

1.0 EXECUTIVE SUMMARY

Groundwater accounts for approximately 40 percent of California's water supply during average climatic conditions. This percentage increases to nearly 60 percent during dry years or periods of drought (California Department of Water Resources [DWR], 2013). Despite its importance, California lacked a statewide framework for regulating the resource until passage of the Sustainable Groundwater Management Act (SGMA) in 2014.

Implementation of SGMA will require agencies throughout the state to undertake management actions that have been necessary for many years or, in some cases, decades, but have not been politically feasible without a state mandate. Specifically, water agencies will need to work collaboratively with one another, land-use planning agencies, and interested parties within the basin to develop plans to manage groundwater sustainably in the face of uncertainties associated with changing land-use practices, water supply, population growth, climate change, and other factors over a 50-year planning and implementation horizon. Where there are multiple groundwater management agencies in a basin, basin management, data collection, and monitoring efforts must be closely coordinated. Additionally, agencies must ensure that their efforts to manage sustainably do not adversely impact neighboring basins. Groundwater models will play a critical role in achieving these goals.

While models are a simplification of reality, they can serve as powerful tools to (1) develop a better understanding of groundwater systems, (2) develop more reliable estimates of water budgets, (3) ascertain future data collection needs, (4) forecast the outcome of future management actions on a groundwater basin, and (5) explore alternative management strategies (Barnett et al. 2012). Relatedly, models will play a critical role in simulating environmental changes during the 50-year planning and implementation horizon required under SGMA. Models provide the link between established management criteria and the management approaches necessary to achieve them. In many cases, models will form the basis of groundwater management decisions.

This report provides a framework for model development under SGMA. It offers guidance on how and when stakeholders should be engaged in model development; milestones for third-party model review; model documentation and archiving; and communicating model outputs to nontechnical audiences. While many of these practices are already occurring, there are additional opportunities during groundwater model development to encourage model coordination and the active engagement of the local entities who will be impacted by management decisions, as well as the state agencies responsible for evaluating Groundwater Sustainability Plans (GSPs) under SGMA. Coordinating model development at the basin-scale and beyond can maximize efficiency, avoid conflicts over boundary issues, provide opportunities for cost sharing, and, ultimately, result in more consistent models that can be used for local and regional management.

This report makes the following recommendations to promote consistency, transparency, and coordination during groundwater model development.

Groundwater models should be

1. **Developed through a collaborative, inclusive, and transparent process.** Local water agencies, county and municipal agencies, managers, advisory committees, and other interested parties should be actively involved in groundwater model development. In particular, they should have a role in defining groundwater model objectives, assumptions, and the level of risk or uncertainty they are willing to tolerate for groundwater management planning purposes. Decision-makers and stakeholders should fully understand the purpose of using a model for water budget development and water management planning and its associated uncertainties.
2. **Developed in a manner that is consistent with model objectives and with the amount and type of data available.** Where the amount or quality of data is inadequate to meet model objectives goals, model limitations and uncertainty must be clearly articulated to decision-makers, stakeholders and other interested parties. Additional data and technical studies should be conducted to remedy data deficiencies.

3. **Communicated clearly to technical and nontechnical audiences.** Model results and uncertainty must be clearly articulated to decision-makers, stakeholders, and other technical and nontechnical users. Presenting model results as a range of possible outcomes rather than as a single “true” value can help to convey the uncertainty inherent in model results.
4. **Developed using consistent datasets and projections.** The state should provide and require the use of consistent datasets for model development and projections under SGMA. These data and projections should include climate, surface water, land-use, regional water budgets, and population.
5. **Developed using public domain, open-source model codes.** Developing models using model codes that are public domain and open-source provides improved opportunity for model review and evaluation. It also improves model access and may encourage coordination between adjacent basins. DWR’s IWFM and the USGS’ MODFLOW are two examples of public domain, open-source model codes.
6. **Developed at the system scale whenever possible.** Developing models of the hydrogeologic system as a whole, rather than modeling individual hydrologically connected basins can maximize efficiency, avoid conflicts over boundary issues, and provide the opportunity to share the financial and personnel costs of model development.
7. **Subject to thorough peer review.** Groundwater models should be reviewed by the state, independent hydrogeologists with modeling experience, neighboring jurisdictions, and other interested parties. Peer review of groundwater models helps ensure that a model is consistent with model objectives and with assumptions in adjacent basins. Model review should be a formal process undertaken after each model reporting milestone.
8. **Subject to thorough model reporting, documentation, and archiving.** Groundwater model reporting should be accessible to technical and nontechnical audiences and should include an executive summary with easy-to-read visuals. Model data and source files should be publicly available in electronic format with all necessary metadata and be in a format that can be easily viewed and shared among multiple model platforms. All relevant data files should be uploaded to the basin’s shared data platform.
9. **Developed with state assistance.** The state should provide technical and financial assistance to develop groundwater models that use a consistent, transparent, and collaborative model development framework and that have been subject to third-party review by a hydrogeologist with modeling experience.