Quality Assurance Project Plan

Hydraulic and Hydrologic Modeling

Title

[Month, Year]

[Ecology Grant Number]

Document Information

Each study funded by the Washington State Department of Ecology must have an approved Quality Assurance Project Plan (QAPP). The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. This QAPP describes a project selected by the [Ecology grant program name], Agreement Number [SEAXXX-XXXX-XXXXX-XXXX] and is valid 5 years from the date of approval.

Contact Information

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Template adapted by SEA Program Flood Unit, last formatted: 8-10-23.

Purpose: This QAPP template is tailored to hydraulic and hydrologic studies only. Larger studies with environmental data collection (e.g. groundwater or water quality sampling) should use the standard QAPP template from Ecology's quality assurance for grantees website.[1]

Each grant project requires coordination with the Ecology Quality Assurance (QA) Coordinator during the Agreement development phase. Projects may not begin until correspondence from the QA Coordinator confirms any QA documentation requirements.

Instructions for authors:

- Include all sections. Where appropriate, write "Not applicable" and explain why.
- Fill in the highlighted text.
- Delete all red text (including this page) before submitting your QAPP. Also delete all comments.
- Use the Styles built into Word to apply formatting.
- Readability recommendations:
    - Limit paragraphs to 10 lines or less.
    - Avoid long sentences (more than 17 words).
    - Add subheadings to sections of text longer than one page. Format subheadings with built-in styles using the style ribbon.
    - Use acronyms only as necessary and always define on first use.
    - Use active voice as much as possible, especially in the Abstract and Background.

[1] https://ecology.wa.gov/issues-and-local-projects/investing-in-communities/scientific-services/quality-assurance/quality-assurance-for-nep-grantees

Quality Assurance Project Plan

Title

Agreement No. 20XX-XXXX

by author(s)

Month Year

Approved by:

Signature:	Date:
QAPP Author's Name, Title, Organization	
Signature:	Date:
Modeling Project Manager's Name (if different from QAPP Author), Title, Organization	
Signature:	Date:
Recipient Project Manager's Name (if different from QAPP Author), Title, Organization	
Signature:	Date:
Ecology Grant Project Manager's Name, Title, Department of Ecology	
Signature:	Date:
Amy Yahnke, SEA Program Quality Assurance Coordinator, Department of Ecology	

1.0 Table of Contents

List of Figures

List of Tables

2.0 Background and Objectives

2.1 Introduction and problem statement

Provide historical and scientific perspective on the project and explain why the project is needed. Describe the decisions to be made, actions to be taken, or outcome expected from the information obtained from modeling activities.

2.2 Objectives

Describe specific activities you want to accomplish, preferably in list form. Use quantitative targets where possible. Examples include to:

- Analyze historic precipitation and stream-gage data to establish a flow-rating curve
- Simulate effects of project elements (e.g., side channel, seback levee) on flood elevations
- Perform two dimensional modeling to show the extents of flood inundation

2.3 Study area and context

Provide a brief description of the study area. Include relevant features such as climate, geology, topography, hydrologic regime, unique features of the landscape, human uses, and relevant history. Figure 1 should reflect these descriptions.

{Insert figure here and modify figure caption below as needed.}

Figure 1. Map of study area.

2.4 Summary of previous studies and existing data

Describe the existing studies, (e.g. a FEMA Flood Insurance Study), and existing data that will be used in the study (e.g. USGS gage data, lidar).

3.0 Organization and Responsibilities

3.1 Key individuals and their responsibilities

List the names, affiliations, and the responsibilities of those who will be involved in this project. Include the Ecology Project Manager, Recipient Project Manager, Ecology SEA Program Quality Assurance Coordinator, and any consultants or staff with project responsibilities relative to this QAPP study.

{Modify table and caption below as needed.}

Table 1. Project staff and responsibilities.

Staff	Title	Responsibilities
Name Organization Email	Recipient Project Manager	Develops scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Name Organization Email	Ecology Grant Project Manager	Reviews draft QAPP, coordinates with Ecology SEA Program QA Coordinator for review and approval.
Name Organization Email	Modeling Project Manager	Oversees development of models and performs QA review of data and modeling. Approves final model and reporting.
Name Organization Email	Project engineer	Writes the QAPP. Collects and/or analyzes data and develops models under the supervision of the modeling project manager. Writes the draft report and final report.
Amy Yahnke Department of Ecology ayah461@ecy.wa.gov	Quality Assurance Coordinator, SEA Program	Reviews and approves the draft QAPP and the final QAPP.

