Understanding and Estimating Interbasin Groundwater Flow

Butte County Groundwater Pumpers Advisory Committee
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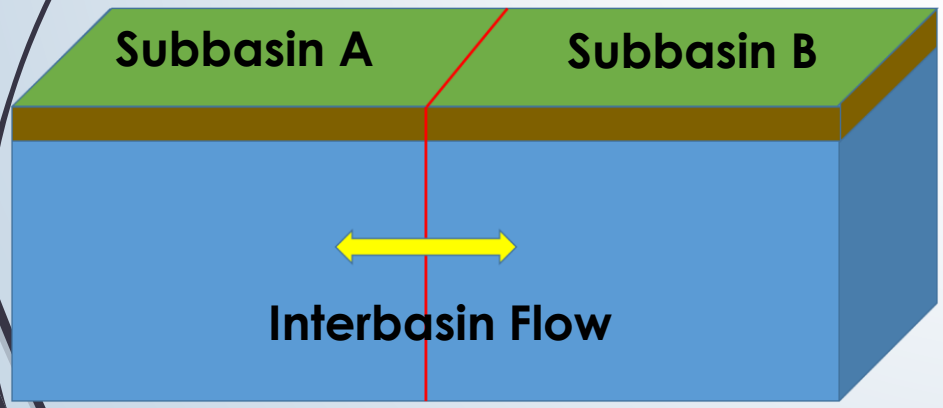
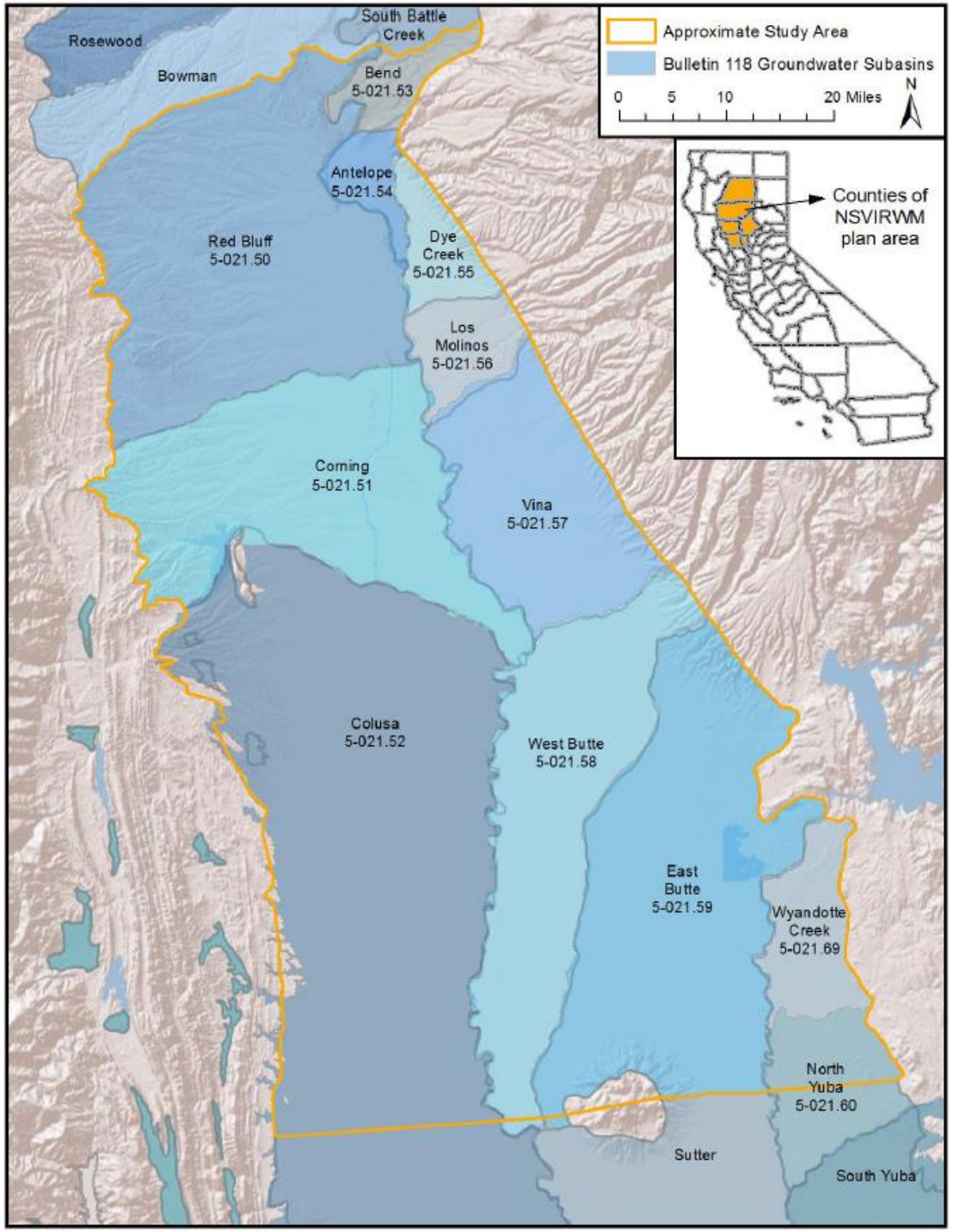
Hydrologically Interconnected Subbasins

- 12 subbasins in Study area
- Relevant to entire Central Valley
- Provide recommendations to GSAs on methodologies to account for interbasin interaction in their GSPs



