

-----in Civilizations.....

“Demography is Destiny”
French philosopher Auguste Comte



WATER EDUCATION
FOUNDATION

... but for California's historical
development ...

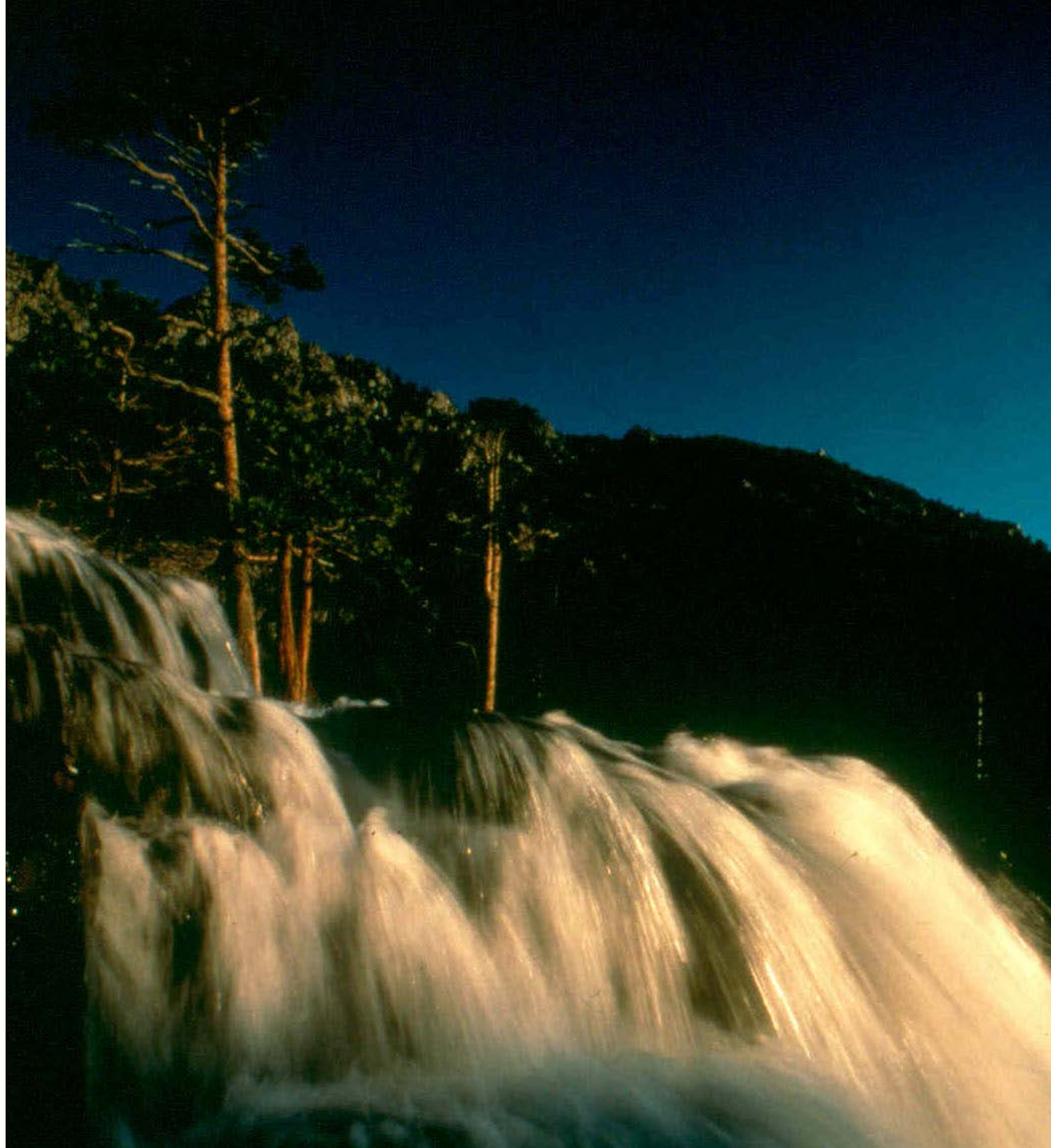
“Geography is Destiny”

Geography

- Determined location of resources leading to California's development
 - Gold
 - Arable land
 - Early irrigation systems
 - Natural harbors
 - Film industry (locations and weather)
 - WWII industrialization – economic geography

AND, WATER

**The story
of
California
is the
story of
water.**





The Gold Rush was the start of a philosophy of putting California's water to work





Hydraulic Mining

1853 - Used powerful jets of water to blast away hillsides



Malakoff Diggings (South Yuba River) - mined 100,000 tons of gravel per day and used 16 billion gallons (32,000 acre-feet) of water per year.

