Quality Assurance Project Plan (QAPP) Template: For Modeling Applications

[REMOVE THIS PAGE BEFORE SUBMITTING.]

PURPOSE: This template is intended to help improve the quality assurance (QA) capabilities and understanding of staff that are required to prepare a QAPP for modeling projects. This template is an aid in developing project specific QAPPs and is expected to improve the quality in both the scope and application of the environmental information gained from projects that have applied a systematic approach to project design. Communication with all parties involved on the specifications of the implementation of project will help ensure transparency and establish criteria consistent with project objectives. In doing so the risk of schedule and budget overruns associated with planning and communication errors can be reduced as well as limit the vulnerability of the model and outputs to be challenged.
The design of this template is intended to improve both the quality and usability of environmental information for DOW projects as well as streamline the QAPP submission and review process.

BACKGROUND: This template follows EPA QA G-5 guidance on QAPPs. Every project is unique, and this QAPP must be edited to meet the specific needs of a project.

USAGE: Text enclosed in square brackets or highlighted in yellow indicates areas meant for review and editing. Text in italics are meant as guidance and are to be removed from the project specific QAPP. Additional text revisions may be needed to meet the requirements of the specific project. Microsoft Word comment fields are used to provide additional guidance/advice for particular sections. The appendices are meant to be a resources and are not to be retained in a specific project QAPP

PRE-SUBMISSION CLEANUP: Before submitting QAPP for review remove all yellow highlighting, make sure all bracketed text has been replaced with project specific text, remove guidance offered in italics and Microsoft Word comments as well as the modeling references and resources in the appendices. The table of contents and lists of tables and/or figures will need to be updated to reflect project specific information.

ADDITIONAL GUIDNACE: May be found in Appendices A, B and C and the reference section. These are all to be removed and replaced with project specific relevant information and references.

[Insert project title here]

Quality Assurance Project Plan

DATE

[Insert name and address of the project organization]

[Insert full contact information for project manager]

This document has been prepared according to the United States Environmental Protection Agency publication *EPA Guidance for Requirements for Quality Assurance Project Plans* for Modeling dated December 2002 (EPA QA/G-5M).

Abstract: This document details a quality assurance plan to guide the successful implementation of [name of project]. [Provide a very brief summary of the project, to orient the reader. Two to three sentences are sufficient. Give a more detailed description of the project in A6.]

Commented [RG1]: This is not required However,it does give the reader a quick overview of the project before getting into details.

1.0 PROJECT MANAGEMENT

1.1 Title and Approval Page

[Insert project title here]

Quality Assurance Project Plan

DATE

[Insert name and address of the project organization]

Provide the project title, name of organization conducting the project, and personnel with approval authority. Approval authorities typically include project organization and regulating authorities.
Approvals Signature (required prior to project start):

_____ Date: _____
Insert Name Program Manager
Insert Agency Name

_____ Date: _____
Insert Name Project Manager
Insert Agency Name

_____ Date: _____
[Insert Additional key personnel] Title
Insert agency name]

Commented [RG2]: Principal investigator, laboratory director, contractor lead, other agencies leads

_____ Date: _____
- Quality Assurance Officer

1.2 Table of Contents

Commented [RG3]: Update table of contents to reflect correct page numbers, table and figure numbers

NOTE: List the section/subsections of the document and all figures, tables, and appendices. Provide associated section/subsection numbers and pages so that all information may be easily located.

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1.3 Distribution List

List all the individuals (along with their titles, organizations, and contact information) who will receive copies of the approved Quality Assurance Project Plan (QAPP) and any subsequent revisions. Include everyone that has a role or responsibility in the project. (include project managers, QA managers, representatives of all groups/agencies involved and points of contact and associated organizations for all consultants and/or contractors).

The following individuals must receive a copy of the approved QAP in order to complete their role in this project.