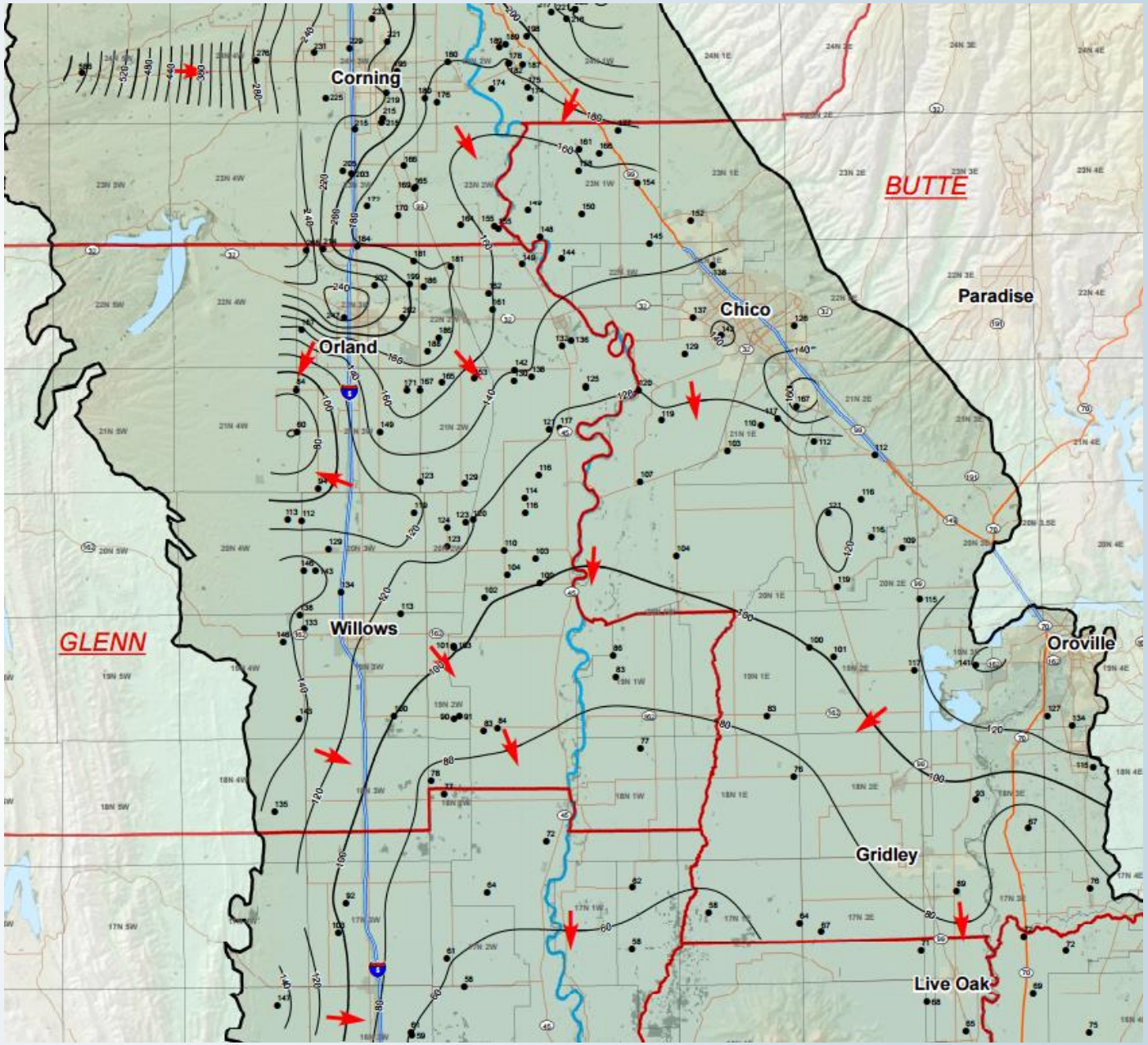


What drives groundwater flow?

- Difference in groundwater levels (i.e. head gradient)
- Characteristics of aquifer materials (transmissivity)

Flow Direction and Magnitude

- Get a sense of flow direction from groundwater level contour maps
- But how much?...water budget



Water Budgets are Required in Groundwater Sustainability Plan (GSP)

