GeoHydros, LLC		Water Resource Management
Project Name & Location	**Begin Date**	**End Date**
Simulation of 3D Groundwater Flow, Los Angeles Co. CA	January 2012	July 2012
Activity Title	**Initial Contract Price**	**Final Amount Invoiced**
Geological & Groundwater Flow Modeling	$60,000	$60,678

Client Name & Address	Technical Contact
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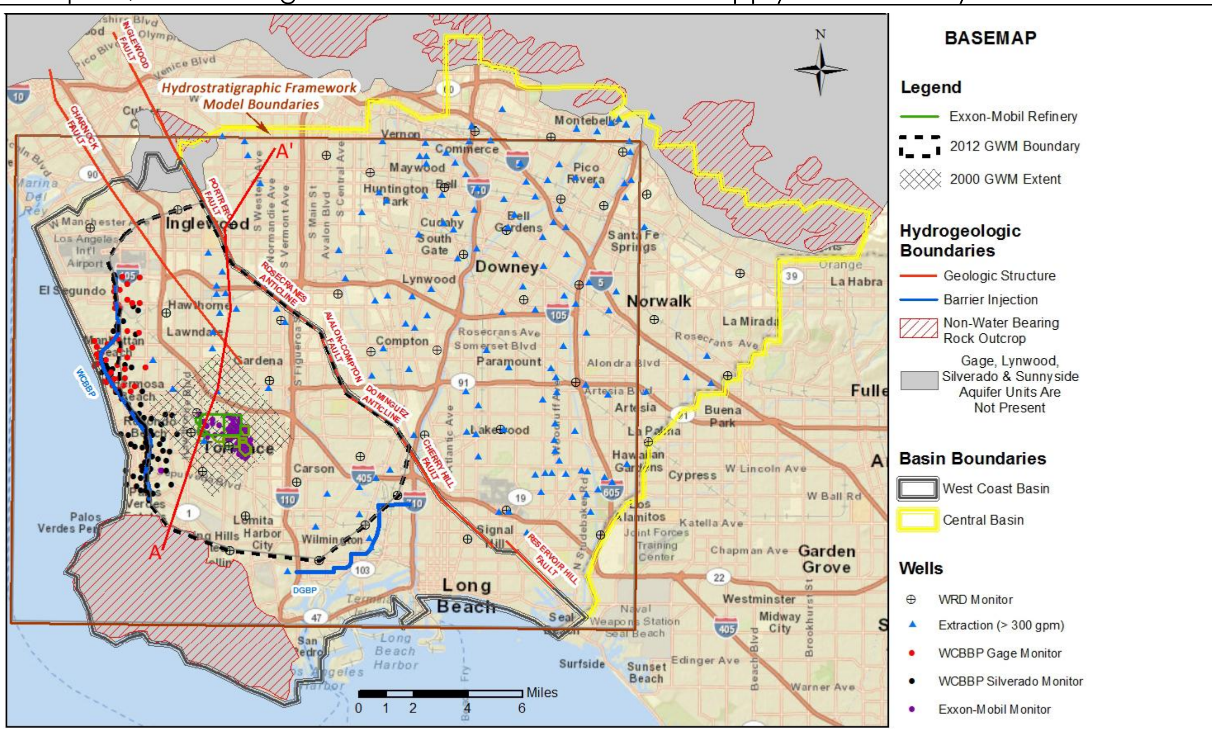
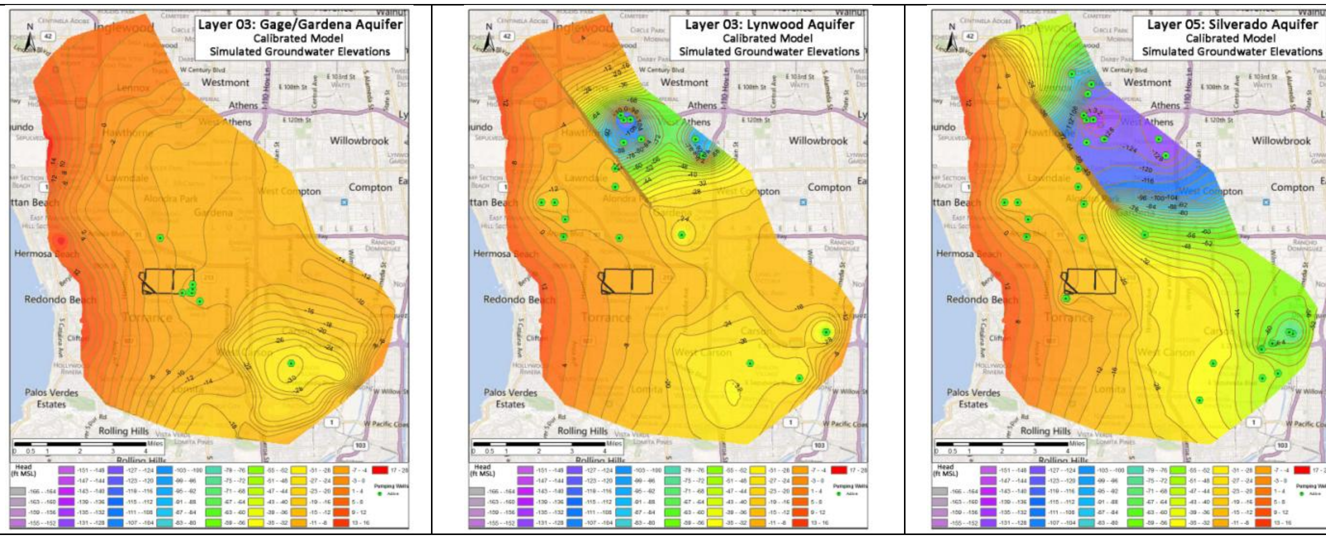
Project Description

