Partnerships On Sustainable Groundwater Management,
Flood Managed Aquifer Recharge

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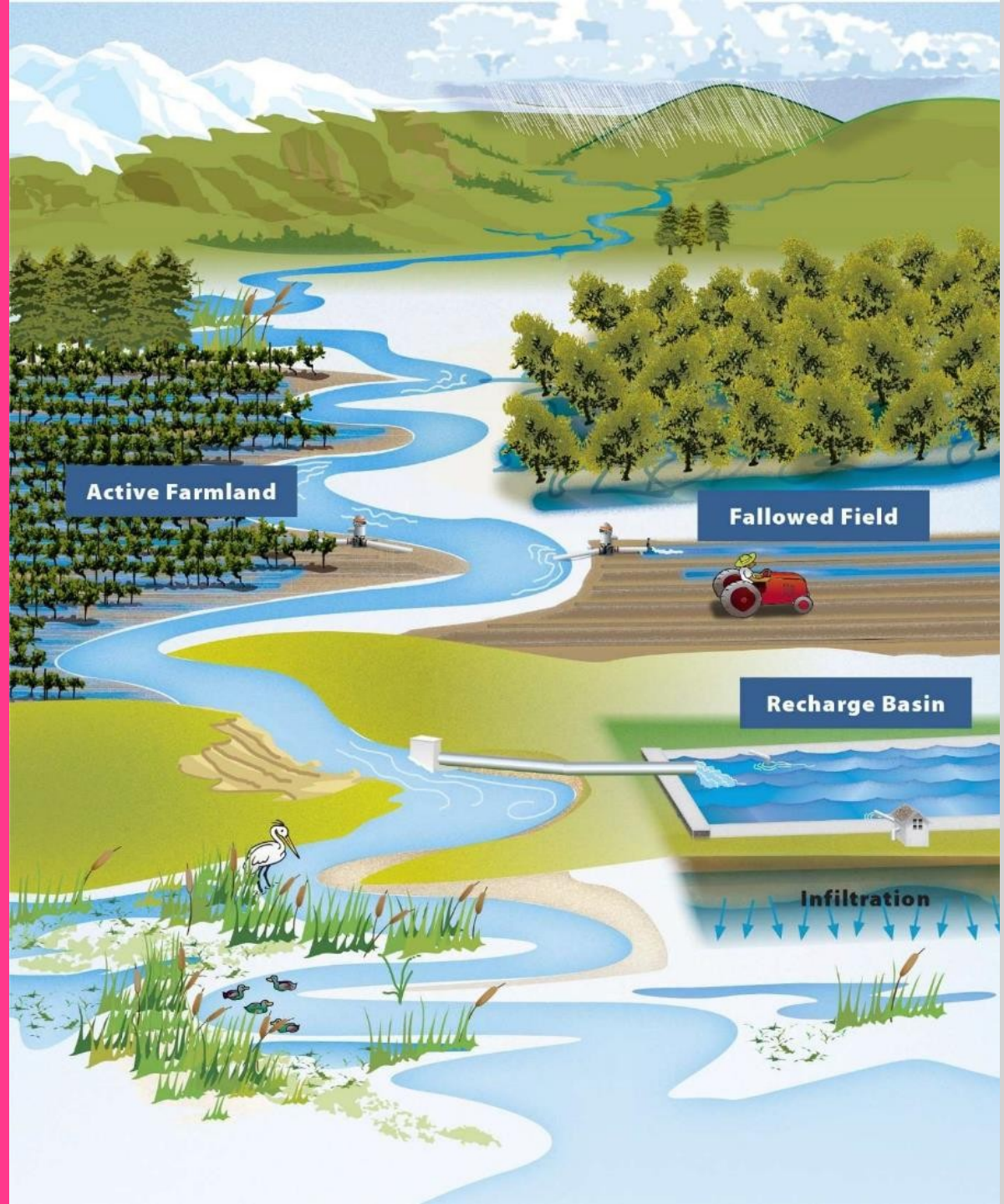
Sustainable Water Resources Roundtable
May 3 – 4, 2018
Sonoma County Water Agency
Westside Water Education Center
9703 Wohler Rd. Healdsburg, CA 95448

BACHAND & ASSOCIATES



FloodMAR Concept – Working Landscapes (DWR DRAFT, 2018)

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NRCS 2010 CIG
On-Farm Recharge (OFR) Demonstration Project
–
NRCS, Terranova Ranch, KRCD, UC Davis and Bachand & Associates

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Overlapping Technologies / Acronyms

- Recharge on Agricultural Lands – Primarily work has focuses on Central Valley
  - OFFCR – On Farm Flood Capture and Recharge
  - OFR – On Farm Recharge
  - AgMar – Agricultural Managed Aquifer Recharge
- Stormwater capture approaches – Work to date in Santa Cruz
  - DSC-Mar – Distributed Stormwater Collection and Managed Aquifer Recharge
- Recharge on Working Landscapes: Agricultural, restored lands, etc…
  - FloodMAR – Flood Managed Aquifer Recharge

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Flood-MAR and Related Studies (e.g.)

- **MAR, OFR and Groundwater Banking**
  - UC Davis – Helen Dahlke, Thomas Harter, Graham Fogg et al.
- **DSC (Distributed Stormwater Capture) – MAR**:
  - UC Santa Cruz – Andrew Fisher et al
- **Regional Tools and Integration / Climate Change / SGMA**
  - Sustainable Conservation and Central Valley water districts (e.g. GRAT)
  - UC Water
  - NIFA San Joaquin Study – Bachand & Associates, Tetra Tech, UCM, UCD
  - GSAs
- **OFR pilot projects and Groundwater / Surface Water Effects**
  - Sustainable Conservation, Bachand & Associates and collaborating farmers (e.g. hydrology, water quality, logistics, crop calendars, management practices, economics, agronomics)
  - Central Valley nut growers – pecans, walnuts, almonds
  - Santa Rosa Plain (e.g. Jackson Family Wines projects)
- **FloodMAR guidelines, data gaps, integration in CA Water Plan**
  - DWR and partners

- Studied Topics
  - Hydrology
  - Water Quality
  - Economics
  - Water Rights
  - CA Water System Reoperation
  - Agronomics
  - Logistics