Name:
Title:
Organization:
Contact Information (Address, Telephone, E-mail, etc.):
Document Type:

Name:
Title:
Organization:
Contact Information (Address, Telephone, E-mail, etc.):
Document Type:

Name:
Title:
Organization:
Contact Information (Address, Telephone, E-mail, etc.):
Document Type:

1.4 Project Organization

Identify the individuals and organizations participating in the project, and discuss their specific roles and responsibilities. Include program or project management, personnel responsible for conducting project activities, the project QA manager. Ensure that the project QA manager is independent of the staff generating the data and model outputs. **Provide a concise organization chart** *showing the relationships and lines of authority/ communication for all named people and organizations. Identify who is advisory only.*

The name of the individual associated with each title needs to be included.

Commented [RG4]: Everyone on the distribution list must also be included in the responsibilities description and organizational chart.

Commented [RG5]: Electronic, hardcopy or both

Project Manager will be the responsible official for overseeing the overall projects and budgets, as well as tasking contractors with work required to complete projects. He/she will communicate project needs to the contractor=s project manager.

Commented [RG6]: Edit the responsibility descriptions as needed for the specific project

QA Manager or Designee will be responsible for reviewing and approving and maintaining the QA Project Plan. He/she may provide technical input.

Contractor (or Grantee) Project Manager will have overall responsibility for assigning appropriate personnel to complete the tasks included in this plan. He/she will ensure that the project budget is adhered to. He/she will communicate with the Project Manager on work accomplished in this plan and any problems or deviations that need to be resolved.

Other Key Project Positions -
Example entry
Jim Shorts
Title/Affiliation: Project Manager
Professor, Water University, Department of Modeling
Address:
Phone No.:
E-mail:
Responsibilities:

- Will have overall responsibility for assigning appropriate personnel to complete the tasks included in this plan. Will ensure that the project budget is adhered to. Will communicate with the Lead Modeler on work accomplished in this plan and any problems or deviations that need to be resolved.
- Will oversee all staff of the Water University, Department of Modeling that will work on the model.
- Will provide technical input on model calibration/validation procedures
- Will ensure the modeling adheres to this QAPP and will meet the criteria for use in an EPA 9 Element Plan.
- Review and edit final modeling report

1.5 Problem Definition/Background

State the specific environmental problem(s) to be investigated. Provide background information to provide an historical and scientific perspective..
State why the environmental problem needs to be addressed using a model.
State what decisions or actions are to be based on model outcomes. Outline any anticipated outcomes from the modeling activity.

1.6 Project/Task Description and Schedule

Summarize the work to be done with a schedule for implementation. Include steps in the model development/selection, evaluation, calibration, application, products, and reports. Identify any resource or time constraints.

Identify geographical locations to be studied, including maps where possible.

1.7 Quality Objectives and Criteria for Measurement Data and Models

What are the quality objectives for this project? Define what model performance criteria and data quality acceptance criteria will be used to evaluate data/information including secondary data/information.
Demonstrate how the data acceptance criteria correspond to producing appropriate and credible model outputs. Specifically, precision, bias, representativeness and completeness

What assumptions are necessary for the modeling process?
Note any regulations, criteria, action levels that are relevant to the model outcomes.

How will modifications to model code be made and provided to users of the model?

If model selection is required, describe the suitability of the various models to resolve the project issue. Areas to be evaluated are:

- *Mapping model attributes to project problem/issue*
- *Degree of certainty needed in model outputs*
- *Amount of reliable data, available resources and technical expertise*

If the model is to determine the best corrective action then

Define the base line conditions: what are the specific conditions, parmaters, values that define the baseline condition.
Define the terms and criteria to conduct the comparison.
What statistical tools will be used to determine the level of differences in the approaches?

Simulation Scenarios: Outline how simulation scenarios take into account what is known from the sensitivity analysis.

Document use of literature searches, calculations or other resources to "ground truth" the model outputs.

1.7.1 Objectives and Project Decisions

Identify the scope of the project.
Elements of the model with supporting science need to be outlined using words, diagrams, or graphs.
Include statement(s) of the general objectives and demonstrate knowledge of the overarching purpose for the project. Phrase decisions in terms of "…if…then…" type of statements.

