

Effects of Groundwater Development



Not that Uncertain

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Effects of GW Development

- Pumpage is development
- Effects are
 - Reduced spring flow
 - Loss of phreatophytic & riparian plants
 - Water level declines
- Drawdown estimated with flow models
- Uncertainty in hydraulic diffusivity creates uncertainty in drawdown

Hydraulic Diffusivity

- Transmissivity divided by Specific yield, T/Sy

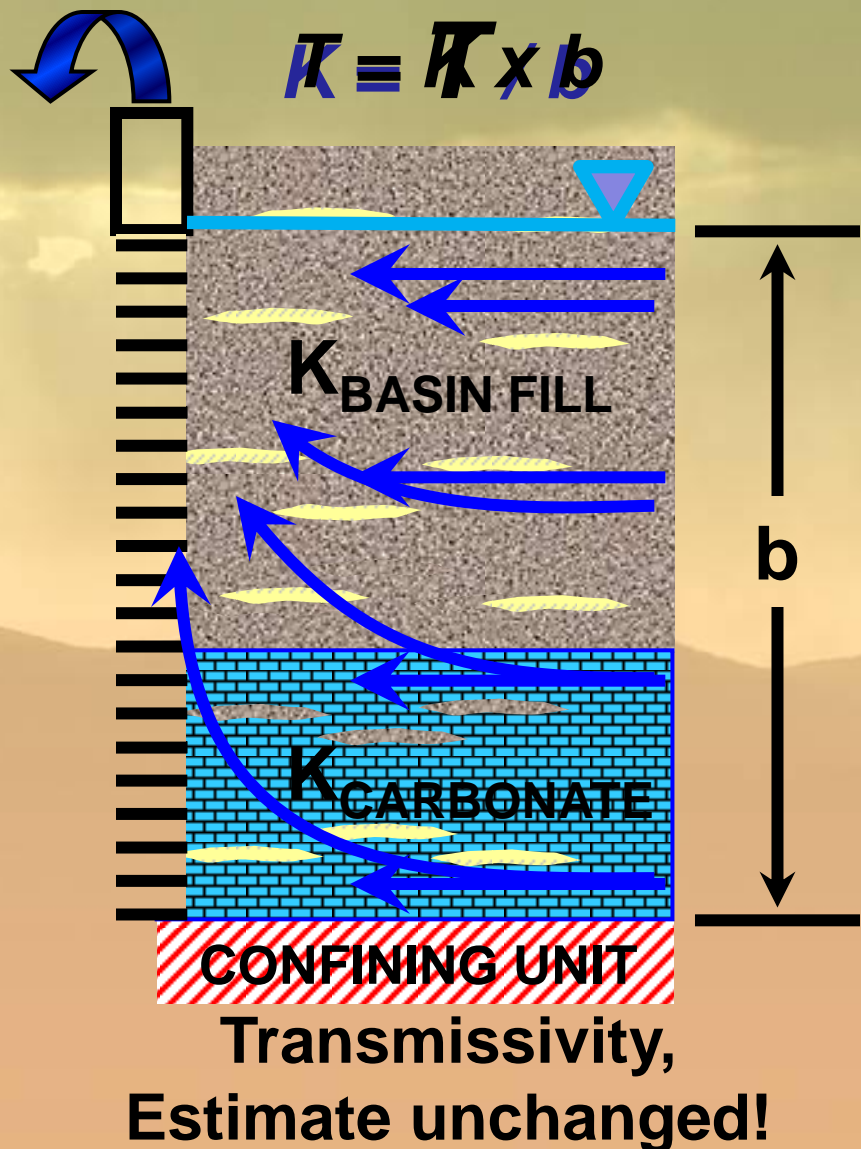
- Specific yield

Basin Fill **10 to 20 %**

Fractured Rock **< 4 %**

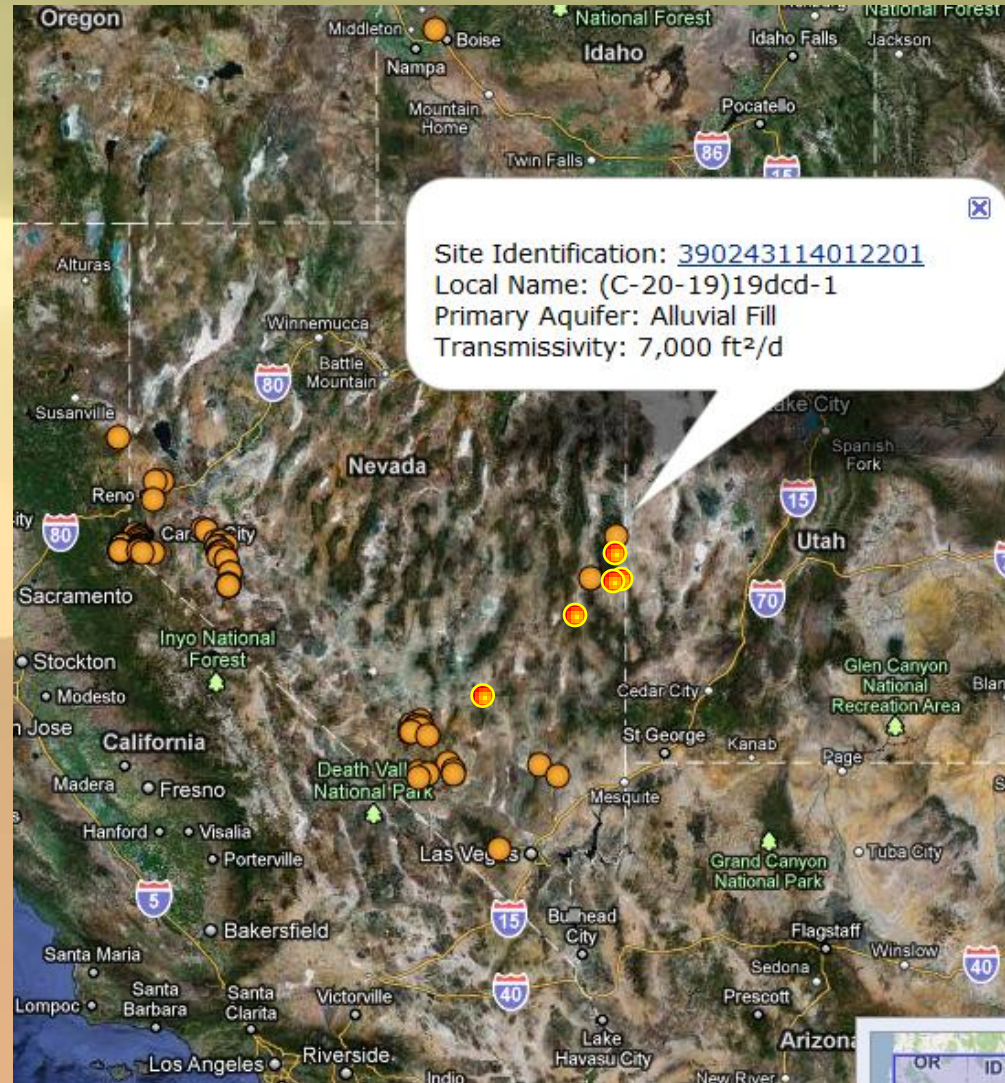
- Transmissivity

- Estimated quantity, not hydraulic conductivity
- Unknown thickness, **OK**
- More variable than **Sy**



