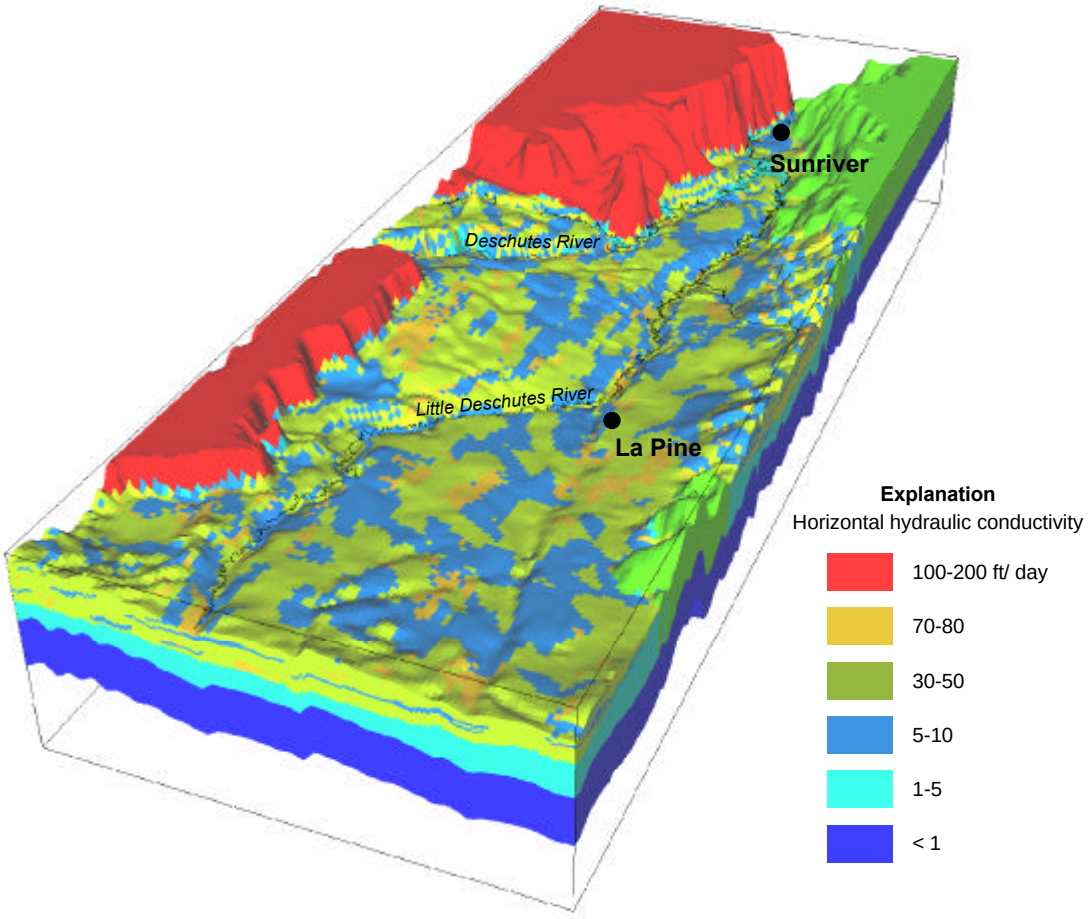
National Decentralized Water Resources Capacity Development Project

Executive Summary



Application of Simulation-Optimization Methods for Management of Nitrate Loading to Groundwater From Decentralized Wastewater Treatment Systems Near La Pine, Oregon

US Geological Survey
Oregon Water Science Center

July 2005

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Submitted by US Geological Survey Oregon Water Science Center

NDWRCDP Project Number: **WU-HT-03-37**

National Decentralized Water Resources Capacity Development Project (NDWRCDP) Research Project

Final Report, **July 2005**

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DISCLAIMER

This work was supported by the National Decentralized Water Resources Capacity Development Project (NDWRCDP) with funding provided by the U.S. Environmental Protection Agency through a Cooperative Agreement (EPA No. CR827881-01-0) with Washington University in St. Louis. This report has not been reviewed by the U.S. Environmental Protection Agency. This report has been reviewed by a panel of experts selected by the NDWRCDP. The contents of this report do not necessarily reflect the views and policies of the NDWRCDP, Washington University, or the U.S. Environmental Protection Agency, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

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The final report was edited and produced by ProWrite Inc., Reynoldsburg, OH.

This report is available online at www.ndwrcdp.org. This report is also available through the

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WWCDMG49

This report should be cited in the following manner:

Morgan, D. S. and R. Everett. 2005. *Simulation-Optimization Methods for Management of Nitrate Loading to Groundwater From Decentralized Wastewater Treatment Systems.* Project No. WU-HT-03-37. Prepared for the National Decentralized Water Resources Capacity Development Project, Washington University, St. Louis, MO, by US Geological Survey, Oregon Water Science Center, Portland, OR.

ACKNOWLEDGEMENTS

Appreciation is extended to the following individuals for assistance in the preparation of this report:

Deschutes County Community Development Department
Catherine Morrow
Peter Gutowsky
Dan Haldeman
Todd Cleveland
Tim Berg

Oregon Department of Environmental Quality
Barbara Rich
Rodney Weick

Appreciation is also expressed to the NDWRCDP for their support of this work:

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ABSTRACT

The objective of this project was to develop and demonstrate a method to estimate the optimal loading of nitrate from decentralized wastewater treatment systems to an aquifer. The method utilizes a simulation-optimization approach in which a nitrate fate and transport simulation model is linked to an optimization model. Using this method, maximum (optimal) sustainable loading rates that meet constraints on groundwater quality and nitrate loading to streams via groundwater discharge can be determined. This method enhances the value of a simulation model as a decision-support tool in developing performance-based standards for onsite systems that will protect the quality of groundwater resources.

The method was demonstrated in conjunction with the National Onsite Demonstration Project (NODP) in the community of La Pine in southern Deschutes County, Oregon. The La Pine NODP has developed an extensive knowledge base on the hydrogeology of the shallow groundwater system, dynamics of nitrogen fate and transport, and performance of standard and new technologies for onsite wastewater treatment in this setting. One of the many products of the NODP was a nitrate fate and transport simulation model that could be used to test the optimization approach.

The La Pine nitrate loading management model (NLMM) was developed by linking the simulation model to an optimization model using the response-matrix technique. The NLMM was used to determine the minimum nitrate loading reductions that would be required in 97 management areas to meet specified water-quality constraints. Constraints can be set on groundwater nitrate concentration, discharge of nitrate to streams, and maximum or minimum loading reductions in management areas. Minimum loading reductions are determined for existing and future onsite systems. Cost factors can be applied to the optimization if the cost of reducing loading favors reductions for existing or future homes. The NLMM was used to perform trade-off analyses on the cost in terms of increased loading reductions required to meet more stringent water quality criteria. The role of the NLMM in the planning process for La Pine, Oregon, as well as considerations for application of the optimization method to other areas are described.

Printed on recycled paper in the United States of America.

WU-HT-03-37

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