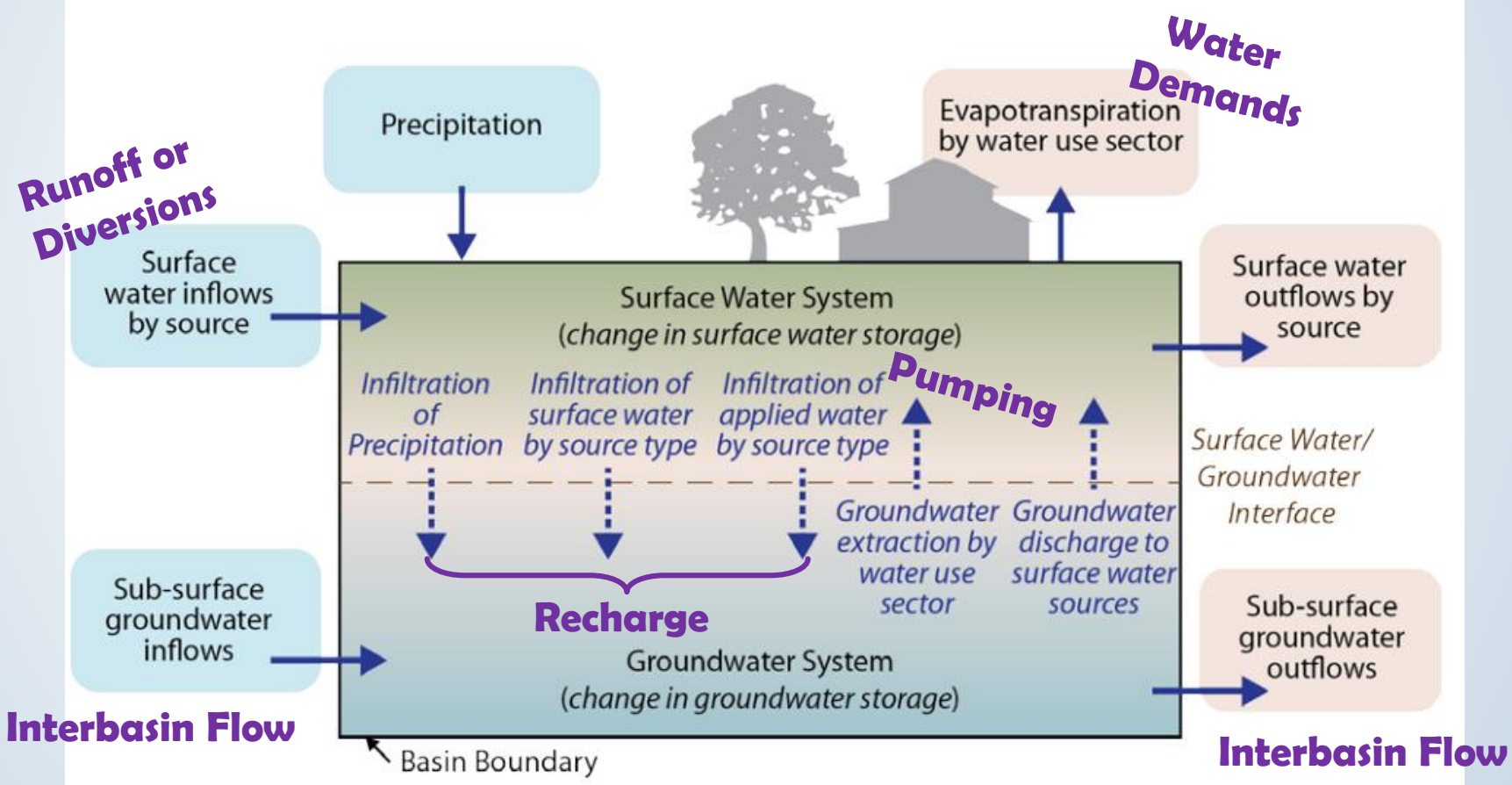
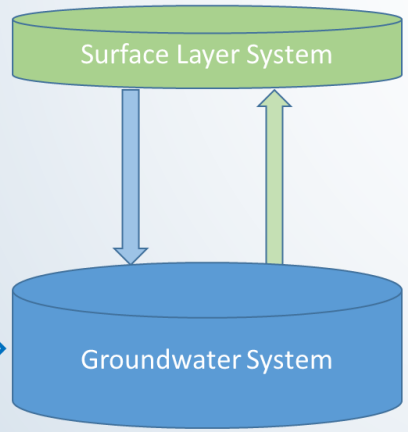


Figure 5 – Required Water Budget Components

From DWR Water Budget BMP

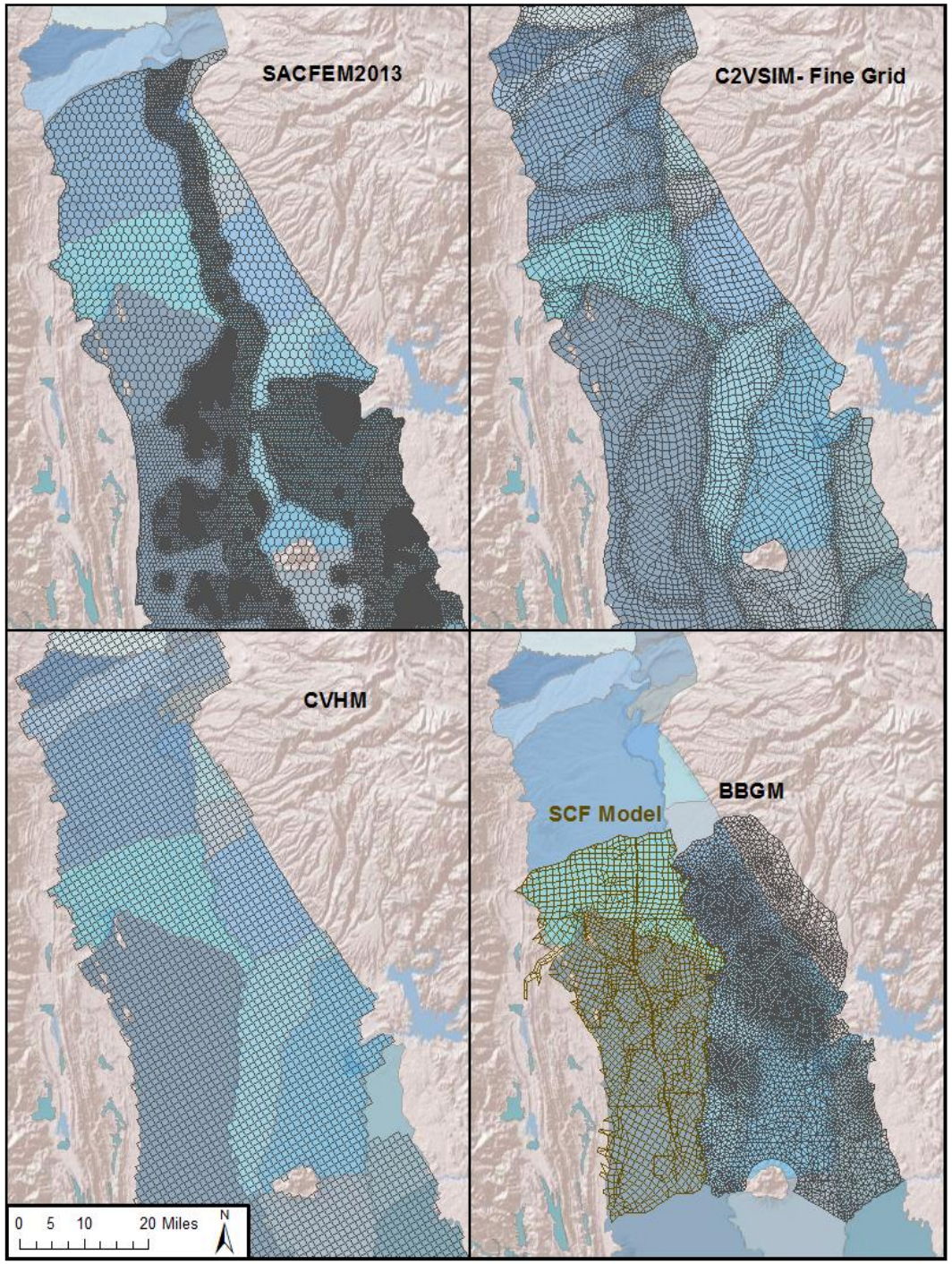
Integrated Groundwater-Surface Water Models

