HOLISTIC WATERSHED MANAGEMENT FOR EXISTING AND FUTURE LAND USE DEVELOPMENT ACTIVITIES: OPPORTUNITIES FOR ACTION FOR LOCAL DECISION MAKERS: PHASE 1 – MODELING AND DEVELOPMENT OF FLOW DURATION CURVES (FDC 1 PROJECT)

SUPPORT FOR SOUTHEAST NEW ENGLAND PROGRAM (SNEP) COMMUNICATIONS STRATEGY AND TECHNICAL ASSISTANCE

QUALITY ASSURANCE PROJECT PLAN; TASK 1
VERSION 1.2
JANUARY 12, 2021

Prepared for:

U.S. EPA Region 1

Prepared by:

Paradigm Environmental

Great Lakes Environmental Center

Blanket Purchase Agreement: BPA-68HE0118A0001-0003
Requisition Number: PR-R1-20-00322
Order: 68HE0121F0001
QA Tracking Number: 21026

This quality assurance project plan (QAPP) is consistent with EPA Requirements for Quality Assurance Project Plans (USEPA QA/R5, 2001, EPA/240/B-01/003); EPA Guidance for Quality Assurance Project Plans for Modeling (USEPA QA/G-5M, 2002, EPA/240/R-02/007) and EPA Guidance for Geospatial Data Quality Assurance Project Plans (USEPA QA/G-5G, 2003, EPA/240/R-3/003). The Great Lakes Environmental Center (GLEC) and its subcontractors will conduct work in conformance with the quality assurance program described in this project QAPP. This QAPP is one of the contractor requirements and is used to communicate to all interested parties the QA/QC procedures that will be followed to ensure that the quality objectives for this project are achieved throughout the project. The QAPP is a commitment by GLEC that must be approved by USEPA Region 1.

APPROVALS

Quality Assurance Project Plan for Phase 1- Modeling and Development of Flow Duration Curves (FDC 1 Project)

CONTRACT NO: BPA-68HE0118A0001-0003
ORDER NUMBER: 68HE0121F0001
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Cody, Ray Digitally signed by Cody, Ray Date: 2021.01.14 12:01:35 -05'00'

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Task Order Contracting Officer's Representative
USEPA Region 1

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1/12/2021

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1/12/2021

Khalid Alvi Date
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1/12/2021

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1/12/2021

John Riverson Date
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VERSION HISTORY

The following table outlines the revision history of this QAPP:

Documents	Version No.	Date	Major Revisions
Phase 1- Modeling and Development of Flow Duration Curves (FDC 1 Project)	1.0	November 4, 2020	Submitted draft QAPP to EPA Region 1 for review.
Phase 1- Modeling and Development of Flow Duration Curves (FDC 1 Project)	1.1	December 29, 2020	Revised draft QAPP to EPA Region 1 to address the comments by EPA QA Officer.
Phase 1- Modeling and Development of Flow Duration Curves (FDC 1 Project)	1.2	January 12, 2021	Finalized QAPP

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
CBI	Confidential Business Information
CD	Conservation Development
CWA	Clean Water Act
DEM	Digital Elevation Model
DQO	Data Quality Objectives
FDC	Flow Duration Curve
GI	Green Infrastructure
GIS	Geographic Information System
GLEC	Great Lakes Environmental Center, Inc.
HRU	Hydrologic Response Unit
HSPF	Hydrological Simulation Program – FORTRAN
IC	Impervious Cover
LiDAR	Light Detecting and Ranging
LSPC	Loading Simulation Program C++
MassGIS	Massachusetts Bureau of Geographic Information Systems
MS4	Municipal Separate Storm Sewer System
NCDC	National Climatic Data Center
nD/rD	New Development and/or Re-Development
NRCS	Natural Resources Conservation Service
PE	Professional Engineer
PM	Program Manager
PWS	Performance Work Statement
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCO	Quality Control Officer
SCM	Stormwater Control Measure
SSURGO	Soil Survey Geographic Database
SUSTAIN	System for Urban Stormwater Treatment and Analysis IntegratioN
TO	Task Order
TOL	Task Order Leader
TOCOR	Task Order Contracting Officer's Representative
TSC	Technical Steering Committee
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

REFERENCE TO EPA QAPP ELEMENTS

To support EPA review of this document, we have developed Table 1 below that cross-references the *Guidance for Quality Assurance Project Plans* sections with the Sections of this QAPP.

EPA QAPP Element	R1 QAPP Section
Group A: Project Management	
A1. Title and Approval Sheet	Cover Page, Page ii
A2. Table of Contents	Page iv
A3. Distribution List	Section A.3
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A5. Problem Definition/Background	Section A.5
A6. Project/Task Description and Schedule	Section A.6
A7. Quality Objectives and Criteria for Model Inputs/Outputs	Section A.7
A8. Special Training Requirements/Certification	Section A.8
A9. Documentation and Records	Section A.9
Group B: Measurement and Data Acquisition	
B1. Sampling Process Design	Not applicable
B2. Sampling Methods	Not applicable
B3. Sample Handling and Custody	Not Applicable
B4. Analytical Methods	Not Applicable
B5. Quality Control	Not Applicable
B6. Instrument/Equipment Testing, Inspection, and Maintenance	Not Applicable
B7. Model Calibration	Section B.7
B8. Instrument/Equipment Calibration and Frequency	Not applicable
B9. Data Acquisition (Non-direct Measurements)	Section B.9
B10. Data Management and Hardware/Software Configuration	Section B.10
Group C: Assessment and Oversight	
C1. Assessment and Response Actions	Section C.1
C2. Reports to Management	Section C.2
Group D: Data Validation and Usability	
D1. Departures from Validation Criteria	Section D.1
D2. Validation Methods	Not applicable
D3. Reconciliation with User Requirements	Section D.3

A. PROJECT MANAGEMENT

Certain Project Management elements have been provided in the preface of this document. Those elements include Sections A.1 Title and Approval Sheet (page ii), and A.2 Table of Contents and Document Control Format (page iv). The Project Management Group begins directly with Section A.3 Distribution List.

A.3 Distribution List

This document will be distributed to the staff within the following organizations (Table A-1): U.S. Environmental Protection Agency Region 1 (USEPA), Great Lakes Environmental Center (GLEC), and Paradigm Environmental (Paradigm).

