

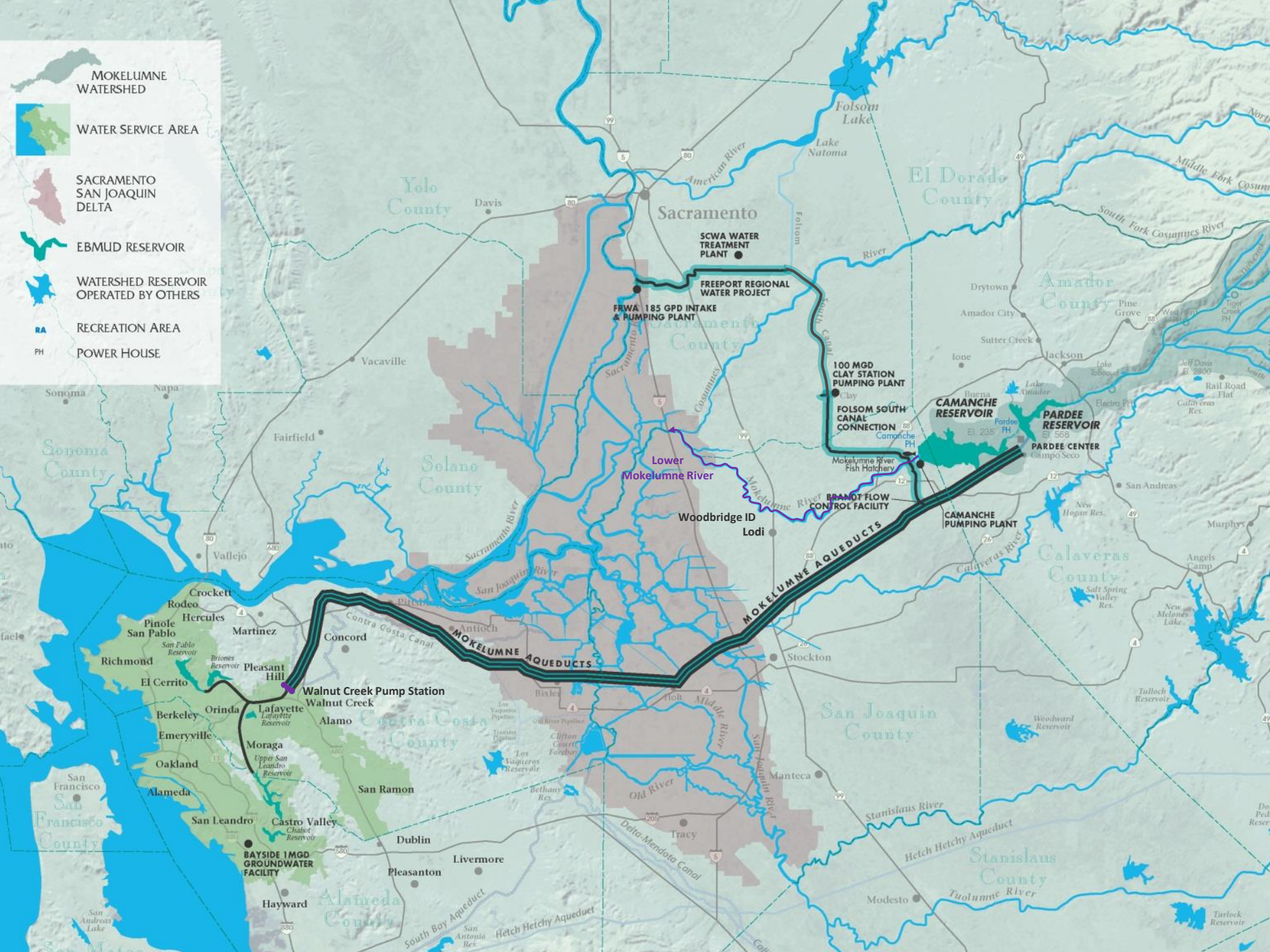
Updating EBMUD's Water Supply Planning Model to Meet Future Challenges

CWEMF 2016

Why a New Planning Model?