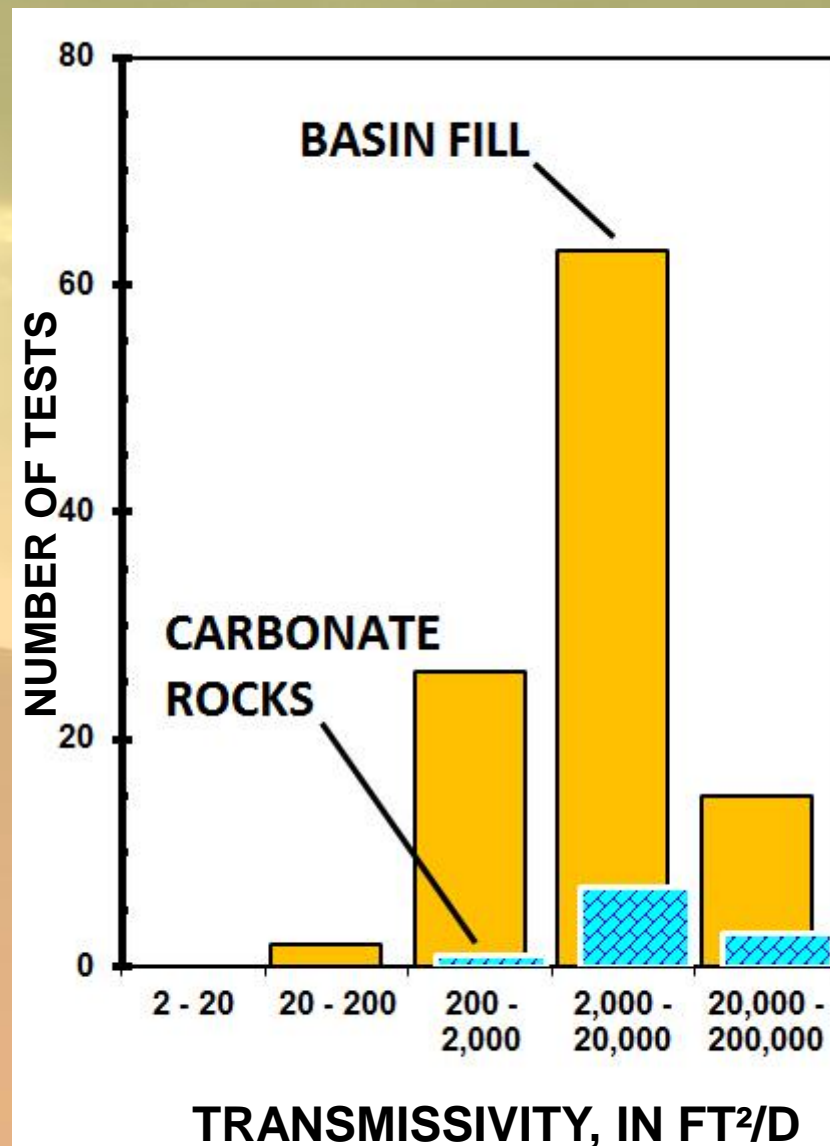
Aquifer Tests—Nevada

- Transmissivity from aquifer tests
 - USGS > 100
 - Consultants > 1,000
- Specific Capacity, SC
 $T \text{ (ft}^2/\text{d)} = 200 \text{ SC (gpm/ft)}$
More than 10,000
- Aquifers
 - Basin Fill
 - Carbonate Rocks
 - Volcanic Rocks



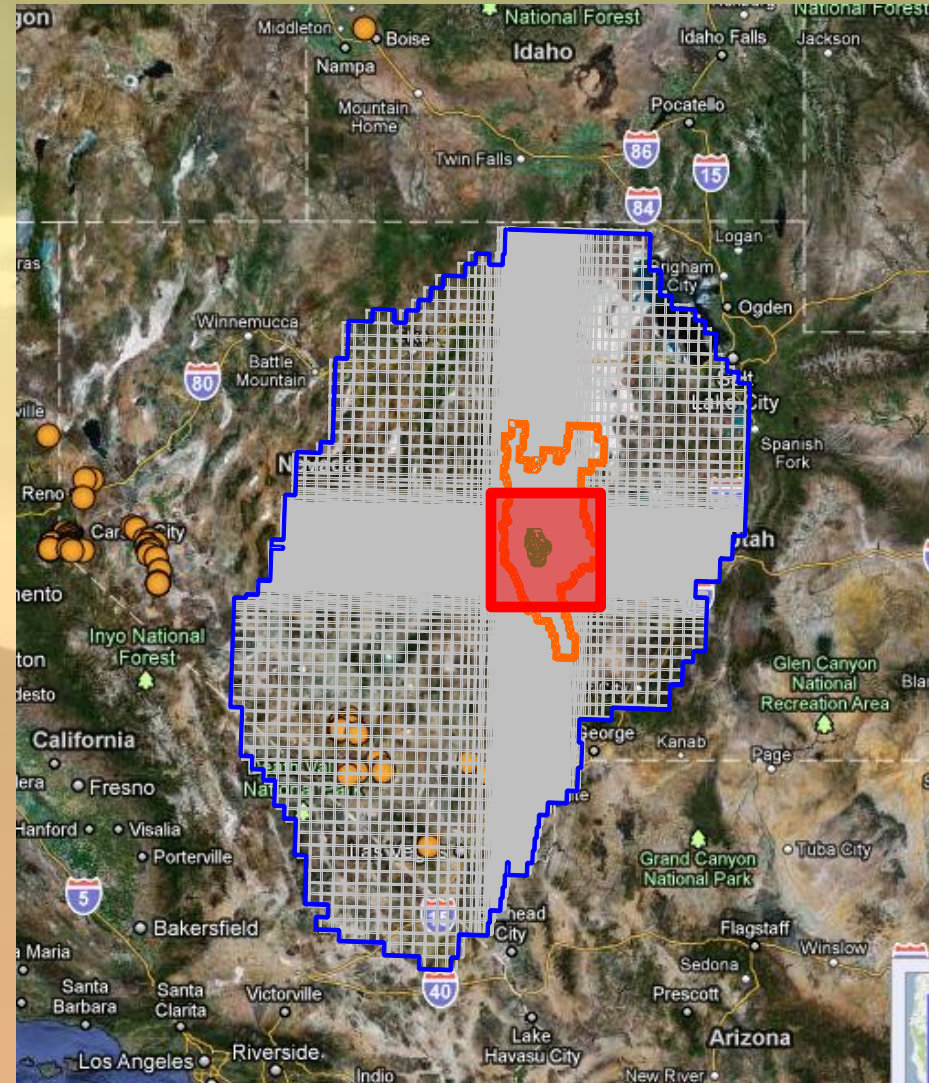
Transmissivity

- 149 estimates
 - 2 to 200,000 ft²/d
- Bedrock impermeable
- Volcanic most variable
- Most tests in basin fill
- 2,000 to 20,000 ft²/d
 - 60 percent
 - Basin Fill & Carbonate Rocks

