Recycled water use, water demand and infrastructure in the Salinas Valley

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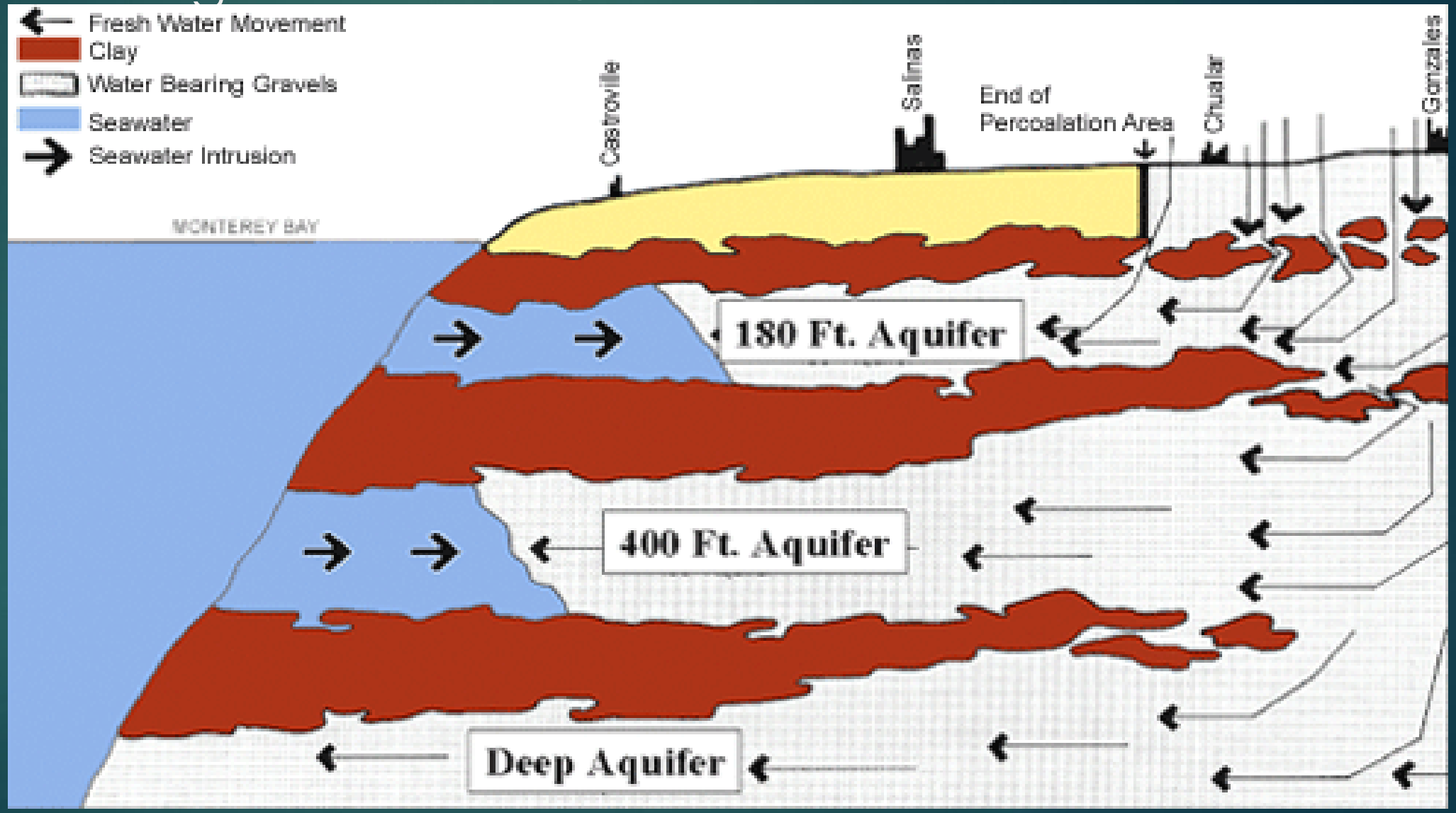
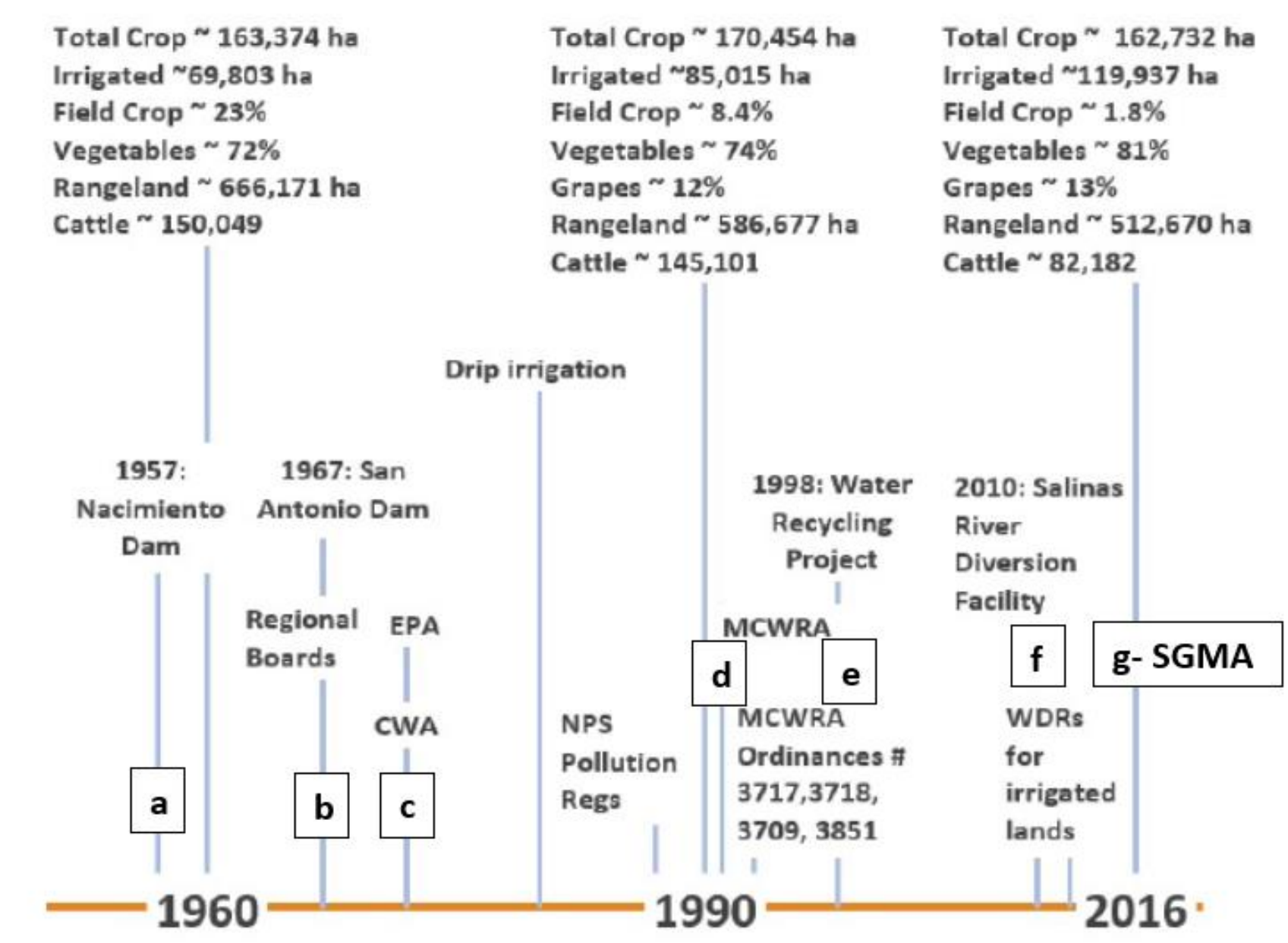
Salinas Valley – Recycled Water Use & Agricultural water use impacts on GW supply

Castroville Seawater Intrusion Project & Salinas Valley Reclamation Project, designed in 1995 & began delivering recycled water to growers in 1998



