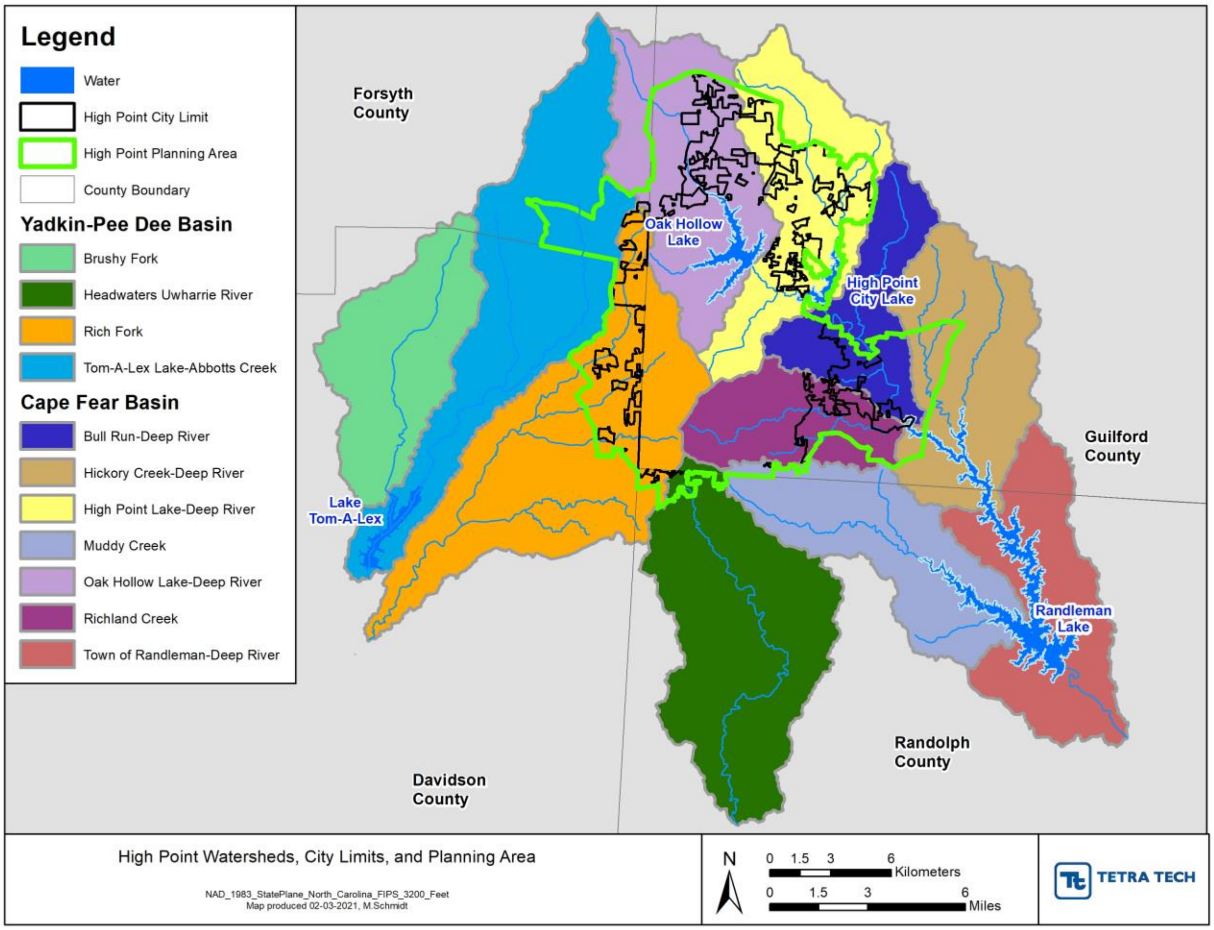

Figure 1. High Point Watersheds, City Limits, and Planning Area

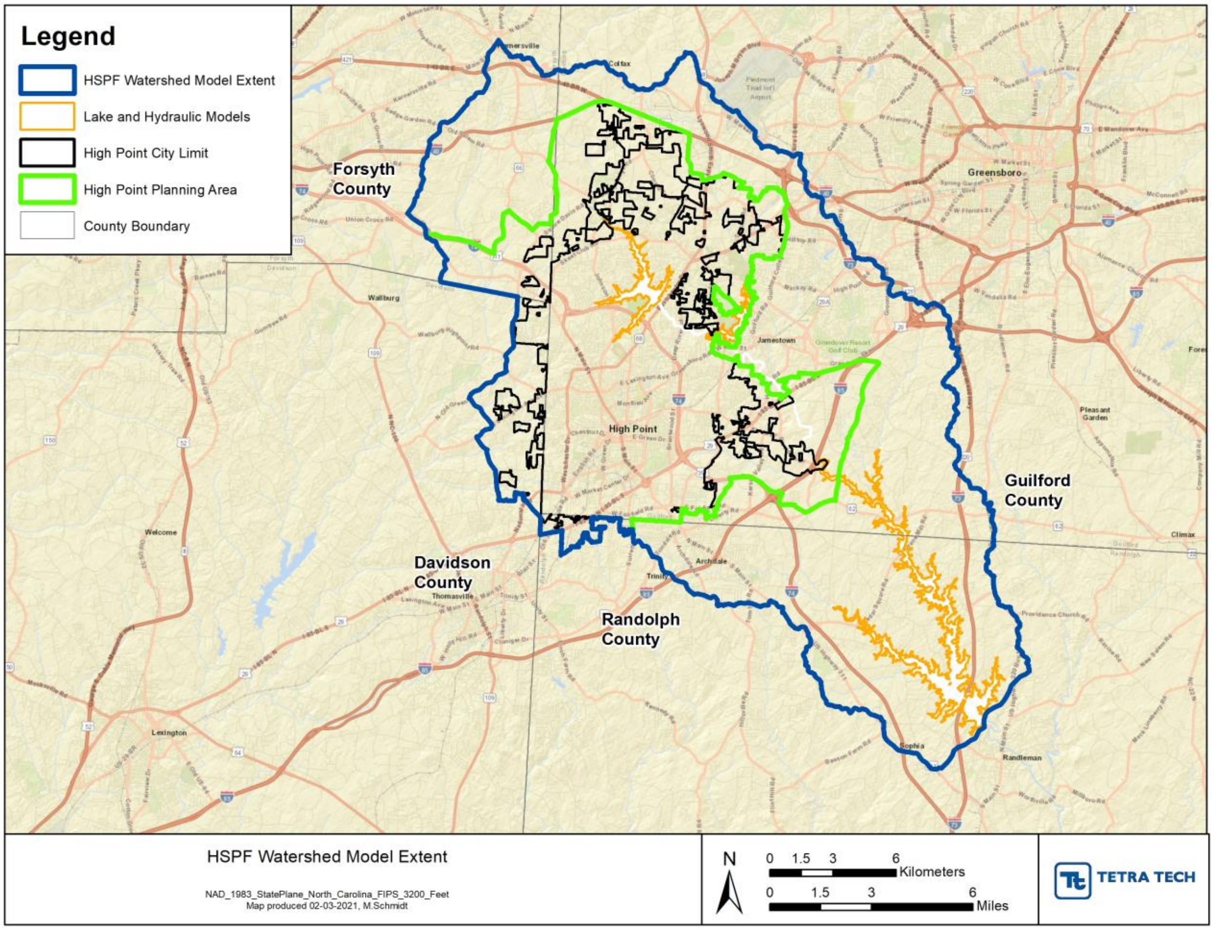

Figure 2. HSPF Watershed Model Planned Extent

2.1.1 Compile and process geospatial data

2.1.1.1 Delineations and hydrography

This task involves establishing the drainage network to be represented in the HSPF model. The 12-digit Hydrologic Unit Code (HUC) catchments will serve as the basis for model subbasin delineations. Delineations will take into account lake extents (i.e., exclude Oak Hollow, High Point City Lake, and Randleman Lake). The catchments will be refined to account for flow gaging locations and water quality monitoring locations to support calibration efforts. Refinements will also consider urban stormwater conveyance infrastructure information to be provided by the City, where available. Model reaches will be defined based on the National Hydrography Dataset (NHD). A subbasin/reach numbering and routing scheme will be developed and incorporated into the HSPF model.

2.1.1.2 Land use/cover

The National Land Cover Dataset (NLCD) provides spatial land use/cover data for 2011 and 2016, the latter of which is the most recent release. NLCD also provides mapped imperviousness data. Other publicly available coverages include LANDFIRE and the Cropland Data Layer, which can inform model land use in natural and agricultural areas of the watershed, respectively. The City of High Point has also provided land use and imperviousness coverages. Tetra Tech will further review the datasets, develop an approach for a land use/cover classification scheme in the model, potentially incorporating multiple spatial data sources, and implement the approach.