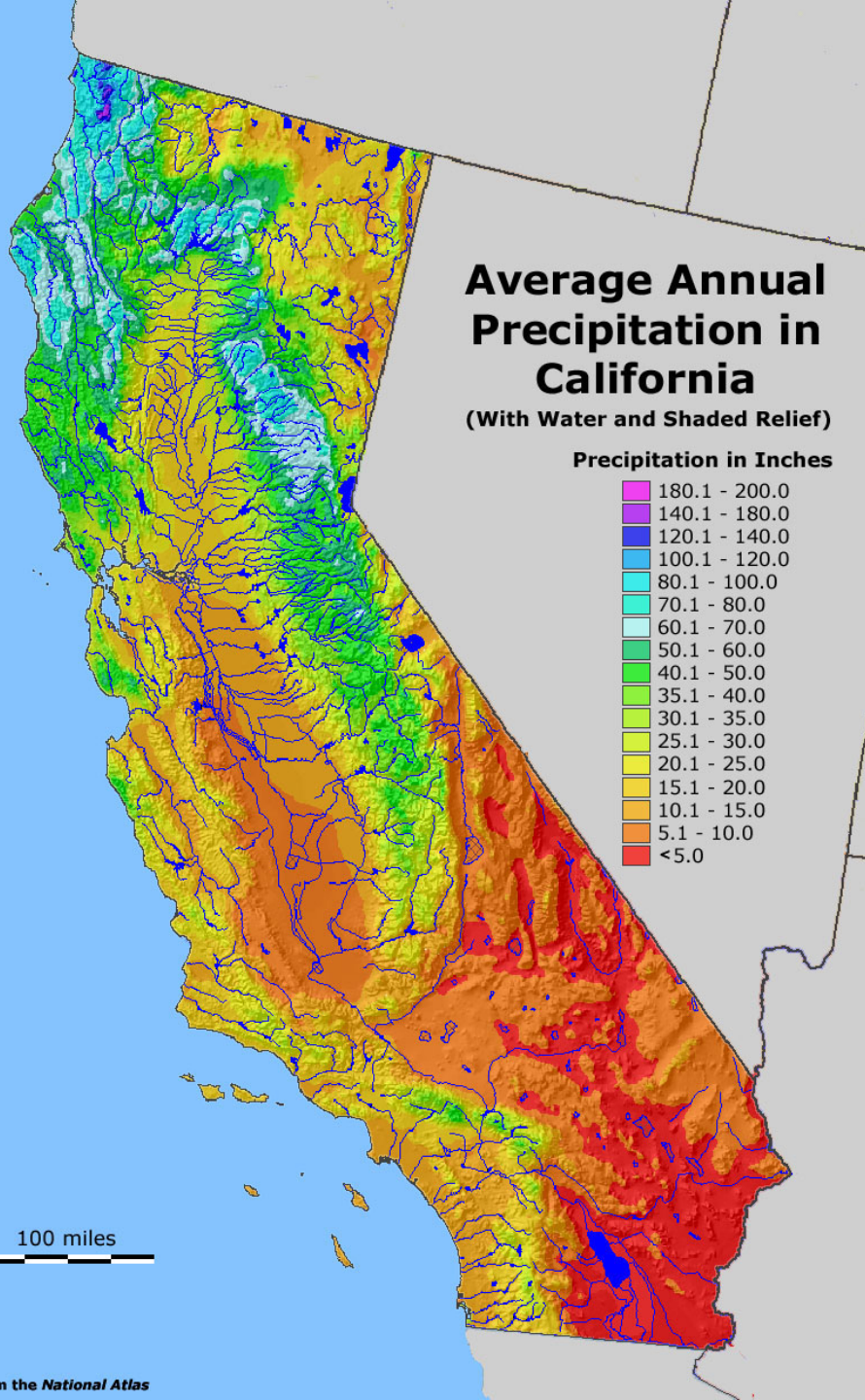
11 million ounces of gold (worth \$9.7 billion) by the mid-1880s.



Arteries of Commerce



California Hydrology

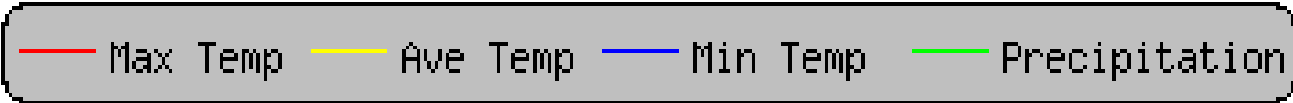
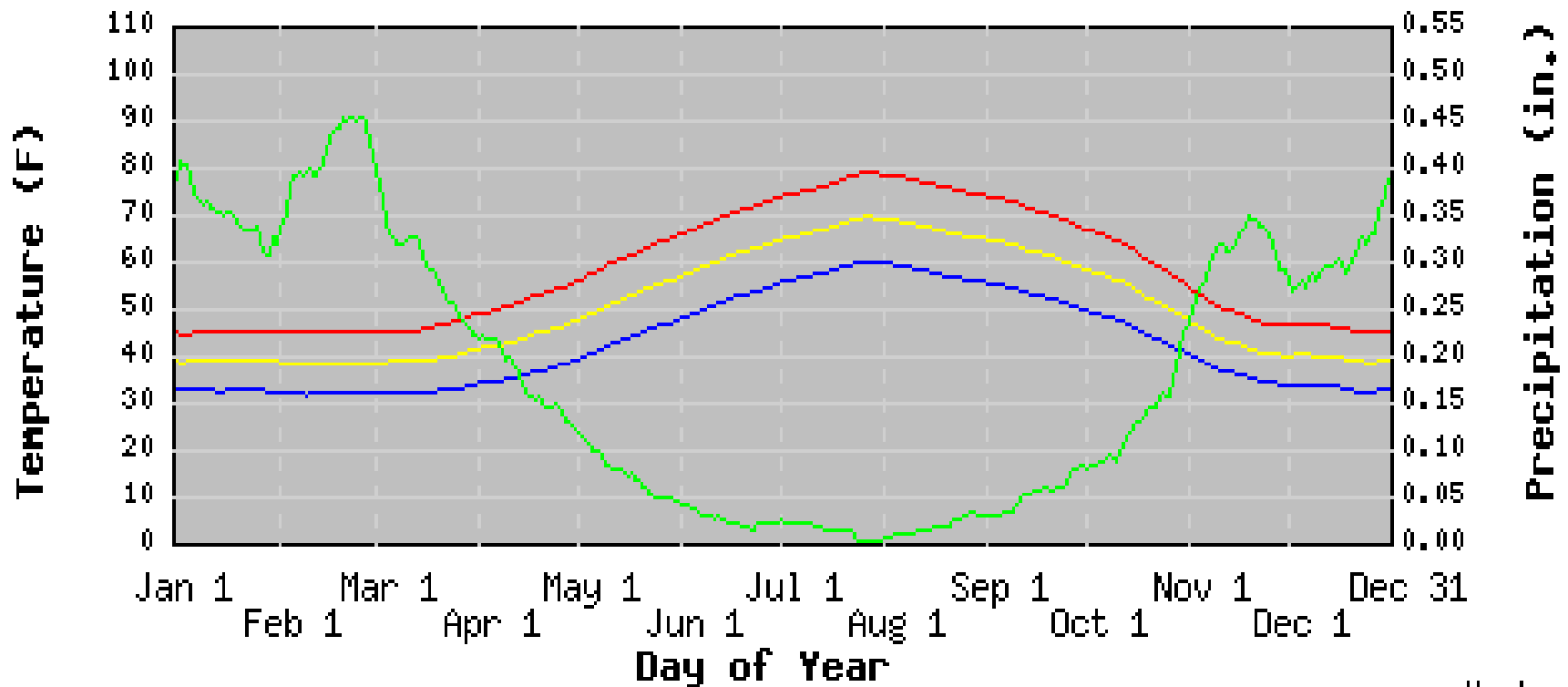