- Previous model built in FORTRAN
 - Many years of edits, changes and manipulation
 - Difficult to make code changes and integrate new components
 - Losing experts that can manage the model
- Update to modern software (*RiverWare*)
 - Improved system and temporal resolution
 - Improved capabilities and flexibility
 - Improved transparency



-  MOKELUMNE WATERSHED
-  WATER SERVICE AREA
-  SACRAMENTO SAN JOAQUIN DELTA
-  EBMUD RESERVOIR
-  WATERSHED RESERVOIR OPERATED BY OTHERS
-  RECREATION AREA
-  POWER HOUSE

Sacramento

Lower Mokelumne River

Woodbridge ID Lodi

MOKELUMNE AQUEDUCTS

MOKELUMNE AQUEDUCTS

Walnut Creek Pump Station Walnut Creek

BAYSIDE 1MGD GROUNDWATER FACILITY

SCWA WATER TREATMENT PLANT

FRWA 185 GPD INTAKE & PUMPING PLANT

FREPORT REGIONAL WATER PROJECT

100 MGD CLAY STATION PUMPING PLANT

FOLSOM SOUTH CANAL CONNECTION

FOLSOM SOUTH CANAL

Mokelumne River Fish Hatchery

BRANDT FLOW CONTROL FACILITY

CAMANCHE RESERVOIR

PARDEE RESERVOIR

PARDEE CENTER

CAMANCHE PUMPING PLANT

WOODWARD RESERVOIR

TULLOCH RESERVOIR

WOODWARD RESERVOIR

TULLOCH RESERVOIR

WOODWARD RESERVOIR

TULLOCH RESERVOIR

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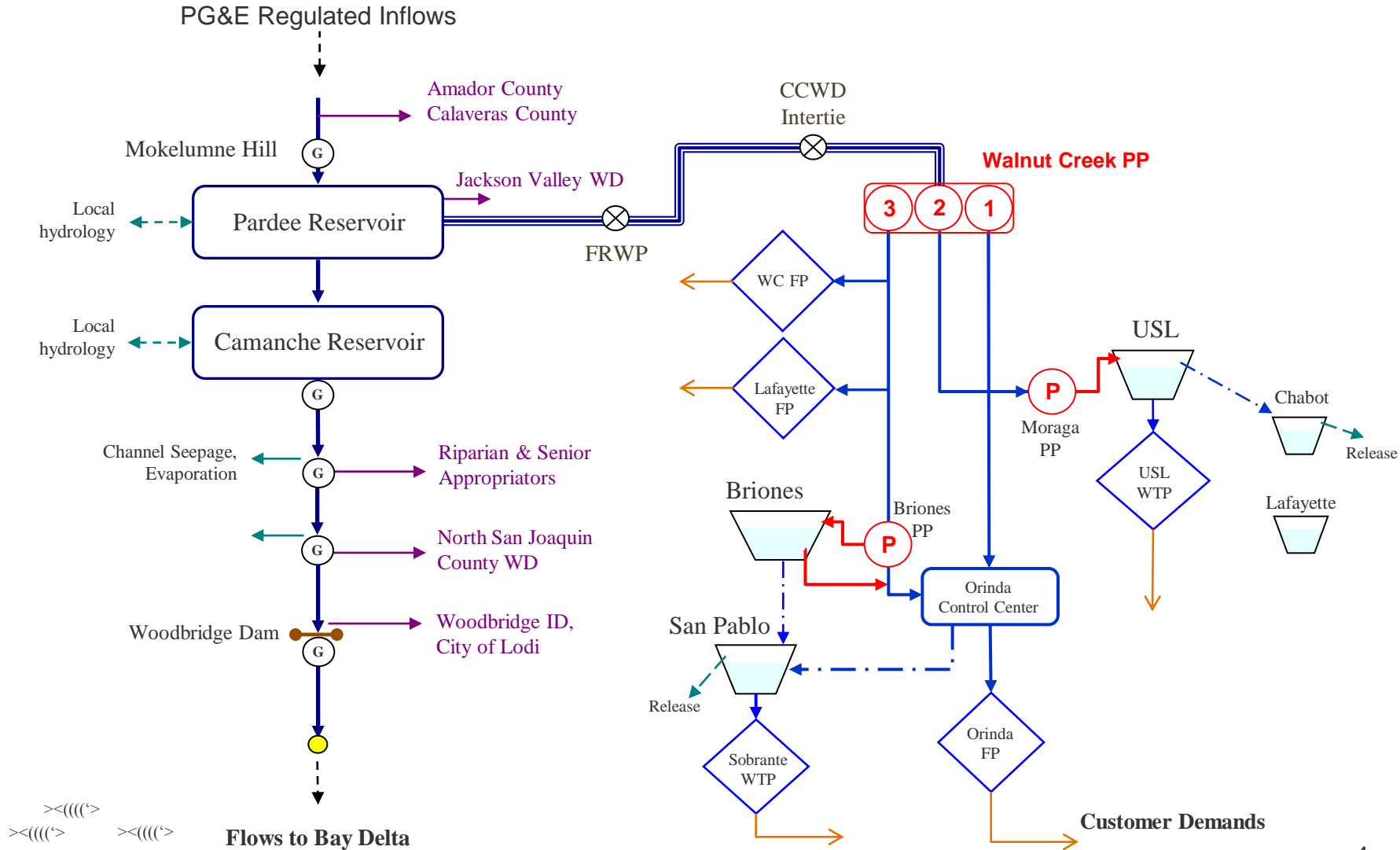
WOODWARD RESERVOIR