Table A-1. Project Distribution List

Name	Phone & email	Address
U.S. Environmental Protection Agency Region 1 (USEPA)		
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Lilly Simmons QA Officer	617-918-8666 simmons.lilly@epa.gov	11 Technology Drive. North Chelmsford, MA 01863 Mail Code: OEME EQA
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A.4 Project/Task Organization

The United States Environmental Protection Agency (USEPA) has retained GLEC to develop and implement a proof-of-concept demonstration that the Region 1 Opti-Tool and associated models can be applied for the development and analysis of flow duration curves (FDCs). The FDCs will be used to investigate the impacts of next-generation new development and/or redevelopment (nD/rD) practices, or Conservation Development (CD) practices, on watershed hydrology and stream health. Phase 1 results will quantify and qualify the impacts and benefits of changes in land cover and CD practices based on an analysis of changes to the frequency and distribution of long-term stream flows. Discharge thresholds associated with flooding, streambed mobilization, and baseflows will be identified and evaluated relative to pre-development, historic land-use (if available), existing conditions, and managed conditions with the implementation of CD practices/stormwater control measures (SCM). The project will be conducted in two phases over two years. For its duration, the project will be guided by a technical steering committee (TSC) consisting of ecologists, hydrogeologists, fluvial geomorphologists, green infrastructure and stormwater specialists, climate resilience professionals, landscape architects, municipal officials, land-use planners, conservation managers, and real estate developers. The project is proposed for the Taunton River watershed. The work will utilize and advance previous work in the Taunton River watershed, including the calibrated continuous simulation hydrologic and watershed management models developed for this system.

The following organizational structure will facilitate project performance and adherence to Quality Control (QC) procedures and Quality Assurance (QA) requirements. The project team is composed of individuals from USEPA and the contractor project team. The contractor project team (GLEC Team) includes GLEC as the prime contractor and its subcontractor Paradigm Environmental (Paradigm). Key project roles are filled by the individuals who are leading the various technical phases of the project and the individuals who are ultimately responsible for approving and accepting final products and deliverables. The responsibilities of these persons are described below.

A.4.1 USEPA Region 1

USEPA Region 1 will be responsible for the coordination of QA aspects at the regional level and with local agencies to ensure technical quality throughout the project. USEPA will coordinate with contractors, reviewers, and others to ensure contract objectives are met. USEPA will also be responsible for ensuring that all technical tasks related to the project are fulfilled, and they will be responsible for final project decisions and direction.

Ray Cody will provide overall project/program oversight for this study as the USEPA Region 1 Task Order Contracting Officer's Representative (TOCOR). Mark Voorhees (USEPA Region 1) and Ray Cody (TOCOR) will serve as the core Project Team (Project Team) and/or Project Technical Leads (PTL) for this project. The PTL, along with Steven Winnett (Alternate TOCOR), will be responsible for coordinating with contractors, reviewers, and others to ensure technical quality throughout the project so that project objectives are met. Mr. Cody will provide oversight for project planning and design, data selection, coordination with the TSC and any local agencies, model selection and application, and adherence to overall project objectives. Lilly Simmons, the USEPA Region 1 QA Officer, will be responsible for reviewing and approving the QAPP and ensuring that the QA/QC practices and requirements specific to Region 1 are achieved.

A.4.2 GLEC Team

The key personnel from the GLEC Team assigned to this project and their roles are summarized below. Figure A-1 presents an organizational chart depicting the roles of key staff and the flow of communications across the project team and with EPA.

Mick DeGraeve is the GLEC Program Manager (PM) for this Task Order (TO). He is responsible for directing and coordinating technical work and interaction with the USEPA TOCOR. He will also track the budget, prepare monthly progress reports and invoices, track and ensure adherence to the schedule, and perform any other administrative functions.

Jennifer Hansen is the GLEC QA Officer (QAO) for this project. Ms. Hansen will work with the GLEC PM in cases that the quality of the data is questioned as it relates to the USEPA objectives defined for the work. Ms. Hansen will review the QAPP on behalf of GLEC and will be responsible for maintaining the official QAPP at GLEC.

Khalid Alvi is the Paradigm Project Manager for this Task Order. He is responsible for executing the tasks and other requirements of the contract on time, within budget, and with the QA/QC requirements as defined by the contract and the QAPP. Mr. Alvi will communicate with the GLEC PM and the USEPA TOCOR on technical matters; he will ensure that the quality of work, schedule, and budget meet Task Order requirements; he will provide technical direction to Paradigm staff and will manage the daily activities on the project, and he will obtain appropriate technical review of all deliverables and will ensure deliverables conform to EPA's technical review requirements.

John Craig is the QA Officer for Paradigm. His primary responsibility will be to provide support to the Paradigm PM in preparing and distributing this QAPP, reviewing and internally approving the QAPP, and monitoring QC activities to determine and document conformance.

John Riverson is the modeling QC Officer for Paradigm. He will be responsible for overseeing the data review and modeling activities and be responsible for QA/QC activities. Mr. Riverson will coordinate with the GLEC QAO to resolve any QA-related issues and he will notify the GLEC and Paradigm PMs of particular circumstances that may adversely affect the quality of the products provided by Paradigm. He will conduct the review of technical QA material and data related to the surface water model system design and analytical techniques and he implements, or ensures, implementation of corrective actions needed to resolve non-conformances noted during QA assessments.