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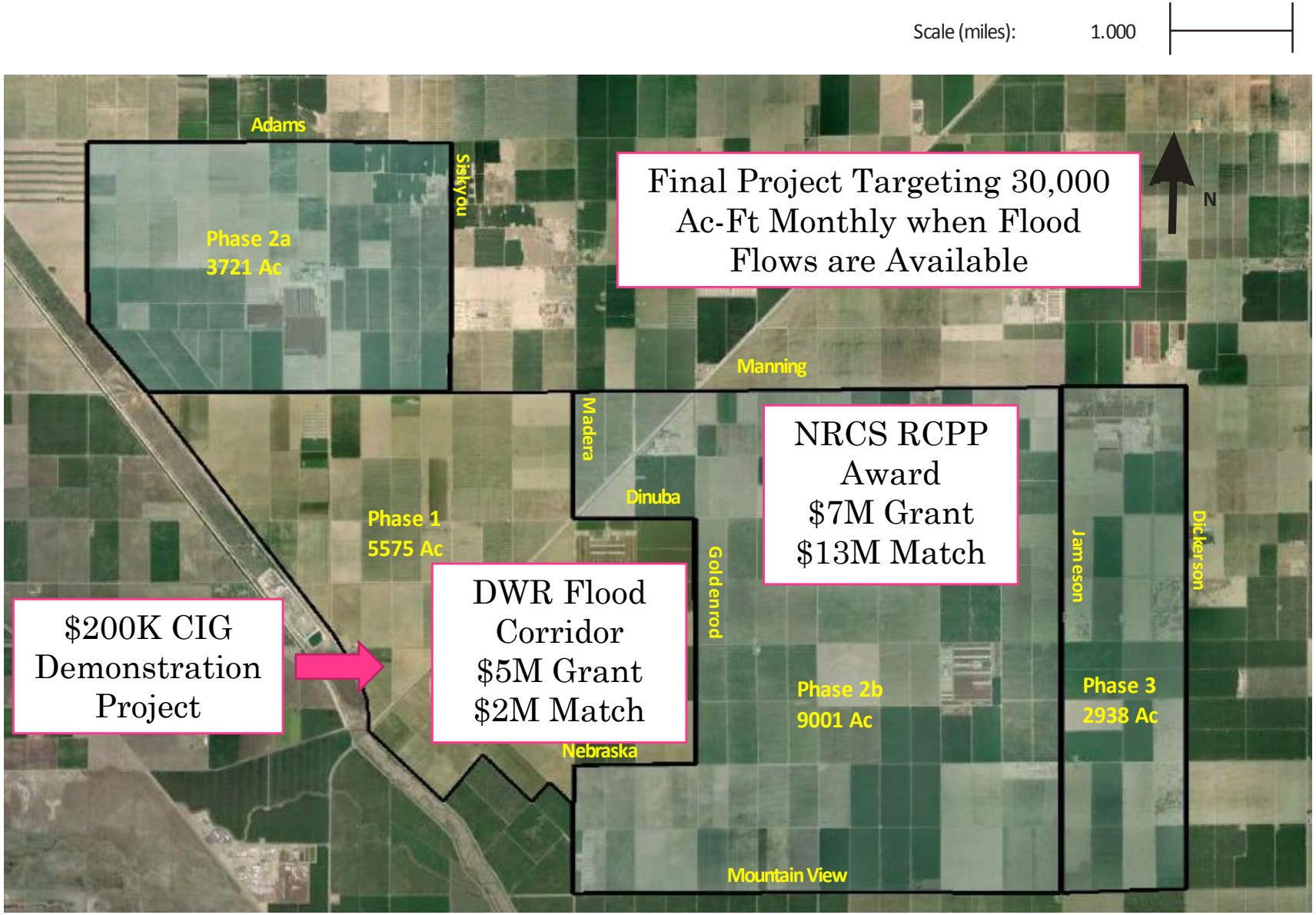
The McMullin Project – Regional Scale Implementation at Significant Scale



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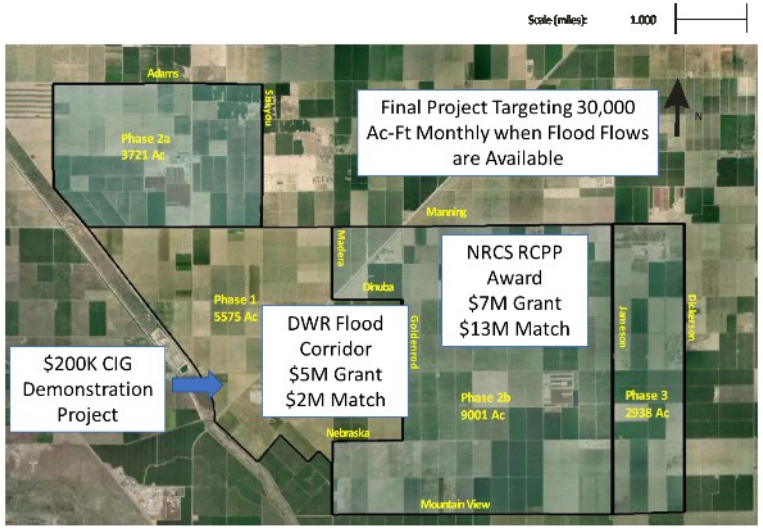

Key Players

- Technical / Private
  - Bachand & Associates – Technical Lead
  - Provost and Pritchard – Project Engineer, Permitting
  - Tetra Tech – CEQA, Groundwater Hydrology Lead
- Farmers and Local Agencies
  - Terranova Ranch – Partner, Match, Agricultural Lead
  - Area Farmers
  - Kings River Conservation District – Phase 1 Project Manager, Phase 2 Partner
  - Kings River Water Authority – Water Rights, Watermaster
  - Raisin City Water District – Lead Partner, Phase 2, Funding Agency
  - McMullin GSA – Local GSA
  - James Irrigation District – Cooperator
  - District 1606 – Cooperator
- Non Profits
  - Sustainable Conservation – Outreach
- Federal and State
  - NRCS – Phase 2 funder, EQIP leader (Conservation)
  - DWR – Phase 1 funder (Flood Risk Reduction, Recharge)
  - CEQA – Army Corp, RWQCB, Caltrans, etc…
- Academic / Cooperative Extension
  - UC Davis – Soils management
  - UCCE – Nutrient Management

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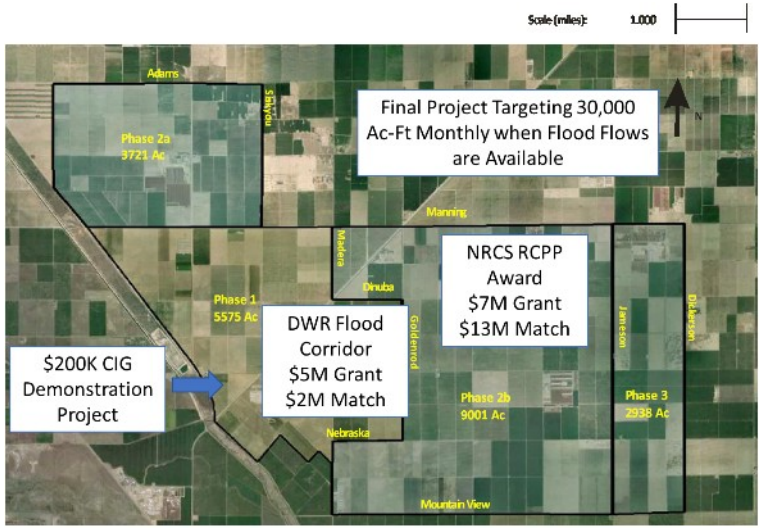
The McMullin Project:
Regional Scale Implementation at Significant Scale



- Phase 1 Key Accomplishments
  - CEQA
  - Permitting
  - Water Rights
  - Legal Agreements
  - Easements
  - Design
  - Outreach and Local Support
  - Integration into SGMA discussions
- Phase 1 Remaining Tasks
  - Construction
  - Final funding agreements for local investment
- Phase 2 Effort
  - Expanded acreage and conveyance
  - Expanding participating landowners
  - Integration with SGMA

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SGMA - Undesirable Results

- Lowering of Groundwater Levels
- Reduction of Groundwater Storage
- Seawater Intrusion
- Water Quality Degradation
- Land Subsidence
- Depletions of Surface Water (e.g.)
  - *Surface water / groundwater connectivity*
  - *Habitat and River Flows*