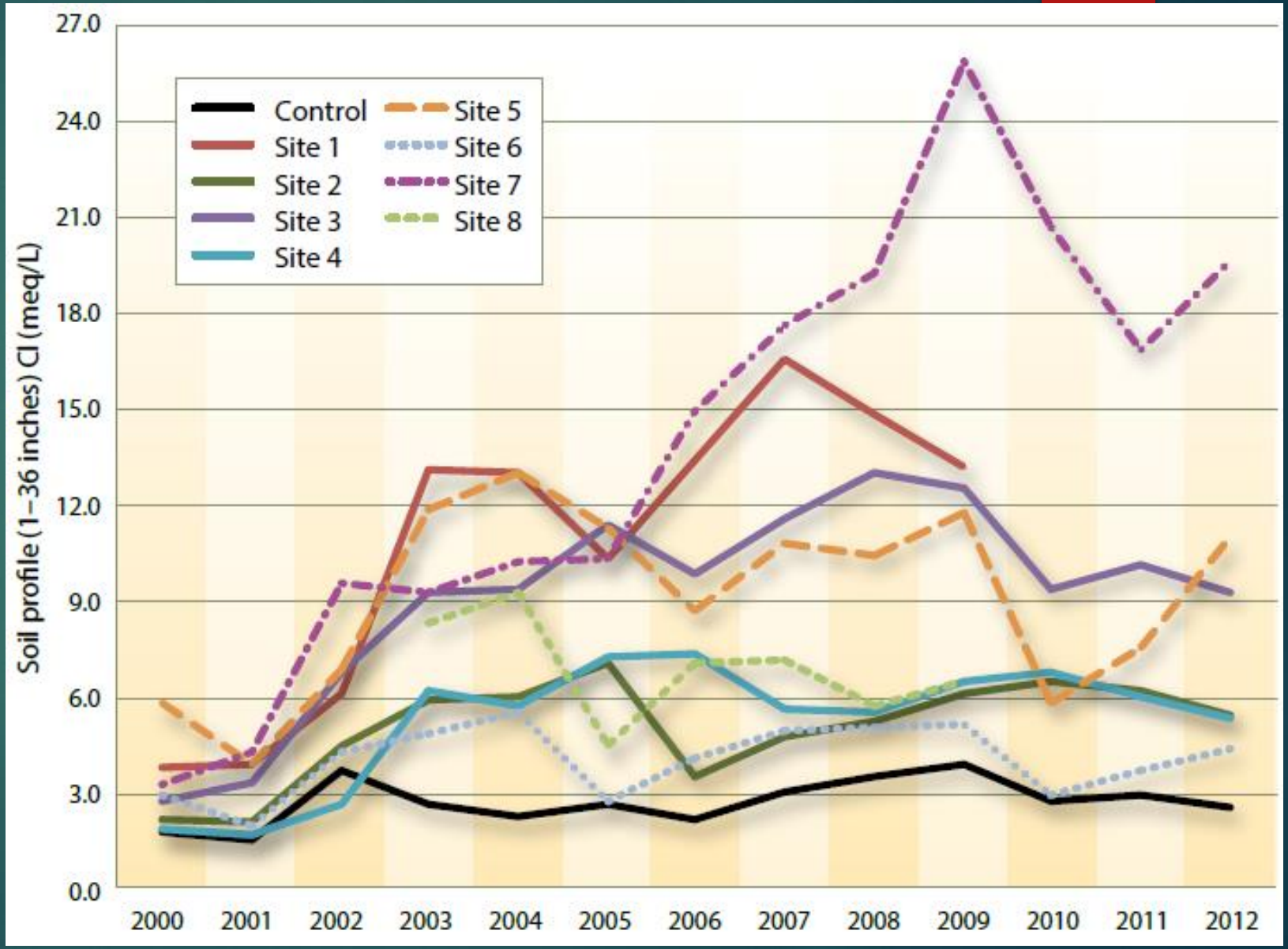
Market drivers – vegetable, lettuce & strawberry crop values for export

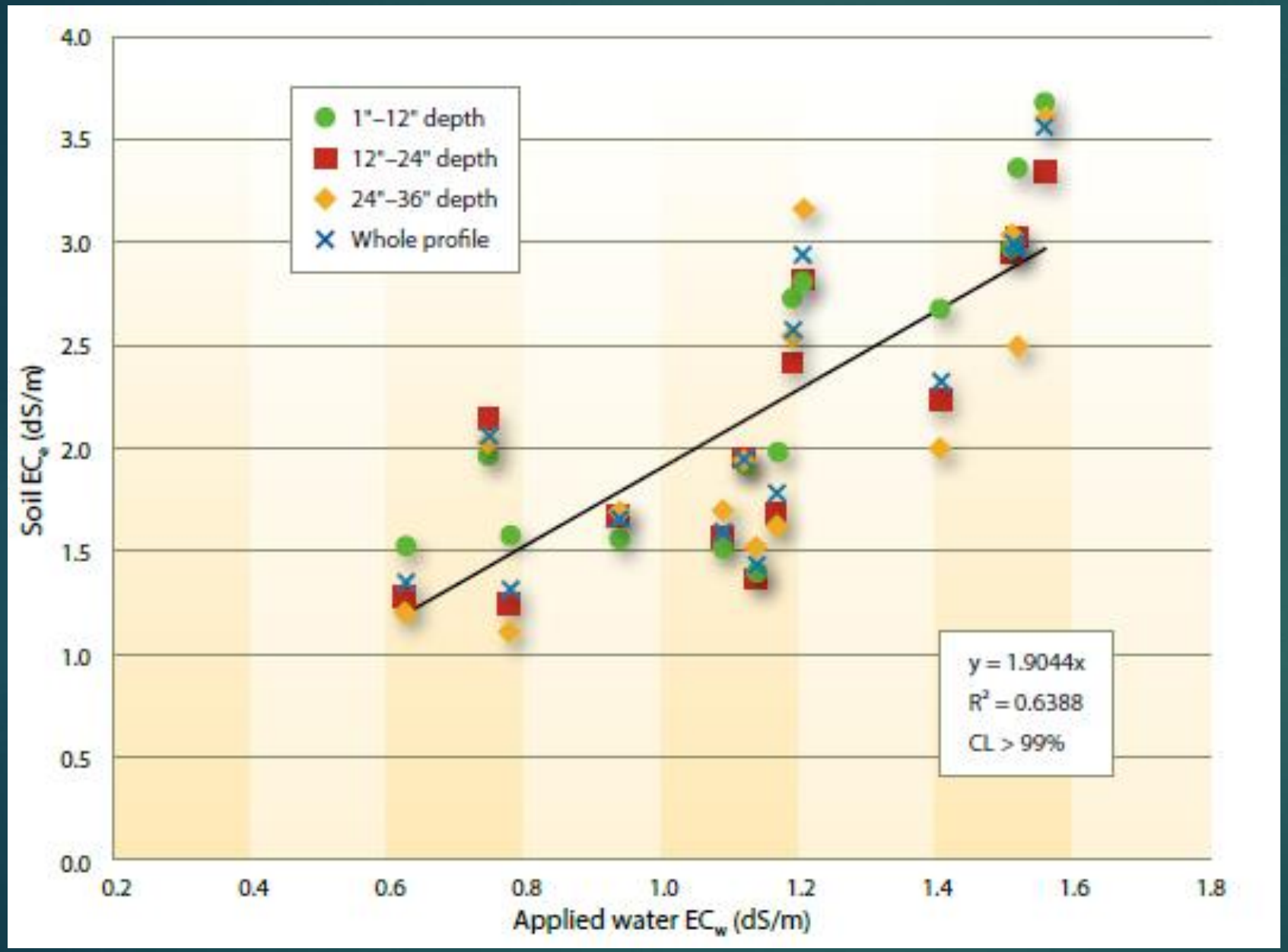
Past decades of ongoing MCWRA Efforts to meet needs of Valley growers & related regulations



Recycled Water Use

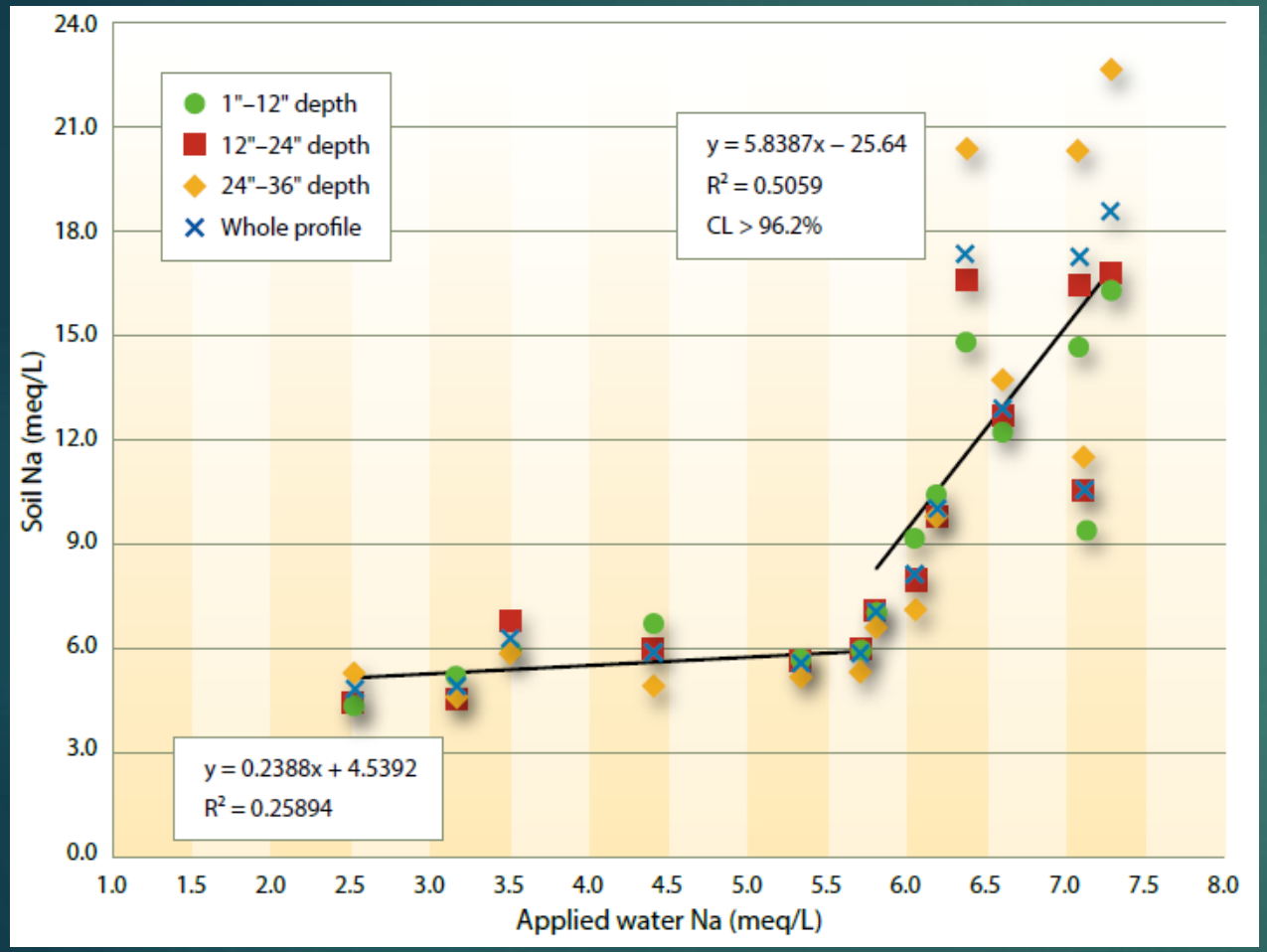
Project - Measured Variation in Soil-water Chloride concentrations