- Integrate lots of different types of data and processes
- Generate water budgets
  - Surface layer system
  - Groundwater system
  - Basin overall

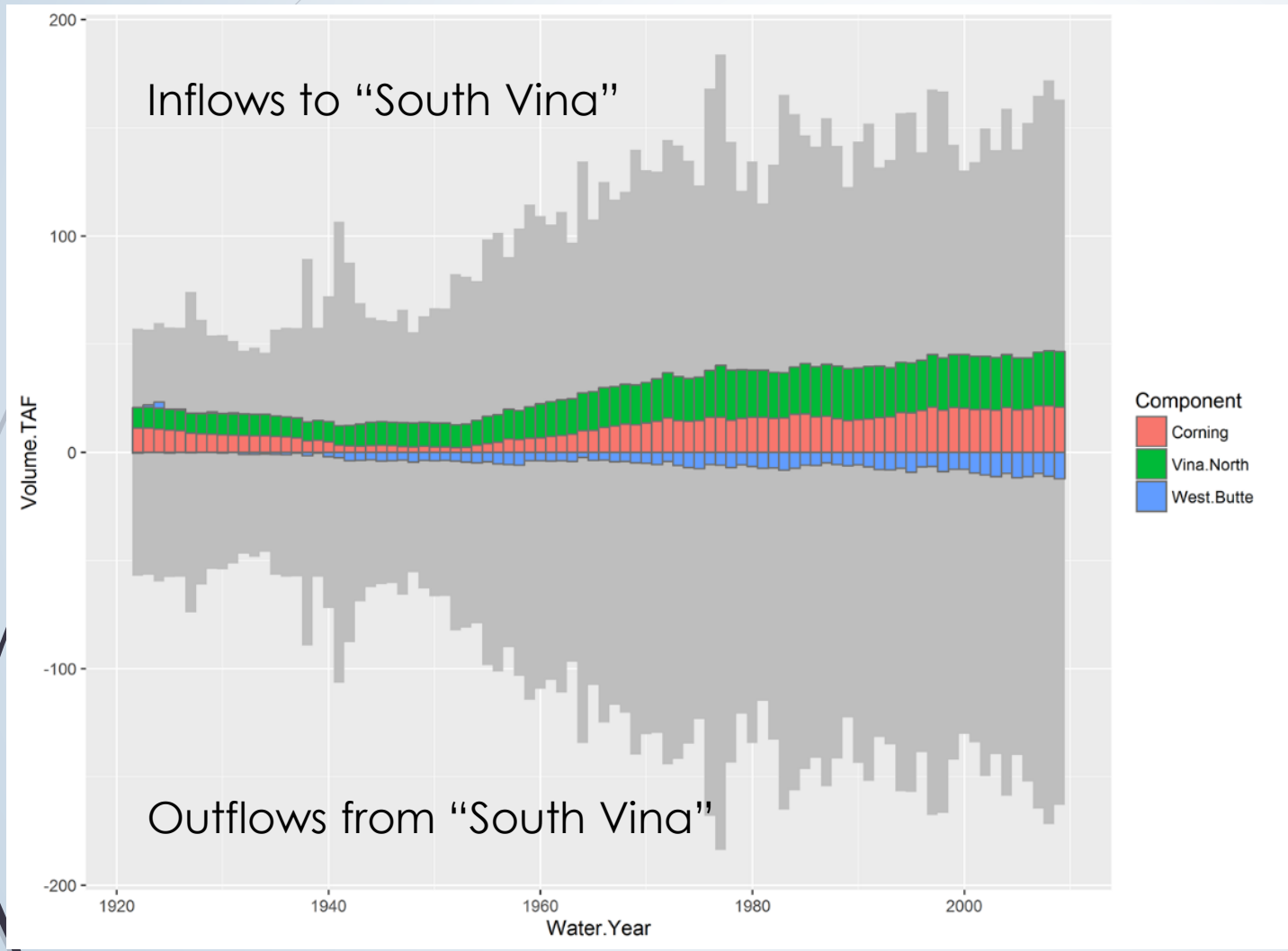


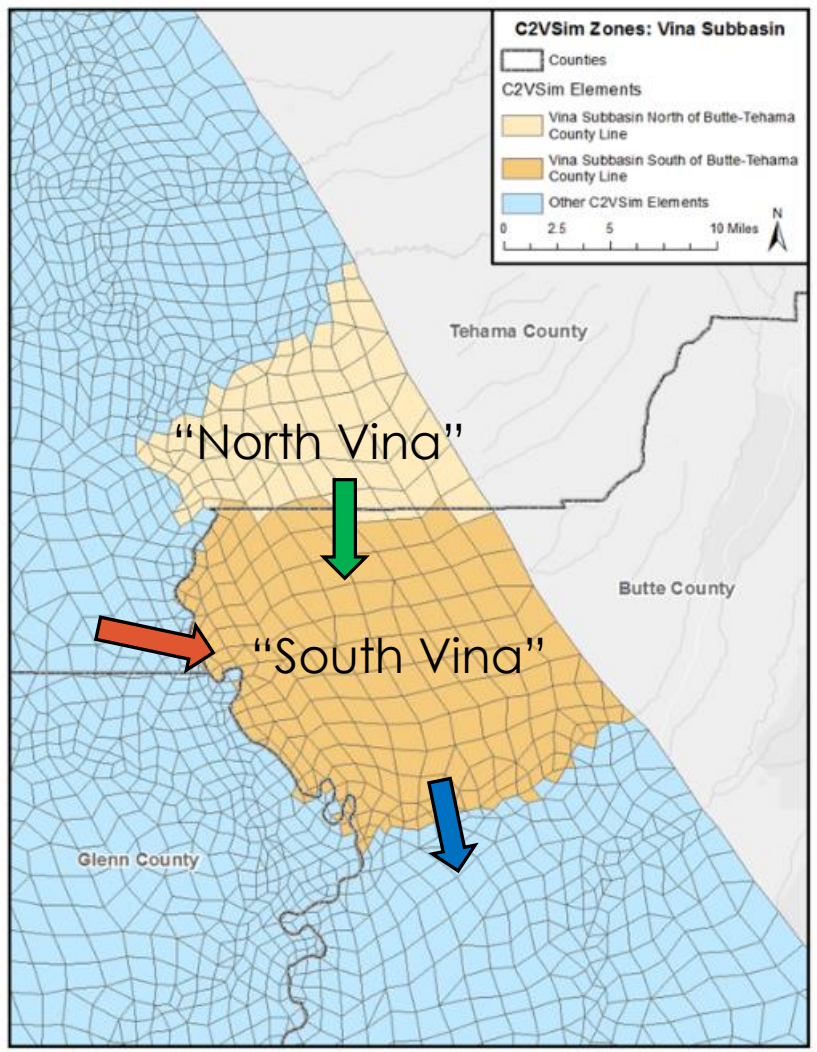
Major Processes
- Precipitation
- Runoff
- Diversions
- ET
- Applied water, irrigation
- Deep Percolation
- Return flow
- Return flow reuse

Major Processes
- Groundwater Pumping
- Groundwater Recharge
- Interbasin flow
- Stream-groundwater interaction
