Modeling Onsite Wastewater Systems at the Watershed Scale: A User's Guide

This user's guide provides direction on modeling watershed-scale scenarios associated with decentralized wastewater treatment systems, with a specific focus on onsite wastewater systems (OWS). The guide focuses on modeling transport and fate of the nutrients nitrogen (N) and phosphorus (P) because these are the most common OWS constituents of concern, and because both N and P are regulated in surface waters, while N is also regulated in groundwater. However, the information presented in the guide on model construction, sensitivity analyses, calibration, risk analysis, and scenario evaluations is also relevant for modeling other pollutants, such as pharmaceuticals, pesticides, and microbial pollutants.

This comprehensive guide provides resources and tools that will be helpful in the watershed planning process.

Decision makers can use the guide to determine whether relatively simple screening models are sufficient for use in the decision-making process, or if sophisticated models are more appropriate (Figure 1). The guide provides advice about the type of model that should be used for particular scenarios, and the data requirements for model implementation.

Modeling experts will particularly appreciate the guidance on important issues such as conceptual-model development, mathematical-model selection, model-sensitivity analyses, model uniqueness, and calibration.

Further, the guide provides both real and hypothetical case studies that demonstrate the usefulness of utilizing watershed-scale models, and provides templates for certain common scenarios relevant to the decentralized wastewater treatment community.

Why is There a Need for this Guide?

The U.S. EPA is promoting a watershed-scale approach with respect to permitting, mitigating, apportioning, or evaluating pollutant and nutrient loading from various sources. For that reason, watershed-scale models of varying complexity are important tools for making quantitative assessments.

Watershed-scale models have been increasingly applied to agricultural problems in the last decade, and mathematical models are frequently used to evaluate groundwater contamination problems. However, before now, models have rarely been applied to investigate important scenarios associated with OWS.

Models can be quite useful, however, when decision makers assess the relative risk to water quality associated with scenarios such as: allowing a large development to use individual or multi-housing OWS; planning for future land-use where OWS are involved with one or more land uses; or evaluating whether advanced treatment of N or P is warranted (i.e., additional treatment beyond that provided by a conventional OWS).

BENEFITS:

- Provides guidance for watershed model selection and use associated with onsite wastewater.
- Enables rigorous and defendable quantitative assessments of onsite wastewater systems performance at the watershed scale.
- Presents rigorous model implementation procedures, including obtaining input data, model sensitivity analysis, and model calibration.
- Provides examples of how to use model results to evaluate different watershed management scenarios.
- Provides relevant information for modeling nitrogen, phosphorus, and other pollutants, such as pharmaceuticals, pesticides, and microbial pollutants.

RELATED PRODUCTS:

Factors Affecting the Performance of Primary Treatment in Decentralized Wastewater Systems (04DEC7)

Guidance for Establishing Successful Responsible Management Entities (DEC5R06)

State of the Science: Review of Quantitative Tools to Determine Wastewater Soil Treatment Unit Performance (DEC1R06)

Performance Dynamics of Trace Organics in Onsite Treatment Units and Systems (DEC14U06)

Performance and Costs for Decentralized Unit Processes (DEC2R08)

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Who Will Find the Guide Most Useful?

This comprehensive guide provides resources and tools to help a variety of users in the watershed planning process. In particular, the guide is intended for:

- Planners/regulators who need to decide whether to implement a modeling solution to a watershed problem related to onsite wastewater systems (OWS).
- Professionals who will implement quantitative GIS methods to evaluate OWS impacts at the watershed-scale.
- Professional hydrologic modelers that implement watershed models.
- Hydrologists, scientists, OWS engineers, and GIS specialists who are not modelers, but who want to learn more about OWS and modeling methods. For example, the guide includes information on the philosophy of modeling and theory behind pollutant transport including N and P.

The chapter, "How to Use this Guide," directs each type of user to the appropriate sections, and suggests a reading order of the relevant sections to optimize the guide's usefulness.