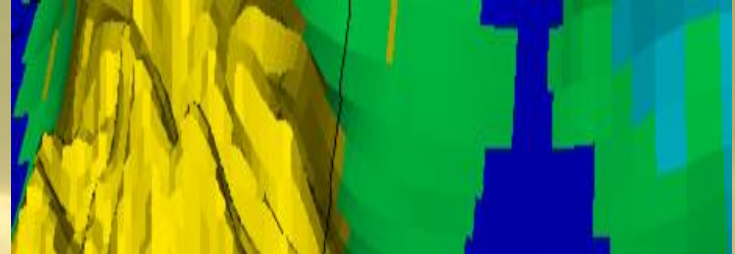


GBNP Model

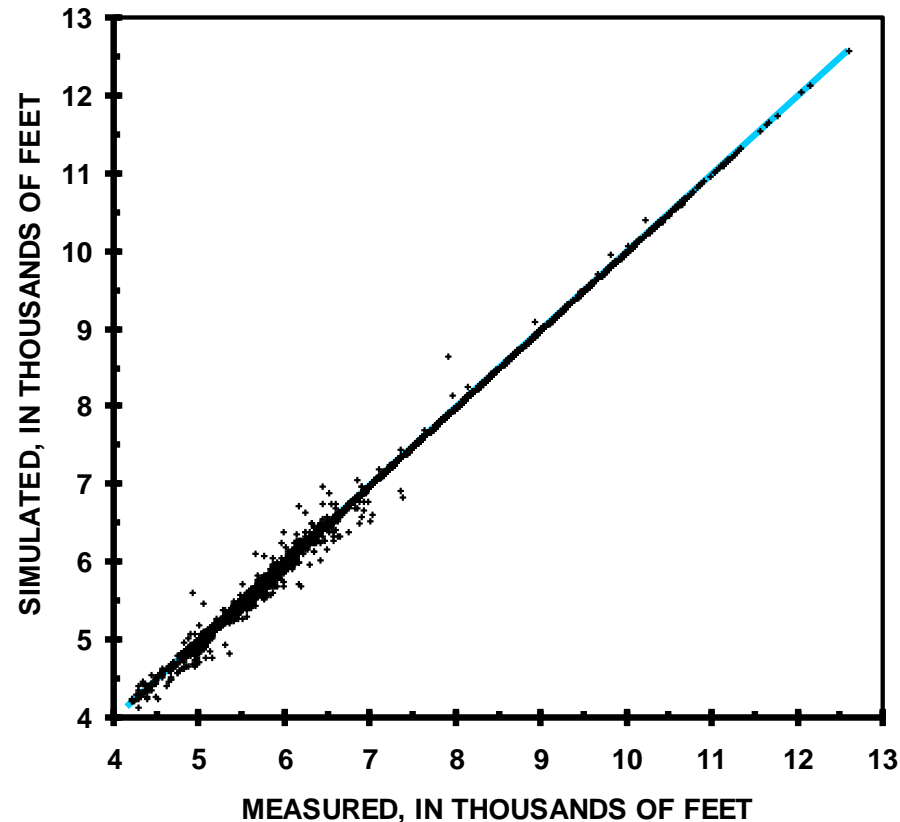
- GBNP Model
 - Original RASA model
 - Refined Spring & Snake V, Great Basin National Park
 - Horizontal-to-vertical anisotropy 10:1
- Test uncertainty of T
 - Pump 40,000 ac-ft/yr
 - 100 years
- Criteria for Effects
 - 5-ft drawdown extents
 - Spring discharges