2.1.1.3 Soils, elevation, and slope

Spatial soils data (e.g., Hydrologic Soil Group information from gSSURGO) and elevation data (e.g., 10-meter resolution Digital Elevation Model) will be reviewed within the extent of the watershed model. Tetra Tech will consider these factors (e.g., land slope) in the development of an upland classification scheme (i.e., model Hydrologic Response Units) for pervious land segments in the HSPF model. The model will contain enough classes to represent differentiation across the landscape that influences hydrologic processes and water quality dynamics, such as infiltration and susceptibility to erosion. Presence of septic systems will also be considered for HRU differentiation.

2.1.2 Model input time series development

The model simulation period will be January 1, 2000 to December 31, 2020. Model input time series, including weather, point source discharges, and atmospheric deposition, will be generated for the full simulation period.

2.1.2.1 Weather

Hourly input weather time series will be developed for the HSPF model. For HSPF model applications that apply the energy balance method for temperature and snow accumulation and melt, the variables required include precipitation, air temperature, potential evapotranspiration, wind, cloud cover, solar radiation, and dew point temperature. The energy balance method will be applied in the High Point HSPF model and these series will be developed for the full simulation period. Relevant data from gridded weather data products, including NLDAS, PRISM, and NARR, will be extracted for the watershed model extent. Series for select variables (e.g., potential evapotranspiration) will be computed as necessary. The gridded time series will be aggregated to model weather zones and imported to a Watershed Data Management (WDM) file for HSPF. The User Control Input (.UCI) file will be updated to link the weather input time series to the model pervious and impervious segments and reaches.

2.1.2.2 Point source discharges

Major and minor NPDES permittees that discharge treated wastewater in the watershed model extent will be inventoried. Discharge Monitoring Records (DMR) for the facilities will be compiled and period of record, completeness, and parameters will be identified. Based on this information and the relative potential influence of the point source on water quality, particularly during low flow, those to be incorporated into the HSPF model will be selected. DMRs will be used to develop input time series for parameters such as flow, total suspended solids, nutrients and potentially other parameters identified by City of High Point aligning with the constituents represented in the watershed model. A plan to patch missing records and assumptions for unmonitored pollutants will be established and implemented. The model input time series for the point sources will be imported to a WDM file for HSPF simulation. The User Control Input (.UCI) file will be updated to link the point source discharge time series to the receiving reach.

2.1.2.3 Atmospheric deposition

Atmospheric deposition of nitrogen is often a non-trivial source to watersheds. Therefore, the HSPF model will include inputs for both wet and dry atmospheric deposition of ammonia and nitrate. Gridded data from the National Atmospheric Deposition Program will be extracted for the watershed extent. The model will link atmospheric deposition to the landscape and direct to model reach surfaces. Phosphorus will be simulated, in part, as a particulate-bound pollutant and the associated build-up/wash-off mechanisms will implicitly represent atmospheric deposition of phosphorus to the landscape.

2.1.3 Hydraulics for model reaches

This task involves developing hydraulic functional tables (FTable) for the HSPF model. A FTable lists the depth-volume-surface area-discharge relationship for a model reach (i.e., free-flowing river segment). This task will include compiling and processing relevant hydraulic data for riverine segments, potentially including cross sections, rating curves, bridge and culvert information, and regional hydraulic equations. A FTable will be developed for each model segment and the approach will depend on data availability at the time of model development.

2.1.4 Establish initial hydrology and water quality model parameterization

The initial, pre-calibration parameterization for the HSPF model will be developed based on the literature (e.g., EPA's BASINS Technical Notes for HSPF), other relevant HSPF/LSPC models (e.g., Jordan Lake watershed model developed and calibrated by Tetra Tech), and best professional judgement. Parameter blocks for hydrology and water quality will be incorporated into the User Control Input (.UCI) file.

Proposed Task 1 Deliverables (schedule)

1A – Model development status presentation (within 150 days NTP)

Note the model development and calibration report will be provided as a deliverable under Task 2.

2.2 (TASK 2) PERFORM HYDROLOGIC CALIBRATION AND BEGIN WATER QUALITY CALIBRATION

2.2.1 Inventory and prepare monitoring data for calibration

This task involves preparing available flow and water quality monitoring records for model calibration. Data from the USGS NWIS system, EPA's STORET and Water Quality Portal, and records provided by the City of High Point and other agencies (e.g., Piedmont Triad Regional Water Authority) will be compiled and prepared for model calibration.