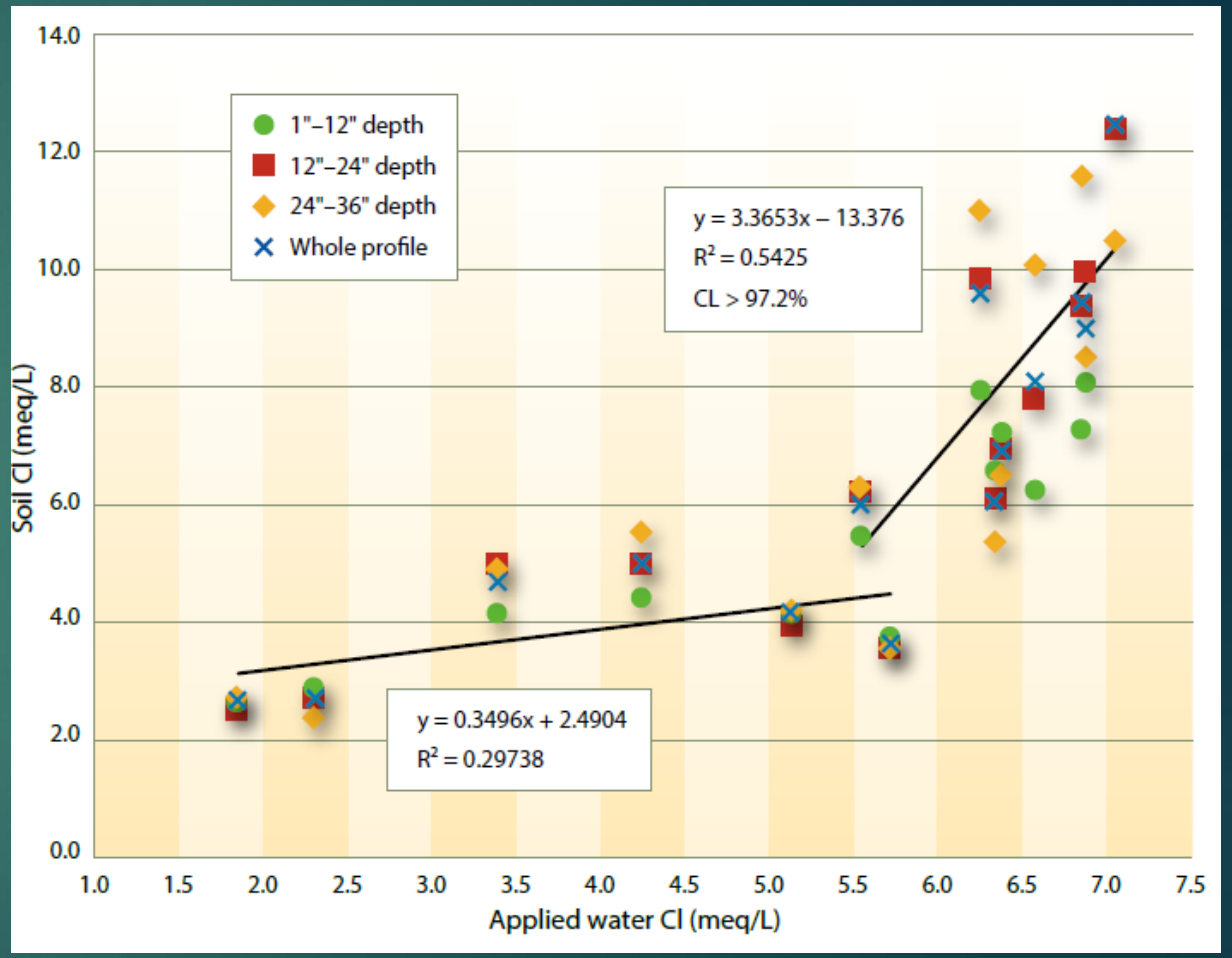




Measured dependence of soil salinity on Applied Water salinity after ~12 years

Apparent threshold salinity values…





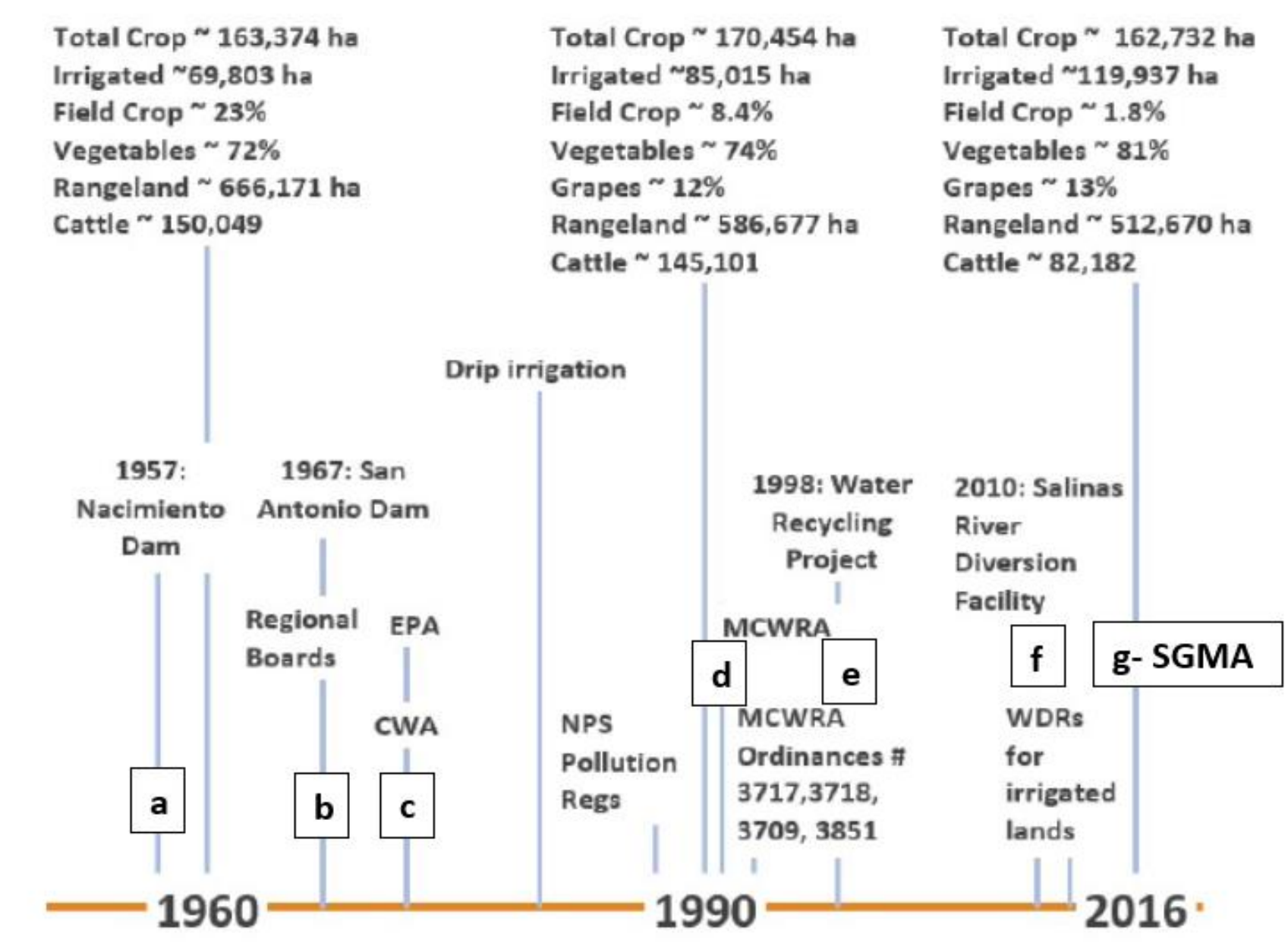
Rootzone monitoring & modeling of fields using recycled water for irrigation

Site No.	2	3	4	5	6	7
Crop management	Vegetables	Vegetables & strawberries	Perennial - artichoke		Vegetables & strawberries	Vegetables
Irrigation management	Sprinkler or drip	Sprinkler then drip	Sprinkler	Sprinkler or drip	Sprinkler then furrow	Sprinkler then furrow
% Recycled water	46-92	94-98	58-96	93-100	70-90	90-96
EC_W (dS/m)	0.94	1.36	1.06	1.36	1.1	1.37
Root zone EC_{SW} (dS/m)	1.74	2.45	2.4	2.89	1.76	1.95
Root zone EC_{eS} (dS/m)	0.13	0.19	0.15	0.18	0.15	0.17
Deep perc. salt load (lb/ac/yr)	37	184	0	0	137	93
Runoff salt load (lb/ac/yr)	1247	2341	822	1219	1352	1774