Wet in north
Dry in south

Greatest population
in south

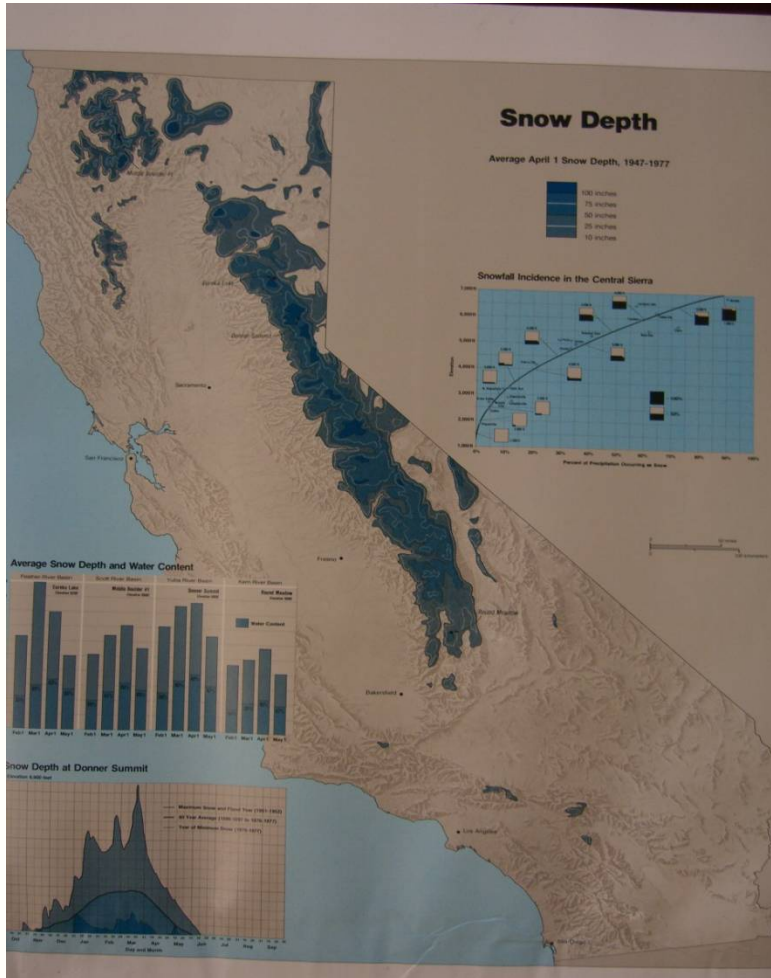
BLUE CANYON, CALIFORNIA (040897)

1971-2000 30 Year Average



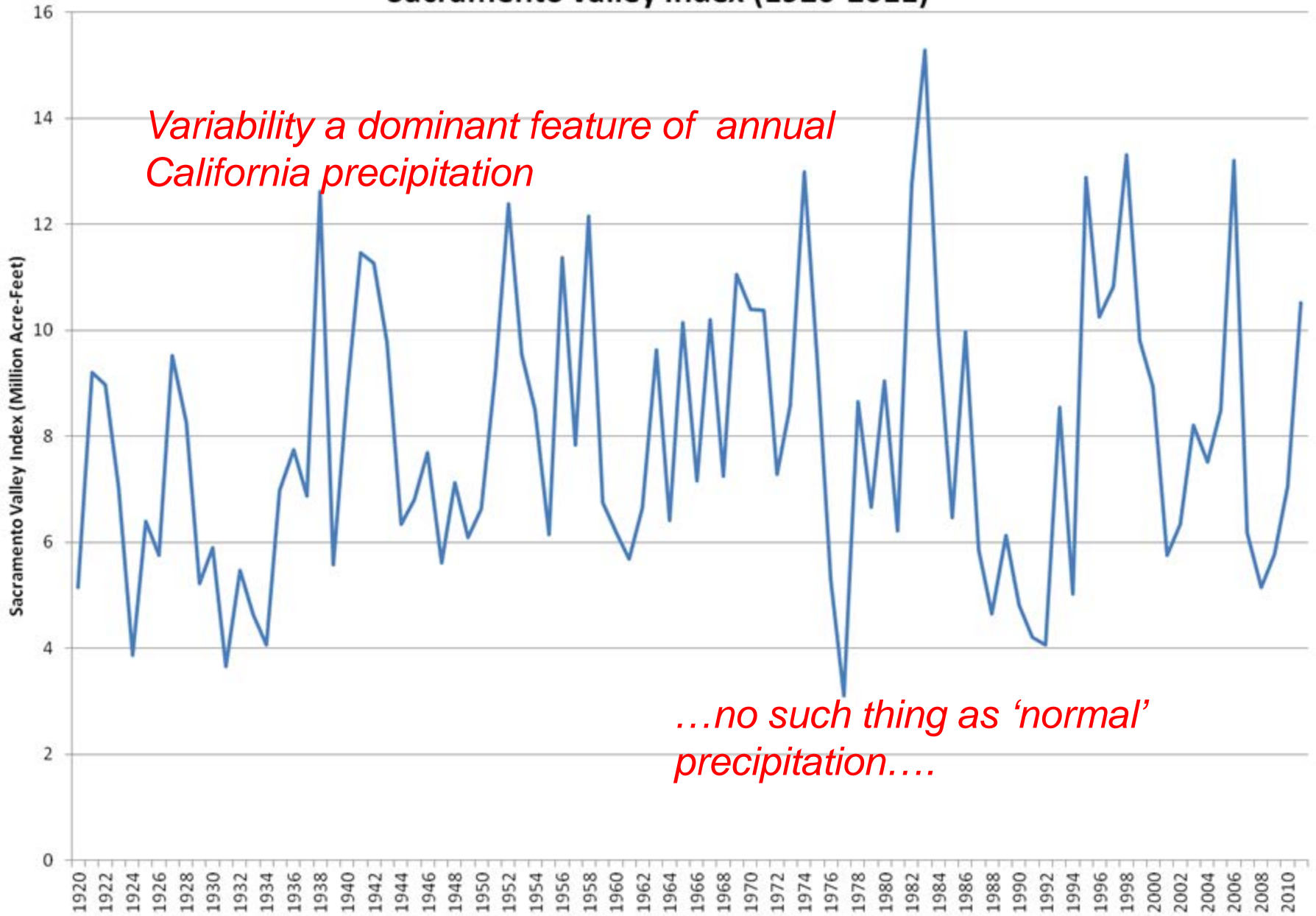
Western
Regional
Climate
Center

California Hydrology



- 💧 Mediterranean climate – dry summers, mild winters
- 💧 In average year, 82 million acre-feet of water used for agriculture, environment and cities
- 💧 More precipitation in north than south, reverse of population location