3D-Calibrated Model



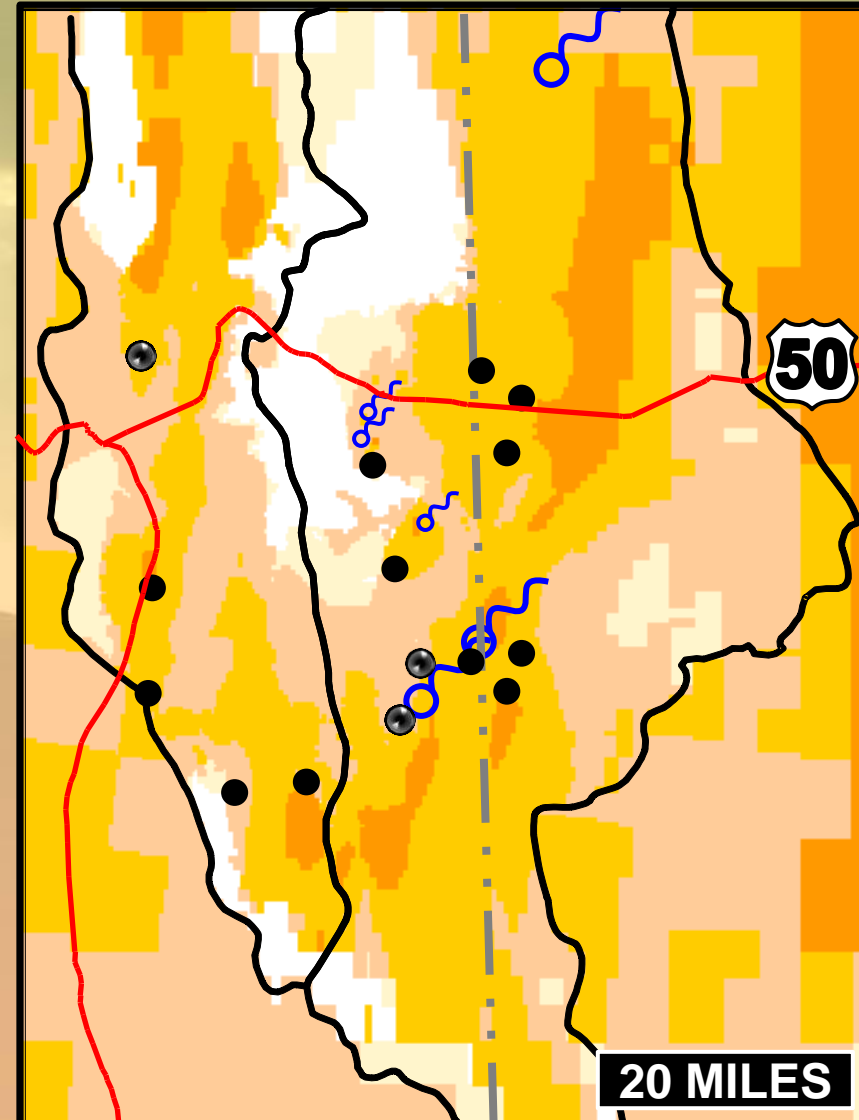
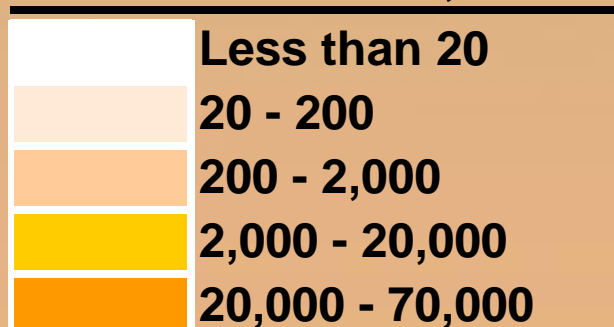
- Geohydrologic framework
- Perfect mass balance
- Calibrated
 - 159 Water levels, RMS = 40 ft
 - ET, Spring discharges, & Land surface
 - 12,350 out of 13,000 within 50 ft
- Wonderous by most measures