3.2 Special training and certifications

Describe relevant experience, training, and certifications of key project personnel. Examples include: engineering or surveying licensure, experience with modeling software and H&H analyses, training related to conducting complex analysis, and/or experience collecting terrain or hydraulic data.

3.3 Tasks required

List project tasks—the specific activities planned to address each objective or obtain the needed information. Include a general overview of the various pertinent work activities (such as: work to be performed in model creation or application, measurements/analyses, data evaluation, etc.), and products/reports to be generated.

3.4 Proposed project schedule

List key activities, due dates, and lead staff for this project. Discuss resource and time constraints, if applicable.

{Modify table and caption below as needed.}

Table 2. Schedule

Task	Due date	Lead staff

3.5 Budget and Funding

List the funding sources and amounts for the study. You may refer to the Ecology grant Agreement if all the pertinent details for the modeling/analysis tasks are included.

4.0 Study Approach

4.1 Overview

Provide a brief overview of the modeling scenarios, inputs, and outputs. For more complex projects, explain any data collection needs, additional analyses outside of the model(s), linkages between multiple models, and other relevant efforts.

4.2 Information needed and sources

List each of the parameters of interest. Summarize the types and sources of existing data to be assembled and all new data to be collected that will address project objectives. Include data gaps and the plan for addressing them.

4.2.1 Data Quality

Existing data that are provided by an agency with established quality management system, such as the USGS, generally does not require data quality evaluations in the QAPP phase. However, if there are any concerns or uncertainties about data quality, they should be documented here.

For new data to be collected or data with concerns or uncertainties, describe the parameters, the organization collecting the data, and quality assurance of that data. Summary tables are recommended to include parameter, methodology, frequency, data collection organization, period of record, and quality assurance information for the data. Key data collection points or areas should be depicted on a map, such as gaging stations, weather stations, lidar, or survey locations.

List the standard operating procedures (SOPs) that will be followed for data collection, analysis, and reporting. For a list of Ecology-published SOPs related to ambient river and streamflow monitoring and watershed health monitoring activities, see https://ecology.wa.gov/About-us/How-we-operate/Scientific-services/Quality-assurance. Any new SOPs generated for the project should be included in an appendix.

4.3 Model selection

Describe what approach will be taken for the hydraulic and/or hydrologic modeling and why the modeling software was chosen. Include the methodology to be used and technical reference materials.

Some of the factors that may influence the selection of a model framework include:

- Fit between model capabilities and project needs
- Proprietary vs non-proprietary software
- Model pedigree (e.g., widespread use) and support community
- Capability to simulate all processes of interest
- Familiarity of model developers with the tool
- Complexity of the problem/tool/products

- Data needs relative to available data

4.4 Model Development

4.4.1 Model Setup

Describe the level of model process complexity appropriate to meet project objectives. Identify, to the extent possible, the various simulations that will be run or the specific scenarios that will be tested using the model.

4.4.2 Boundary conditions

Include a map of the study area and description of the spatial domain of the model(s). Describe the boundary conditions represented in the model, including tributaries, inflows, outflows, precipitation, etc.

4.4.3 Spatial and temporal resolution

Describe the spatial and temporal resolution of the model(s). For gridded models, the spatial resolution is defined by the sizing of the computational cells, whereas one dimensional models are defined by cross sections. Resolution may be adapted as the model is developed based on an evaluation of errors and inconsistencies. Describe the rationale for setting up the grid or cross sections and the plan for adapting these parameters after initial model runs.

Include the time steps anticipated for use in modeling scenarios and rationale.

4.4.4 Time frame of simulation

Identify the time frame that will be simulated by the model(s). This may include storm events or inflow hydrographs.

4.4.5 Assumptions

Identify assumptions in the modeling process. Models are a combination of theory, observations, and assumptions that represent the best available understanding of the waterbody. Modeling software incorporates mathematical or empirical equations and the variables are driven by the available data in the watershed. Describe the likely assumptions used in the modeling process to the extent possible.

4.4.6 Model calibration

Describe the plan for model calibration, such as comparing simulated flows to measurements from observed flood events. Calibration can be an interative process, but the general sequence of taks can be identified. Describe the elements of the model that are likely to be important in the calibration process.