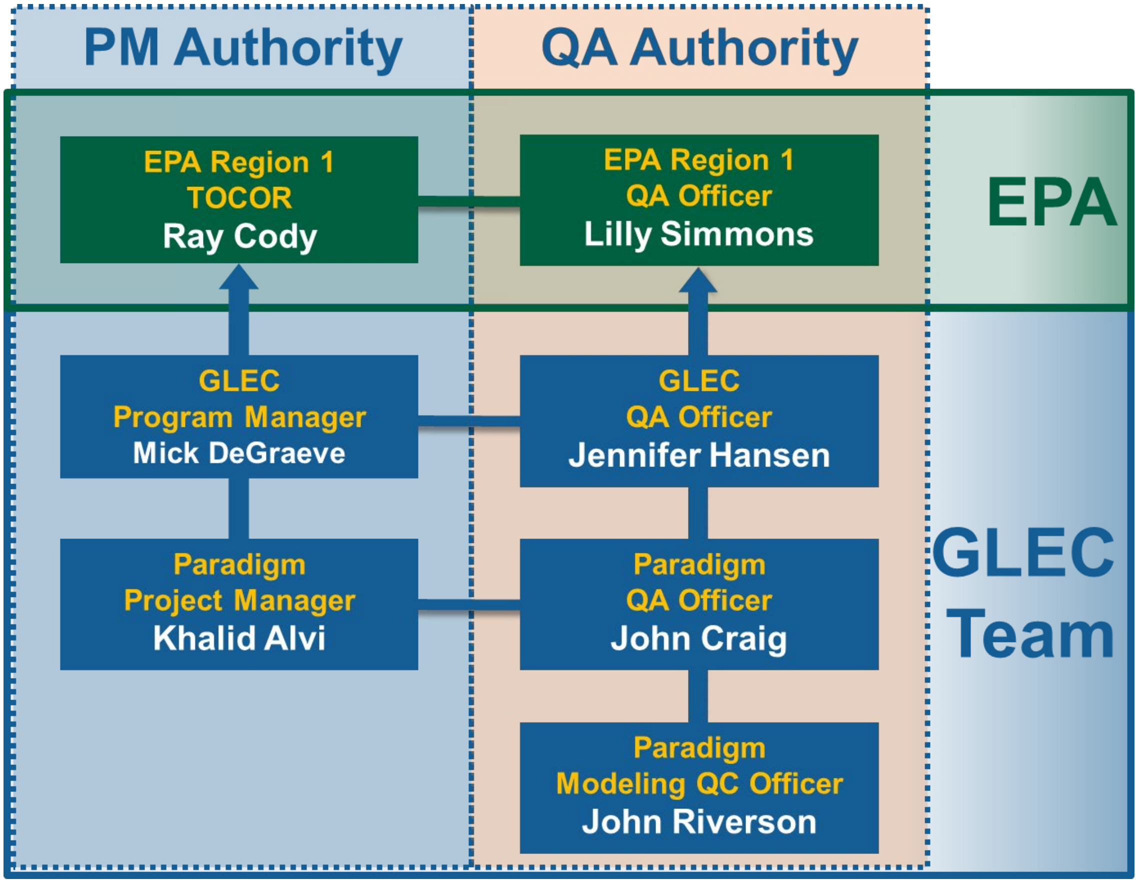

Figure A-1. Organizational diagram for both technical and QA lines of communication.

A.5 Problem Definition/Background

Conventional development approaches and existing stormwater management standards (where applicable) do not adequately address the full range of hydrologic, water quality, and aquatic life impacts associated with human development and impervious cover (IC). The weight of evidence is clear that human development and urbanization have had a profound impact on water resources in multiple ways. The paving of vegetated land disrupts the natural hydrologic cycle at a site scale that has ramifications for the larger watershed. Recent research assessing the health and integrity of watersheds indicates that efforts to restore the hydrological and ecological function of our watersheds are not likely to offset the combined impacts of 1) past and future development that expands watershed impervious cover (IC), and 2) changing climate conditions. Watershed management needs to consider the magnitude, frequency, and timing of various flow events–and incorporate new insight on the role of lesser permeability soils (e.g., tills) which indicate such soils provide a primary mechanism for maintaining hydrological balance. As human populations continue to grow, and population centers shift in response to changing natural hazards associated with climate change impacts, appropriate guidance on resource protection is a fundamental need for humans and ecological communities. The FDC encapsulates the full spectrum of hydrologic and hydrogeologic balance needed for assessing and preserving the future health of watersheds.

The goal of Phase 1 of this project is to develop and implement a proof-of-concept demonstration that the Region 1 Opti-Tool and associated models can be applied for the development and analysis of flow duration curves. The FDCs will be used to investigate the impacts of next-generation nD/rD practices, or CD practices, on watershed hydrology and stream health. Phase 1 results will quantify and qualify the impacts and benefits of changes in land cover and CD practices based on an analysis of changes to the frequency and distribution of long-term stream flows. Discharge thresholds associated with flooding, streambed mobilization, and baseflows will be identified and evaluated relative to pre-development, historic land-use (if available), existing conditions, and managed conditions with the implementation of CD practices/SCMs.

The following provides important background information about FDCs and the Taunton River watershed:

- While stormwater management is often focused on addressing nutrient over-enrichment and mitigating peak flows, less attention is paid to the geomorphic and ecological degradation resulting from changes in the frequency, magnitude, and duration of hydrologically induced disturbances.
- Flow duration curves provide valuable insight into how land use and climate impact the frequency and duration of stream flows. Changes in the FDC can lead to geomorphic and ecological degradation and may provide a framework for connecting the science of urban stream ecology to management strategies that are accessible to watershed managers, engineers, and developers.
- Calibrated, continuous simulation hydrologic models, including the Hydrologic Simulation Program – Fortran (HSPF) and Opti-Tool exist for the Taunton River watershed. While the HSPF model is specific to the Taunton watershed (Figure A-2), the Opti-Tool represents a regional, New England (EPA Region 1 states) calibration. Therefore, the geographical extent of the HSPF model is within the calibrated extent of the Opti-Tool.
- Existing data for the Taunton River watershed includes several datasets that are relevant to the project. A relevant dataset for this project includes those containing information that can be used to improve the accuracy and precision of the modeling. These datasets allow for the configuration and calibration of the model. The datasets available in the Taunton River watershed include long-term continuous streamflow and precipitation monitoring as well as GIS layers representing existing and historic land use.