Salinity Analysis – modeling efforts

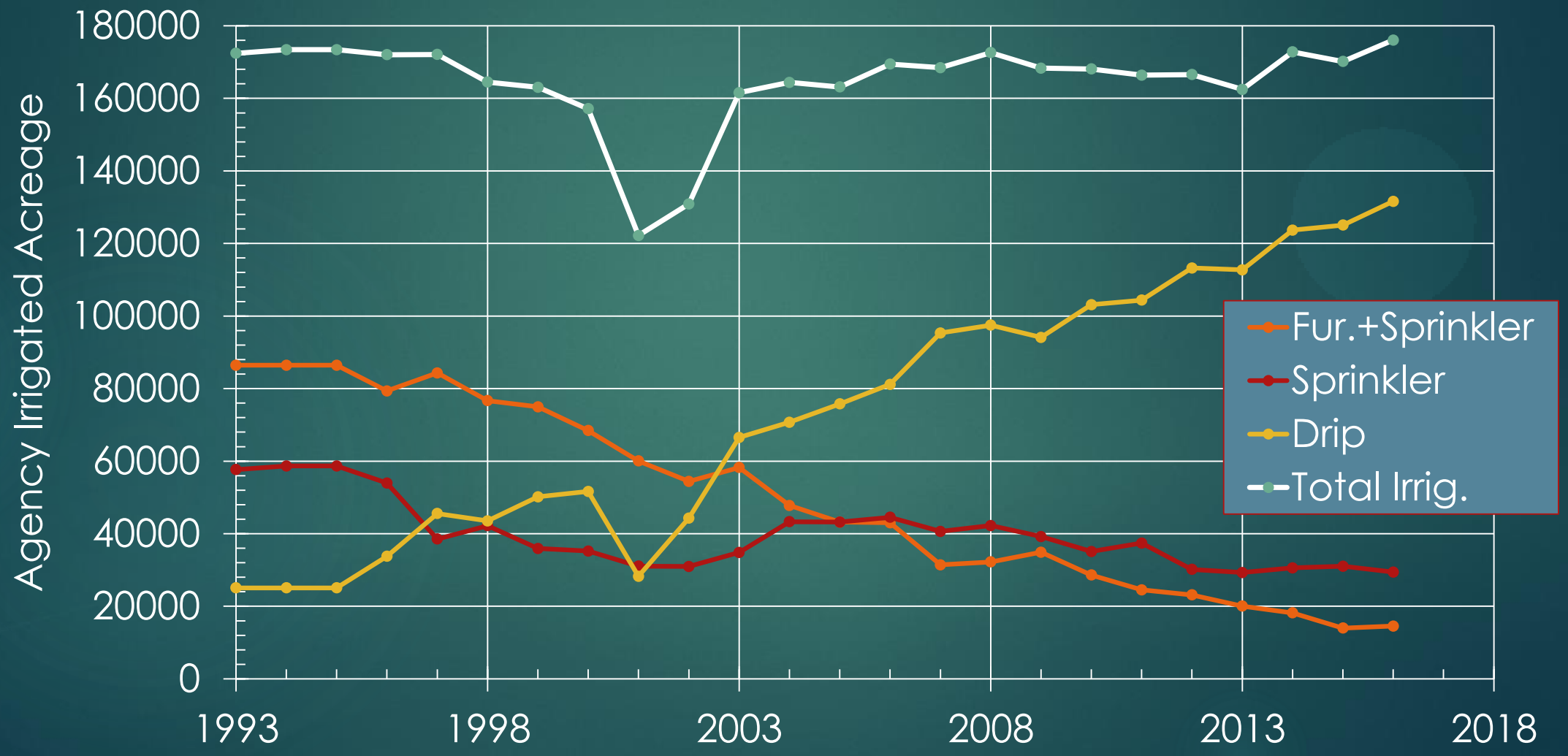
- Hydrologic assessment based on 13-year field study employs a daily soil-water balance & water chemistry analysis to assess the critical hydrologic factors controlling rootzone salinity.
- Rootzone salinity model was developed that includes plant-water uptake, salt dissolution and chemistry, shallow groundwater salinization combined with hydrologic analyses.
- Global assessment of key model parameters indicated **only 7 of 33** were interactively influential – these were related to salt dissolution rates, soil hydraulic parameters and crop rooting depth.
- Applied calibrated & validated process model to 50-year climate record; results indicated relative soil-water chemistry equilibrium achieved within roughly one decade ($0.6<EC_{sw}<1.8$ dS/m) at different sites and under various management practices.

Past decades of ongoing MCWRA Efforts to meet needs of Valley growers & related regulations

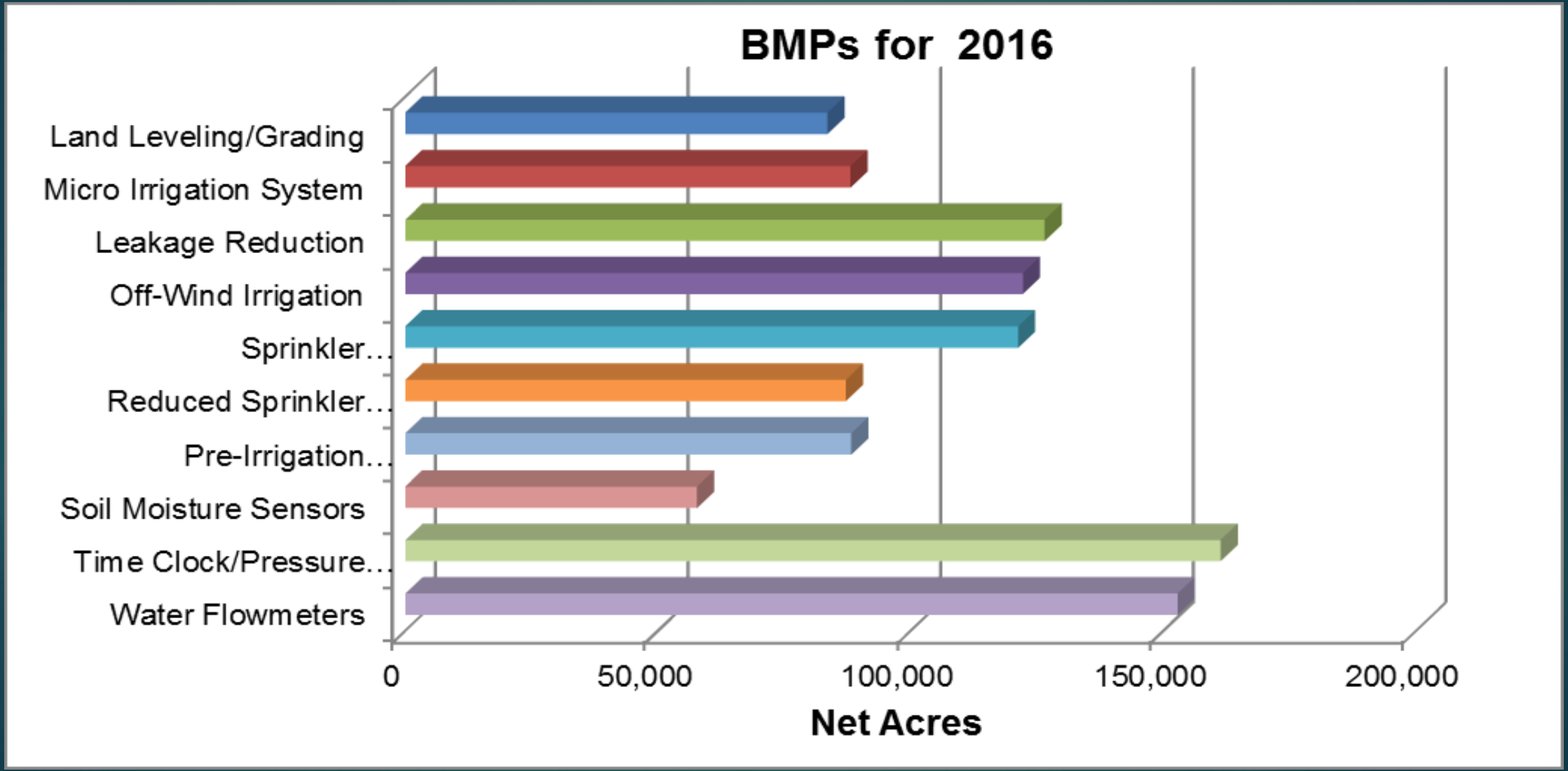


The Salinas River Diversion Facility (SRDF) - constructed in 2010 to provide treated (filtered and chlorinated) river water for irrigation, with goal of reducing need to pump groundwater