Sacramento Valley Index (1920-2011)

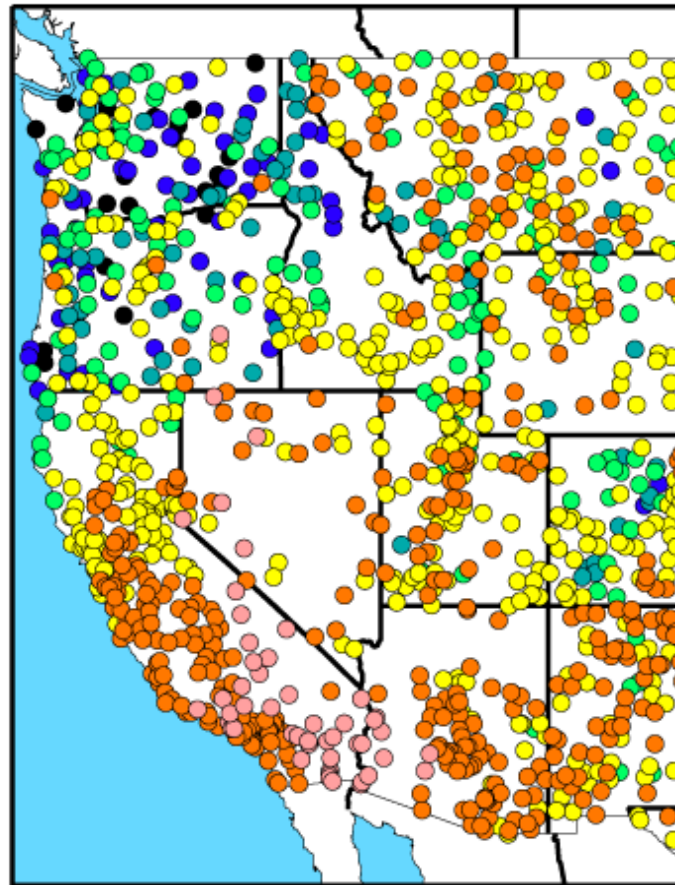


Variability a dominant feature of annual California precipitation

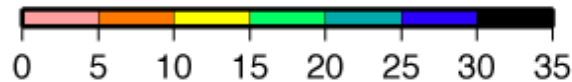
...no such thing as 'normal' precipitation....

Just a few storms each year are the core of California's water supplies

c) AVERAGE NUMBER OF DAYS/YR TO OBTAIN HALF OF TOTAL PRECIPITATION, WY 1951-2008



days/year



The Great Projects



They were built to alleviate drought. They were built to protect against floods. And as California boomed, projects were built to generate electricity and move the water from where it occurred to where it could provide the most benefit for a booming economy – in the fields and cities.

*A*t the turn of the century, John Muir played an influential role in gaining national park status for the beautiful Yosemite Valley. But the conservationist – standing posed with President Theodore Roosevelt high above Yosemite Valley – failed to win protection for another valley just to the north, the Hetch Hetchy Valley.

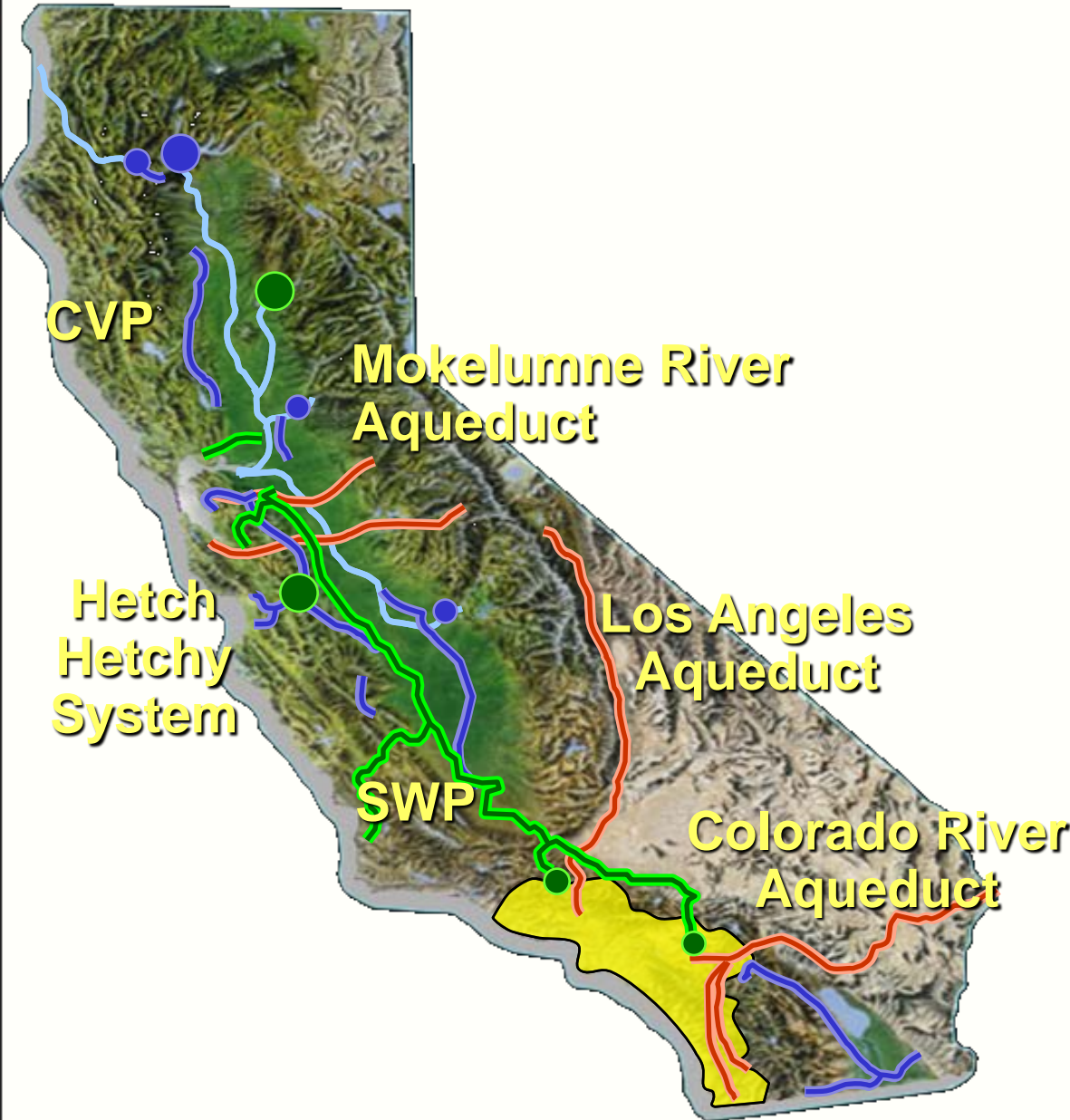
The city of San Francisco selected Hetch Hetchy in 1901 as the place to dam the Tuolumne River, conveying

its pristine water by gravity to San Francisco.