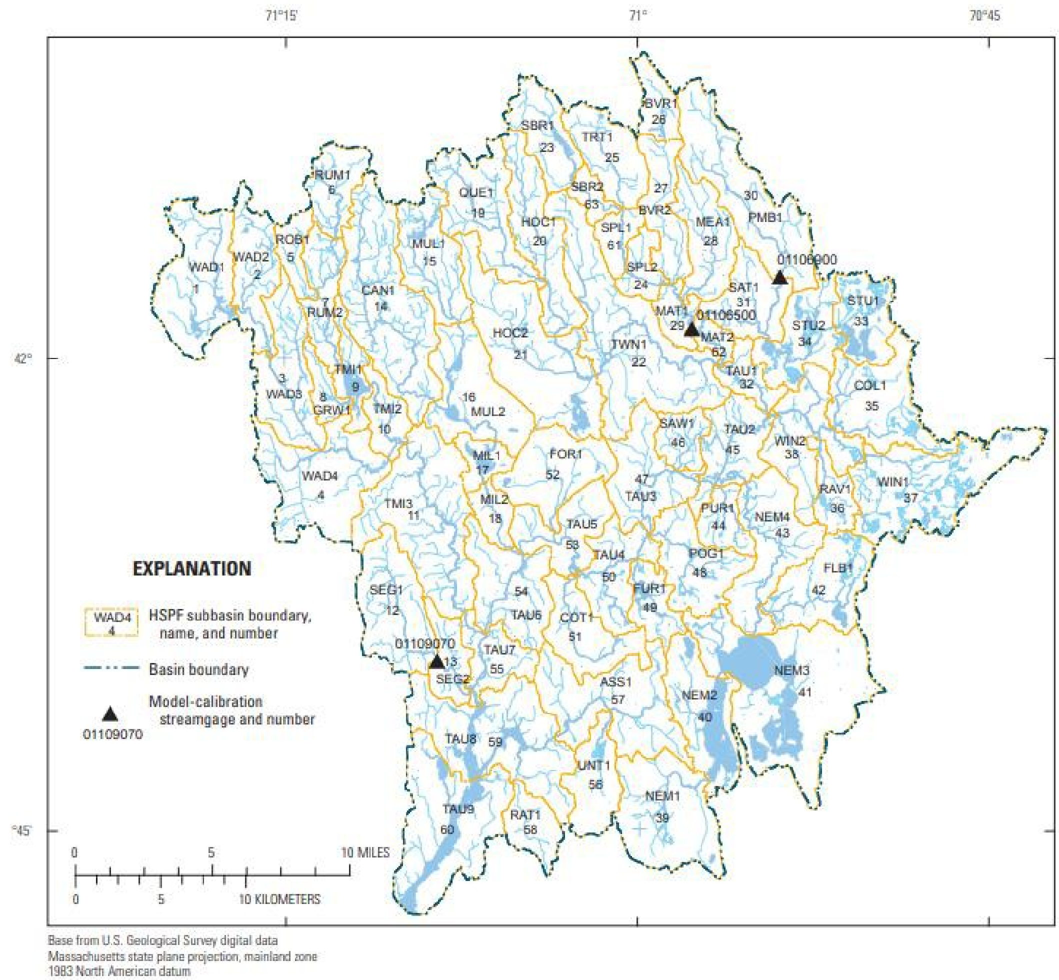

Figure A-2. Model reaches and subbasin boundaries for the existing HSPF model of the Taunton River Basin, Massachusetts. Source: Barbaro and Sorenson 2013

A.6 Project/Task Description and Schedule

Phase 1 of this project is a 'proof of concept' demonstration: the development and use of flow duration curves (FDC) for low-order and/or headwater stream segments as an important next-generation watershed optimization management tool for qualifying and quantifying the impacts and benefits of changes in land cover from nD/rD, including impacts from changes to water quality, flooding frequency and duration, channel stability, ecohydrological function, and hydrogeomorphology. FDCs will also be used to assess impacts and inform on potential management actions related to development activities under existing and future climate change, such as flooding risks, stream-channel stability, increased pollutant export, and reduced base flows. The overall data quality objectives (DQOs) and criteria for data usage and documentation are presented in Section A.7.

The project includes the following specific tasks and deliverables, further detailed in Table A-2:

- Prepare a Work Plan, Budget, and Schedule (Task 0);

- Prepare a Quality Assurance Project Plan (QAPP) (Task 1);
- Participate in a project kick-off meeting, monthly conference calls, and a post-project webinar (Task 2);
- Assist EPA with the formation and management of a TSC comprised of members with expertise in a wide variety of disciplines. Work with EPA to inform and solicit guidance and feedback from TSC members (Task 3);
- Coordinate with TSC to develop Phase 1 project approach (Task 4);
- Develop a watershed characterization(s) by performing Geographic Information System (GIS) spatial data analyses and identify three candidate subwatershed drainage areas for analyses by following these criteria (Task 5);
  - Very rural (<10% IC),
  - Rural/Suburban (15%-25% IC), and
  - Suburban to urban (>30% IC).
- Compile and analyze past, current, and future climatic and landuse data. The following are the potential range of dates that will be used to distinguish each time (Task 5):
  - Past:1965-1985
  - Current:1999-2019
  - Future 2030-2050
- Conduct baseline unit-area continuous simulation modeling (Task 5);
- Develop a proposed modeling approach for hydrologic and streamflow conditions with and without stormwater management actions—develop Technical Memorandum (Task 5);
- Develop continuous simulation hydrologic modeling tools suitable for creating FDCs to quantify stream flows for the pilot sub-watersheds associated with baseline and future climatic conditions for varying levels of land cover (Task 5);
- Adapt models for FDC analyses (Task 6);
- Adapt EPA R1 Opti-Tool for stormwater and FDC management analyses (Task 6);
- Conduct stormwater/hydrologic management optimization analyses using Opti-Tool (Task 6);
- Prepare final report and outreach materials (Task 7); and
- Prepare and participate in a webinar to present Phase 1 study results and findings (Task 8).

This project will rely on a set of analytic tools, including spreadsheet tools, GIS, HSPF, Loading Simulation Program C++ (LSPC), System for Urban Stormwater Treatment and Analysis IntegratioN (SUSTAIN), and the Opti-Tool. The model development process can be a good platform for gaining valuable information and insight into a natural system. If well-designed, the model development process is an iterative and adaptive cycle that improves understanding of the natural system over time as better information becomes available. Ultimately a model can inform future data acquisition efforts and management decisions by highlighting factors that have the most impact on the behavior of a natural system. A well-designed model development cycle is conceptually circular allowing for feedback loops at key points.

The tasks to be implemented under this QAPP are described in the following sub-sections. This project will include identifying, compiling, evaluating, and analyzing existing data (i.e., secondary data), refining and updating existing HSPF models, and updating the user-interfaces and developing visual basic application (VBA) source code for the Opti-Tool spreadsheet to include groundwater/aquifer functionality and an FDC evaluation factor. Existing data for this project will primarily be readily available GIS and stormwater-related time-series data.

A.6.1 Watershed Characterization & Data Analysis

Under this task, all available data will be reviewed and evaluated for possible use in characterizing the watershed characteristics, including drainage patterns, existing SCMs, observed stream flows, and problem areas for flooding and stream instability. This data will be used to set model initial conditions and perform modeling calibration. A preliminary list of data (e.g., GIS, precipitation time-series) that will be part of this analysis is described further in Section B.9. The minimum number of datasets that will be sought for this project is 12 (see Table B-1 in Section B.9), the maximum number of datasets would likely be less than 100. The large number accounts for the possibility that several datasets exist that allow for a more detailed model configuration such as dam and wastewater treatment plant releases and drinking water and irrigation diversions. This information may exist as daily timeseries or simple yearly averages that would then be considered for disaggregation to shorter timesteps for incorporation into the model.

A.6.2 HSPF/LSPC Modeling

Modeling for Phase 1 of this project will build upon existing calibrated continuous simulation hydrologic and watershed management models developed for a portion of the Taunton River watershed. The existing HSPF models will be converted into LSPC, which is based on HSPF algorithms but has expanded functionality to provide seamless linkage to Opti-Tool's SUSTAIN optimization engine. The LSPC models will be used in conjunction with the Opti-Tool, which uses the EPA SUSTAIN model for GI SCM process simulation and optimization, to develop flow duration curves (FDCs) of stream flows that are representative of pre-development and existing development conditions to demonstrate impacts and develop optimized stormwater retrofit management strategies for improving conditions for the key watershed processes. Based on the existing HSPF models and GIS analysis, refined LSPC models for the three sub-watersheds will be developed to represent hydrologic processes and streamflow routing for predevelopment, historic, and existing conditions for the selected baseline climatic period. The refined hydrologic models will be used to develop FDCs for the selected sub-watersheds for pre-development, historic development, and existing development conditions for baseline and future climatic conditions. Resulting FDCs will be used to assess how changes in land use and climate impact the outcomes such as the magnitude and frequency of flooding, habitat health and suitability, and channel stability.