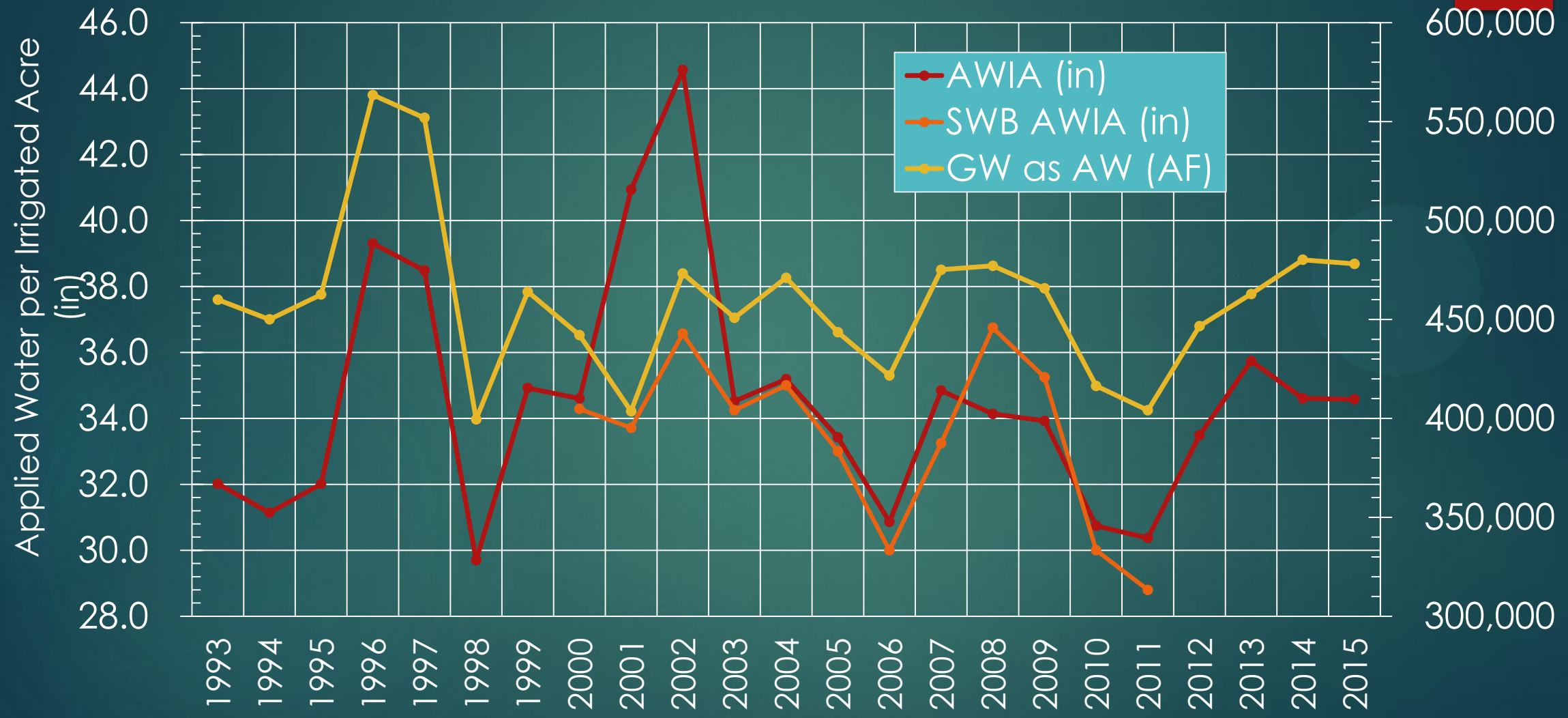
Adoption of new irrigation technology and alternative water supplies



And Water Conservation Measures…

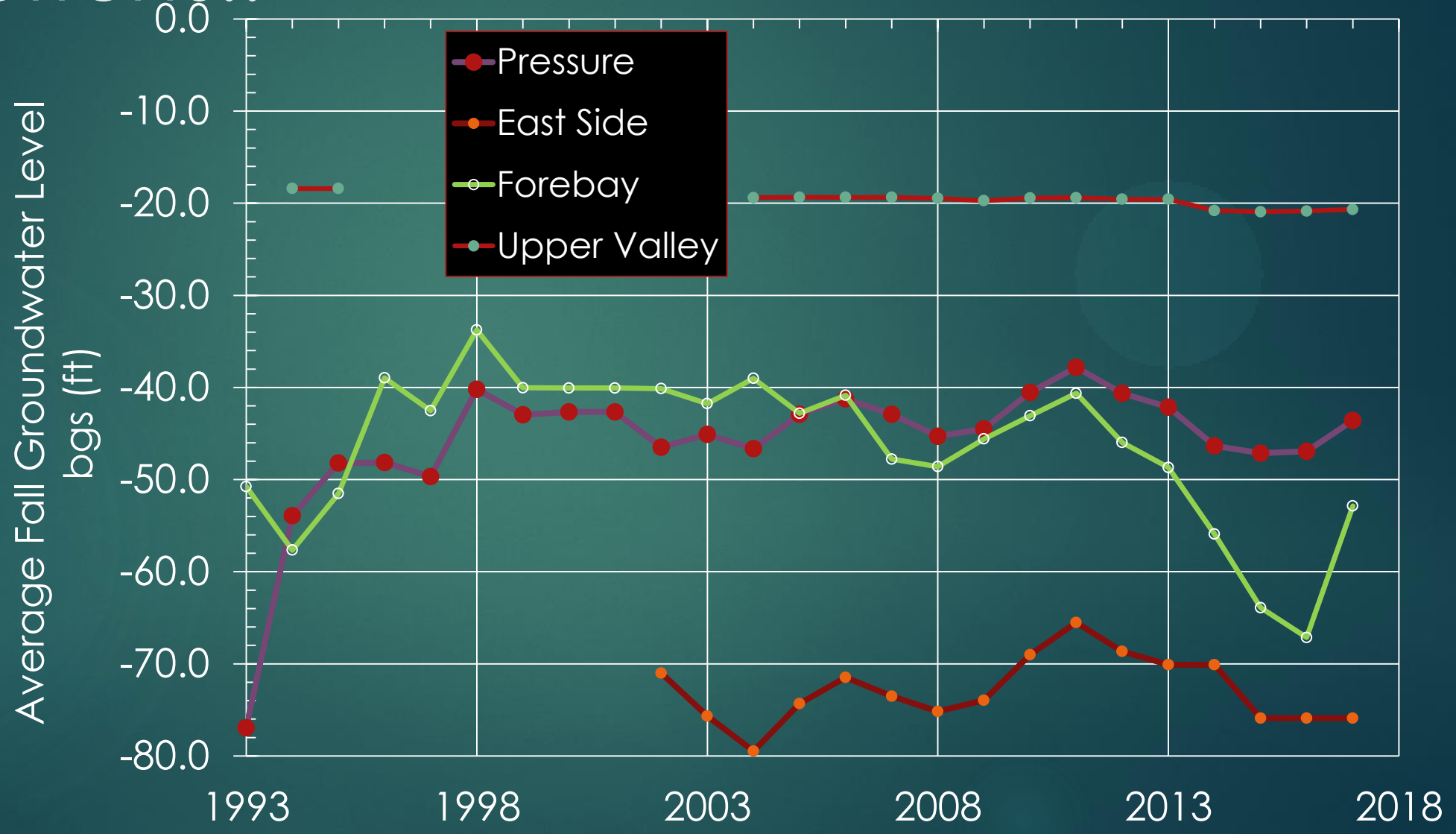


Leading to improved water 'productivity'…

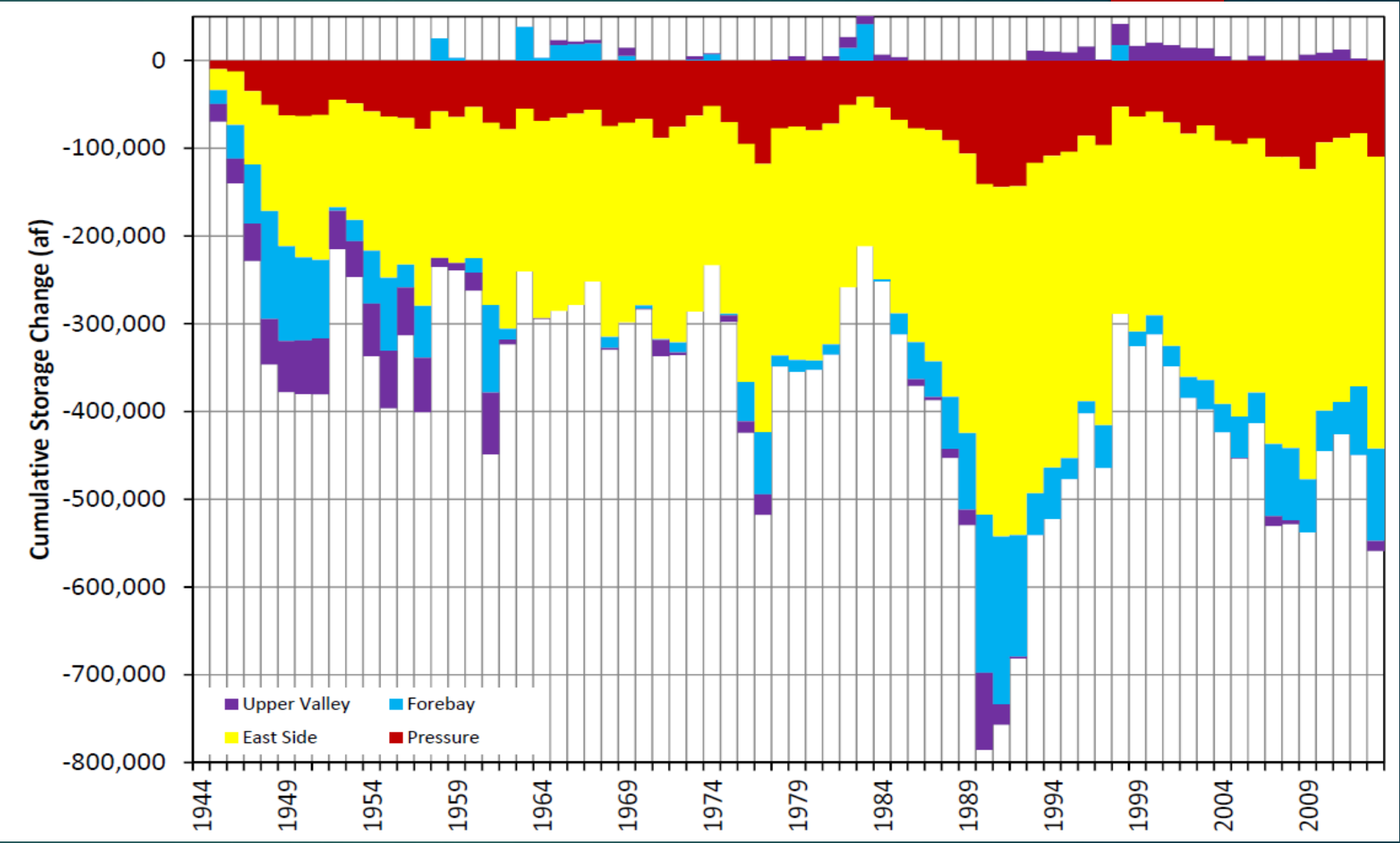


Though not necessarily less groundwater used across the Valley…

Leading to declining GW levels despite efforts..