TULLOCH RESERVOIR

WOODWARD RESERVOIR

TULLOCH RESERVOIR

RiverWare Schematic



Operational Priorities



- Meet obligations for water right holders
- Comply with environmental requirements
 - Flows and temperature
- Meet USACE flood reserve requirements
- Meet EBMUD customer demands

Water Right Holders



- PG&E (non-consumptive use)
 - Unimpaired Runoff \Rightarrow Regulated Undiminished Flow
- Upcountry
 - Amador County Water Agency
 - Calaveras County WD, Calaveras Public Utility District
 - Jackson Valley Irrigation District
- **East Bay Municipal Utility District**
- Lower Mokelumne River
 - North San Joaquin Water Conservation District
 - Woodbridge Irrigation District, City of Lodi
 - Riparian and Senior Appropriators

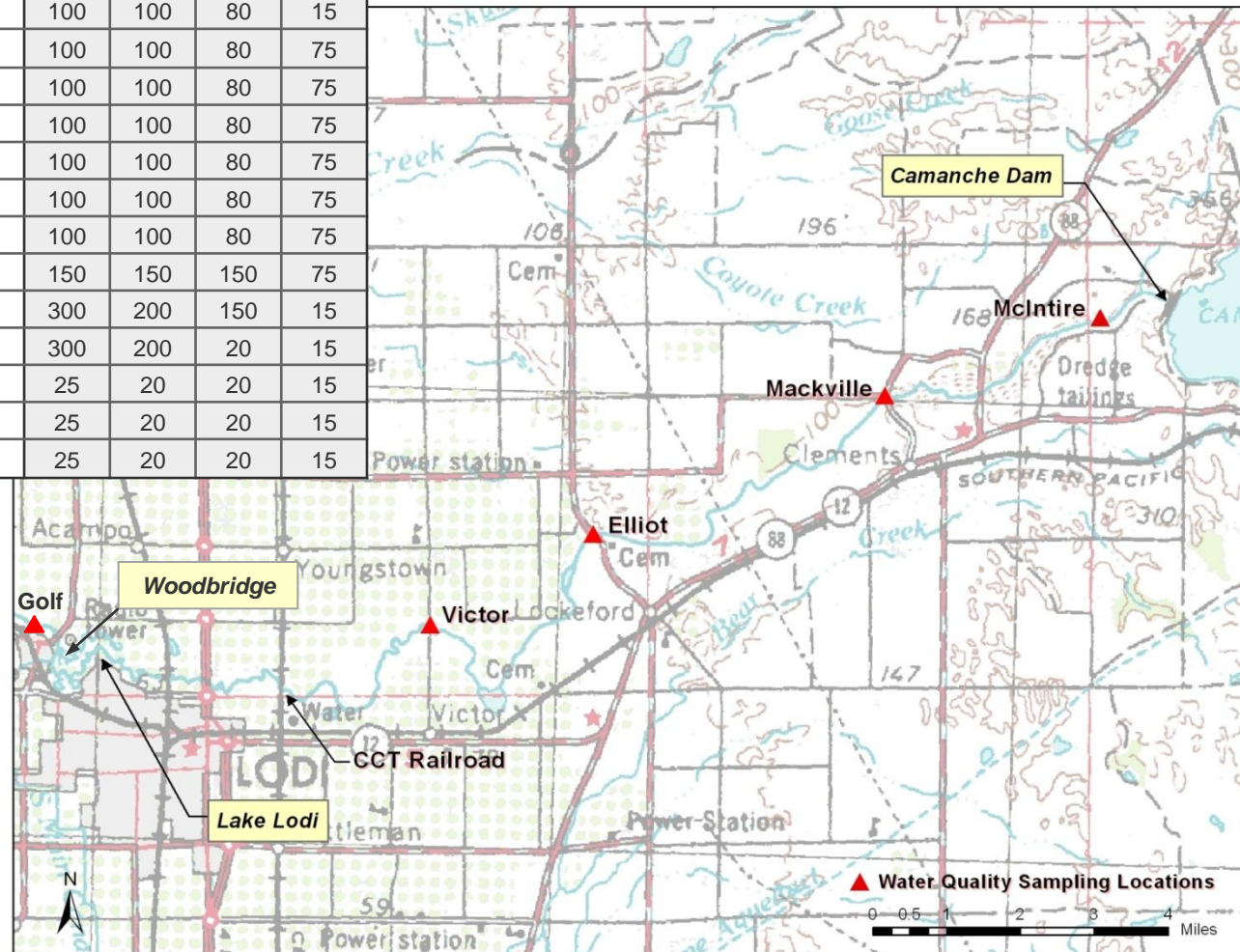
Environmental Flow Requirements



$$R = \max \left\{ \begin{array}{l} \text{Below Camanche} \\ \text{Below Woodbridge + diversions and losses} \end{array} \right.$$

Month	Below Camanche				Below Woodbridge			
	AN/N	BN	D	CD	AN/N	BN	D	CD
	[cfs]				[cfs]			
Oct 1-15	325	250	220	100	100	100	80	15
Oct 16-31	325	250	220	130	100	100	80	75
Nov	325	250	220	130	100	100	80	75
Dec	325	250	220	130	100	100	80	75
Jan	325	250	220	130	100	100	80	75
Feb	325	250	220	130	100	100	80	75
Mar	325	250	220	130	100	100	80	75
Apr	325	250	220	130	150	150	150	75
May	325	250	220	100	300	200	150	15
Jun	325	250	100	100	300	200	20	15
Jul	100	100	100	100	25	20	20	15
Aug	100	100	100	100	25	20	20	15
Sep	100	100	100	100	25	20	20	15