A.6.3 Opti-Tool Modeling

EPA Region 1 has developed the spreadsheet-based Opti-Tool, a stormwater best management practice optimization tool for use by municipal stormwater managers and consultants. The tool supports the development of technically sound, robust, and optimized cost-effective stormwater management plans, which can demonstrate accountable progress and compliance with stormwater Municipal Separate Storm Sewer System (MS4) permit requirements.

The Opti-Tool provides the ability to evaluate options for determining the best mix of structural best management practices (BMPs) to achieve quantitative water resource goals specific to New England, EPA Region 1 states. The tool incorporates long-term Hydrologic Response Unit (HRU) runoff and pollutant load time-series for regional climate conditions that are calibrated to regionally representative stormwater data and annual average load export rates from nine (9) major land uses. Opti-Tool also incorporates regionally representative BMP cost functions and regionally calibrated BMP performance parameters for pollutants including total phosphorus (TP) and total nitrogen (TN), to calculate long-term cumulative load reductions for a variety of structural controls (USEPA 2016).

Currently, Opti-Tool is designed to optimize the treatment of overland flow, it does not include groundwater components comparable to those found in the EPA SUSTAIN model. Water that infiltrates to 'active groundwater storage' can move laterally and contribute to baseflow, percolate to the deeper groundwater or leave the groundwater through plant uptake. Adding the functionality of a SUSTAIN aquifer unit into the Opti-Tool is necessary for tracking and attenuating infiltration for the water balance. All Opti-Tool modeling conducted for this project will utilize the project-modified version that includes SUSTAIN functionality.

Upon approval of the QAPP, the GLEC Team will further analyze existing hydrological datasets and identify any missing gaps or alternative information that is needed for analysis. Once complete, LSPC and Opti-Tool models will be set up and applied as described above and in **Section B.7**. Modeling will be conducted entirely using secondary data. This process will involve gathering, evaluating, and analyzing existing data. Evaluation of secondary data will be conducted based on USEPA guidance documents USEPA QA/G-9R and USEPA QA/G-9S (USEPA 2006a and b).

A.6.4 Electronic Data and Administrative Record

Our team will maintain an ongoing, updated inventory of all data compiled (and how/if it is being used), all studies reviewed, all GIS data collected, all derived GIS products, all model input and output files (including calibration and validation calculations), all draft and final products (electronic and hard copies), and project communications. All materials will be delivered to USEPA at the project close per the schedule in Table A-2.

A.6.5 Schedule

Table A-2. Project Schedule.

Project Elements/Sub-Tasks	Deliverables
Task 0: Work Plan, Budget, and Schedule	
Draft work plan, budget, and schedule	11/6/2020
Final work plan, budget, and schedule	11/20/2020
Task 1: Prepare Quality Assurance Project Plan	
Prepare draft QAPP	11/6/2020
Final QAPP	12/31/2020
Task 2: Project Management and Administration	
Kickoff call	11/9/2020
Kickoff meeting and summary	11/13/2020
Monthly progress calls and summaries	Monthly
Task 3: Technical Steering Committee Meetings	
TSC Meeting 1: Completion of Subtask 4A - Draft Technical Scope Outline	12/18/2020
TSC Meeting 2: Completion of draft Task 5 technical memorandum	4/22/2021*
TSC Meeting 3: Completion of draft Task 6 technical memorandum	6/24/2021*
TSC Meeting 4: Completion of draft Task 7 technical memorandum	9/23/2021*
Task 4. Coordinate with TSC to Finalize Phase 1 Project Approach	
4A: Draft Technical Scope Outline	
Draft technical approach outline	12/11/2020
4B: Final Technical Scope	
Final technical approach memo	12/31/2020
Task 5. Compile Available Data/Information for Taunton River Watershed Modeling Analyses	
5A: Data/Information Assessment	
5B: Past, Current, and Future Climate Data Analysis	
5C: Baseline Unit-Area Modeling Analysis	
5D: Develop Hydrologic/Streamflow and W ater Management Modeling Approach for Taunton River Sub-watershed Analyses	
Draft technical memo and fact sheets	4/16/2021
Final technical memo and fact sheets	4/30/2021
Task 6. Phase 1 Hydrologic Streamflow Modeling Analyses	
6A: Adapt Models for Flow Duration Curve Analyses for Pilot Sub-watersheds	
6B: Adapt R1 Opti-Tool for Stormwater and FDC Management Analyses	
Draft technical memo	6/18/2021
Final technical memo	6/30/2021
Task 7. Phase 1 Stormwater/Hydrologic Management Optimization Analyses	
Draft project report and outreach materials	9/17/2021
Final project report and outreach materials	9/30/2021
Task 8. Phase 1 Project Webinar to SNEP Region	
Draft presentation slides	9/27/2021
W ebinar presentation	9/30/2021*

*=tentative, to be finalized in consultation with EPA

As needed, 1 call each month

A.7 Quality Objectives and Criteria for Measuring Data

This QAPP is intended to ensure that any collected information is of the quality necessary to support USEPA in the tasks described above. This support may include a review of existing data; collection and review of additional data; performing data analyses in spreadsheets, databases, and models; and project deliverable review. The data quality criteria and/or quality control for each of these activities are outlined in the following subsections. While datasets may be added during the project, Table B-1 provides a list of starting datasets that will be used in this project:

A.7.1 Data Compilation and Information Collection

In support of this project, the GLEC team will review existing data and collect/review new data (e.g., readily-available GIS datasets, climate datasets, etc.). We will review local and regional governmental and non-governmental sources for available land-use, flow gauging, and hydrologic data. GLEC will not perform sampling as part of this Task Order. Factors that the GLEC Team will consider in reviewing gathered information for use in the calibration and development of the models are described in Table A-3.