1.7.2 New Data Measurement Performance Criteria/Existing Data Acceptance Criteria

Describe the data quality needed to support project decisions. Discuss the data quality indicators (DQIs) and the acceptance criteria/measurement performance criteria for each DQI, and identify the quality control (QC) or other mechanism to be used to assess if the criteria were met.

Identify how acceptance/performance criteria will be established for:
Existing data (including when data is deemed outdated or otherwise excluded)
Model parameterization (calibration)
Model corroboration (validation)
Model sensitivity analysis: identify when sensitivity analysis will be performed (early in the process and throughout model development.)
Model uncertainty analysis

1.8 Special Training Requirements/Certification

Identify and describe any specialized training or certification requirements. Discuss how such training will be provided, as well as how and where the training records will be documented.

Indicate the personnel responsible for assuring that these tasks are satisfied.

1.9 Documents and Records

Summarize the type of information necessary to be included in report packages, including electronic data deliverables.

Describe the format for reporting of model parameterization, model inputs and model output.

Identify any other project records to be maintained, how/where the records will be stored, and the length of time of storage. This should include information generated in assessment/oversight reports, interim progress/status reports and final reports, including:

Technical reviews, model tests, data quality assessments of output data and results;
Candidate model assessments for model selection, including references;
Actual input used and databases used;
Pre- and post-software development information;
Spreadsheet data files containing monitoring data; and
Copy of modeling reports

Describe the type of information to be included in the final reports (for example: if it will be summarized in a data base and/or Excel spreadsheet with all supporting information to be retained in a project file). Discuss back up plans for records stored electronically.

1.9.1 QA Project Plan Distribution

Describe the process and responsible individual for distributing the most current approved QAPP, as well as any revisions/updates, to appropriate project staff (see Section 1.4).

2.0 DATA GENERATION AND ACQUISITION

2.1 Data Acquisition Requirements (Non-Direct Measurements)

Identify the range of data sources, for example, computer databases or literature files, and/or models that may be accessed and used. Describe the intended use of this information and the rationale for their selection, i.e., its relevance to the QAPP Objectives.

Identify how acceptance criteria will be established for all previously collected information. Discuss precision, bias, representativeness, completeness and how it will be assessed in relation to model performance criteria.

Identify any types of data needed (for project implementation or decision making) that may be obtained from non-direct measurement sources such as existing data from another project, photographs and maps, literature files, and historical databases.

Discuss procedures to ensure that data used are not outdated and that there is consistency when excluding data and in documentation of excluded data.

Identify key resources/support facilities needed.

2.2 Data Management

Describe how the data will be managed, tracing the path of data generation in the field or laboratory to final use or storage.

Describe or reference the standard record-keeping procedures, and discuss the approach to be used for data storage and retrieval of electronic media.

Discuss the plan for detecting and correcting errors from conversion of data (e.g. metric/english, units-to-units, significant figures, etc.) as well as for preventing loss of data during reduction, reporting, and entry to forms, reports, and databases.

Identify and describe all data handling equipment and procedures to process, compile, analyze and interpret the model data, including any necessary computer hardware and software. Address any specific data management performance requirements and describe the procedures that will be followed to demonstrate acceptability of the necessary hardware/software configuration.

Identify who is responsible for each data management task.

3.0 ASSESSMENT AND OVERSIGHT

3.1 Assessments/Oversight and Response Actions

Describe the assessments to be performed Aduring@ the project to ensure activities are being conducted as planned. State the frequency and purpose of each assessment, along with the success/acceptance criteria for each assessment proposed. List the approximate schedule or timing of activities, and identify potential organizations and participants.

Define the scope of authority of the assessors, including stop work orders. Discuss how response actions to non-conforming conditions shall be addressed and by whom. Define the conditions under which the assessors are authorized to act.

Describe how and to whom the results of the assessments shall be reported. Indicate that a summary of the assessments will be provided in the modeling report and kept in a modeling journal.

