

Memorandum

Date: February 25, 2020

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From: Jacob Krall and Rob Annear, Geosyntec Consultants

Subject: Review of Ecology Green/Duwamish River Watershed Pollutant Loading Assessment Quality Assurance Project Plan

INTRODUCTION

This memorandum summarizes a review of the Washington State Department of Ecology (Ecology) Green/Duwamish River Watershed Pollutant Loading Assessment (PLA) Quality Assurance Project Plan (QAPP). The focus of this review is on the watershed modeling goals and objectives as outlined in the QAPP, the Data Quality (Usability) Assessment and the extent to which the QAPP describes the scope and content of model documentation.

REVIEW OF STATED GOALS AND OBJECTIVES

- The QAPP includes sections for PLA project goals, watershed modeling goals, PLA project objectives and Watershed modeling objectives. The section entitled Watershed modeling objectives (Section 4.2.2) itself has a subsection (Section 4.2.2.2) also called Watershed modeling objectives. Overall, the goals and objectives sections are difficult to follow. We recommend the document clearly state the difference between “goals” and “objectives” for this context and ensure that these sections do not overlap in content.
- The watershed modeling questions (Section 4.2.2.1) are specific and well defined. We recommend a greater focus on these specific questions that the model will be designed to answer, such as “What is the contribution of contaminant loadings coming from Howard Hanson Dam versus downstream sources?” The QAPP should be focused on how it will be ensured that the model will be an appropriate tool to answer these questions.
- The watershed modeling objectives subsection (Section 4.2.2.2) includes the objective “Characterize the watershed to estimate loadings from pollutant-generating sources and the pathways pollutants can take.” The first part of this objective (“characterize the watershed to estimate loadings from pollutant-generating sources”) is appropriate and well stated.

However, the second part “and the pathways pollutants can take” seems to mix qualitative and quantitative evaluations. Which specific pathways will be evaluated and quantified?

- Section 4.2.2.2 also includes the objective “Evaluate the effectiveness of proposed mitigation strategies.” We recommend specifically naming the mitigation strategies that will be considered.
- Section 4.2.2.2.9 is entitled “Summary of objectives,” but instead includes specific statements regarding how boundary conditions will be specified. For example, “Rates of atmospheric loadings of pollutants onto land will likely be applied as two distinct time series: higher loading rates for land within the LDW basin and lower rates for land in the Green River basin. The relative importance of background atmospheric loading rates can be compared to what is generated from stormwater and subsurface contributions.” Such statements would be more appropriate in a different section.

REVIEW OF DATA QUALITY (USABILITY) ASSESSMENT SECTION

- Section 14.0, Data Quality (Usability) Assessment states that “the primary model development goals are (1) to minimize the difference between simulated and observed hydrology, water/sediment quality and fish tissue concentration, and (2) to capture the spatial and temporal patterns in the observed environmental conditions.” We recommend restating this—model development goals should be based on key questions to be answered. While minimizing difference between observed data and model predictions as well as matching spatial and temporal patterns is important, we recommend referring to these as criteria for assessing how effective the model is at reproducing reality.
- We agree that model-data error statistics and plots are not the only way in which model quality is evaluated. It is acceptable that the QAPP does not suggest numerical targets that must be met. However, we still recommend comparing model statistics to reasonable targets (e.g. those described in Donigian, 2002¹) and, for cases where the model fails to meet these targets, clearly describe the reasons why the model error exceeds the target and why the key modeling questions can still be answered.
- The QAPP mentions that assessing the overall quality of a model goes beyond error statistics and graphical plots and includes “several parallel tasks to achieve overall model quality” alongside efforts to reduce model error. We agree with this in general but have concerns regarding the descriptions of the parallel efforts. The specific efforts mentioned are listed below, with our annotations:

¹ Donigian, A. S. "Watershed model calibration and validation: The HSPF experience." *Proceedings of the Water Environment Federation* 2002.8 (2002): 44-73.