Table A-3. Factors considered when reviewing gathered information for model development

Quality Criterion	Description/Definition
Accuracy	All (100 percent) data will be proofread to ensure accurate data entry into any data tables, spreadsheets, or databases.
Completeness	All data collected or received into any data tables, spreadsheets, or databases will be checked to ensure the presentation of results is complete.
Comparability	Data from different locations or within a single field site will be compared by checking methods used to collect the data and that the units of reporting are standardized.
Relevance	Data sources specific to the topic being investigated will be considered for use. Sources that most closely represent the topic/data of interest are the most relevant.
Reliability	The information/data source is reliable. For example, this criterion includes at least one of the following acceptance specifications: • The information or data is from a peer-reviewed, government, or industry-specific source. • The source is published. • The author is engaged in a relevant field such that competent knowledge is expected (i.e., the author writes for an industry trade association publication versus a general newspaper). • The information was presented at a technical conference where it is subject to review by other industry experts. • The documented quality assurance program for various information will be reviewed to assess the data's precision and accuracy. Data limitations that are identified in the quality assurance program will be included in model reporting to properly present results in the context of the uncertainty associated with the input data.
Representativeness/Content	The information/data source is represented in its content. Examples of source content can include the extent of data (e.g., what geographical area does it cover, over what period) and level of documentation describing the generation of the data.

A.7.2 Opti–Tool and Other Analytical Tools

All Opti-Tool and other analytical spreadsheets will undergo review by technical/project staff other than the original spreadsheet developer. The responsibilities of the technical reviewer are to verify that the technical approach and procedures used in the spreadsheet are reasonable and logical, verify that the spreadsheet documentation is complete and clear, and verify that calculations and results are accurate by manually verifying equation cells. Project staff will document the technical review of spreadsheets. The technical reviewer will provide a written summary of the data checked, errors or problems found, and recommendations for revisions. This summary may be provided separately or included in a QA worksheet in the spreadsheet workbook. Additional discussion of model calibration and proposed DQOs specific to Opti-Tool inputs and outputs are presented in Section B.7.

A.7.3 Deliverable Review

The GLEC Team has an established internal QC review procedure for all deliverables (memoranda, spreadsheets, etc.). Table A-4 shows the levels of review that the GLEC Team requires for various types of deliverables. At the direction of the USEPA TOCOR, GLEC will deviate from these levels of review to accommodate situations where there is limited time and/or budget.

Table A-4. Summary of required review levels by type of deliverable

Work Product	Degree of QC Reviewer Involvement			
	Team Member / Technical Reviewer	Project / Modeling QA Manager	Technical Editor	Senior Manager
Internal project documentation, including modeling and GIS products	●	--	--	●
Methodology development	●	--	●	●
Papers, reports, technical memos, and all project deliverables	●	●	●	●
QA Project Plan (QAPP)	●	●	--	●

The GLEC Team conducts technical tasks and prepares deliverables using in-progress/interim deliverable reviews and final product reviews. The quality of intermediate products and draft and deliverables are evaluated as these work products evolve. Progress reviews include a check on calculations and data and reviews of draft documents. Draft and final deliverables are reviewed by an independent senior manager and a technical editor before delivery to USEPA.

A.8 Special Training Requirements/Certifications

Work processes performed under this TO may require experience, advanced training, or academic degrees in such topics as environmental science, computer science, data management, GIS, statistics, engineering and SCM principles, and watershed management. The requirements will vary depending on the portion of the project that a staff member is assigned. All staff proposed to work on this project are trained and have a professional proficiency with the following skills that will be utilized in this project:

- Database management, basic database skills using such packages as Microsoft Excel or Microsoft Access and basic GIS skills;
- Experience in developing and reviewing datasets for model development;
- Experience with application and development of the HSPF/LSPC, SUSTAIN, and Opti-Tool models;
- High-level geospatial analysis using a variety of GIS software; and
- Strong science background and knowledge of major USEPA programs, including the Clean Water Act (CWA), and other major natural resource and water quality laws.

The GLEC Team PMs will be responsible for ensuring the qualifications of their respective staffs. All staff participating in this project will be qualified and have previous experience with the skills required for the assigned task. The GLEC Team does not expect to collect or review any confidential business information (CBI) under this Task Order; however, all project staff will strictly adhere to all USEPA procedures when handling industry information and will coordinate with the USEPA TOCOR to ensure that CBI is not used or disclosed.

A.9 Documents and Records

Thorough documentation of all project activities will be a priority for the GLEC Team. We understand the need for document control for review, version control, and the development of an accurate electronic library and administrative record. Our team retains and stores all project documents and communications, including modeling input and output files that will be necessary for review of the study results.

Data and assumptions used to develop project models will be recorded and documented in the draft and final reports and memos as well as internal approach and preliminary results documents. We will document and save the results of technical reviews, model tests, assessments of output data and audits, actual input and databases used, and our responses to comments in model development.

The GLEC Team will deliver the project files that will contain copies of project documents and data, including model input and output datasets. The GLEC Team will deliver those files to USEPA at the end of the project as part of the final deliverables outlined in the Performance Work Statement (PWS). The GLEC Team will maintain files, as appropriate, as repositories for information and data used in models and for the preparation of any reports and documents during the project. GLEC will distribute the approved QAPP and any updates to the approved QAPP to project staff on the distribution list (Section A.3).

It is expected that most project information will be stored as electronic files, although there may be cases where data is stored as a hard copy. An example is a previous study that only exists as a hard copy and whose conversion to a digital version is overly cumbersome. The following outlines the kinds of information and data that will be included in the hard copy or electronic project files in the administrative record:

- Reports and documents prepared, including the draft and approved QAPP;
- Electronic copies of model input/output;
- Electronic data files, including physical measurements, land use data, and any watershed data;
- Electronic copies of all GIS data, including derived products (some of this will likely be delivered via external hard drive or other electronic media based on the size of the files);
- Maps, photographs, and drawings (if applicable);
- Results of internal technical reviews, model tests, data quality assessments of output data, and audits;
- Studies, reports, documents, and newspaper articles about the project (hard copy and electronic—hard copy documents may be scanned depending on size); and
- Contract and project information.

The GLEC Team will also prepare monthly progress reports that will address task and subtask milestones, deliverables, adherence to schedule, and financial progression at the end of each full month while the TO for this project is open.

The modeling software to be used on this project consists primarily of the USEPA developed HSPF/LSPC and Opti-Tool. The code and executables to be used are publicly available from USEPA. Any other post-processed model outputs (primarily Microsoft Excel-based) will be included with final electronic deliverables.

B. MEASUREMENT AND DATA ACQUISITION

Only sections B.7, B.9, and B.10 are included with this QAPP. The remaining sections are not relevant to this QAPP.

B.1 Sampling Process Design (Experimental Design)

This section does not apply to this QAPP.

B.2 Sampling Methods

This section does not apply to this QAPP.

B.3 Sample Handling and Custody

This section does not apply to this QAPP.

B.4 Analytical Methods

This section does not apply to this QAPP.

B.5 Quality Control

This section does not apply to this QAPP.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

This section does not apply to this QAPP.