Provide examples of any forms or checklists to be used to document assessments and response/corrective action activities.

Peer review of the model will be conducted by _____ to ensure that the model is technically adequate, properly documented and meets established quality requirements through the review of assumptions, calculations, extrapolations, methodology, and acceptance criteria.

Commented [RG7]: Reviewer should be independent of the developer. Reviews should be conducted from early on in the project to identify any issues with approach.

4.0 MODEL APPLICATION

4.1 Model Parameterization (Calibration)

Describe the range of calibration performance measures that will be applied.

Identify the critical activities and qualitative and quantitative methods for model calibration. Examples of calibration activities; processing calibration data, decoupled calibration and sub-area calibration. Examples of calibration methods are graphical, deviance, mean error, mean square error, automatic optimization, pure random search, multi-start and clustering methods.

Describe how one or more criteria will be established to determine when to stop model parameterization (calibration).
Describe activities and methods for parameter estimation and criteria for defaulting to non site-specific data.

Describe how parameters used for calibration will be selected and how parameters to be kept constant shall be determined. Describe how parameters considered statistically important to the prediction process (and included as model inputs) will be determined. Describe how the calibration uncertainty and soundness of calibration will be determined and how they will be related to calibration performance measures.

Discuss the activities and methods (e.g., Morris's One-at-a-Time, differential analyses, Monte Carlo analyses and variance-based methods, etc.) that will be used for conducting sensitivity analyses.

Identify how records of model parameterization (calibration) and corroboration (validation) will be maintained.

Identify how deficiencies should be resolved and documented.

4.2 Model Corroboration (Validation and Simulation)

Describe the qualitative and quantitative (statistical) methods to be used for model corroboration (validation). Note how the process for documenting the model validation. A few examples of validation activities might include setting up test schemes and performance criteria to focus the simulations, processing validation data and performing validation tests. A few examples of validation methods might include graphical methods, deviance methods and statistical tests for bias and precision.

Describe how model corroboration (validation) performance measures will be established.

Commented [RG8]: Options for model validation; test cases – run the model using a project with known data and outcomes, compare model results with data collected in the field, sensitivity analysis, what parameters drive model results, model resolution capabilities- identify the level of spatial, temporal and demographic information needed for model application

Describe how the soundness of validation (for example, professional judgment) and validation uncertainty will be evaluated (for example, error propagation, regression techniques and Monte Carlo simulation.)

Describe how the soundness of model simulations (for example, internal quality assurance, peer review and practical experience based evaluations) and simulation uncertainty will be determined.

Describe the use of independent data sets for model parameterization and corroboration. Note how issues will be resolved and who has authority to resolve such issues.

Include any forms or checklists to be used in an appendix/attachment. All associated criteria identified in the documentation should be consistent with and/or supportive of the model quality objectives and performance criteria.

4.3 Reconciliation with User Requirements

Describe how the results (which have already been reviewed, verified, and validated/evaluated) obtained from the project will be reconciled with the project objectives and performance criteria/acceptance criteria.

Outline the proposed methods to analyze the modeling results and to determine possible anomalies or limitations on the use for the intended purpose. Outline how departures from assumptions established in the planning phase of the modeling process will be assessed.

Describe how anomalies will be resolved. Discuss how limitations on the use of the data from anomalies and departure from assumptions will be reported to decision makers.

4.4 Reports to Management

Identify the frequency and distribution of reports issued to inform management of the status of the project, results of performance evaluations and systems assessments, results of data quality and modeling evaluations, and any significant quality assurance problems and recommended solutions.

Document how information will be communicated between model developers and users during development.

Identify the preparer and the recipients of the reports, and any specific actions management is expected to take based on the reports.