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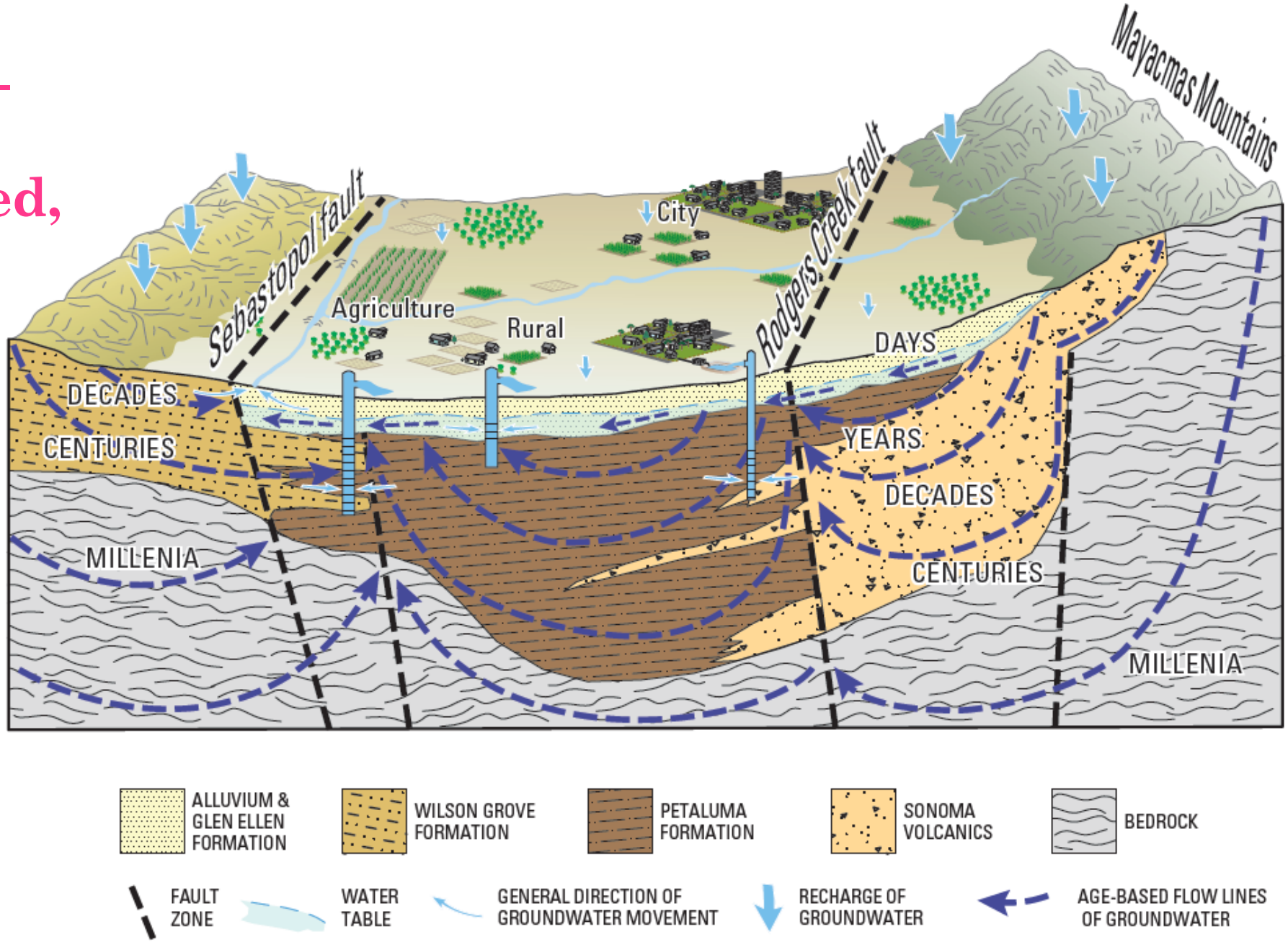
Conceptual Groundwater-Flow System, SRP Watershed, USGS 2014-5052

Annual Overdraft Estimated at **3,500 ac-ft** (1976 -2000)



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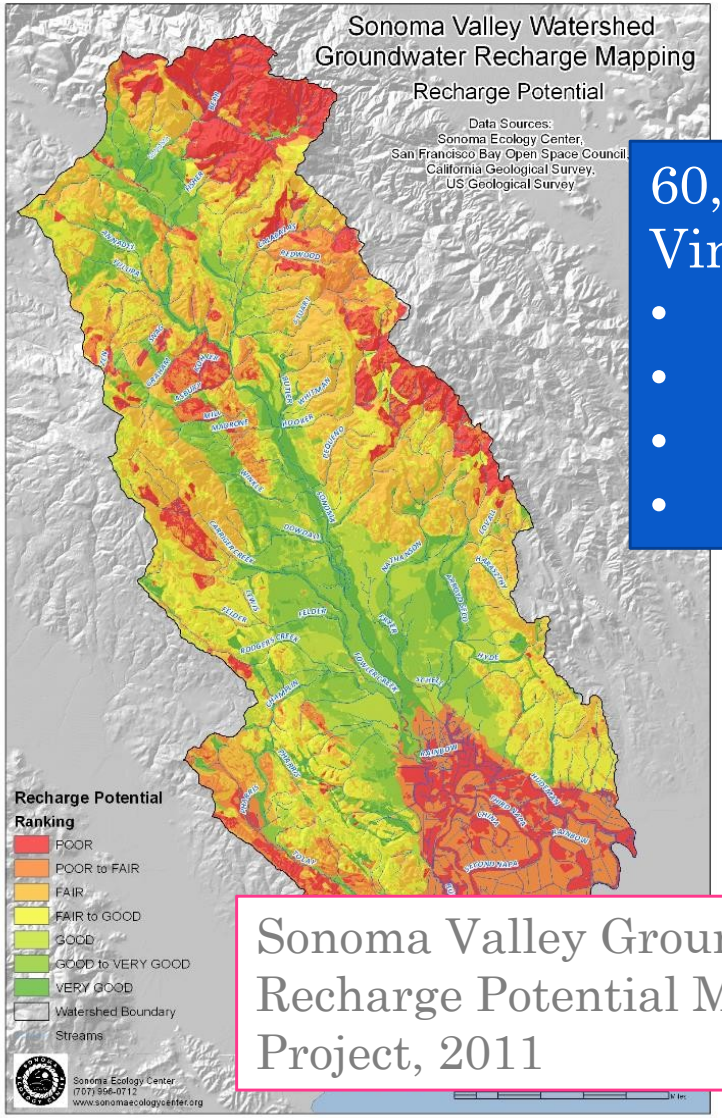
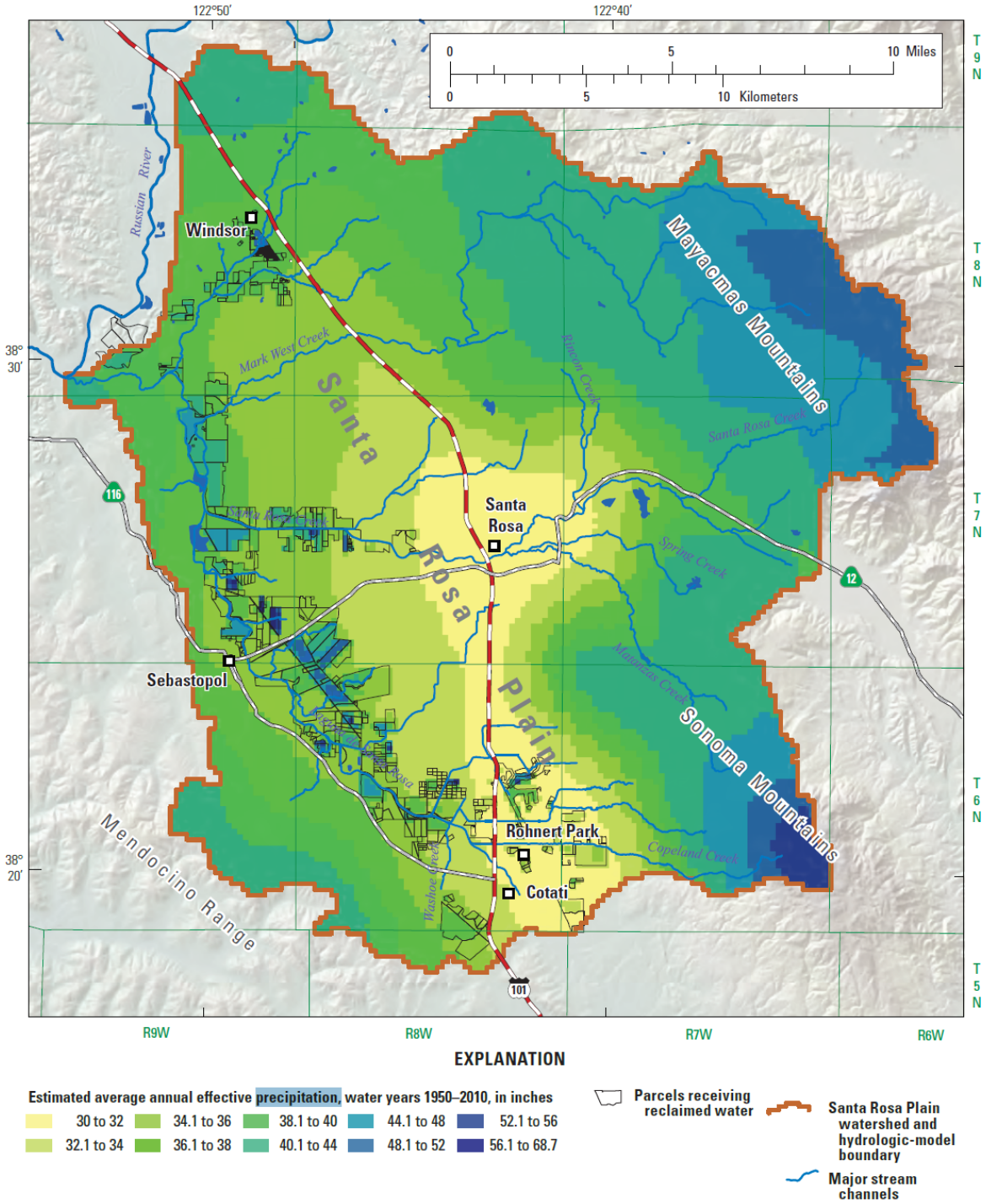
Precipitation and Available Lands