Available daily flow records will be compiled, and key hydrologic calibration sites will be identified based on period of record, completeness, and location within the watershed. Data will be formatted to support model calibration efforts.

To support the water balance and actual evapotranspiration (ET) calibration, gridded ET estimates (e.g., from SSEBop or MODIS) will be downloaded, extracted, and processed. These data will be used to refine the hydrologic parameterization, including monthly parameters such as interception of precipitation by vegetation (MON-INTERCEP) and lower soil zone ET (LZET-PARM).

Lastly, available water quality data will be inventoried. Based on frequency of sample collection, geographic distribution, period of record, and parameters quantified, key locations for water quality calibration will be identified. Observed records will be formatted for water quality calibration tool purposes.

2.2.2 Hydrologic calibration

The first step in calibrating the HSPF model is adjusting the model parameterization to improve the representation of hydrologic processes in the watershed. At the primary flow calibration locations for the specified calibration period, observed and simulated annual flows, total storm volumes, seasonal flows, and low/baseflows will be compared using visual and statistical metrics (e.g., relative percent error and flow duration curves). In addition, the water balance for the watershed will be adjusted to be reasonable based on available information, such as ET estimates from SSEBop or MODIS. Surficial geology and soil characteristics will inform selection of values for parameters such as infiltration rates and upper soil zone storage. Hydrograph shape will inform adjustments to interflow and groundwater parameters as well as storm peaks. Model calibration will follow recommended procedures in guidance documentation, including EPA's BASINS Technical Notes for HSPF. Methodologies, calibration results, and potential future improvements will be documented in the model development and calibration report.

2.2.3 Sediment calibration

Tetra Tech will review existing information on sediment sources to develop a conceptual understanding of sediment source apportionment and processes that drive sediment erosion, landscape and instream fate and transport in the watershed/region. Upland sediment yields will be calibrated by land use to be consistent with export rates presented in the literature. Surface runoff (SURO) volumes and sediment loadings to the receiving reach network will be reviewed to ensure that erosion rates are reasonable (via adjustment of upland parameters KSER, AFFIX, etc.). Monthly values for key sediment factors (i.e. COVER) will be used where appropriate, such as for row cropland and other temporally varying land segments. Non-zero values for KGER (and adjust JGER) will be used if evidence suggests sediment scouring/gully erosion is observed in the watershed. Upland sediment will be apportioned to three particle sizes for simulation within the reach network – sand, silt, and clay. Simulated instream sediment concentrations will be compared to observed total suspended solids and/or suspended sediment concentrations, where available and sufficient based on sample count. Key instream sediment parameters including critical shear stresses for scour and deposition (i.e. TAUCS and TAUCD) will be adjusted for each particle size. Simulated and observed sediment concentrations will be compared using visual and statistical metrics to evaluate model performance and guide and sediment calibration. Model calibration will follow recommended procedures in guidance documentation, including EPA's BASINS Technical Notes for HSPF. Methodologies, calibration results, and potential future improvements will be documented in the model development and calibration report.

2.2.4 Water quality calibration

This task involves calibrating the model for temperature, nitrogen, phosphorus, dissolved oxygen, biochemical oxygen demand, and algae to be consistent with observed available data. It is anticipated that the current scope will cover the water temperature calibration and if time allows start on the calibration for nutrients, DO, and algae. The water quality calibration will be finalized under a subsequent scope of work.

Water temperature is always a critical constituent in the simulation of dissolved gases, most notably dissolved oxygen (therefore, HTRCH will be used) and influences algal and nutrient dynamics. Parameters associated with the land segments as well as receiving reaches will be analyzed, and if necessary, adjusted in accordance with available water temperature records. Solar radiation inputs will be checked for reasonableness.

The model will include a representation of fundamental processes that affect nitrogen and phosphorous concentrations within the reach (RQUAL/NUTRX will be used). The consultant will formulate and implement an approach to adjust parameters related to nutrient species for surface runoff, interflow, and active groundwater from the land segments. For particulate phosphorus, potency factors for sediment derived from each land segment and dissolved phosphorus concentrations for interflow and active groundwater flow will be calibrated. Nitrogen and phosphorus contributions from wastewater will be included. Upland nitrogen and phosphorus yields will be calibrated by land use to be consistent with export rates presented in the literature and based on instream observations in the watershed. Simulated time series for nitrate/nitrite, ammonia, organic nitrogen, and organic and inorganic phosphorus will be compared to available records at key water quality calibration locations and instream dynamics will be calibrated.