5.0 REPORTS

Describe the content of modeling reports as including each of the following:

Introduction and Background

Purpose of Modeling/Modeling Objectives
Scope and Approach for Each Model Used (including):
Physical Setting (and Hydrology, if applicable)

Observational Data Used to Support Modeling
Quality of Acquired Data (and references to data quality reports)
Achievement in Meeting Data Acceptance Criteria
References to Monitoring Data
Discussion on Excluded Data and Basis for Exclusion

Description of Model (including):
Documentation of Candidate Model Assessments

Model Configuration (discusses how model was applied, including):
Spatial and Temporal Resolution
Nature of Grid, Network Design or Sub-watershed Delineation
Application of Sub-models
Model Inflows, Loads and Forcing Functions
Key Assumptions (and associated limitations, if any)
Changes and Verification of Changes Made in Code

Model Parameterization (Calibration) and Corroboration (Validation)
Objectives, Activities and Methods
Parameter Values and Sources
Rational for Parameter Values Estimated in the Absence of Data
Calibration Variables and Targets
Measures of Calibration Performance
Calibration Input, Output and Results Analysis
Model Validation Results

Model Use Scenario Analysis and Results (should relate to purpose)
Output of Model Runs and Interpretation
Summary of Assessments and Response Actions, if any
Soundness of the Calibration, Validation and Simulations
Review of Initial Assumptions and Model Suitability Evaluation

Performance Against the Performance Criteria Including:
Model Parameterization (Calibration) and Corroboration (Validation)
Model Sensitivity and Uncertainty Analyses

Pre- and Post-Processing Software Development

Maps, Photographs and Drawings

Deviations from the QAPP Including a List of Non-Applicable Reporting Elements with Explanations

Conclusions, Recommendations, References and Appendices

6.0 REFERENCES

APPENDIX A - EPA Council for Regulatory and Environmental Modeling (CREM) Guidelines for Model Development

Note: ***Detailed guidance on model development, evaluation and application may be found in the EPA Council for Regulatory and Environmental Modeling (CREM) document at the following address:*** **http://www.epa.gov/crem/library/cred_guidance_0309.pdf**

Summary of Recommendations for Model Development

►Regulatory models should be continually evaluated as long as they are used.
►Communication between model developers and model users is crucial during model development.
►Each element of the conceptual model should be clearly described (in words, functional expressions, diagrams, and graphs, as necessary), and the science behind each element should be clearly documented.
►When possible, simple competing conceptual models/hypotheses should be tested.
►Sensitivity analysis should be used early and often.

►The optimal level of model complexity should be determined by making appropriate tradeoffs among competing objectives.
►Where possible, model parameters should be characterized using direct measurements of sample populations.
►All input data should meet data quality acceptance criteria in the QA project plan for modeling.

Introduction
Model development begins after problem identification i.e., after identification that an environmental problem needs to be addressed and after determining that models may provide useful input for the decision making needed to address the problem. In this guidance, model development comprises the steps involved in (1) confirming whether a model is, in fact, a useful tool to address the problem; what type of model would be most useful; and whether an existing model can be used for this purpose; as well as (2) developing an appropriate model if one does not already exist. Model development sets the stage for model evaluation, an ongoing process in which evaluates the appropriateness of the existing or new model to help address the environmental problem.

Model development can be viewed as a process with three main steps: (a) specify the environmental problem (or set of issues) the model is intended to address and develop the conceptual model, (b) evaluate or develop the model framework (develop the mathematical model), and (c) parameterize the model to develop the application tool. Model development is a collaborative effort involving model developers, intended users, and decision makers (the "project team"). The perspective and skills of each group are important to develop a model that will provide an appropriate, credible, and defensible basis for addressing the environmental issue of concern.

A "graded approach" should be used throughout the model development process. This involves repeated examination of the scope, rigor, and complexity of the modeling analysis in light of the intended use of results, degree of confidence needed in the results and resource constraints.

APPENDIX B – QAPP Guidelines for Use of Models for Comparative Purposes

Occasionally, comparative modeling is used, for example, to evaluate potential water flow and water quality benefits from combinations of storm water management practices and designs that have yet to be implemented. A cost benefit analysis of varying designs and design combinations may be the basis for this type of modeling. In these types of instances, the following should be addressed in the quality assurance project plan (QAPP) and included in a report.

