COSIA Regional Groundwater Solutions Project for the Southern Athabasca Oil Sands – Evolution of a numerical model

Regional Groundwater Solutions (RGS)
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ABSTRACT
The COSIA RGS project was established to evaluate the potential range of aquifer pressure changes resulting from groundwater withdrawals and disposal associated with future in situ bitumen production within the Southern Athabasca Oil Sands (SAOS) region. The main objectives of this project were: provide COSIA members with a regional groundwater risk assessment and management tool; set a baseline to answer groundwater resource availability questions; and evaluate realistic water source and disposal forecasts for industry growth.
The SAOS numerical groundwater flow model was originally developed for the Government of Alberta (GoA) in 2009. The model was loaned to COSIA for the RGS project, where it was updated and re-calibrated to the most recent industry water use data. In 2016, Matrix Solutions Inc. was retained to undertake the model update and the computationally intensive coupled steady-state and transient calibration using PEST software.
As a first step, the numerical model's material property zones, numerical settings, and boundary conditions were modified from its initial state. The number of adjustable parameters was also modified, and Cauchy boundary condition transfer rates were tied to element hydraulic conductivities.
Calibration targets for the inversion included, water table depth, 209 measured hydraulic heads in industrial groundwater wells, 724 hydraulic heads inferred from drill stem tests, and 13 years of transient hydraulic head data that was reduced to 21,782 monthly changes in hydraulic head. The calibration process required harnessing the power of cloud computing, allowing for up to 100 model runs to be solved simultaneously for a total of 3,310 hours (equivalent to 138 days of continuous CPU time if the model had been solved in series). This presentation describes challenges in the calibration optimization processes and an innovative approach to computing an arbitrary Global Transient Misfit Quality Indicator (GTMQI) allowing visualization of the spatial distribution of transient misfits, based on statistics.