Controversy over developing the valley, which was within the confines of Yosemite National Park, brewed for decades with the fight against the project led by conservationist and Sierra Club founder Muir.

In 1913, Congress passed the Raker Act, authorizing the project. Muir died two years later and in 1923, with completion of O'Shaughnessy Dam, the Hetch Hetchy Valley was flooded. •

California Water Development



Hetch Hetchy System
San Francisco PUC
1913 - Raker Act

Los Angeles Aqueduct
Los Angeles DWP
1913

Mokelumne River Aqueduct
East Bay MUD
1929

Central Valley project
U.S. Bureau of Reclamation
1940 (C.C. Canal first)

Colorado River Aqueduct
MWD of So. Cal.
1941

State Water Project
California DWR
1960 - Burns Porter Act

Federally Funded Projects

💧 35 federally funded dams, reservoirs and canals. Built by U.S. Army Corps of Engineers and U.S. Bureau of Reclamation



Shasta Dam

💧 Central Valley Project (CVP), which begins on the Sacramento River at Shasta Dam and ends near Bakersfield.

Federally Funded Projects - CVP



- 💧 90% used to irrigate farms in Central Valley
- 💧 Some water to urban residents in the Bay Area

Financing

- 💧 1902: Reclamation Act – 160 acre service limitation
- 💧 1982: Act increased service limitation to 960 acres
- 💧 1992: CVPIA added environment as specific purpose created water account for environment

Committed to the State Water Project



Governor Pat Brown was elected in 1958.

Gov. Brown made passing the State Water Project a priority of his administration.

“I was absolutely determined that I was going to pass this California water project.”

Burns-Porter Act



1959 - The state Legislature authorized construction of the State Water Project through the California Water Resources Development Bond Act, also known as the Burns-Porter Act

State Water Project



Gov. Pat Brown at Oroville Dam

1961 – construction begins

Facilities were built from north to south – Oroville Dam to Southern California.

The State Water Project is the largest state-financed water project ever built.

State-Funded Projects - SWP



- 💧 State Water Project (SWP) consists of 29 dams and reservoirs and runs almost 600 miles from Northern- to Southern California.
- 💧 Planned to deliver 4.2 million acre-feet; actually delivers less than 3.0 million acre-feet – reliability diminished due to regulatory actions.
- 💧 About of deliveries to agriculture in the San Joaquin Valley and half for urban Southern California and the Bay Area.

Financing the SWP

- 💧 1960 - \$1.75 billion bond
- 💧 29 contractors pay all costs, including bond interest, energy and transmission charges – whether water delivered or not
- 💧 No acreage limitations



San Luis Reservoir

Water and Energy

- 20% of state's electricity is used to bring water to consumers and send it away for sewage treatment.

- SWP is single-largest power consumer in California

- SWP is the fourth largest power generator in California, generating about two-thirds of electricity to run its facilities.



Hyatt Powerplant below Lake Oroville is in a cavern the size of two football fields.

Operation of the CVP/SWP

- Coordinated operations – joint responsibilities for Delta Water Quality Management
- Upstream reservoirs capture water during wet season and snow runoff