B.7 Calibration

The USEPA QAPP guidance indicates that calibration refers to the configuration and refinement of the analytical instruments that will be used to generate analytical data. As eluded to in the QAPP modeling guidance document, by analogy the "instrument" is the predictive tool (i.e. the model) that is to be developed and/or applied. A robust modeling platform not only makes the best use of available data but also it may help to highlight certain areas of deficiency in understanding of the natural system. Ultimately a model can inform future data acquisition efforts and improve understanding of the behavior of a natural system. In this context, model calibration is defined as the systematic changing of initial model parameters to minimize the error between predicted and observed values. Model validation is an evaluation of the model goodness-of-fit using an independent data set.

Model refinement and calibration will occur as follows:

- Conduct Model Refinement
  - Review existing HSPF models for the study area.
    - Map HSPF land segments to Opti-Tool HRU classification.
    - Review land/stream parameters
    - Review point source representation in the model
    - Identify data gaps
  - Develop LSPC models for the selected sub-watersheds
    - Configure the delineated sub-watersheds with land (HRUs) and stream segments
    - Assign existing HSPF land/stream parameters to the LSPC model
    - Assign Opti-Tool's SWMM-HRU water quality parameter values to the LSPC model. The SWMM-HRU water quality parameter values are the result of the regional calibration discussed previously. They are values for the build-up and wash-off functions for pollutants.
    - Assign weather boundary condition
    - Calibrate hydrology to selected observed gage (e.g., USGS 01109000 flow gage)

Opti-Tool and its SWMM-based sub-modules contain buildup/washoff parameters for HRUs representative of Region 1 specific land use. Available land cover/use, soil, and slope data for the Taunton River watershed may need to be reclassified into those specific HRU categories to facilitate the Opti-Tool application. Tables and figures will be created to identify how available information was reclassified into the equivalent Opti-Tool categories. The resulting hourly time-series for each HRU will allow for a detailed evaluation of long-term, cumulative alterations, and impacts to watershed functions associated with land-use change/IC conversion. For historical and existing conditions in which observed data is available, model performance will be evaluated using both visual and statistical approaches.

Calibration and validation activities and procedures will be documented in associated technical memorandums.

B.8 Instrument/Equipment Calibration and Frequency

This section does not apply to this QAPP.

B.9 Data Acquisition (Non-Direct Measurements)

Non-direct measurements (i.e., secondary data) are data that were previously collected under a different effort outside this Task Order. Non-direct data can come from numerous sources, but the non-direct data most likely to be used for this project will originate from the Massachusetts GIS (MassGIS) repository per USEPA request (MassGIS 2018). Non-project-generated data may be obtained from published or unpublished sources. The published data are likely to have had some form of peer review. These data are generally examined by modelers as part of a data quality assessment. Databases that have not been published are also examined in light of a data quality assessment. The GLEC Team will confirm that data provided by USEPA, USGS, or other sources meets precision objectives established by those entities. A preliminary list of secondary datasets identified through a review of the PWS and development of the Work Plan are presented in Table B-1.

Table B-1. Inventory of non-direct measurement datasets to be collected under this Task Order

Source	Dataset	Purpose
MassGIS	Impervious Surface	Base layer for impervious cover for use within the Opti-Tool HRUs
	Land Use	Representing existing and historic land use within the Opti-Tool model HRUs
	NRCS SSURGO-Certified Soils	Representing Hydrologic Soil Groups (HSG) in the Opti-Tool model HRUs
	Digital Elevation Model (DEM)	Deriving and representing slope categories within the Opti-Tool model HRUs
	LiDAR Terrain	
	Building Structures (2-D)	Representation of buildings to cross-reference against impervious surface layer
	Drainage Sub-basins	Reference layers for delineation of watershed and subwatershed boundaries; these may be further subdivided as needed for the project goals
	NRCS HUC-12 Subwatersheds	
Multi-Resolution Land Characteristics	National Land Cover Database	Snapshots of historic land cover dating back to the early 1990s
USGS	Stream discharge	Calibrate modeled hydrological response,
National Climate Dataset Center	Global Historical Climatology Network	Evaluate trends and provide meteorological input for models
	Local Climatological Data (e.g. T.F. Green Regional Airport, Warwick, R.I., station no. 376698)	Provide additional hourly meteorological input for models

The quality of data used for this project is addressed, in part, by the training and experience of project staff (as described in Section A.8) and the documentation of project activities (as described in Section A.9). This QAPP and other supporting materials will be distributed to all personnel involved in this project. Mr. Craig (Paradigm QA Manager) and Mr. Riverson (Paradigm Modeling QC Officer) will ensure that all tasks described in the Task Order are carried out following this QAPP.

GLEC Team personnel performance will be reviewed throughout each of the project phases to ensure adherence to project protocols. QC is defined as the process by which QA is implemented in the project. GLEC Team personnel will conform to the following guidelines:

- All activities that include data interpretation and computation are subject to audit, peer review, or both. GLEC Team personnel will maintain careful written and electronic records.
- A written record of where the data used in the project analyses were obtained will be kept, and any information on data quality will be documented for inclusion in the final report. A

written record of where this information is located on a computer or backup media will be maintained in the project files.

- GLEC Team personnel will evaluate the quality of all existing data. When existing data are published with an accompanying report, document, or other metadata describing data quality, data quality will be inferred from statements made in the accompanying documentation. Data used to drive model processes, such as landuse/landcover, soil, precipitation, and observed flow data, will have detailed documentation about data collection and management. It is not expected that data with only inferred quality will impact the goals of the project, such data will be used primarily as supporting information. If the quality of a data source cannot be determined at all, it will not be used. Additionally, existing data values incorporated into the Opti-Tool model or report will be verified against the source data (i.e., transcription checks).
- Non-modeling data (e.g., watershed characterization and data assessment) will be checked through technical reviews. As an example, a table presenting landuse/landcover areas and percentages will be checked by ensuring that the individual areas equal the known total watershed area.

When data comes with associated QA/QC flagging, the information will be used to quantify its completeness and quality. Since the focus of this project is on the development of FDCs, quantifying the completeness and quality of observed flow data helps to assure that model results are reflective of the best available data. Additionally, the assessment of observed data helps to provide simulated results within the context of the uncertainty and limitations of the observed data used to calibrate the model. Table B-2 provides an example summary of observed flow data quantity and quality by the station. The project will use the data quality flagging provided by the USGS to develop a similar table. Other tables will be developed depending on the flagging available for other datasets.

Table B-2. Example assessment of completeness and quality of observed flow data.