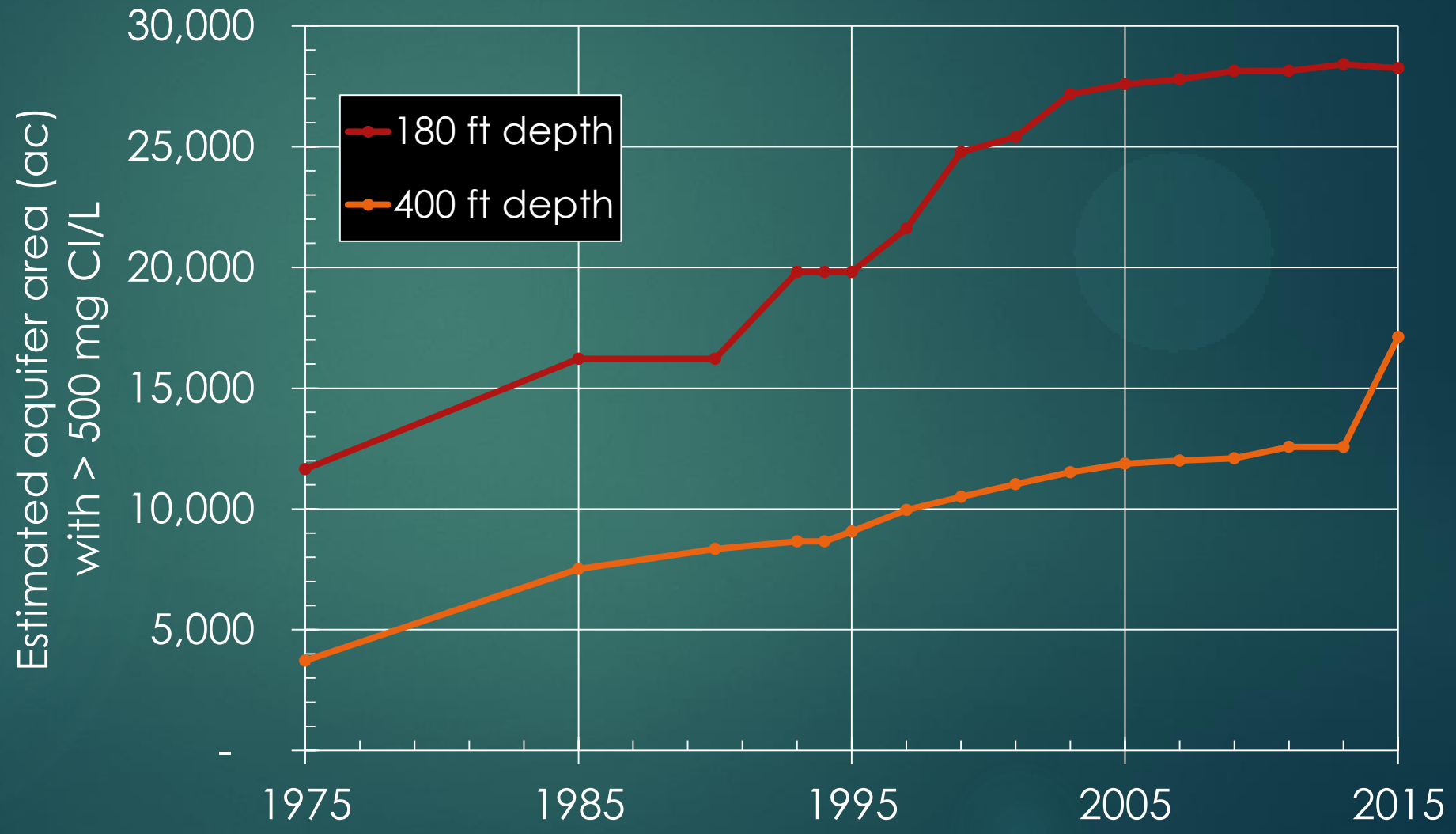


But not necessarily greater water availability…



Irrigation efficiency paradox… Grafton et al., (2018)

As well as GW salinization – combined effect of rootzone drainage (lag) & seawater intrusion…



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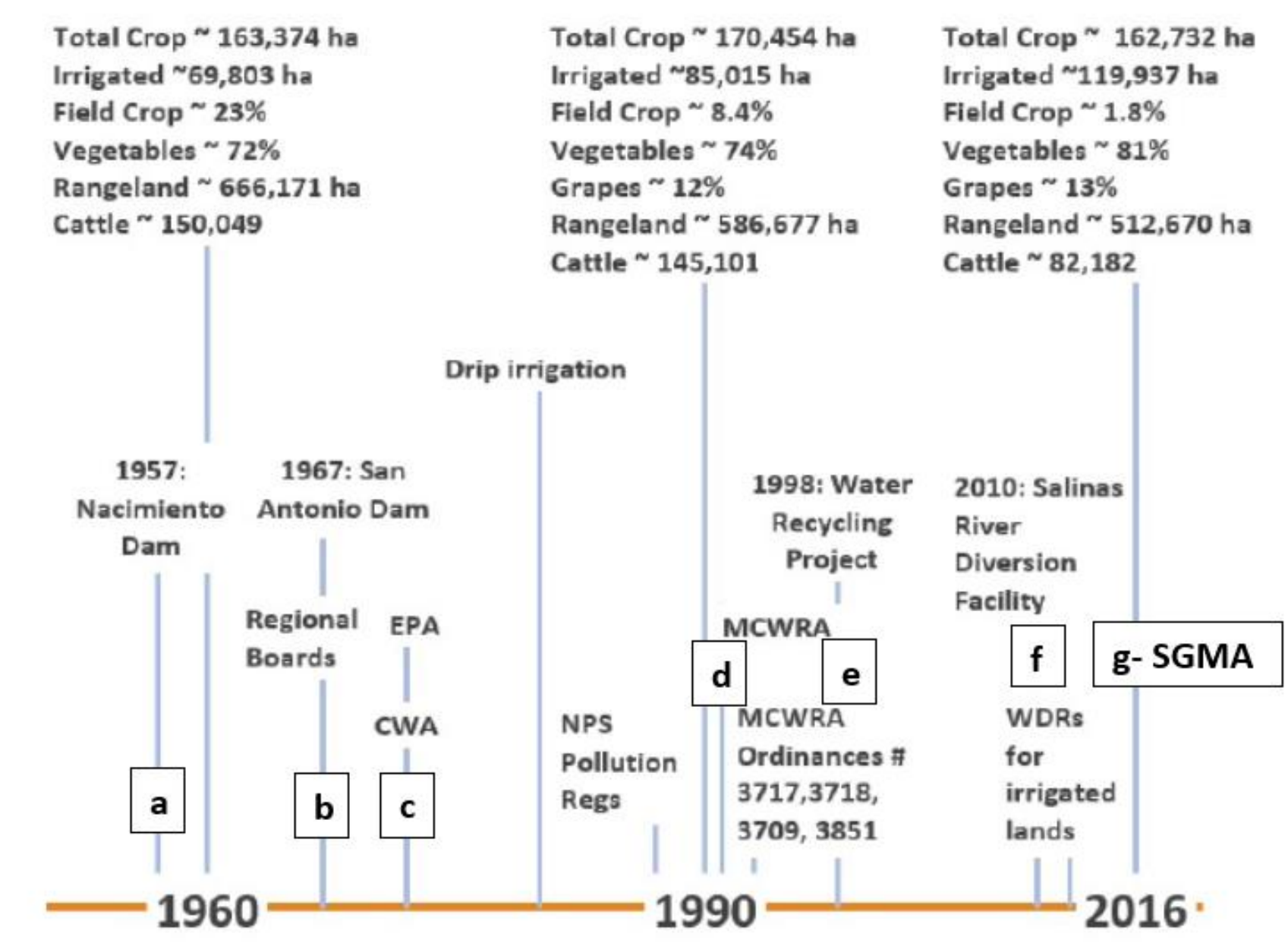
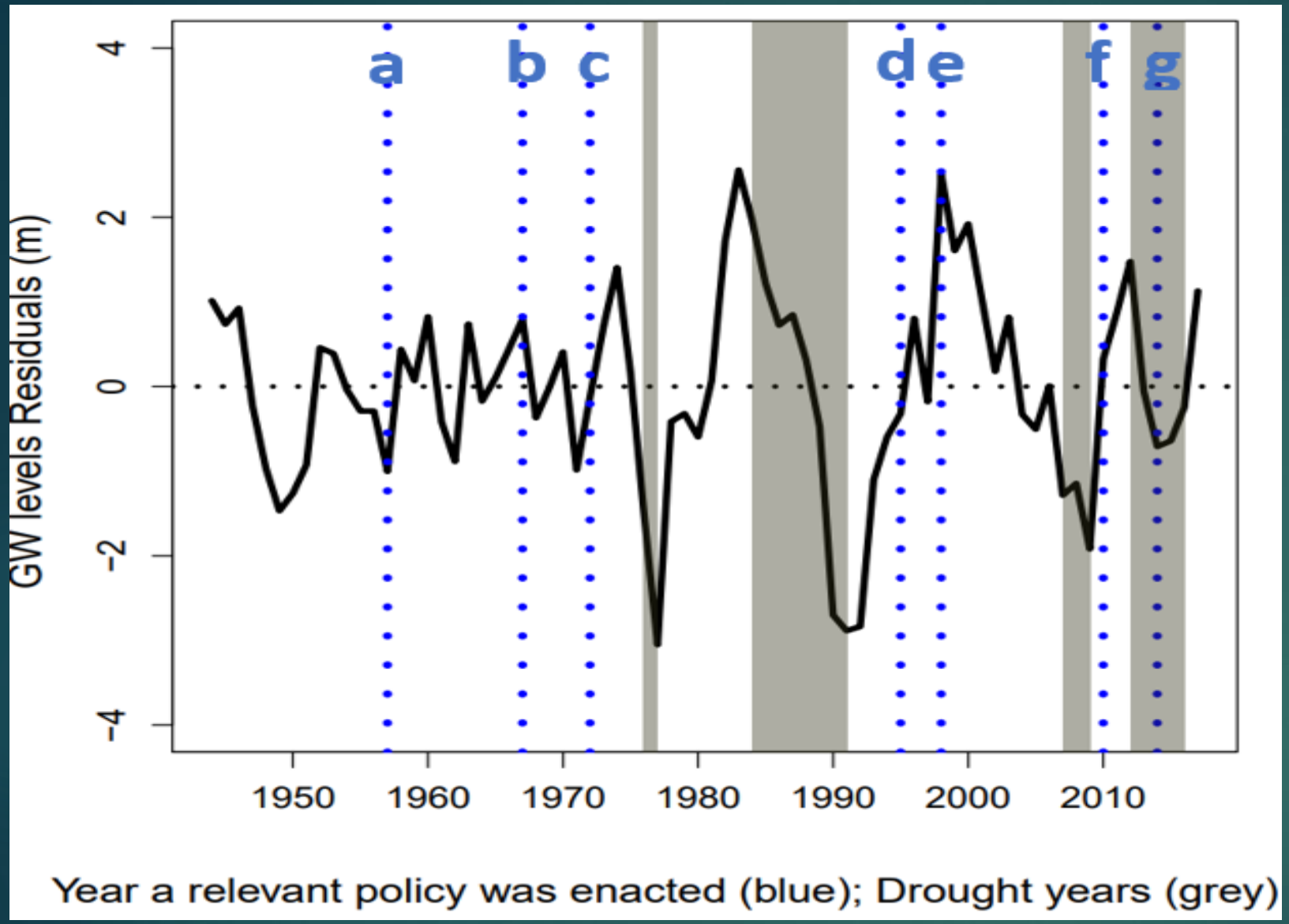