5.0 Data Management Procedures

5.1 Documentation and reporting

Describe how the modeling process and results will be reported. Information in a QAPP is not only relevant to the initial planning of the project but remains relevant in the final documentation of the model. In fact, much of the information in a QAPP should be incorporated into the final documentation. In this sense, the QAPP is the first draft of the final model development report. The sequence of topics covered in this guidance can be used as a table of contents template not only for the QAPP but also for the opening chapters of the final model development report.

The use of models in the regulatory arena requires more detailed documentation (such as for a Letter of Map Revision). The expected sequence of the documentation process should be considered in the project scoping and schedule.

5.2 Model information management

Describe how modeling information will be managed, including data gathering, organizing, and sharing. This should include, at a minimum:

- The volume of input and output data expected
- Input and output data storage needs
- Version control
- Mapping post-processed model outputs to the appropriate version of the model.

6.0 References

Most QAPPs refer to studies, reports, SOPs, and scientific literature. Include these references in this section. Spell out all journal names. Add URLs and DOIs wherever possible.

Below are examples of common types of references. Delete all of the following references that aren't cited in your QAPP.

Ecology, 2019c. Quality Assurance at Ecology. Environmental Assessment Program, Washington State Department of Ecology, Olympia. https://ecology.wa.gov/About-us/How-we-operate/Scientific-services/Quality-assurance.

England, J.F., Jr., Cohn, T.A., Faber, B.A., Stedinger, J.R., Thomas, W.O., Jr., Veilleux, A.G., Kiang, J.E., and Mason, R.R., Jr., 2018, Guidelines for determining flood flow frequency—Bulletin 17C (ver. 1.1, May 2019): U.S. Geological Survey Techniques and Methods, book 4, chap. B5, 148 p., https://doi.org/10.3133/tm4B5

Janisch, J., 2006. Standard Operating Procedure for Determining Global Position System Coordinates, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP EAP013. Published SOPs.

Sullivan, L., 2007. Standard Operating Procedure for Estimating Streamflow, Version 1.0. Washington State Department of Ecology, Olympia, WA. SOP EAP024. Published SOPs.

USACE, 2023. HEC-RAS Software Documentation, U.S. Army Corps of Engineers Hydrologic Engineering Center. Available from https://www.hec.usace.army.mil/software/hec-ras/documentation.aspx.

USEPA, 2016. Guidance for Quality Assurance Project Plans for Water Quality Modeling Projects, EPA 910-R-16-007. U.S. Environmental Protection Agency Region 10, Seattle, WA. Available at: https://19january2021snapshot.epa.gov/sites/static/files/2020-02/documents/wq_modeling_qapp_guidance_region_10_dec_2016.pdf

7.0 Glossary, Acronyms, and Abbreviations

Glossary of General Terms

Delete all terms that don't apply to this QAPP and add other terms as needed.

Bankfull stage: Formally defined as the stream level that "corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels (Dunne and Leopold, 1978).

Baseflow: The component of total streamflow that originates from direct groundwater discharges to a stream.

Hydraulic model: a mathematical model of a fluid flow system that uses physical attributes and equations to simulate flow conditions and analyze hydraulic behavior.

Hydrology: the science that encompasses the occurrence, distribution, movement and properties of the waters of the earth and their relationship with the environment within each phase of the hydrologic cycle.

Hyporheic: The area beneath and adjacent to a stream where surface water and groundwater intermix.

Riparian: Relating to the banks along a natural course of water.

Salmonid: Fish that belong to the family *Salmonidae*. Species of salmon, trout, or char.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Streamflow: Discharge of water in a surface stream (river or creek).

Thalweg: The deepest and fastest moving portion of a stream.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and Abbreviations

Delete all of the following that aren't used in this QAPP and add other acronyms that aren't listed below.

e.g.	For example
Ecology	Washington State Department of Ecology
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System software
GPS	Global Positioning System
HEC-RAS	Hydrologic Engineering Center, River Analysis System
i.e.	In other words
QA	Quality assurance
QC	Quality control
RM	River mile
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area

Units of Measurement

Add any additional units of measurement used in the QAPP.

cfs	cubic feet per second
cms	cubic meters per second
ft	feet
in	inches
kcfs	1000 cubic feet per second
km	kilometer, a unit of length equal to 1,000 meters
m	meter
mm	millimeter