

Application of Singular Value Decomposition and Regularization Techniques for Optimization of a Highly Parameterized FEFLOW Model

Daron Abbey¹, Scott C. James², Beiyan Zhang¹, C. Gabriel¹, Paul Martin¹, Bill W. Arnold²,
Richard Andrachek³, William Woessner⁴

¹*AquaResource Inc., Canada, dabbey@aquaresource.ca, bzhang@aquaresource.ca,
cgabriel@aquaresource.ca, pmartin@aquaresource.ca.*

²*Sandia National Laboratories, Livermore, CA, scjames@sandia.gov, bwarnol@sandia.gov.*

³*MWH Global, Walnut Creek, CA, Richard.G.Andrachek@us.mwhglobal.com.*

⁴*University of Montana, Missoula, MT, William.Woessner@umontana.edu.*

ABSTRACT

Groundwater flow predictions in complex geologic environments require the use of models that represent all potentially important physical features. Oversimplification of the flow system may neglect features that are important to understanding the range of possible flow predictions. FEFLOW was used to develop an equivalent porous medium model representing all of the key features of the conceptual model describing a folded and faulted fractured rock environment located in Southern California, USA. FEFLOW allows dipping layers with layer parallel anisotropy, vertical faults, and decreasing hydraulic conductivity with depth. The variably saturated flow model consists of 46 layers and 1,245 parameters supported by 302 point observations of heads, head differences, pumping rates and seepage flow. The flow solution was optimized using Singular Value Decomposition and Tikhonov Regularization techniques implemented in the SVD-Assist tool within PEST. Optimization improved the model fit significantly; the objective function was reduced by 80% from its initial value. The optimized model retains sufficient parameter detail to predict flow directions. The predictive analysis mode in PEST is also being used to identify potential end-member flow predictions using alternative two alternative conceptual models. Moreover, the analysis can be extended to facilitate a probability-based assessment of flow prediction uncertainty.