- Lake-groundwater interaction
- Tile Drain
- Small watershed surface water Inflow



Interbasin Flows Example





Water Budget Output from C2VSim

Model Evaluation & Comparison

- For available models, GSAs should consider:

  How well does the model match my current understanding of the surface layer and groundwater budget in my area?

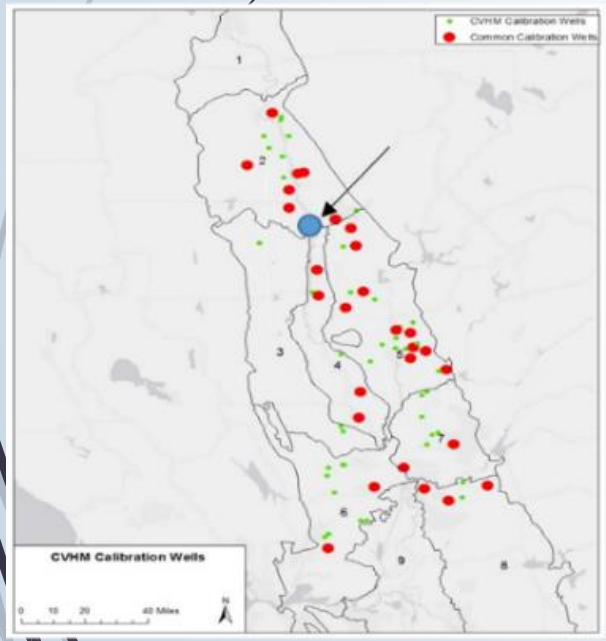
  How well does the model match historical groundwater level conditions, particularly near subbasin boundaries?