60,000 Acres of Vineyards

- 38% very good
- 26% good
- 29% fair
- 7% poor

Sonoma Valley Groundwater Recharge Potential Mapping Project, 2011



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Complementary Efforts in Sonoma Co. for OFR and DSC

- Sonoma County, Dept of Agriculture's Land Stewards Guide
  - Recommended Practices
  - Erosion Control and Stormwater Mgmt Opportunities on Vineyards
- Sonoma Co. Ag Preservation & Open Space District
  - The Watershed Collaborative
  - Watershed analyses – hydrology, vegetation, soils
- Sonoma Co. Water
  - Sonoma Valley Groundwater Recharge Potential Mapping Project, 2011
  - Reservoir Operation Strategies
    - Lake Mendocino FIRO Preliminary Viability Assessment
    - SGMA process

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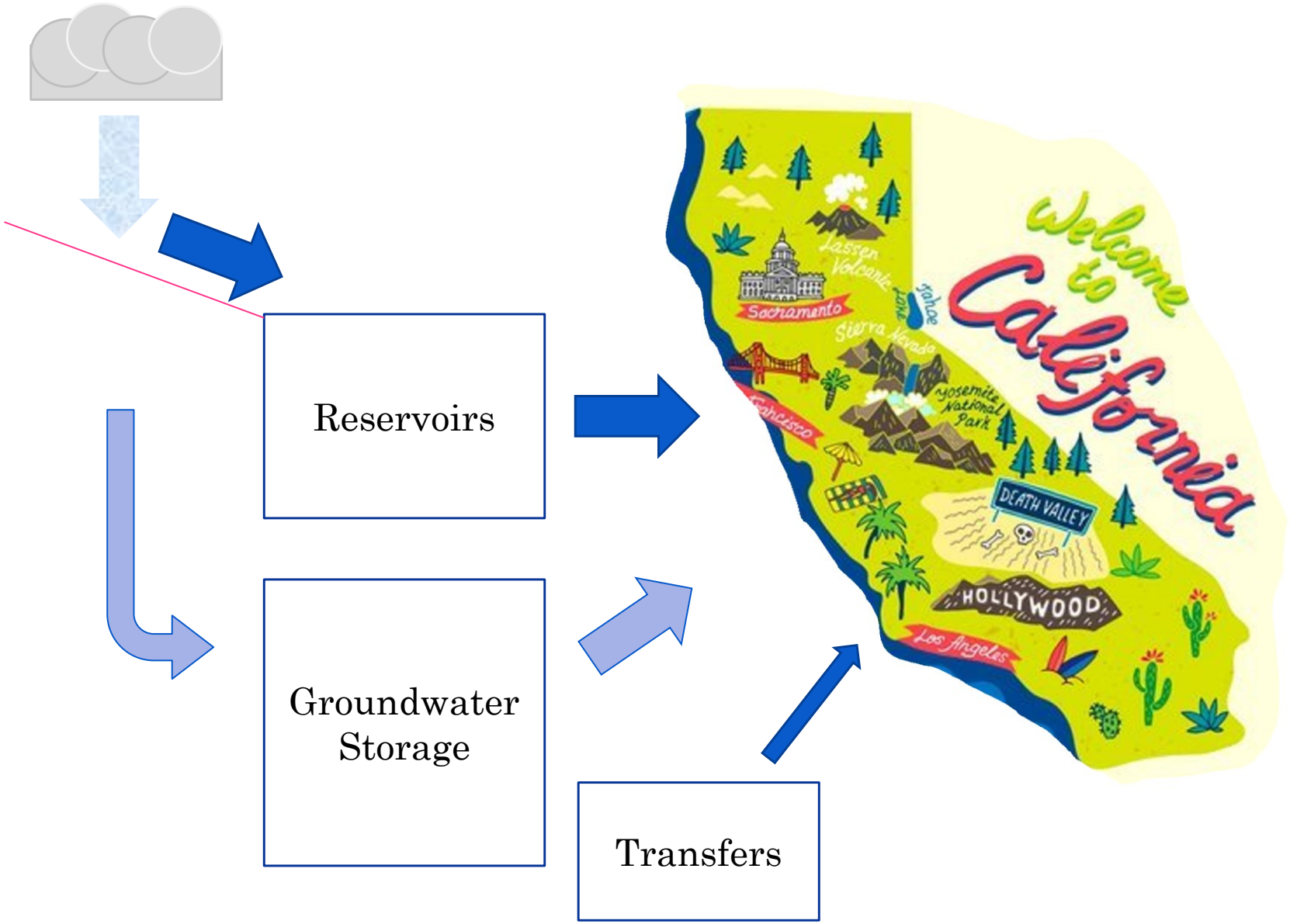
Conceptual Model California Water Delivery



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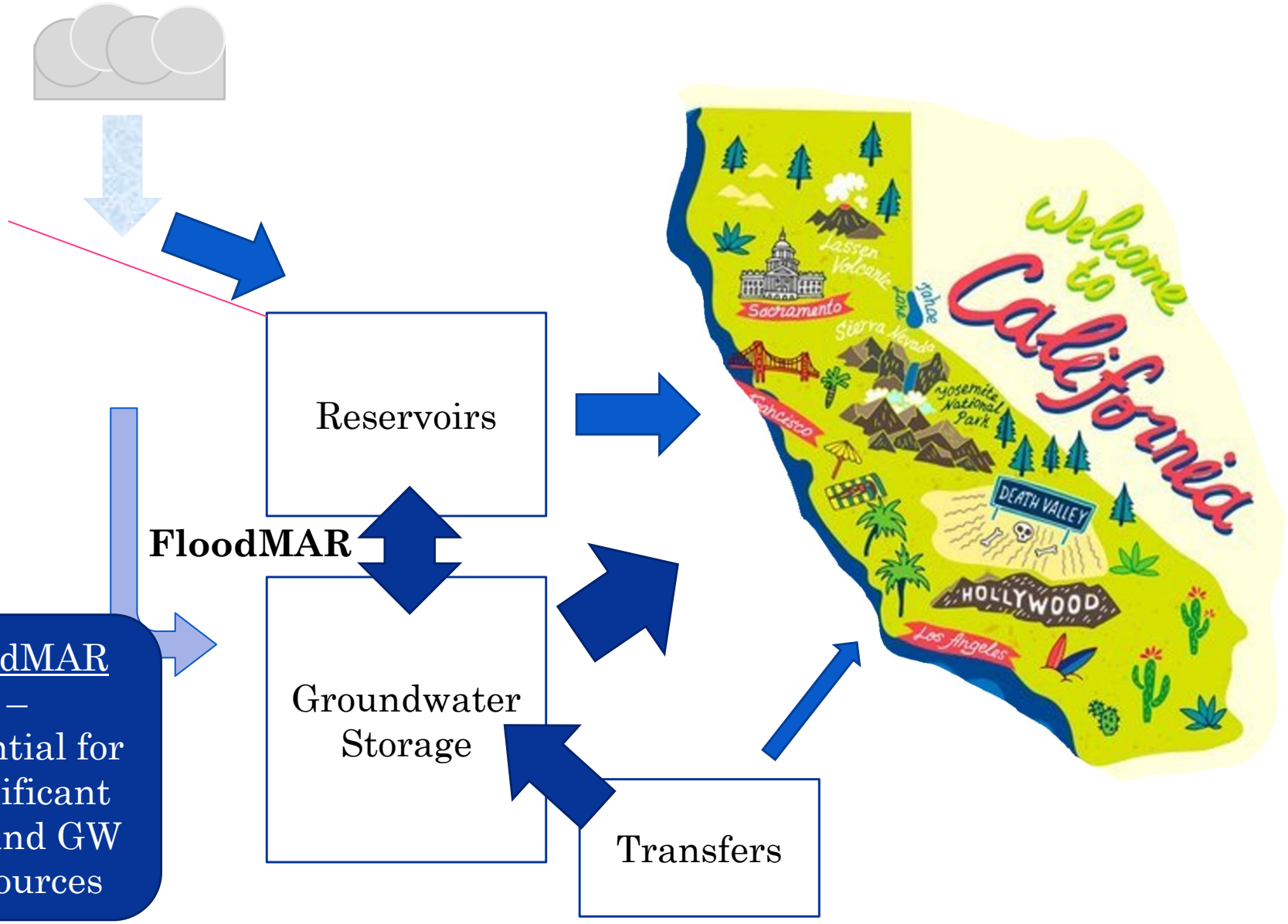