GeoHydros revised and expanded a 3D steady-state numerical groundwater flow model for the West and Central Basins in Los Angeles County California in order to simulate capture zones for a network of remediation pumping wells. The objectives were to: 1) revise the model framework to honor new geologic and hydraulic data; 2) adjust boundary conditions to honor elevated groundwater levels; 3) recalibrate the model to the new groundwater level data; 4) use a parameter estimation routine (PEST) to optimize the model variables; and 5) develop new simulated well capture zones to evaluate plume capture under high, normal, and low water level conditions and recovery well pumping rates.

The GWM simulated a 3D flow system consisting of three aquifers: Gage/Gardena, Lynnwood, and Silverado, variably separated by discontinuous aquicludes and deformed in the northeast by the Charnock Fault and the Newport-Inglewood Uplift. The model was constructed in FEFLOW™ using geologic data compiled from more than 300 onsite and offsite boreholes describing hydrostratigraphic contacts and lithology; average head data compiled from more than 10,000 water level measurements collected from 198 monitoring wells in the Gage aquifer, 15 wells in the Lynnwood aquifer, and 39 wells in the Silverado aquifer; and average extraction rates for 136 water supply and recovery wells.



Groundwater model domains and boundaries of the hydrostratigraphic framework model constructed to provide the conceptual basis for the revised groundwater model, boundaries of the Central and West Coast Basins, lines representing the West Coast Basin Barrier Project (WCBBP) and Dominguez Gap Barrier Project (DGBP) injection wells, and the monitoring and injection wells from which data was used for model construction and calibration.



Simulated Best-Fit Head Fields (Gage/Gardena, Lynwood and Silverado Aquifers.

The model calibrated to within +/- 0.4 feet of the observed head range at 8 of 11 Silverado aquifer calibration wells (73%), at 11 of 15 Lynwood aquifer calibration wells (73%), and at 145 of 179 Gage-Gardena aquifer calibration wells (81%) for a total of 164 of 205 (80%) calibration wells. The remaining wells were either close to the calibration targets, determined not to be indicative of head in the simulated aquifers, or not considered to significantly impact the simulated extraction well capture zones.

Five scenario analyses were performed to define and evaluate well capture zones under different hydraulic and pumping rate conditions: 1) anticipated normal rates, 2) anticipated minimum rates, 3) anticipated and design maximum rates, 4) delineation of groundwater travel-time-based estimates for contaminant movement and 5) an evaluation of contaminant capture at various pumping rates.

Self Assessment

There are a few areas where the design of the GWM could be modified to produce a better fit to the steady-state calibration dataset and / or make scenario results more defensible. The most significant improvement would be the inclusion of well depth and screened interval data for all of the extraction wells within the model domain for which no data was available during this effort. WRD has a web-based interactive well search system which reportedly allows users access to all known well development data in the West Coast and Central Basins. With these data, any incorrect well placement assumptions could be corrected increasing the accuracy and defensibility of the simulated flow field and capture zones.

Model calibration could also be improved by spending more time on the delineation of aquifer heterogeneity near the regional WRD monitoring locations. More accurately calibrating to all regional wells would improve the reliability of the simulated capture zone boundaries. This would be particularly relevant to efforts aimed at minimizing extraction rates and/or optimizing pumping designs while maintaining plume capture.

Model predictions of travel-time could be improved by more closely analyzing the three very high conductivity zones (one in each aquifer layer) that were defined by PEST. Though the flow directions and plume capture predicted by the model should remain relatively unchanged because the calibration in these regions is good and flow direction and therefore capture are defined by heads, the high conductivity zones could be generating over-predicted travel-times through these areas. To evaluate this, a sensitivity analysis should be performed in order to determine if equally good calibration could be achieved with lower assigned conductivities in these zones.

Finally, we could expand the calibration dataset, and therefore increase the model's defensibility, if we could gain access to head measurements recorded by the WCBBP for their monitoring well system. We were only able to find head measurements from this system from one measurement period. However, we did find references to semi-annual system reports and contour maps developed on this measurement cycle. Collection of head data from this system for the steady-state time period would allow us to develop steady-state values for these wells and use them to better control the PEST estimations.