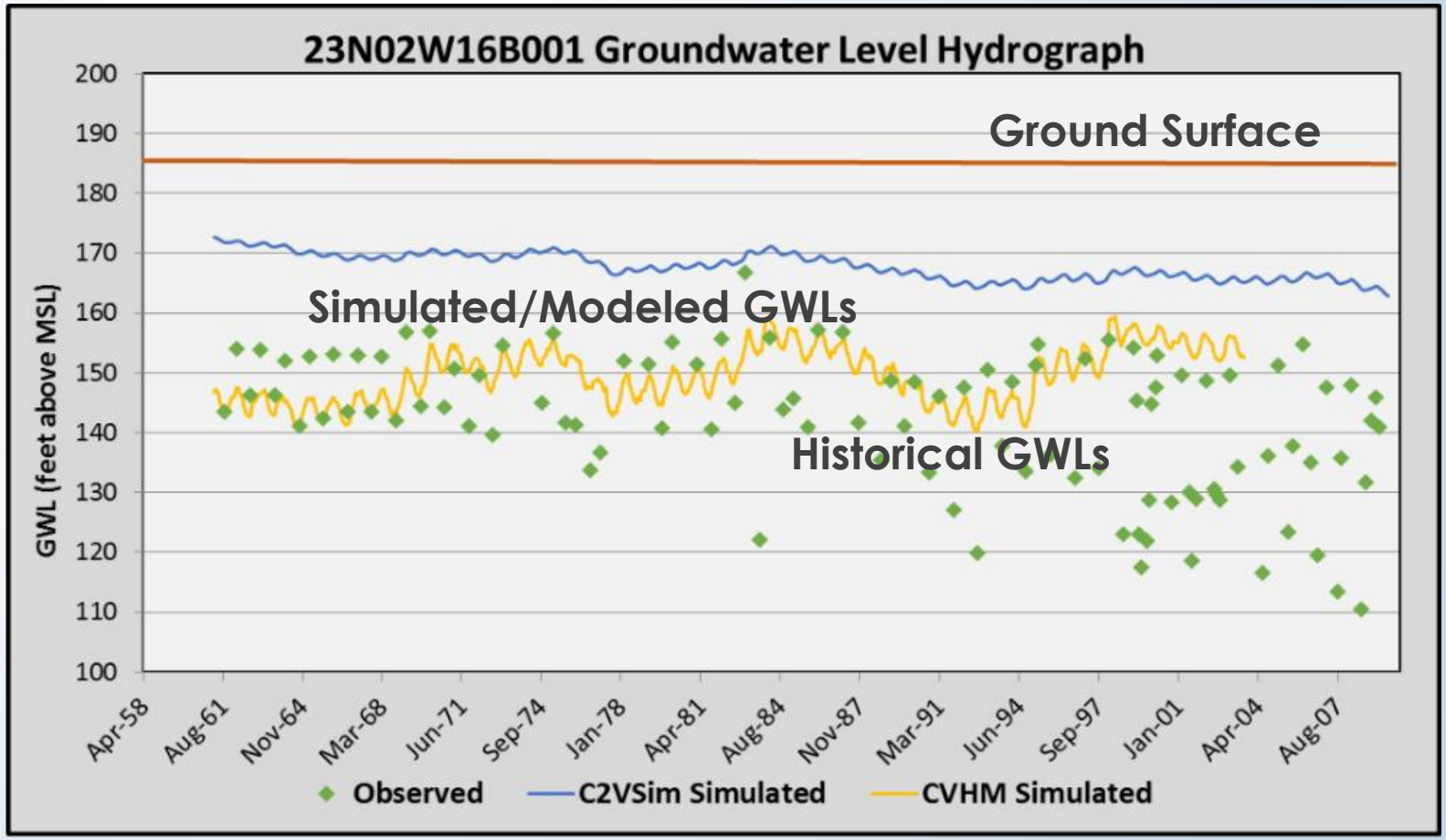
- Want to use a groundwater model that best reflects subbasin conditions
- Cooperate early with neighbors

Model Calibration: GW level comparison

How well does the model match historical groundwater level conditions, particularly near subbasin boundaries?

- Active Irrigation
- Shallow (100 – 120 ft)



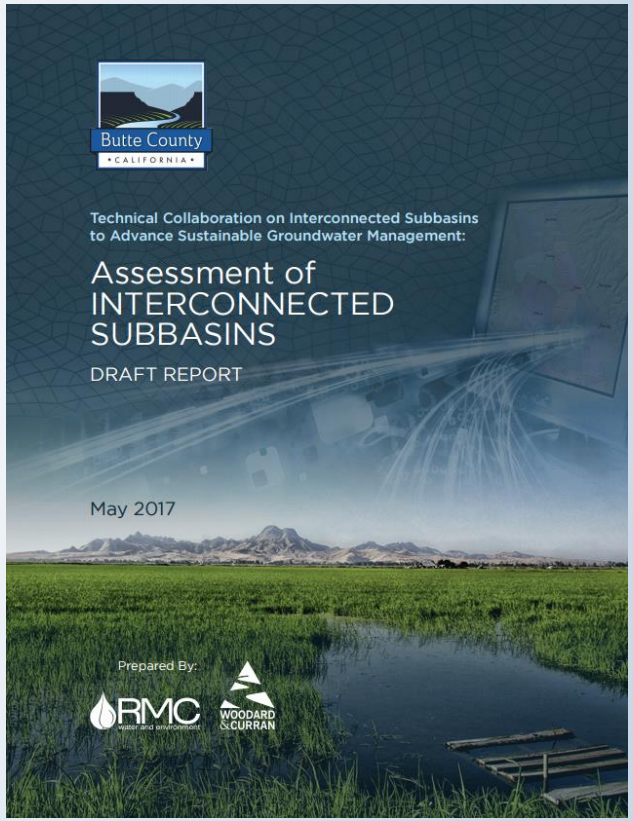


Assessment of Interconnected Subbasins Report

- Discussed approaches for estimating interbasin flows
- Evaluated available groundwater models
- Provided recommendations to GSAs in the Northern Sacramento Valley and Statewide, and to DWR/USGS