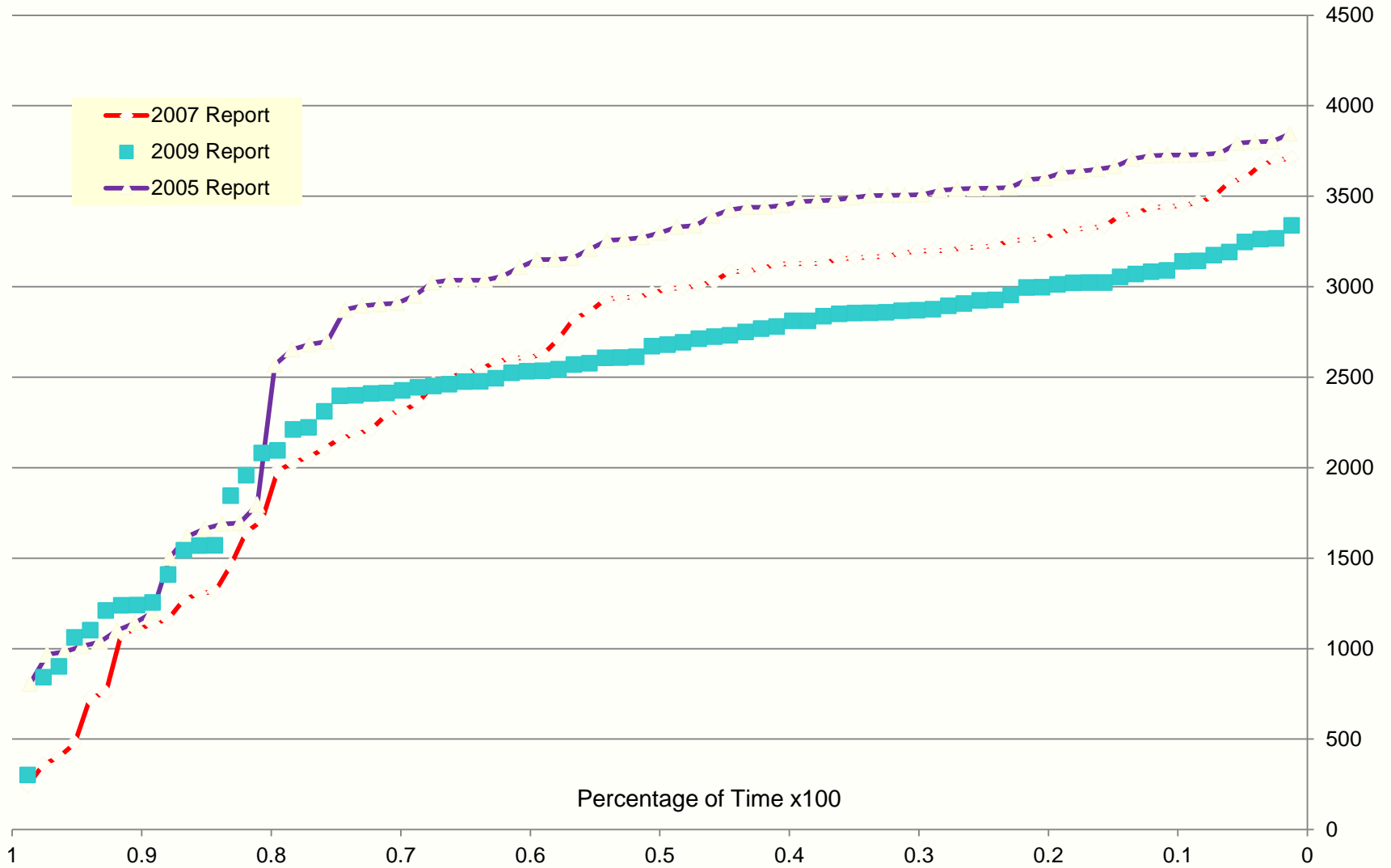
Operation of the CVP/SWP

- Water delivered to service areas by contract, subject to agreements with *senior* rights holders
 - *Sacramento River Settlement Contractors (CVP)*
 - *San Joaquin River Exchange Contractors*
 - *North Delta Water agency (SWP)*
 - *City of Sacramento*
 - Project contractors:
 - Tehama Colusa Canal, Sacramento area contractors, Contra Costa WD,
 - Export service: San Luis Delta Mendota Water Authority, Santa Clara Valley WD
- Reservoir storage, natural river conditions and regulatory requirements determine water available for export

Operation of the CVP/SWP

- Export supply determined by:
reservoir/river supply - instream flow requirements - delta flow/water quality – export pumping limitations vs. demand.
- *If demand exists and there is pumping capacity within requirements, water can be pumped.*
- *Shift from demand limited system to regulatory constrained system*

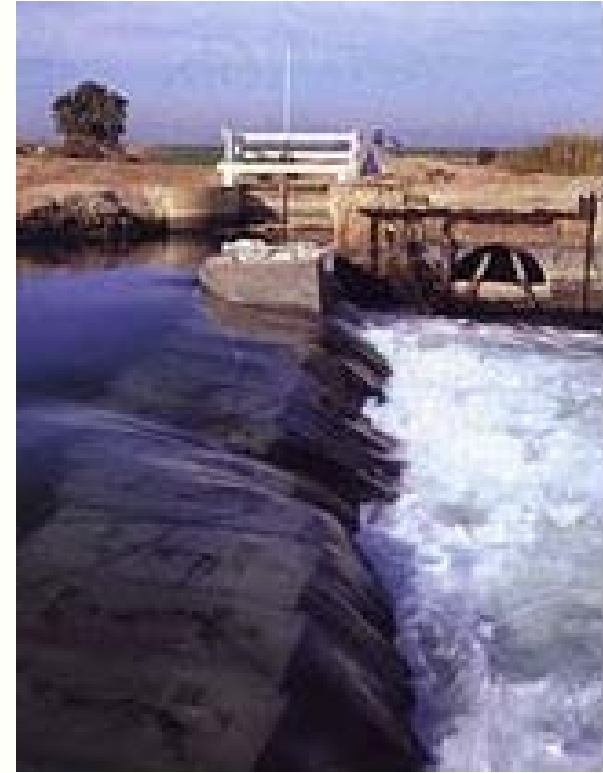
Regulatory Restrictions Have Degraded SWP Water Reliability



Locally Funded Projects

600 cities and local agencies provide water through local projects and imported supplies.

- 💧 Local systems –
 - San Francisco's Hetch Hetchy
 - East Bay Municipal Utility District's Pardee and Camanche Reservoirs
 - Los Angeles' Owens Valley and Los Angeles Aqueducts





Hetch Hetchy

Raker Act (1913):
federal lands in the
Sierra Nevada
Mountains, including
Hetch Hetchy Valley
in Yosemite, used to
build the water
system

- The Bay Area
Water Supply and
Conservation
Agency (BAWSCA)
- 1.7 million citizens
and businesses

More Local Systems

- 💧 Metropolitan Water District of Southern California largest local district

 - operates Colorado River Aqueduct.

- 💧 Other local projects serve farmers, such as Glenn-Colusa Canal in the Sacramento Valley.



Diamond Valley Lake (MWD photo)



**SAN DIEGO AQUEDUCT
2nd BARREL NORTH SECTION
THE LAST PIPE**

DESIGNED United States Bureau of Reclamation
FOR San Diego County Water Authority
FINANCED United States Navy
WATER FROM Metropolitan Water District of So Calif
BUILT BY Johnson Western Construction

Wild & Scenic Rivers



American River

- 💧 1972 State Wild and Scenic Rivers Act - no dams or diversion facilities on the Smith River and parts of Klamath, Trinity, Van Duzen, Scott, Eel, Salmon, Feather and American
- 💧 In 1980, some rivers added to the Federal Wild and Scenic Rivers System
- 💧 Today parts of other rivers included