FloodMAR
–
Potential for Significant SW and GW Resources

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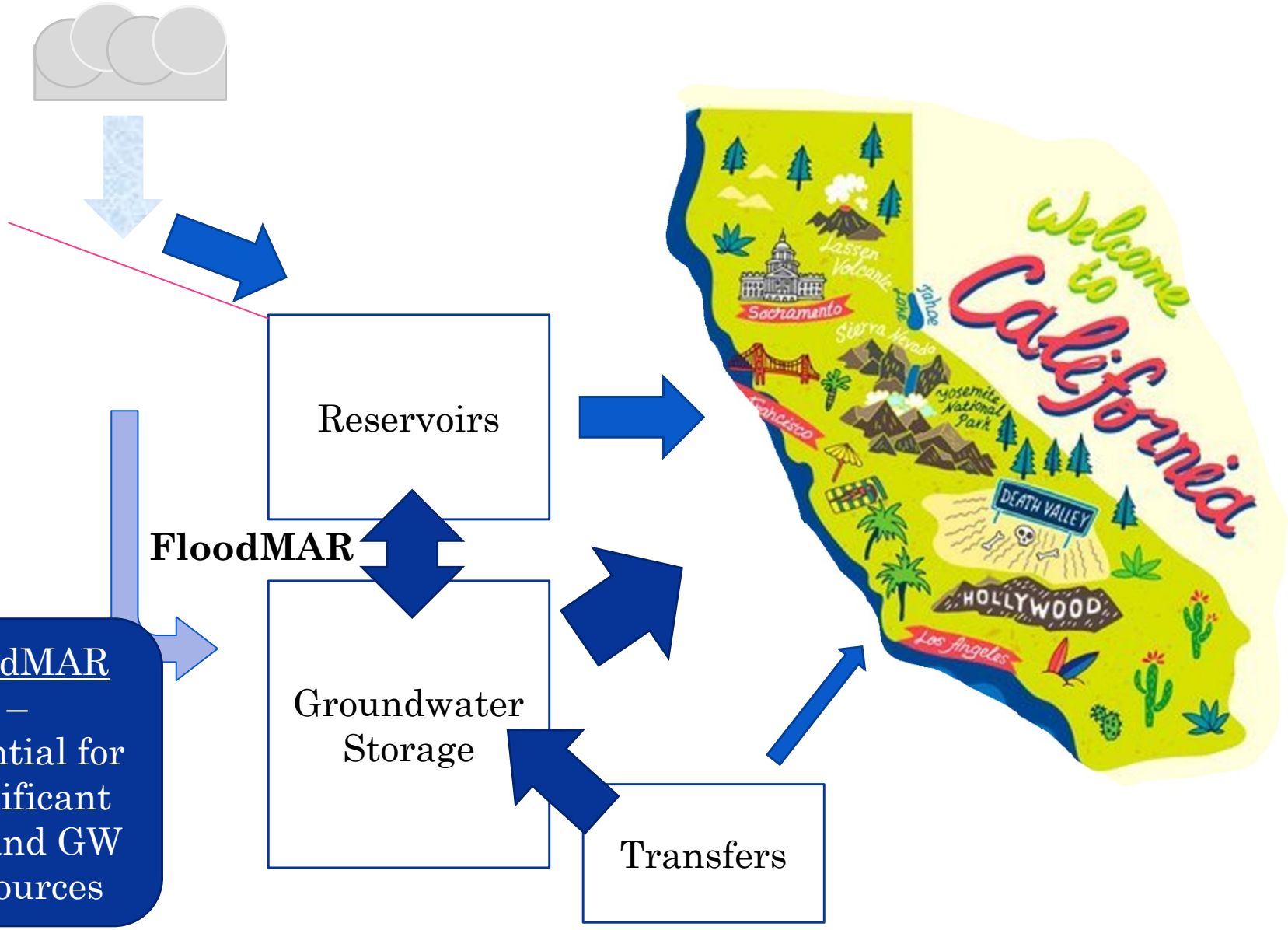
Conceptual Model California Water Delivery



FloodMAR – Potential for Significant SW and GW Resources

Challenges (e.g.)

- Re-imagining CA Water
- Water Rights
- Water Transfer Programs and Methods
- Energy Demands
- No. vs. So. Politics
- Infrastructure
  - Conveyance
  - Power
- Integration Locally and Regionally
  - Engineering
  - Design
  - Operating Guidelines
  - Etc…

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Q1: Resources State can provide to support development of groundwater sustainability indicators. Information gaps?

- What is readily available
  - Foundational technical information available (e.g. LIDAR, CDEC, CIMIS, CASGEM)
  - Technical services (private, public, nonprofit)
- Data and Information gaps and uncertainties
  - Water budgets: ET and Climate change uncertainties
  - Linkage to undesirable Groundwater Sustainability impacts (e.g.)
    - Impacts on river flows *and* fisheries
  - Strategy Development
    - Testing and modeling outcomes
    - Economic Costs and Benefits
    - Linkages to other effects considerations
      - Flood Mitigation
      - Restoration
      - Energy/Water Nexus at State Scale
  - Water Rights and Beneficial Use
    - Uncertainty and complications on how to proceed

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Q2: Local Institutional/Societal barriers to achieving sustainable groundwater?

- Collaboration and Cooperation – different missions, agendas, resources and goals
  - Collaboration
    - Local and Local
    - Governmental vs Non-governmental
    - Regional/State and Local
  - Cooperation
    - CA in it together
    - What are the incentives for coordination
- SGMA
  - Serious, solutions-based effort
  - Could strain resources
    - Needs to figure out how to be efficient and streamline
- Water Rights and Beneficial Uses
  - Cumbersome even when streamlined
  - Uncertainty
- Equitable Distribution of Costs and Benefit
  - Compensation and Penalties

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Q2: Regional Institutional/Societal barriers to achieving sustainable groundwater?

- Collaboration and Cooperation – different missions, agendas, resources and goals
- SGMA
- Water Rights and Beneficial Uses
- Equitable Distribution of Costs and Benefit
- Statewide strategies for water resources management
  - Current water system design and operations and barriers to change
  - Water Markets and Water Allocations
  - Agencies and Institutions focused on particular resource or concern

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Q3: How does your project consider needs or engage with disadvantaged communities and California's tribes?