Draft Report posted at project website:

https://www.buttecounty.net/waterresourceconservation/SpecialProjects/InterbasinGroundwaterFlowProject



Report Highlights

- An integrated gw-sw model should be used for water budget and GSP development by GSAs in the Northern Sacramento Valley (and Central Valley as a whole).
- Tools exist, but locals need to evaluate them for their specific area/subbasin
  - Significant differences in water budgets and groundwater level representation
- Existing tools are a valuable starting point, but long term commitment is needed by GSAs and DWR/USGS to make them better for management under SGMA
- Need DWR/USGS to provide tools and guidance to make these models more easily comparable

Acknowledgements

- Water Foundation, an initiative of the Resources Legacy Fund, for their generous support
- Technical Collaborators
- RMC, a Woodard & Curran Company

Discussion

Creek
Bowman
Bend
5-021.53
Antelope
5-021.54
Red Bluff
5-021.50
Dye
Creek
5-021.55
Los
Molinos
5-021.56
Corning
5-021.51
Vina
5-021.57
Colusa
5-021.52
West Butt
5-021.58

Technical Collaborators

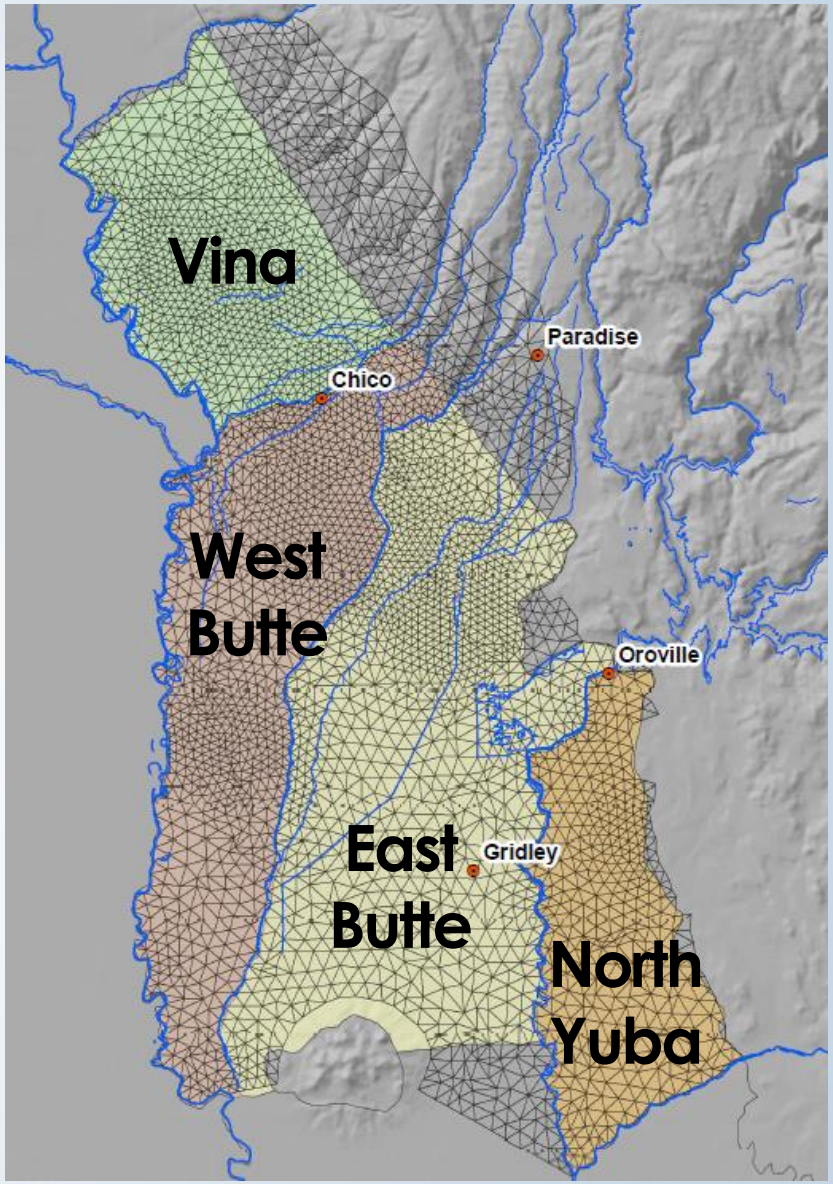
Name	Organization	NSVIRWM TAC Member?
Charlie Brush	DWR Bay-Delta Office, Modeling Support Branch	
Christina Buck	Butte County Department of Water and Resource Conservation	
Grant Davids	Davids Engineering, Inc.	
Bill Ehorn	DWR Northern Region Office	✓
Claudia Faunt	United States Geological Survey	
Allan Fulton	University of California, Cooperative Extension	✓
Thomas Harter	University of California, Davis	
Peter Lawson	CH2M	
Steffen Mehl	California State University, Chico	
Vickie Newlin	Butte County Department of Water and Resource Conservation	✓
Ben Pennock	Glenn Colusa Irrigation District (Retired)	✓
Steve Phillips	United States Geological Survey	
Mary Randall	DWR Northern Region Office	
Oscar Serrano	Colusa Indian Community Council	✓
Ali Taghavi	RMC, a Woodard & Curran Company	

Model Comparison & Selection

- **Not an obvious choice between CVHM and C2VSim for the NSV region as a whole**
  - Significant differences in land use and crop acreage inputs (although, they are more similar in recent years)
  - Significant differences in estimates of water budget components
  - Significant differences in simulated groundwater levels and how they compare to historical data

Role of Local Models

- Valuable for detailed local analysis to evaluate management actions (e.g., recharge project)
- Feed data upward into regional models
- Differing estimates of interbasin flows may result in the initial GSPs but should tell a similar story
- Differences in part reflect the uncertainty in the modeled systems
- Overtime, regional tools will more closely reflect local data/knowledge and interbasin flow estimates should become more similar.