The model will include the representation of biochemical reactions that affect dissolved oxygen concentrations within each reach (OXRX must be used). Parameters related to accumulation and storage of BOD on the land surface and concentrations of BOD in surface runoff, interflow, and active groundwater flow will be adjusted based on available information. Factors including biochemical oxygen demand decay rates, settling rates, reaeration rates, and benthic algal demand will be established, reviewed, and refined as appropriate based on available instream BOD and DO data. The HSPF model will include an algal representation (PLANK must be used). Algal growth, respiration rates, phytoplankton settling rates, and the maximum density of benthic algae in each RCHRES will be reviewed and adjusted.

Simulated and observed water quality conditions will be compared using visual and statistical metrics to evaluate model performance and guide and calibration efforts. Model calibration will follow recommended procedures in guidance documentation. Methodologies, calibration results, and potential future improvements will be documented in the model development and calibration report.

It is anticipated that the current scope will cover a portion of the water quality calibration effort (i.e., water temperature), however, a subsequent contract is anticipated to cover finalizing the water quality calibration (i.e., nutrients, DO, and algae).

Proposed Task 2 Deliverables (schedule)

2A – HSPF model files (within 270 days NTP)

2B – Draft HSPF model development report describing progress made in the calibration under this scope of work (within 270 days NTP)

2C – Final HSPF model development report, which incorporates revisions based on comments received from the City (within 15 days receipt of comments)

2.3 (TASK 3) QUALITY ASSURANCE/QUALITY CONTROL, MEETINGS, CORRESPONDENCE, AND CONTRACT COORDINATION WITH THE CITY OF HIGH POINT

2.3.1 Quality Assurance/Quality Control

Throughout implementation of this scope of work, Quality Assurance/Quality Control (QA/QC) will be conducted by the technical team. To support and document QA/QC activities, a QA/QC spreadsheet will be maintained for the HSPF model development and calibration project. It will contain records of data sources used in model development, processing notes, QA/QC review requirements, QA/QC events led by a senior scientist/engineer/modeler, and QA/QC outcomes for the project.

2.3.2 Meetings

Tetra Tech will participate in two meetings with the City of High Point regarding the HSPF modeling effort. These could potentially include a model development and calibration status presentation mid-project and a subsequent presentation describing the HSPF model results and next steps in the Integrated Watershed Assessment Framework. Tetra Tech will collaborate with the City of High Point regarding the timing and content of these project meetings.

2.3.3 Correspondence and Contract 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, and preparing work summaries to accompany billing invoices.

Proposed Task 3 Deliverables (schedule)

3A – Quality Assurance/Quality Control documentation (as requested by the City)

3B – Contract documents (as requested by the City)

3C – Project presentations and meeting summaries (via email within 1-5 days following calls/meetings)

3D – Invoices and progress reports (monthly or as invoiced)

3.0 PROPOSED BUDGET

The proposed budget amendment for this SOW is $85,000, bringing the total cost approved for the Watershed Assessment Framework project PO #103547 to $150,000. The amount represents a total not-to-exceed value without written approval from City contract manager. It is anticipated this will cover the model construction, hydrologic calibration, and a significant portion of the water quality calibration, which will be finalized under another scope for the 2021-22 fiscal year. Billing will be based on the following staff and rates as outlined in the master services contract for Tetra Tech with the City.

Time and Material rates for proposed staff (per Master Services Agreement)

Person	Role	Billing Category	2021 ($/hr)
1. Trevor Clements	PM/Principal Manager	Principal Contract Manager	185
2. Jon Butcher	Principal Modeler	Principal Scientist	256
3. Holly Miller	Planner Manager	Planner Manager	180
4. Sam Sarkar	Modeling Task Lead	Project Engineer	147
5. Michelle Schmidt	Modeling Task Lead	Project Engineer	147
6. Hillary Yonce	GIS/Modeler	Project Planner	143
7. Allison Barker	Contract Administration	Contract Administration	99
8. Christina Buxton	Editor/Technician	Science Technician	89

Other direct costs (local travel, equipment/supplies) will be billed at cost plus 15% fee

4.0 SCHEDULE

It is anticipated that the performance for this work will be completed on or before November 30, 2021. Work is expected to continue with the 2021-2022 fiscal allocation to complete HSPF modeling and support HEC-RAS and SWMM modeling.