- Sustainable GW DAC effects
  - positive health effect from sustainable water resources and water quality
  - potential negative health effects from economic effects
    - Less likely in diverse and wealthier economic region
    - More likely in Ag. Intensive regions
- Funding incentives create incentives for engaging with DACs
- SGMA potentially creating a framework for community involvement
- Broader strategy needed
  - Incentivizing more diverse economies
  - Concerted outreach to DACs in the SGMA process

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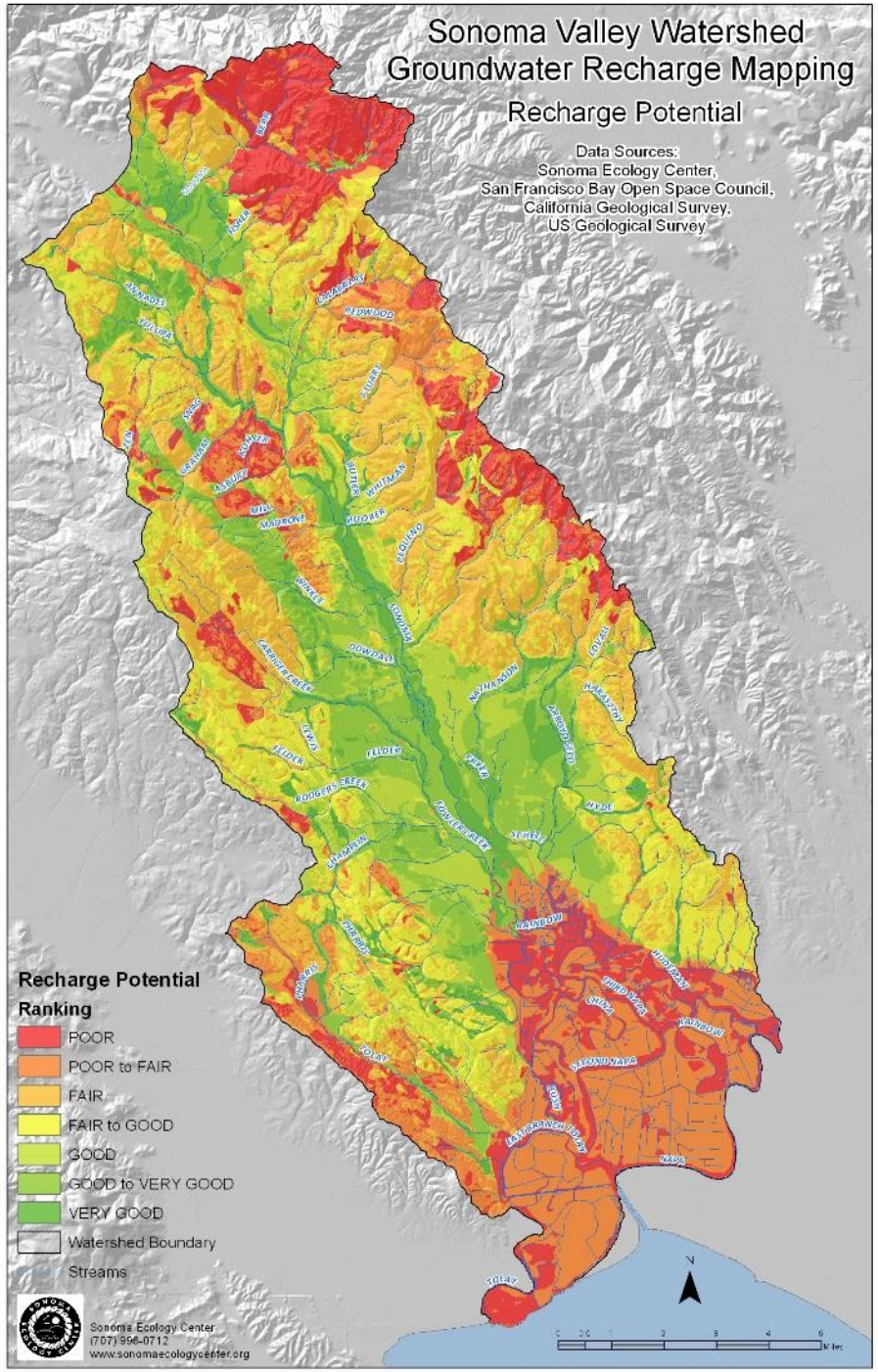
Potential OFR Opportunities Vineyards, Sonoma Co. Watershed

- 60,000 acres total wine grapes (Sonoma Co. Crop Report, 2016)
- Recharge Potential within Sonoma Valley Vineyards (Sonoma Valley Groundwater Recharge Potential Mapping Project, 2011)
  - 38% very good
  - 26% good
  - 29% fair
  - 7% poor
- Land Stewards Guide to Vineyard and Orchard Erosion Control (CDFA SCBG), Sonoma Co., Dept of Agriculture offering methods to manage storm runoff
- Average 30” rain per year (Western Regional Climate Center)

Sonoma Valley Vineyards Recharge Suitability

60,000 Acres of Vineyards

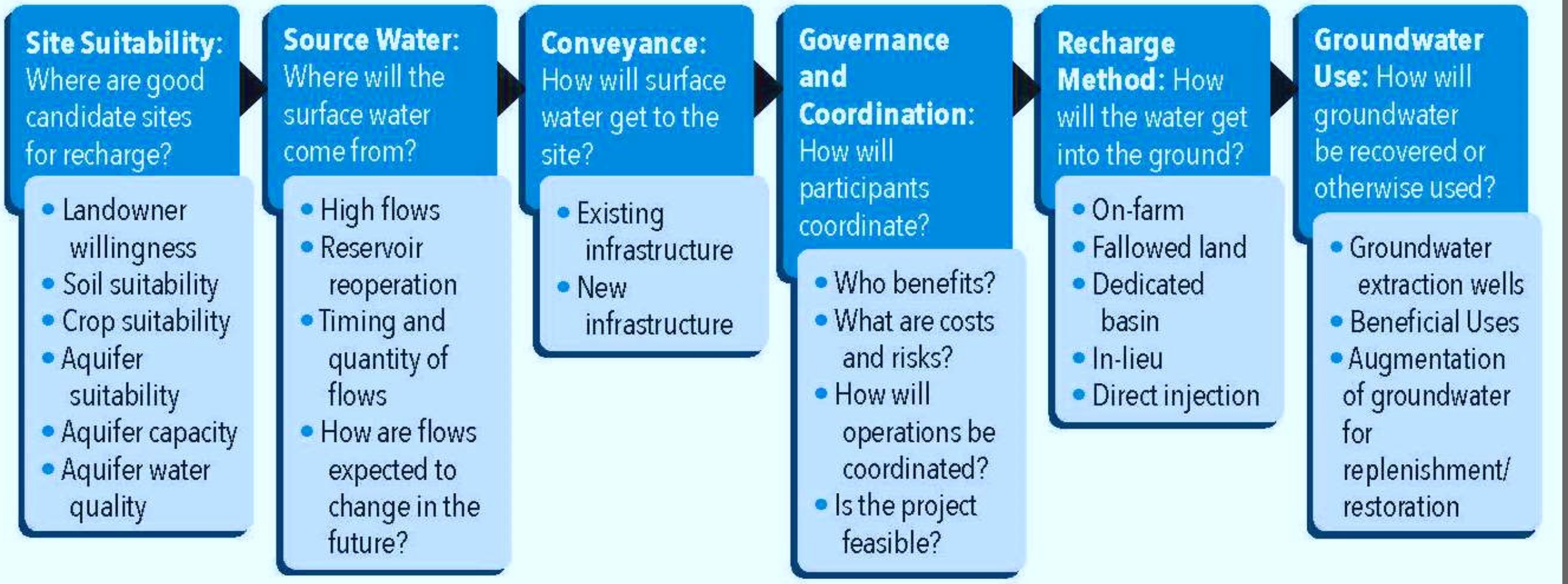
- 38% very good
- 26% good
- 29% fair
- 7% poor