Transmissivity Map

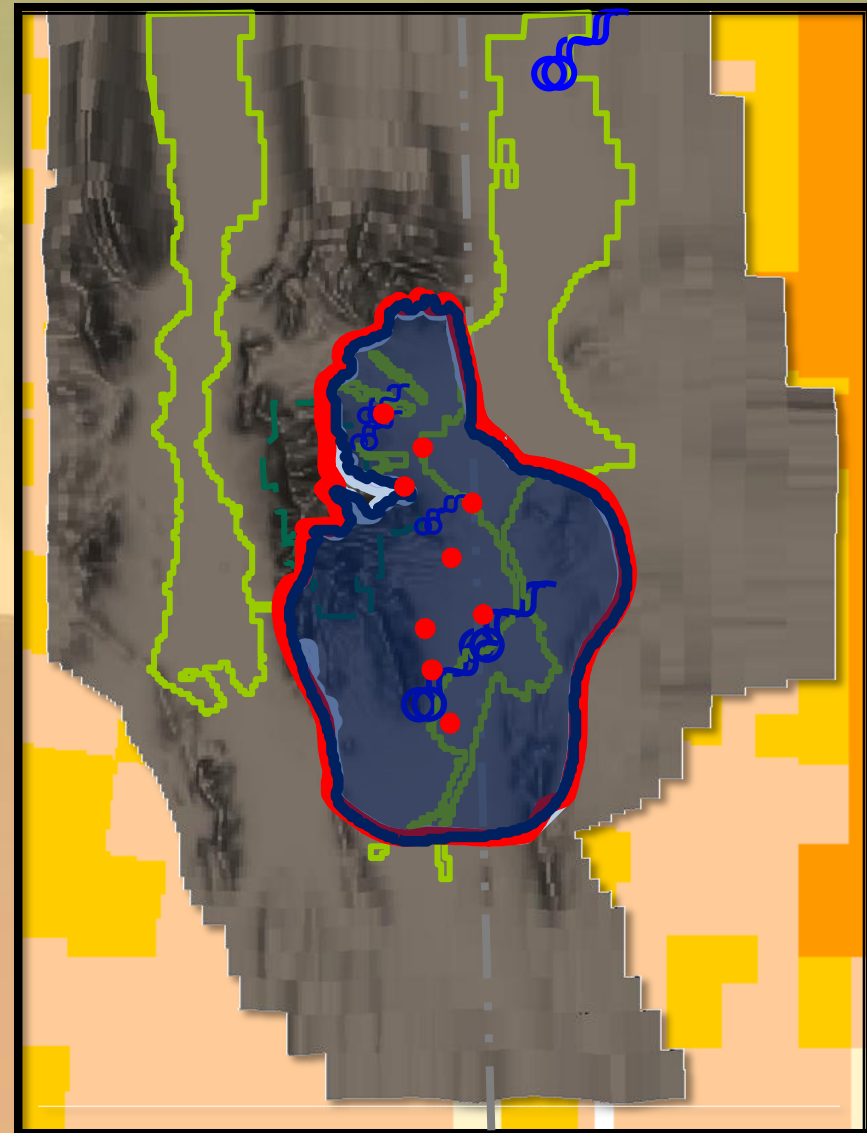
- Aquifer tests constrain
- Simulated transmissivity similar to 3 additional aquifer tests
- Basin fill & carbonate are both significant

TRANSMISSIVITY, FT²/D








Drawdown Extent

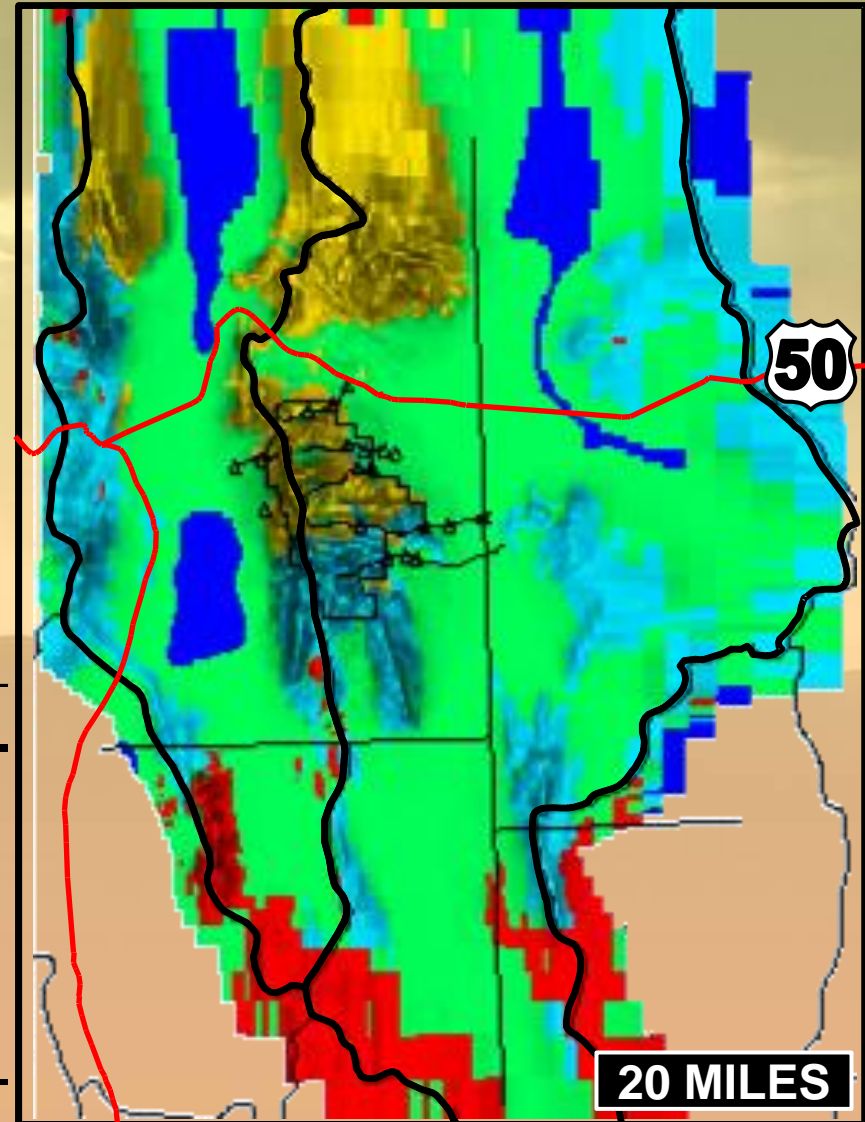
- Pumping for 100 years
 - 4,000,000 AC-FT
- Specific yield
 - Basin Fill 15%
 - Hard Rock 2%
- Direct-Drawdown Approach
 - Groundwater discharge to capture is specified
- Drawdown exceeds 5 ft
- Water table & base similar
- Collapse 3-D to 1 layer
- 2-D & 3D water table similar