Butte Basin Groundwater Model

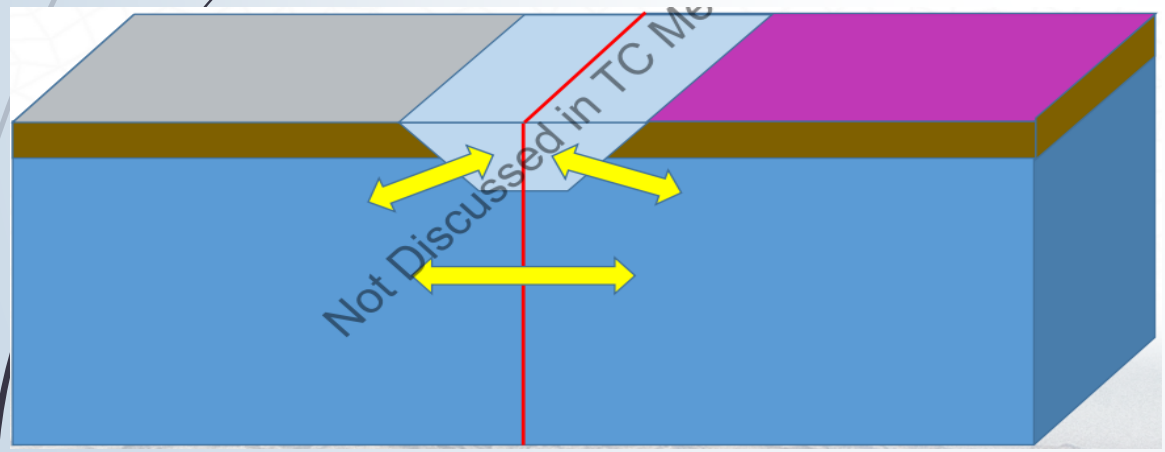
Perspectives on Models

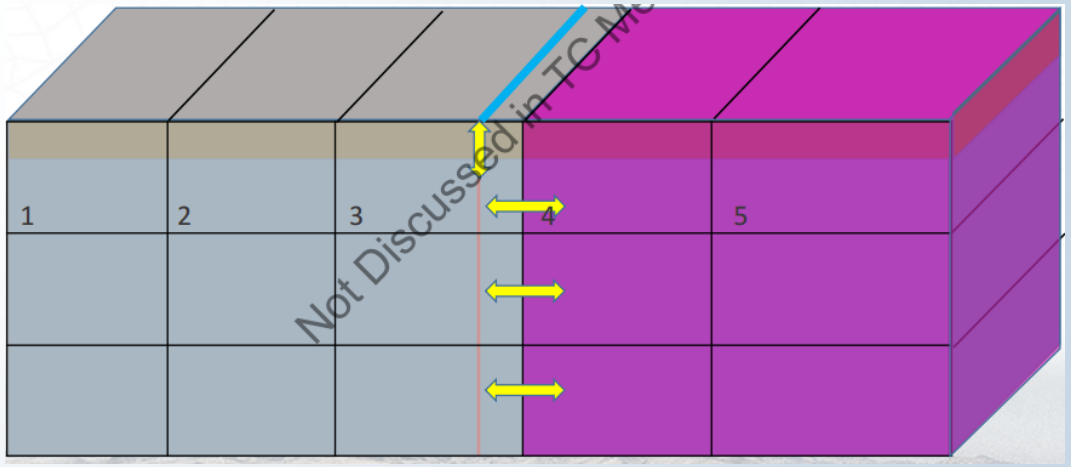
- Expect a long term commitment- model updates are motivated by desire to better understand the system to support more effective management
- Models are more reliable in characterizing relative changes rather than predicting the absolute conditions resulting from a scenario
- Different models will not perfectly agree
- Acknowledge that there is no "right model"
- Importance of Adaptive Management- uncertainty inherent in models needs to be accounted for when making decisions based on their results

"All models are wrong; some are useful" – George Box

Side note: Evaluating Interbasin Flows where the Boundary is Defined by a River/Stream

- C2VSim and CVHM account for stream recharge differently in their model water budgets





Recommendations for GSAs in NSV

- Evaluate most current version of available models at time of GSP development: C2VSim, CVHM, SVSim (?)
- Compare to local surface layer models or water budget data to select model. Do not mix output from groundwater model with other local water budget sources.
- Over time, work with agencies to incorporate local knowledge/data into the selected regional groundwater model
- When evaluating a groundwater model, consider representation of:
  - Crop acreage
  - Irrigation practices
  - Surface water supplies and diversions
  - Rivers and streams (does it include ones the GSA considers important?)
  - Subsurface flows from outside the subbasin boundaries (eastern or western foothills)

Recommendations for DWR and USGS

- **Important opportunity to provide specific recommendations for technical assistance to GSAs**
- Develop tools and guidance to **ease comparison of models** (inputs like crop data, and outputs of water budget components)
- Process to **incorporate local data** into regional tools
- Provide guidance on use of these tools to address the six Undesirable Results defined by SGMA
- Report includes other specific technical assistance needs (e.g., methods for developing water budgets where boundaries align with streams)