Sonoma Valley Groundwater Recharge Potential Mapping Project, 2011

Factors for Implementing Flood-MAR

(DWR 2018, DRAFT)



Land Stewards Guide: Erosion Control and Stormwater Mgmt Opportunities on Vineyards

- Site audits
- Planning, design and adaptation
  - Roads
  - Drainage Ditches
  - Basins
- Field Strategies and Practices, E.g.:
  - Structural
    - Straw Wattles / Bales
    - Terracing (?)
  - Soil Mgmt:
    - Cover (crops)
    - Organic matter
    - Mulch
    - Tillage practices

- Fundamental Principles:
  - Disperse Flow and Reduce Energy
  - Increase Surface Friction
  - Increase Retention
- Fundamental Benefits, E.g.
  - Protect Ecosystems
  - Conserve soils
  - Reduce Pollution
  - **Promote Recharge and Infiltration**

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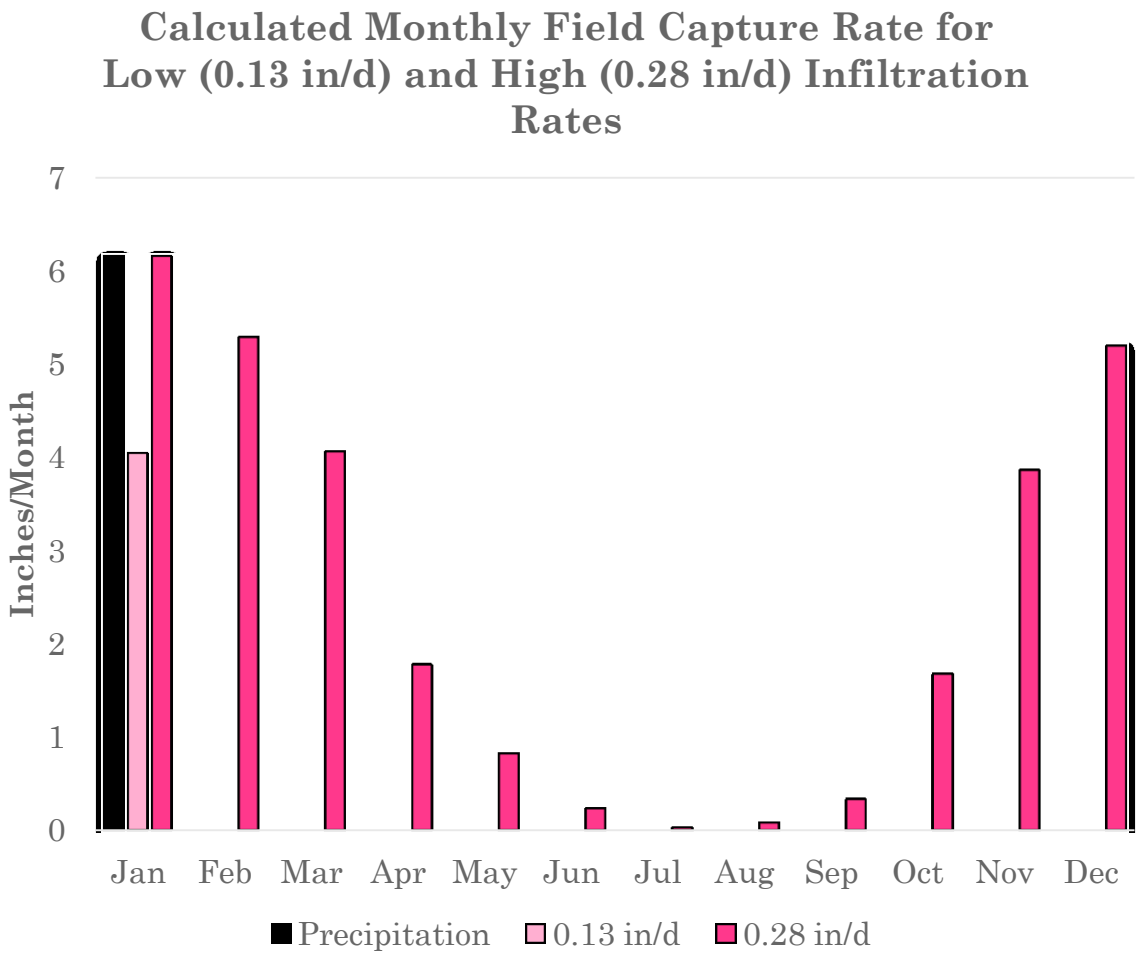
Infiltration Rates Estimated at Saralee sufficient to capture most rain falling on property (with caveats)



- Need sufficient time
- Does not consider upstream sheetflow

- Low infiltration rates still offer opportunities for capture and recharge

- Average Winter Rain falling (Dec – Mar) on Vineyards =
- 103,000 ac-ft/yr

Rational Method – Runoff Coef (RN) by Land Use

Land use	Slope (%)	Sand	Loamy sand	Sandy loam	Loam	Silt loam	Silt	Sandy clay loam	Clay loam	Silty clay loam	Sandy clay	Silty clay	Clay
Forest	< 0.5	0.03	0.07	0.10	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.40
	0.5 - 5	0.07	0.11	0.14	0.17	0.21	0.24	0.27	0.31	0.34	0.37	0.41	0.44
	5 - 10	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50
	>10	0.25	0.29	0.32	0.35	0.39	0.42	0.45	0.49	0.52	0.55	0.59	0.62
Grass	< 0.5	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50
	0.5 - 5	0.17	0.21	0.24	0.27	0.31	0.34	0.37	0.41	0.44	0.47	0.51	0.54
	5 - 10	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60
	>10	0.35	0.39	0.42	0.45	0.49	0.52	0.55	0.59	0.62	0.65	0.69	0.72
Crop	< 0.5	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60
	0.5 - 5	0.27	0.31	0.34	0.37	0.41	0.44	0.47	0.51	0.54	0.57	0.61	0.64
	5 - 10	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70
	>10	0.45	0.49	0.52	0.55	0.59	0.62	0.65	0.69	0.72	0.75	0.79	0.82
Bare Soil	< 0.5	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70
	0.5 - 5	0.37	0.41	0.44	0.47	0.51	0.54	0.57	0.61	0.64	0.67	0.71	0.74
	5 - 10	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80
	>10	0.55	0.59	0.62	0.65	0.69	0.72	0.75	0.79	0.82	0.85	0.89	0.92
IMP	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Rational Method – Runoff Coef (RN) by Land Use

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	5 - 10	0.13	0.17	0.20	0.23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.43	0.47	0.50
	>10	0.25	0.29	0.32	0.35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.55	0.59	0.62
Grass	< 0.5	[illegible]	0.17	0.20	0.23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.43	0.47	0.50
	0.5 - 5	[illegible]	0.21	0.24	0.27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.47	0.51	0.54
	5 - 10	[illegible]	[illegible]	0.30	0.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.53	0.57	0.60
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IMP	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Adding Cover Crops May Drop RN 10%:

- Example on Sand:
- 23 – 45% for "Crop"
- 13 – 35% for "Grass"

Rational Method – Runoff Coef (RN) by Land Use

Each Texture Change affects CN by 3 - 4%:

- For "Crop"
- Silty Clay Loam has CN = 0.5 – 0.72
- Clay Loam has CN = 0.47 – 0.69

