Design Objectives:
Wood River Valley Aquifer System Groundwater-Flow Model

Draft by the USGS/IDWR Modeling Team
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The Idaho Department of Water Resources (IDWR) and the United States Geological Survey (USGS) have entered into a cooperative study in order to develop a numerical groundwater-flow model of the Wood River Valley Aquifer System (WRVAS). This groundwater-flow model is being developed by the USGS in close collaboration with IDWR staff and is intended for use as a tool to assist water-resource managers and planners in administration and management of water resources in the Wood River Valley. The model will advance understanding of hydrologic processes in the Wood River Valley and similar alluvial valleys undergoing intensive development. The model *will not* be suitable for evaluating localized well-to-well effects.

Design objectives

A groundwater-flow model should be constructed so that it is suitable for the intended uses and may adequately address the problems posed. The design objectives of the WRVAS numerical groundwater-flow model are to:

❖ Provide a basis for conjunctive administration and conjunctive management

Water-rights administration is the allocation and enforcement of water rights under the prior appropriation doctrine. Conjunctive administration is based on the principle that ground- and surface-water are interconnected, thus water rights authorizing diversions from surface water and groundwater are administered as withdrawals from a common resource. To this end, the model will serve as a tool for simulating and quantifying: (1) the effects of withdrawals from different depths in various parts of the valley on surface water; (3) the effects associated with point-of-diversion transfers; (4) proposed mitigation requirements; and (4) possible curtailment effects.

Conjunctive management seeks to optimize the beneficial use of groundwater and surface-water resources by means other than the administrative process. The model will be used by the IDWR to evaluate potential WRVAS management options on a valley-wide basis.

❖ Represent the current understanding of the Wood River Valley aquifer system in order to simulate and quantify recharge to, flow through, and discharge from the aquifer on a valley-wide scale

Groundwater-flow models integrate a number of data sets including hydrology, geology, and land use to provide insights into such processes as aquifer recharge and discharge, aquifer hydraulic properties and boundary conditions, groundwater levels, streamflow, and water chemistry. Thus a groundwater-flow model not only furthers the understanding of the aquifer, it also integrates these data sets and acts as a repository for these data.

In terms of volume, the movement of water between the groundwater and surface-water systems is one of the most important hydrologic processes operating in the Wood River Valley. To this end, gaining and losing reaches of the Big Wood River, Silver Creek, and tributary streams will be delineated; contribution from tributary basins will be estimated as reliably as possible, and seasonal exchange of groundwater and surface water will be quantified for inputs to the model. The model will be developed using the collected data to simulate groundwater movement in the WRVAS including the interaction of groundwater and surface water.

The model will be calibrated to transient hydraulic conditions on the basis of current and historical data using automated parameter estimation methods. The model grid, representation of the physical boundaries, steady-state conditions, and calibration period for the transient model will be recommended by the Modeling Team and presented to the Modeling Technical Advisory Committee.

System responses to hypothetical variations in aquifer recharge, groundwater withdrawals, surface-water operations, and other model conditions will be investigated. A predictive uncertainty analysis (Doherty and others, 2010) will be performed in order to understand the effects of parameter uncertainty on model predictions. The model will be designed to evaluate stresses on the surface-water system (but with limitations of scale). The Modeling Team will clearly state the limitations of the WRVAS groundwater-flow model in the final report.

❖ Provide an improved understanding of the aquifer system and guide future investigations

The WRVAS groundwater-flow model will provide transferable information that advances understanding of hydrologic processes in the Wood River Valley and similar alluvial valleys undergoing intensive development. The improved understanding of the aquifer system will allow testing of alternative interpretations, provide information on the hydraulic connection of bedrock aquifers, and suggest areas that warrant additional investigation for model improvement.

❖ Provide a tool for long-term aquifer planning

The WRVAS groundwater-flow model will assist water-resource planning efforts. The Statewide Comprehensive Aquifer Planning and Management Program is designed to provide the Idaho Water Resource Board and the Idaho Department of Water Resources with the necessary information to develop plans for managing groundwater and surface-water resources 50 years into the future. The planning effort is intended to

investigate strategies and develop plans which will lead to sustainable water supplies and optimum use of the water resources by integrating technical knowledge with an assessment of current and projected future water uses and constraints. The groundwater-flow model can be used to help evaluate strategies for water management proposed in the planning process.

Other considerations

In addition to meeting these design objectives, the completed groundwater-flow model of the WRVAS model will be:

❖ Accessible and well-documented

A version of the open-source, USGS groundwater-flow model MODFLOW will be used to simulate flow in the Wood River Valley aquifer system. Significant model construction decisions will be documented and made available as technical memorandums. The model will be documented in a peer-reviewed USGS report. The completed model, USGS publications, and relevant GIS datasets and metadata will be fully documented and publicly available on the IDWR and USGS websites.

Although not part of the current project, the model will be designed so that it may be updated with additional data in order to remain a current and viable tool to meet the State of Idaho's water-administration and management objectives.

❖ Defensible in litigation

USGS and IDWR personnel will develop the model cooperatively with input from a Modeling Technical Advisory Committee. The use of widely-accepted, public domain model code along with stringent development procedures, and state-of-the-art calibration techniques will produce a tool capable of withstanding the scrutiny of formal administrative or legal proceedings.

References cited

Doherty, J.E., Hunt, R.J., and Tonkin, M.J., 2010, Approaches to highly parameterized inversion: A guide to using PEST for model-parameter and predictive-uncertainty analysis: U.S. Geological Survey Scientific Investigations Report 2010-5211, 82 p. Accessed December 2, 2013 at *http://pubs.usgs.gov/sir/2010/5211/*