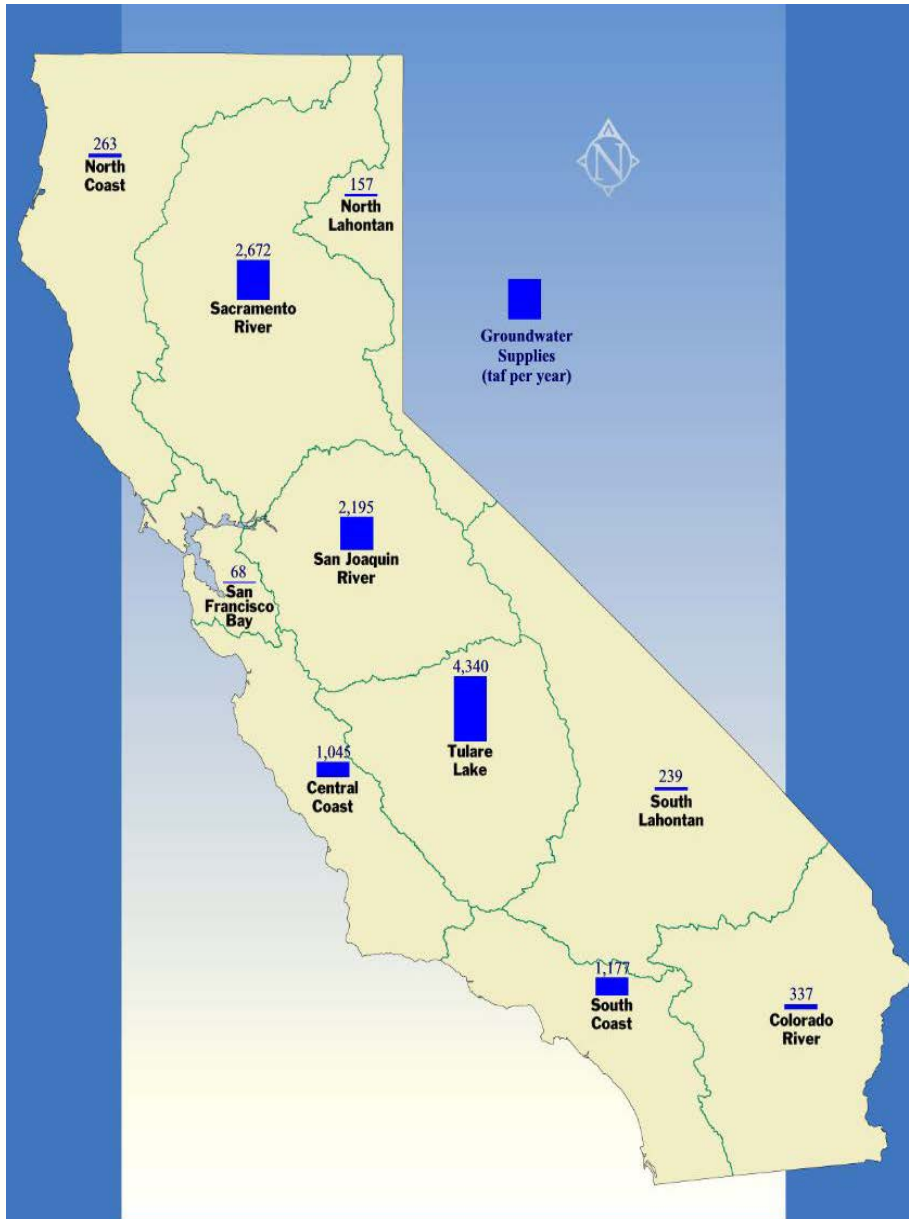
Groundwater

Groundwater exists in aquifers – water bearing rock layers

- 💧 About 30% (15 million acre-feet) of state's water comes from groundwater in normal years; 40%-45% in drought years, or more
- 💧 California uses more groundwater than any other state – about 40% of population gets drinking water from groundwater



Groundwater Supplies



Where is the groundwater?

DWR estimates more than 400 groundwater basins hold a total of about 850 million acre-feet of water.

Groundwater Management

- 💧 Historic regulation of groundwater – 2014 legislation
- 💧 In Southern California, many groundwater basins have been adjudicated, with courts establishing the pumping rights of many parties. A watermaster appointed to oversee – largely exempt from new legislation

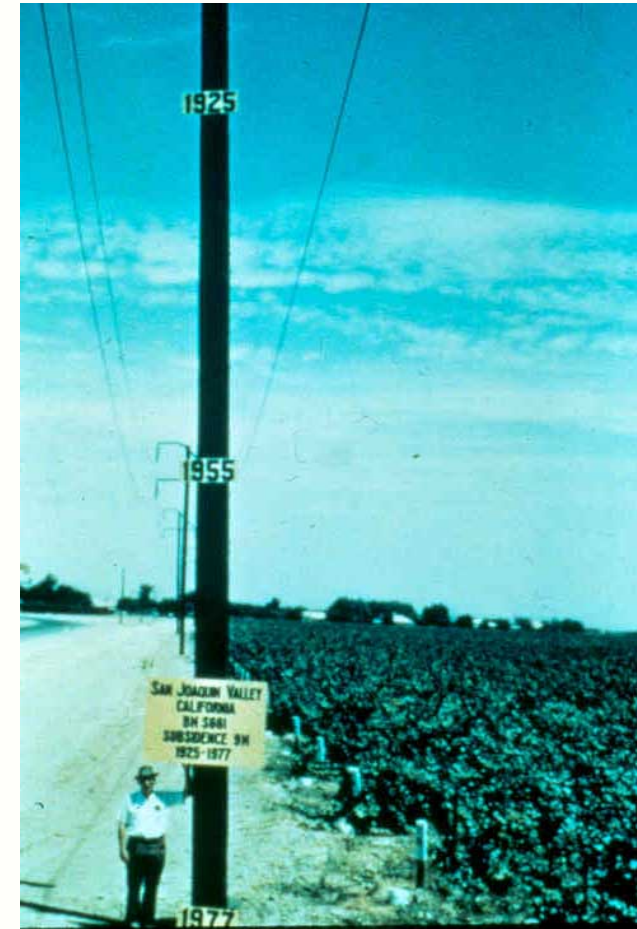
Groundwater Overdraft

Overdraft is taking more water out of the ground than is recharged (time dimension)

- Historical overdraft in Central Valley led to construction of Central Valley project

- NASA - Central Valley has lost enormous amounts of groundwater from 2003-2009 - 24.3 million acre feet since 2003 – enough to fill Lake Powell, 2nd largest reservoir in USA

USGS scientist shows overdraft in San Joaquin Valley, 1970s



Groundwater Pollution

Pollution is a serious threat. All the state's groundwater basins are contaminated to some degree.