Land use	Slope (%)	Sand	Loamy sand	Sandy loam	Loam	Silt loam	Silt	Sandy clay loam	Clay loam	Silt clay loam			
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	5 - 10	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.4			
	>10	0.25	0.29	0.32	0.35	0.39	0.42	0.45	0.49	0.5			
Grass	< 0.5	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.4			
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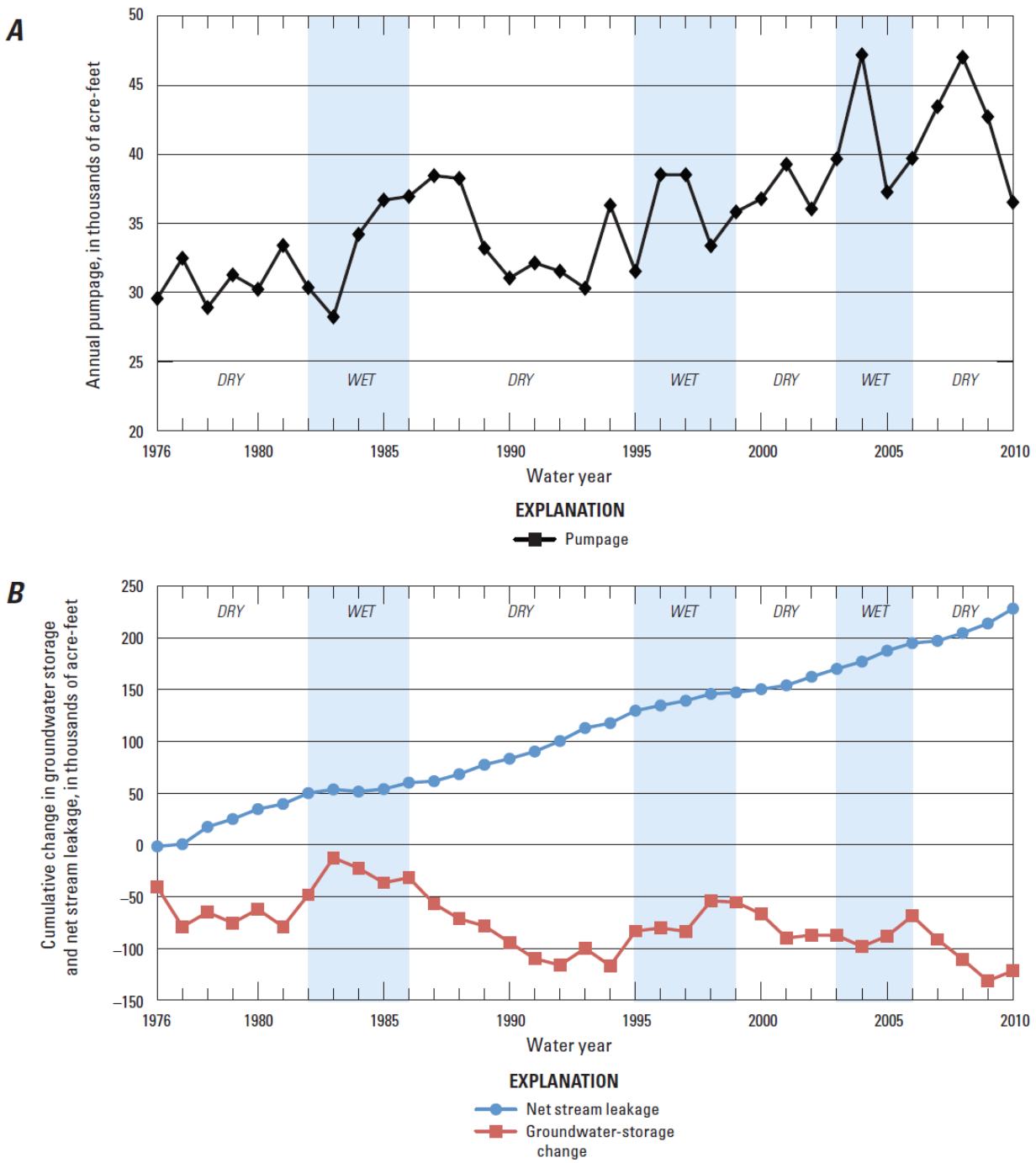
	5 - 10	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80
	>10	0.55	0.59	0.62	0.65	0.69	0.72	0.75	0.79	0.82	0.85	0.89	0.92
IMP	All	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

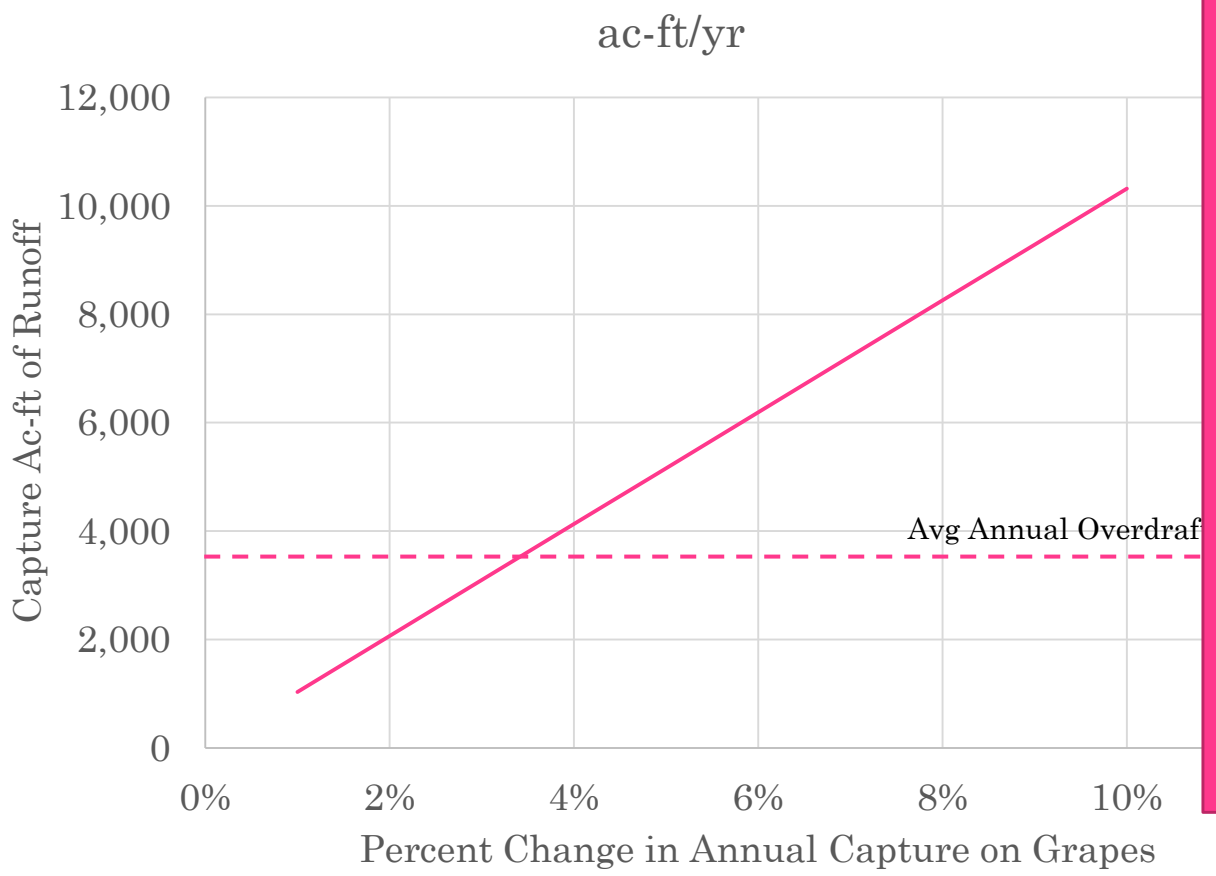
Simulation of Groundwater and Surface-Water Resources of the Santa Rosa Plain Watershed, Sonoma County, California



Annual Overdraft

- Estimated Avg = 3,500 ac-ft from 1976 -2000
- Wet year recovery
- Dry year drops

Estimating Potential Capture of Storm Flow with Change in Percentage Capture of Annual Storm Runoff on Sonoma Co. Vineyards



- Key Points –
  - Increasing Precipitation Capture by 4% on Grapes potentially overcomes Annual Storage Loss
  - Back of envelope assessment
  - Need testing and validation with local and regional studies