Simple Approach

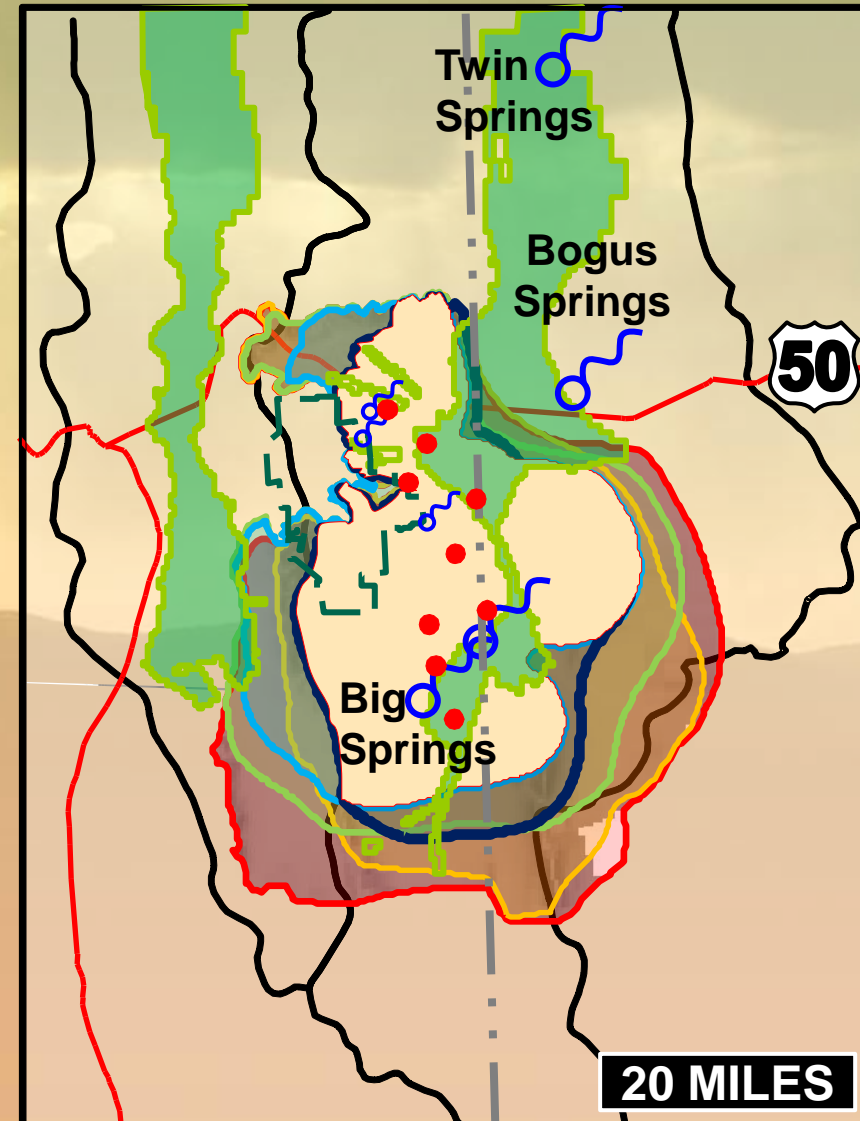
- Surface geology
- Uniform transmissivity
- Simulate 4 models
- Vary transmissivity of playa, carbonate, & coarse fill