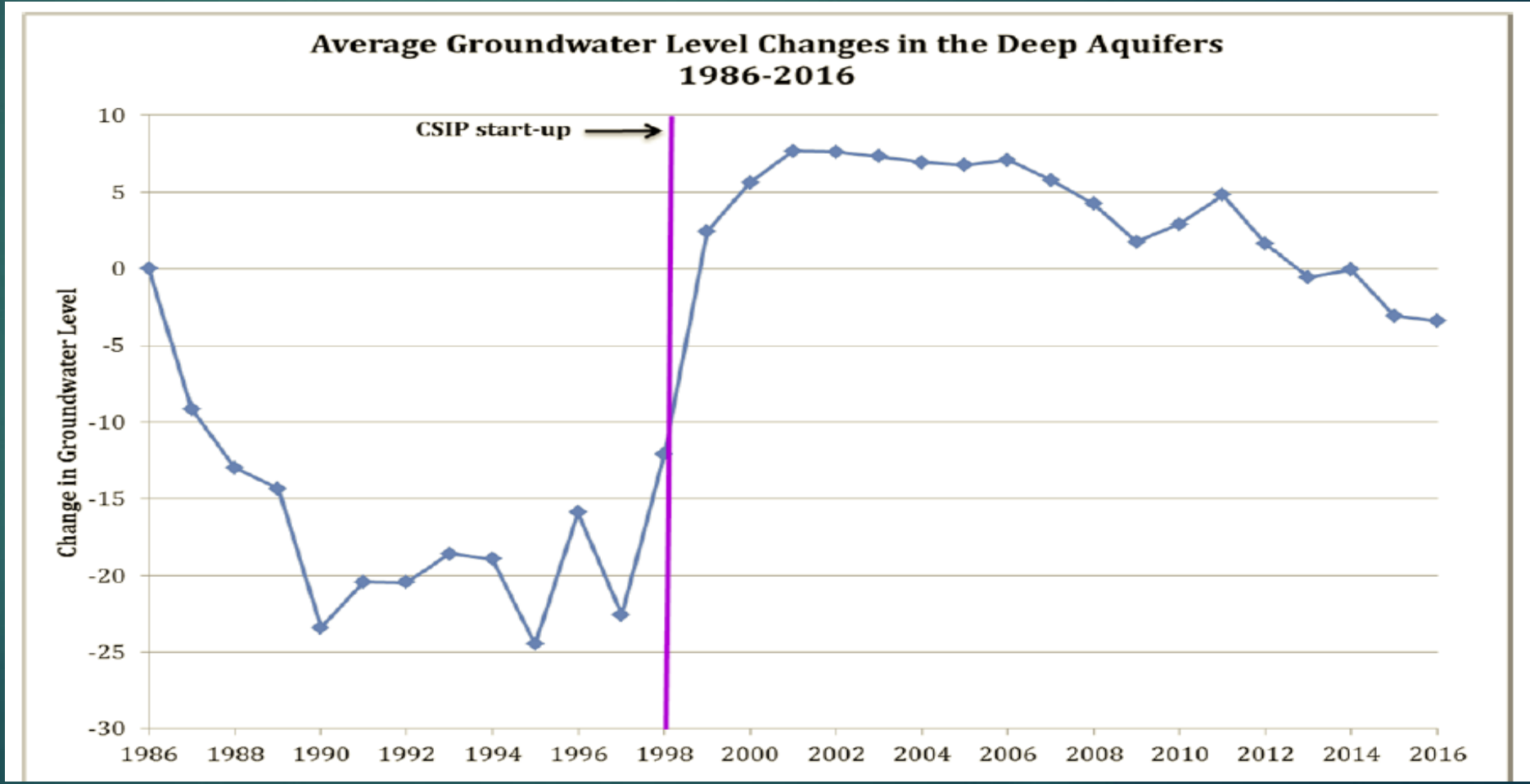


Water supply or environmental policy enacted:

a) Nacimiento dam
b) San Antonio dam & Porter-Cologne WQ Control Act
c) Clean Water Act
d) Seawater Intrusion Project (CSIP)
e) **Recycled Water Project (RWP)**
f) **Salinas R. Diversion Facility (SRDF)**
g) **Sustainable GW Mgmt Act (SGMA)**

Likely **unsustainable groundwater (GW) extraction rates** occurred **after 1972** as shown by extreme magnitudes of negative residuals particularly **during drought years**.