What Model(s) Does this Guide Focus On?

It is not the intent of the guide to provide information relevant only to specific models, because this would be too restrictive. New models are developed regularly, and existing models are continually updated. Therefore, the guide provides advice relevant to classes of models, while relying on specific models, to demonstrate important practical concepts associated with model use, and to simulate case studies of relevant watershed-scale scenarios relevant to OWS. The watershed model WARMF, and the groundwater model Modflow-MT3D/RT3D, are readily available to the public at low cost, and can simulate the necessary processes. These models are used in the guide to demonstrate implementation of the more complex distributed watershed models for OWS.

An appendix presents a comprehensive review of watershed models that were evaluated for use in this research. The review includes relatively simple mass-balance models, GIS-based screening models, and spatially distributed numerical models.

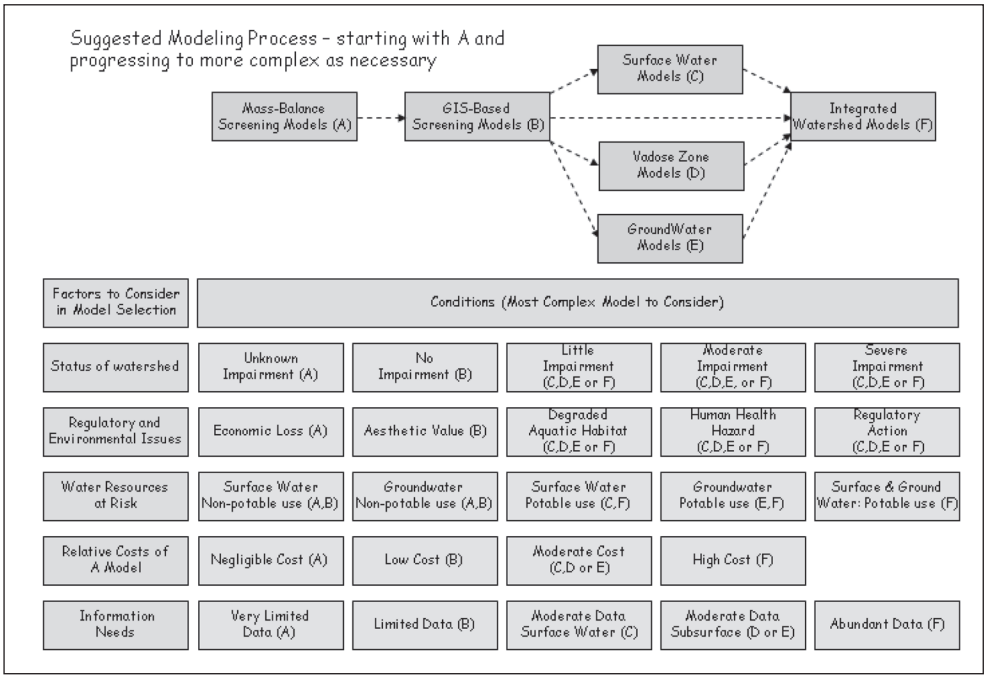

Figure 1. Model Type Selection Matrix.

CONTRACTOR

John E. McCray, Ph.D., P.G.
Colorado School of Mines

RESEARCH TEAM

Mengistu Geza, Ph.D.
Eileen P. Poeter
Colorado School of Mines

David Morgan, M.S.
U.S. Geological Survey

Kyle E. Murray, Ph.D.
University of Texas at San Antonio

PROJECT SUBCOMMITTEE

Ken Jones, Ph.D.
Green Mountain Institute for Environmental Democracy

W. Keith Taulbee, Ph.D.
U.S. Environmental Protection Agency

Lilit Yeghiazarian, Ph.D.
Department of Bioengineering, University of California, Los Angeles

Leanne Whitehead
Tennessee Valley Authority

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