- 💧 Trichloroethylene (TCE) - Used in adhesives, lubricants, paint products, pesticides, adhesives, rug-cleaners
- 💧 Perchlorate - Primary ingredient of solid rocket propellant
- 💧 Methyl tertiary butyl ether (MTBE)
 - added to gasoline to reduce air pollution in 1990s. Today leaky underground tanks



Flood Management

- 💧 Floodplain Management
 - In next 25 years population increase of about 14 million. Development will impact floodplains

- 💧 Levee Repairs
 - Nearly 250 levee repair sites identified and work progressing

- 💧 Climate Change
 - Warming ocean water and melting ice = sea level increase by 1.6 feet by 2050 along coastlines. By 2100 sea rise could be more than 3 feet. Recent warming running ahead of predictions and estimates may be low



Flood Management: Levees

2005 – Hurricane Katrina

2006 – Ca. Preparation

Gov. Schwarzenegger declares a State of Emergency for California's levee system

- Flood Bonds passed

2012 – Central Valley Plan

Plan will detail how to improve flood management in Central Valley

2013 – Statewide Plan

Plan will detail how to improve flood management statewide



Diversifying Water Supply

Non traditional/alternative supplies

- State/local Water management plan requirements require analysis of diversification:
- Ocean Desalination
- Wastewater Recycling
- Water Conservation
- Stormwater Capture
- Water Transfers

Ocean Desalination

- Popularly viewed as ‘ultimate’ solution
- Process is reliable but expensive
- Limited application
 - For additional baseload supply where imported water is expensive and unreliable
 - For isolated coastal urban locations
- Uneconomic for agriculture or urban irrigation
- Will see limited application in future

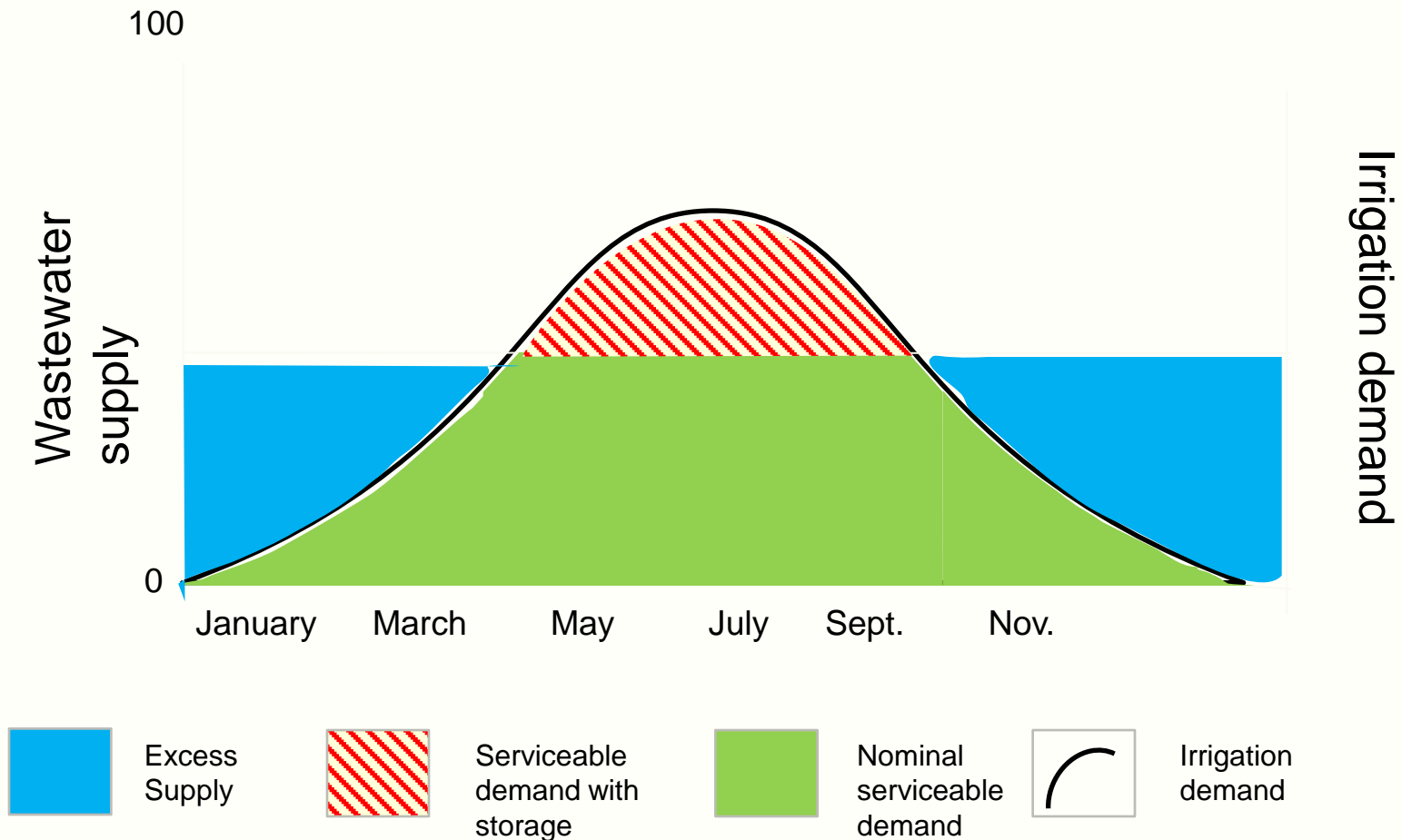
Wastewater Recycling

- Process of recycling treated sewage for non-potable and potable uses
 - Occurs by design in Sacramento San Joaquin Valley
 - Requires separate plumbing system for non-potable applications
 - Economics can be daunting as demand is for summer irrigation

Wastewater Recycling

- Non-potable wastewater recycling
 - Potential use that could justify storage
 - Effectively being used in Orange County
 - Pioneering efforts in San Diego – indirect potable reuse project
 - DHS regulation of drinking water

Conceptual Recycled Water Potential Typical Urban Location



Water Conservation

- Reduction in use/demand management
- Role in water supply reliability planning – long term efforts
- Role in drought response – temporary use reductions
- Long term efforts cause ‘demand hardening’, limiting easy drought response

Stormwater Capture

- Generally focused on urban areas
- Receiving re-look as other sources less available, costs rise
- Very site specific: capture opportunities, storage opportunities, treatment issues
- Link to sustainability planning – limiting hardscape, local water retention, infiltration strategies

Water Transfers

- Where one entity with excess supply transfers to another in need
- Common inter and intra-district strategy in agriculture
- Increasingly a way to shore up urban supplies
- Transfers using CVP/SWP infrastructure
 - Temporary land fallowing
 - Transfers from water storage
- Complicated due to legal and physical constraints

Water Transfers

- Legal issues:
 - Real water test
 - Source of water and water rights:
 - location, pre-'14 water right no SWRCB jurisdiction, lead agency under CEQA is transferring agency one-year
 - If a post-'14 water right SWRCB lead agency and exempt from CEQA for one year transfer
- Physical issues: can you move it through the Delta?

Questions?