- Definition of the Base Line Conditions - the specific conditions, parameters and values that define the baseline condition.
- Criteria for Comparisons - the terms for comparing the model simulation results to the base line condition. For example, the terms may be found in quantities or percentages of runoff, infiltration or storm water contaminant loads.

- Identify Significant Change from Baseline - the application of statistical tools and criteria used to determine if there are significant differences between the baseline condition and model simulation results.
- Identify Simulation Scenarios from Sensitivity Analysis - how the simulation scenarios take into account what is understood from the model sensitivity analysis.
- Corroboration of Model Outputs - use of literature searches, calculations and, for example, the growing number of storm water performance databases to "ground truth" the projected water flow and/or water quality benefits from storm water management designs. Some examples include the following:

EPA Urban Best Management Practices Performance Tool
http://cfpub.epa.gov/npdes/stormwater/urbanbmp/bmpeffectiveness.cfm

University of New Hampshire Stormwater Center
http://www.unh.edu/erg/cstev/pubs_specs_info.htm

University of Massachusetts Stormwater Technologies Clearinghouse http://www.mastep.net/

International Stormwater Database http://www.bmpdatabase.org/

National Pollutant Removal Performance Database, September 2007
http://www.cwp.org/Downloads/bmpwriteup_092007_v3.pdf

Center for Watershed Protection http://www.cwp.org/PublicationStore/special.htm#pollut2

Boston Metropolitan Area Planning Council - Massachusetts Low Impact Development Tool Kit
http://www.mapc.org/regional_planning/LID/LID_Links_References.html#national

EPA Low Impact Development Literature Review http://www.epa.gov/owow/nps/lid/lid.pdf
and: http://newmoa.org/prevention/webconferences/stormwaterweb/stormwaterresources.pdf

APPENDIX C - Useful Project Plan Guidelines for Model Evaluation and Documentation

The following list provides additional useful project plan specifications, as appropriate, for model evaluation and documenting the results of model evaluation as conducted during model development and application (EPA 2009, NRC 2007):

Peer review. Document any critical review of a model or its application conducted by qualified individuals who are independent of those who performed the work, but who collectively have at least equivalent technical expertise to those who performed the original work. Peer review attempts to ensure that the model is technically adequate, competently performed, properly documented, and satisfies established quality requirements through the review of assumptions, calculations, extrapolations, alternate interpretations, methodology, acceptance criteria, and/or conclusions pertaining from a model or its application (modified from EPA 2006a).

To be most effective and maximize its value, external peer review should begin as early in the model *development* phase as possible (EPA 2006b). Because peer review involves significant time and resources, these allocations must be incorporated into components of the project planning and any related contracts. Peer review in the early stages of model development can help evaluate the conceptual basis of models and potentially save time by redirecting misguided initiatives, identifying alternative approaches, or providing strong technical support for a potentially controversial position (SAB 1993, EPA 1993). Peer review in the later stages of model development is useful as an independent external review of model code (i.e., model verification). External peer review of the *applicability* of a model to a particular set of conditions should be considered well in advance of any decision making, as it helps avoid inappropriate applications of a model for specific regulatory purposes (EPA 1993).

Test cases. Provide for basic model runs where an analytical solution is available or an empirical solution is known with a high degree of confidence to ensure that algorithms and computational processes are implemented correctly.

Corroboration of model results with observations. Include comparison of model results with data collected in the field or laboratory to assess the model's accuracy and improve its performance.

Benchmarking against other models. Include comparison of model results with other similar models.

Sensitivity and uncertainty analysis. Conduct investigation of the parameters or processes that drive model results, as well as the effects of lack of knowledge and other potential sources of error in the model.

Model resolution capabilities. Identify the level of disaggregation of processes and results in the model compared to the resolution needs from the problem statement or model application. The resolution includes the level of spatial, temporal, demographic, or other types of disaggregation.