1. *Incorporation of all available observations of the system (e.g., geometry, flow, boundary inputs/withdrawals, and meteorology) for the time period simulated.*

We disagree with this as a measure of model quality. While it is important to include appropriate inputs to the model, that does not mean including “all” available data—some data may be poor in quality, old or superseded, or otherwise not appropriate for inclusion.

2. *Reasonable estimation methods and assumptions to fill gaps in the observations.*

We agree that this is important.

3. *Calibration of model parameters and unmeasured boundary conditions within reasonable bounds to improve agreement between simulated and observed water quality.*

We agree that calibration is an important part of the modeling process. However, it is not clear how this step is in parallel with an effort to reduce model error—rather, calibration is the process of reducing model error through appropriate changes to model parameters and unmeasured boundary conditions.

4. *Identification of key parameters/processes through model calibration and sensitivity analysis.*

We agree that this is an important analysis, but it is not clear how identifying key parameters and processes is a measure of model quality.

5. *Clear communication of key assumptions during model development with the project team.*

As with #4, we agree that this is important, but it is not clear how this relates to a measure of model quality.

6. *Clearly written documentation of all important elements in the model, including model setup, boundary conditions, assumptions, and known areas of uncertainty.*

We agree that written documentation is critical; we recommend a full separate section of the QAPP describing and outlining the report and outlining the report that will be developed. We expand on this recommendation in the next section of this memorandum.

7. *Development of management scenarios to meet the project objectives.*

We agree that management scenarios are an important part of a modeling project—however, this is not related to model quality. Rather, a model that is accurate enough to

evaluate which mitigation strategies are effective is a prerequisite before evaluating management scenarios.

8. *Peer review.*

Conducting an independent peer review is a valuable way of ensuring model quality. However, this should be done after the model has been developed and calibrated. As written, this section implies peer review will be done in parallel with model development and calibration.

REVIEW OF DESCRIPTIONS OF MODEL DOCUMENTATION

The QAPP includes the phrase “model development report” three times and also refers to documentation in several other places (including item #6, above, from the Data Quality (Usability) Assessment section). However, we recommend a separate section of the QAPP describing what will be included in the model development report, who will have the opportunity to review the report, and the process for revising the report. We recommend that the QAPP state clearly that the model development report will include the following sections:

- Executive Summary—it is important that the most important points of the modeling (purpose of the model, how it was developed, how well it matched measured data and the results of the management scenarios) be conveyed in a format that can be understood and utilized by non-modelers, including policy makers as well as the general public.
- Background—The background section of the approach should include an overview of the project site and a description of the key questions the model will answer. The report should also describe the goals and objectives from the finalized QAPP, either in the background section or in a separate section.
- Model Development—this should include a description of the model geometry, boundary conditions, initial conditions and parameters and how they were specified (e.g. datasets used and assumptions made).
- Model Calibration—this should be a description of which parameters were varied, the justification (e.g. literature, site-specific data) for the final values used, and plots and statistics showing how well the final model agrees with data.
- Model Validation—ideally, the model should be compared to at least one additional dataset not used during model calibration (without further model adjustment). This demonstrates that the model can accurately simulate reality for an appropriate range of conditions. The validation process should be described in the model development report.
- Sensitivity Analysis—As alluded to in item 4 of the previous section, the purpose of the sensitivity analysis should be to identify the parameters that most impact the model results.

This section of the model documentation should include which parameters were adjusted, how sensitive the model is to these parameters, and the implications for overall uncertainty as well as the confidence stakeholders can have in the answers to the key modeling questions and ability of the model to be used to evaluate mitigation strategies.

- Summary—the report should summarize clearly the purpose of the model and the key questions it is intended to be used to answer. This should help ensure the model is used for appropriate purposes and not to attempt to answer questions it was not built to answer.

SUMMARY

The QAPP document includes some well stated goals and objectives. Sections 4.1.1 and 4.2.2.1 are well written. The document could be improved by clearly stating the difference between goals and objectives in this context and then ensuring the appropriate sections clearly define the goals and objectives without overlap. We recommend significant revisions to the Data Quality (Usability) Assessment (Section 14) as well as expanding the descriptions of model documentation into a separate section and with additional detail.