General Lithology	TRANSMISSIVITY, FT ² /D	
	Minimum	Maximum
 Playa	200	2,000
 Carbonate	5,000	20,000
 Coarse Fill	2,000	20,000
 Basement	10	10
 Volcanic	100	100



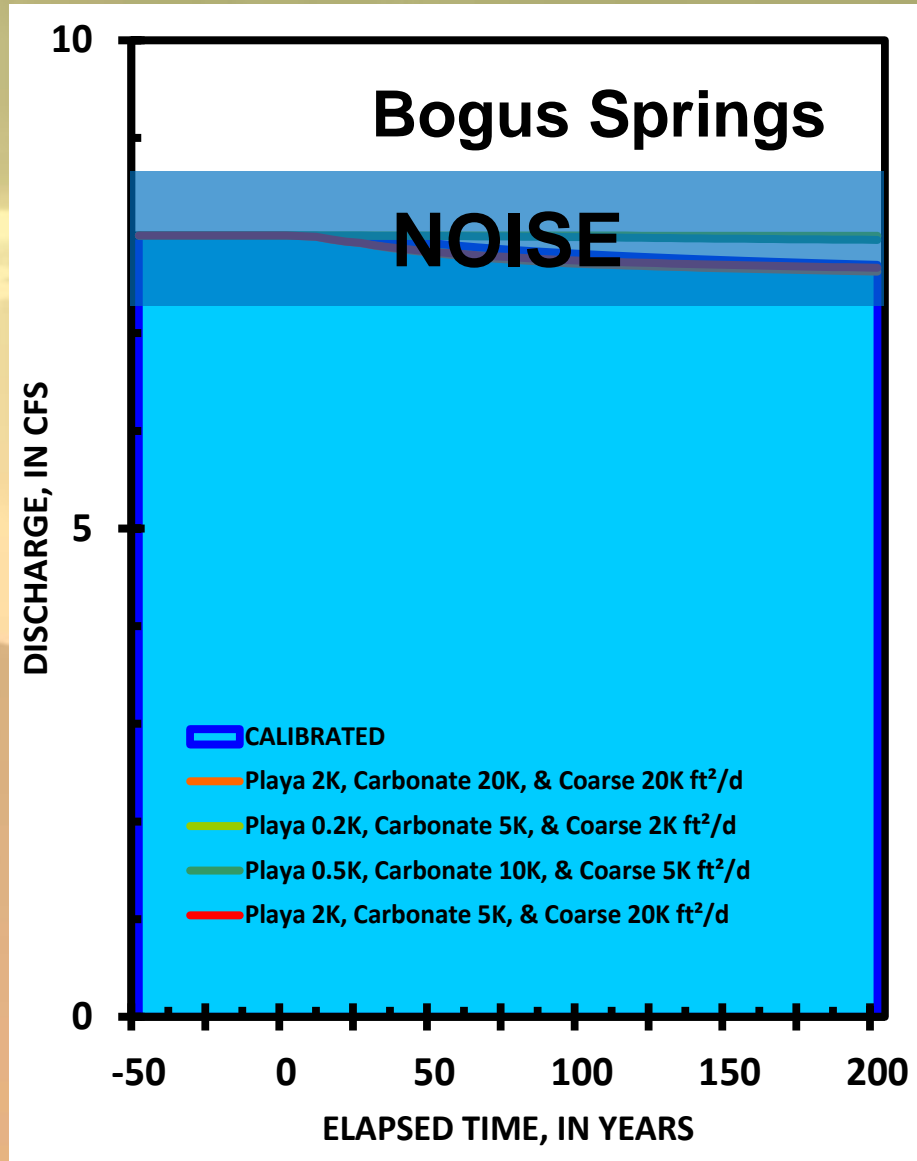
Simple Drawdown Extents

- Same Pumping
 - 4,000,000 AC-FT
- Same 5-ft threshold
- Transmissivities
 - Max 10 times Min
- Extents limited
 - GW capture & bedrock
- Minimal differences between results



Another Criteria—Springs

- All Models
- Big Springs
 - More than 5 ft drawdown
 - Discharge declines
 - Similar magnitudes
- Bogus Springs
 - Near 5-ft drawdown
 - No measureable change
- Twin Springs
 - Minimal drawdown
 - Unmeasurable capture



Conclusions

- Hydraulic diffusivity controls drawdown
- Transmissivity of aquifers relatively well known
 - Basin Fill, **2,000 to 20,000** ft²/d
 - Carbonate Rocks, more variable, similar average
 - Demand transmissivity map of next used model
- Two-dimensional models adequate
- Define ambiguous areas before arguing

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