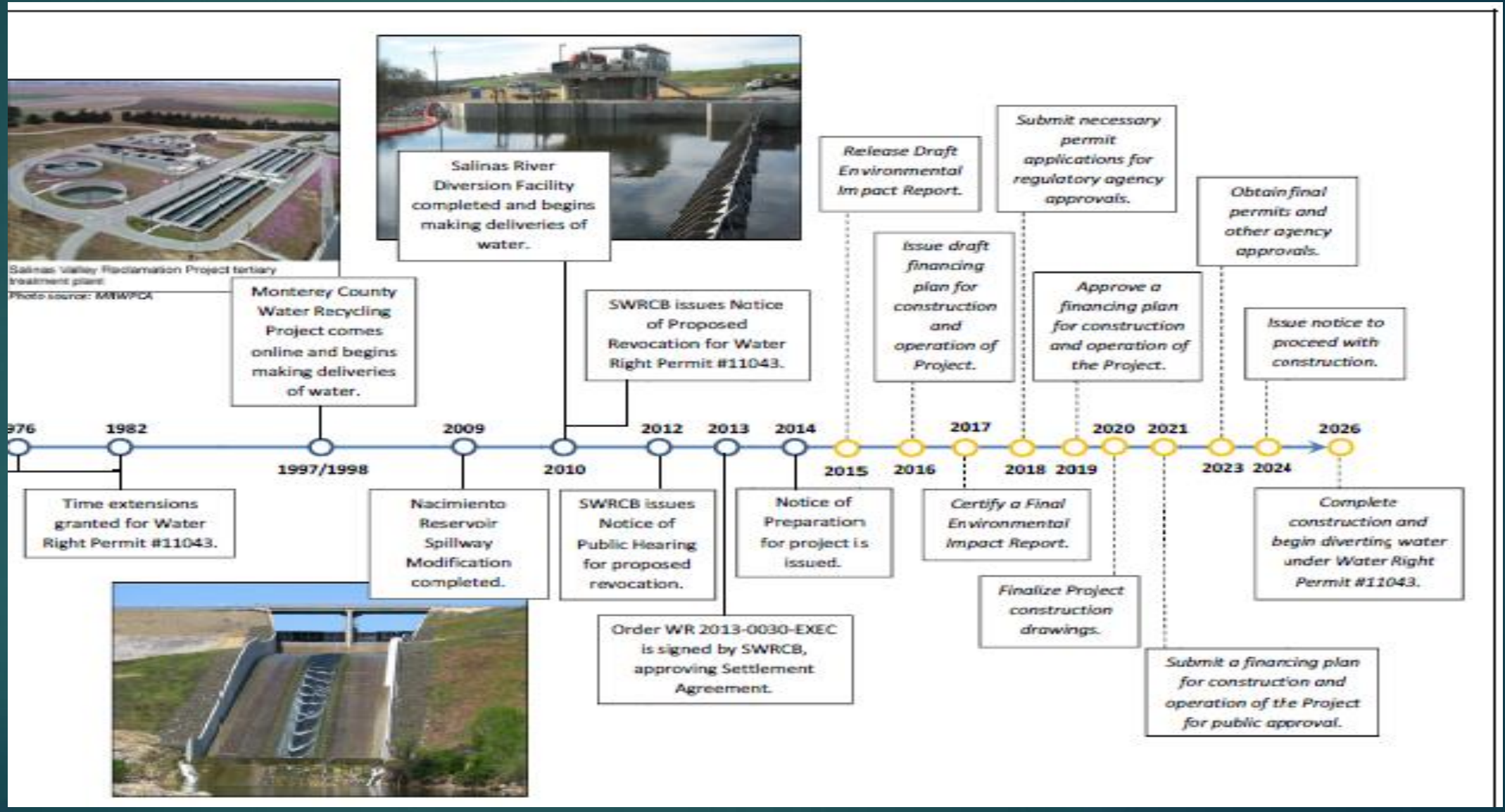
A similar response in the deeper aquifers to the adoption of CSIP, SRDF & RWP. Can implem-entation of SGMA help recover GWLs?



Accounting for Water – Variable WB Estimates

Water Balance (WB) Estimates	Bulletin #52; years 1929-1945	1995 White Paper; years 1970-1992	St. of Basin 2015; years 1959-2013
Basin Inflows			
Salinas River	701,000	547,000	ND
Valley Seepage	239,000	66,000	ND
GW inflows	ND	44,000	ND
Totals	940,000	657,000	508,000
Basin Water Use			
Agriculture	400,000	ND	464,000
Municipal, Industry & Domestic	15,000	ND	59,000
Totals	415,000	391,000	523,000
Water Outflows to (from) Ocean			
River Flows to Ocean	503,000	303,000	-
GW Flows (Intrusion) to Ocean	24,000	(17,000)	(11,000-18,000)
Annual Change in Storage	(2000)	(20,000)	(6000)

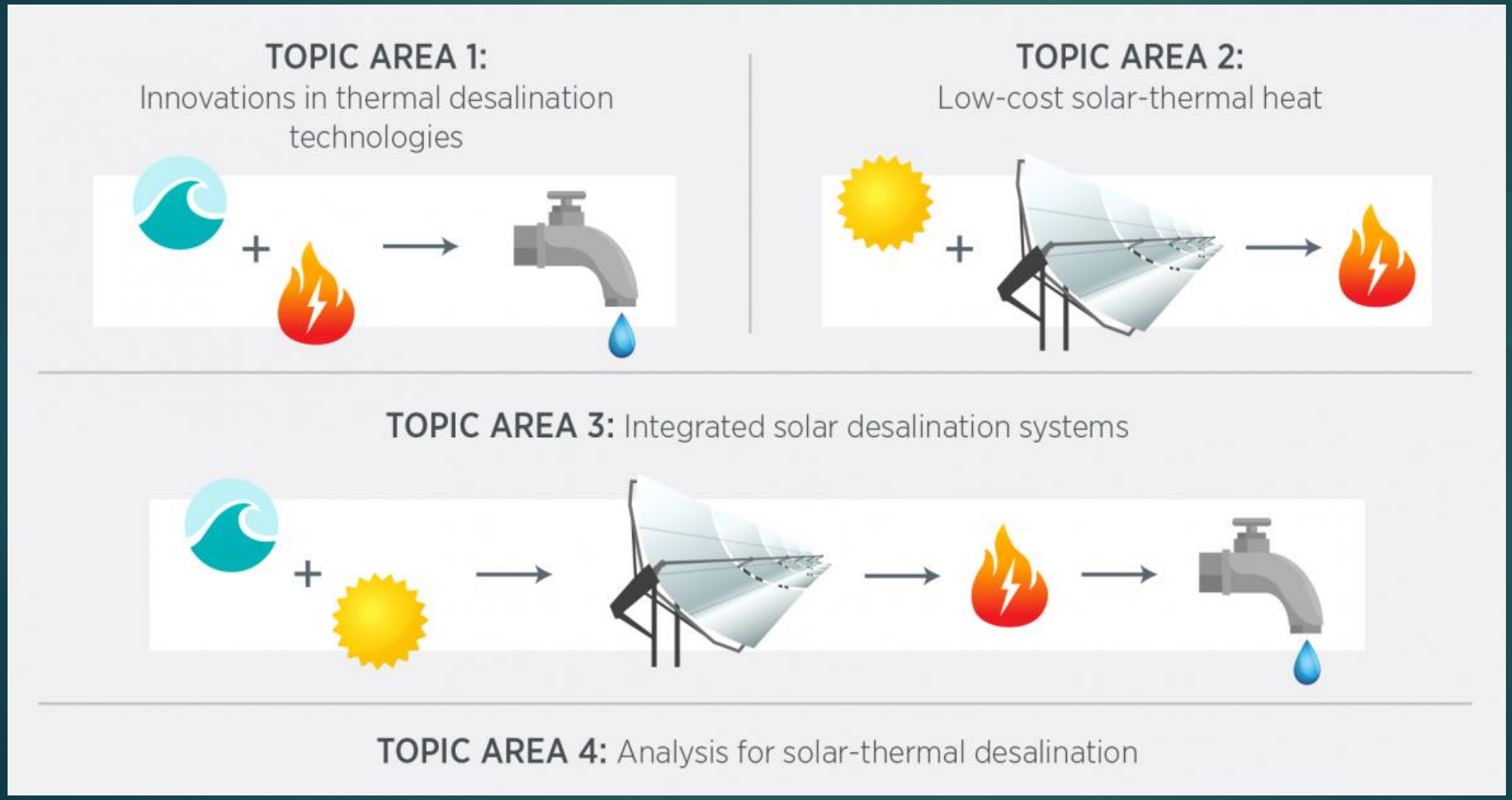
Future efforts to capture more of water right allocation?



Thank you

- Where do we go from here in terms of planning, development of new water resources, water conservation, etc.
- We probably need more ideas on cooperative water use allocations…

OR, developing cost-effective desalination methods to create recycled water for agriculture?



Solar Desalination projects should reduce the LCOW by lowering the LCOH, which will result in more efficient desalination processes and lower overall capital and integration costs for solar-thermal desalination. Goal of reducing water cost (LCOW) to $0.50/m^3, or **~$620/AF** for seawater conversion, less for lower salinity ag- drainage waters

New DOE funded Projects in CA

Project Name: Direct Solar-Thermal Forward Osmosis Desalination of Produced Waters
Location: Lawrence-Berkeley NL, Berkeley, CA
DOE Award Amount: $800,000
Awardee Cost Share: $200,000
PI: Robert Kostecki
Project Summary: This team will develop an integrated ionic liquid-based forward-osmosis water treatment system for waters produced from high-salinity and/or high total dissolved solids levels which cannot be treated directly by reverse osmosis. By enabling the use of low-grade solar heat to drive the separation and regeneration processes at a small capacity, this technology will allow for integrated desalination systems that can be built at a low capital cost.

Project Name: Energy Where it Matters: Delivering Heat to the Membrane/Water Interface for Enhanced Thermal Desalination
Location: UC Los Angeles, CA
DOE Award Amount: $1,995,249
Awardee Cost Share: $516,644
PI: David Jassby
Project Summary: This project will modify a typical membrane distillation (MD) system by deploying layers of materials with high thermal and electrical conductivity at the membrane/water interface. These conductive materials will be able to deliver solar-thermal energy directly to where it's needed in the MD system. By directly coupling the membrane surface to a thermal input, this technology has the potential to be substantially more energy efficient than current MD systems.

Project Name: Low-Cost Dispatchable Heat for Small-Scale Solar-Thermal Desalination Systems
Location: UC Merced, CA
DOE Award Amount: $1,081,793
Awardee Cost Share: $277,133
PI: Roland Winston
Project Summary: This team will design, build a prototype, and test a novel, low-cost solar-thermal energy system that can reduce the levelized cost of heat (LCOH) to <1.5 cents per kilowatt-hour thermal, while also incorporating dispatchability and portability features. The project includes the design and development of a new collector or concentrator, called the Integrated Compound Parabolic Concentrator, as well as the design and development of an accompanying thermal energy storage system.