Station Name	Station ID	Drainage Area (sq. km.)	Water Year (October 1 – September 30)																	
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
E Holland River - Holland Landing	02EC009	173.0	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Tannery Creek - St Andrews Coll	LS0105	28.6						●	●	●	●	◕	◕	◕	◕	◑	◕	●	●	●
Western Creek at Charlotte St.	LS0201	5.9														●	●	●	●	●

Data Quantity (Percent Complete):

Legend:	0%	25%	50%	75%	100%

Data Quality (Percent Estimated):

	○	◔	◑	◕	●
No Data	90-100%	65-90%	35-65%	10-35%	0-10%

B.10 Data Management and Hardware/Software Configuration

Secondary data collected as part of this TO will be maintained as hardcopy only, both hardcopy and electronic, or electronic only, depending on their nature. In some cases, hardcopy reports will be scanned and/or digitized if they are not too large or in a condition that precludes easy scanning or digitization. If scanned, the document will be included in the electronic repository. Our team routinely deals with large amounts of data from diverse sources and in multiple formats. We are experienced at managing and storing information in an orderly fashion to avoid the production of conflicting or duplicate data and to allow for the efficient transfer of project files and administrative records in a timely and accurate manner. The GLEC Team will perform general quality checks on the transfer of data from any source database to another database, spreadsheet, or document. Other activities related to model development, such as verifying continuity of boundary conditions and observed data during calibration, will be performed per direction from the project QC Officer.

The HSPF, LSPC, and Opti-Tool modeling software will be the primary models used for this project, and the code, executables, and project documentation are all readily and publicly available from USEPA.

The nature of the GLEC Team's work requires that we possess and maintain a variety of state-of-the-art computer resources. All of our team's computer resources are covered by on-site maintenance agreements. We also possess computer redundancy to ensure resources are always available. If a problem with a computer or server occurs, our computer specialists diagnose the problem and correct it. Routine maintenance of computers and servers is performed by in-house computer specialists. All computers are connected to a surge suppressor to protect them from damaging voltage spikes. The GLEC project files are stored on the company network server which is backed up nightly. Screening for viruses on electronic files loaded on computers or the network is standard company practice, and every machine has the latest updated antivirus installed. Regular maintenance, and update if necessary, of software, is performed to keep up with changes in computer storage, media, and software.

C. ASSESSMENT AND OVERSIGHT

The QA program for this TO provides a framework to oversee the quality of work being released to clients. It consists of QC reviews, QA audits, and technical reviews. QC is the process of checking specific work products completed for a task. QA audits provide a method for checking that work performed follows established procedures. Audits help to standardize the product that is provided to the client. Finally, technical reviews ensure the accuracy of reports that are published for or delivered to the client.

C.1 Assessment and Response Actions

The GLEC Team will use secondary data discussed in Section B.9 for the development of model inputs. The Paradigm Modeling Quality Control Officer (QCO), Mr. Riverson, will examine the representativeness and comparability of project-generated input and output data. Modelers will cross-check data for potential problems through visual inspection of time-series and comparison of mean data to model means as discussed in Section B.7.

The QA program under which this TO will operate includes surveillance, with independent checks of the data obtained from sampling, analysis, and data-gathering activities. The essential steps in the QA program are as follows:

- Identify and define the problem;
- Assign responsibility for investigating the problem;
- Investigate and determine the cause of the problem;
- Assign and accept responsibility for implementing appropriate corrective action;
- Establish the effectiveness of and implement the corrective action; and

- Verify that the corrective action has eliminated the problem.

If problems arise in the process of completing the aforementioned activities, the GLEC PM will determine the appropriate long-term or short-term action to be taken. Steps to address the problem could include investigation and determining the cause of the problem, implementing corrective action, and following up with team members to ensure that the appropriate corrective action has been taken and that the problem has been resolved. If these steps do not adequately address the problem, the GLEC QAO will be responsible for corrective action and will inform the GLEC PM as appropriate.

GLEC will prepare monthly progress reports and provide them to the TOCOR. These progress reports will describe the status of the project and work completed, including any identified problems with remedies, as well as anticipated work to be completed during the next reporting period.

C.2 Reports to Management

Individual assignment status will be reported monthly to the PM by each staff member. These reports will be submitted at the beginning of the month and will cover the previous month's activities. The PM will compile inputs from all project staff and create a monthly report for their task order that will be reviewed by the GLEC PM. The monthly report will be edited and formatted by the document preparation staff before submission to the TOCOR. All QC documentation forms will be signed by the Project Manager. This will ensure that the Project Manager is kept informed about QA/QC problems that may exist within the project.

D. DATA VALIDATION AND USABILITY

D.1 Departures from Validation Criteria

Data review is an internal check performed to ensure that data have been recorded, calculated, and transmitted correctly by checking original records, transcription, and calculations for errors (USPEA 2002). The GLEC Team will perform a proof-read level check (i.e., 100% check) for all data transcribed from existing data sheets, field notebooks, literature sources, and other data sources to work assignment products (e.g., spreadsheets models, databases, reports). QC reviews will be an on-going effort during the project execution and will be documented in the monthly progress reports. The GLEC Team Program Manager and Project Manager will be responsible for the review of data.

Data verification is the process of evaluating the completeness, correctness, and conformance/ compliance of a specific data set against the method, procedural, or contractual requirements (USPEA 2002). The GLEC Team will compare the data to the data quality criteria presented in Table A-3 and identify any data that do not meet the requirements. The GLEC team Project Manager, or his designee, will be responsible for data verification.

Opti-Tool model inputs and Opti-Tool model outputs will be evaluated as part of data verification as part of the "weight of evidence" approach described in Section B.7 which will rely on visual inspection of model data plots and observed input data. Any comparison of model results yielding differences in system behavior from visual inspection or comparison with expected mean values will trigger a discussion between the GLEC Team and USEPA regarding (1) potential causes of the discrepancy, and (2) obtaining a consensus on how the discrepancy will affect the use of the model for application purposes. The discussion will generally reflect the cause of non-agreement within the context of the study objectives.

D.2 Validation Methods

Data validation is an analyte and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set. No data validation will be performed because no sample data will be collected as part of the work assignment.

D.3 Reconciliation with User Requirements

All data quality indicators will be calculated after the data analysis phase. Measurement quality requirements will be met and compared with the DQOs to confirm that the correct type, quality, and quantity of data are being used for the analyses. The Paradigm QCO (Mr. Riverson) will perform internal reviews to assess departures from assumptions established in the planning phase of the modeling process. If requested by the USEPA TOCOR and funding is available, the GLEC Team will perform a post-audit for the project. A post-audit is an evaluation of the correctness of the initial model predictions conducted several years after the original modeling study is completed. If the models' predictions are deemed to be representative of the natural system, the model can be considered valid for making management decisions at the specific site and the actual stresses. A post-audit requires new field observations for the predicted variables, which are to be collected at a time after the system has had a chance to adjust to the management changes. Uncertainties and limitations in the use of such data and interpretation of results will be provided to USEPA.

E. REFERENCES

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