Year Type	
AN	Above Normal
N	Normal
BN	Below Normal
D	Dry
CD	Critically Dry

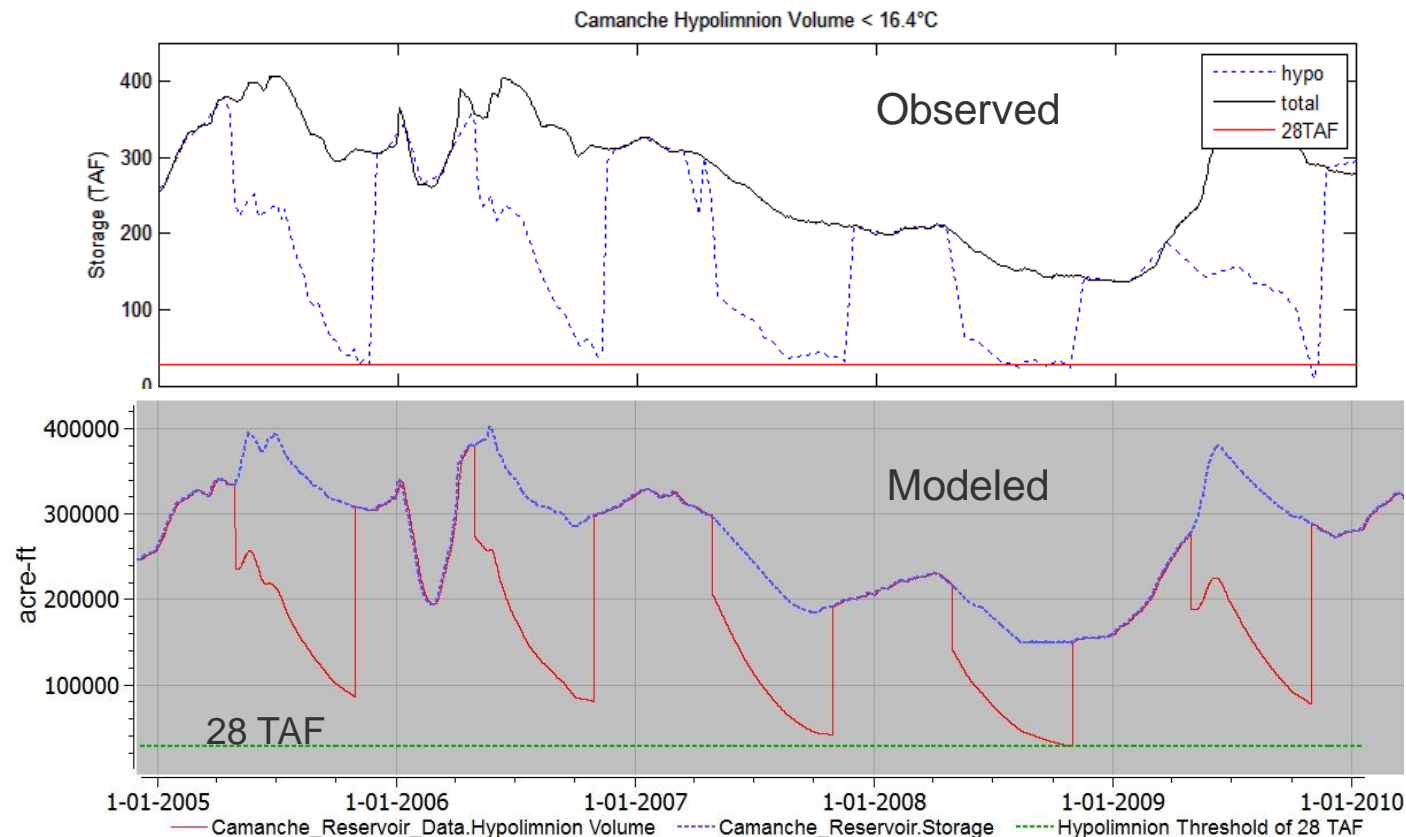


Environmental Flow Temperature Requirements

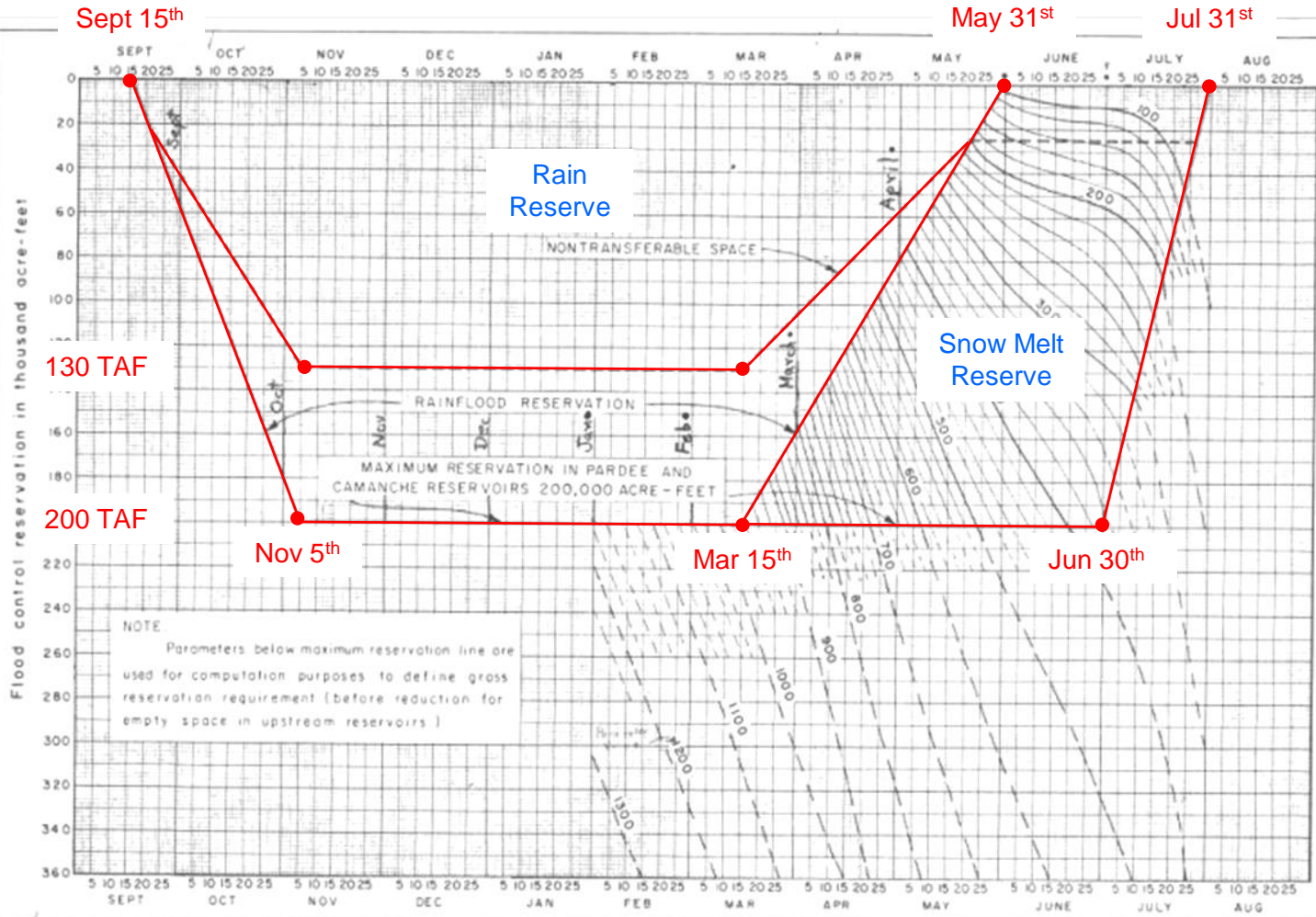


Goal: Maintain cold water temperatures in the Lower Mokelumne River

- Maintain Camanche hypolimnetic volume ≥ 28 TAF thru October
- Colder than 16.4 degrees Celsius
- Supported by Pardee Reservoir



Flood Reserve Requirements



- USE OF DIAGRAM
1. Parameter value is the forecasted natural runoff in thousand acre-feet into Cananche Reservoir between the given date and 31 July.
 2. Read **gross reservation** indicated by rainfall reservation line, or parameters (extrapolated, if necessary), whichever is larger.
 3. Subtract nontransferable space to obtain **transferable space**.
 4. That portion of the gross reservation within the rainfall reservation line may be reduced by (a) the amount of the empty space below the fixed crest of the spillway of Salt Springs Reservoir, less 40,000 acre-feet, or by (b) three-fourths of the transferable rainfall space, whichever is smaller. The rainfall reservation may be further reduced by (c) the amount of the empty space in Lower Bear Reservoir, less 15,000 acre-feet, or by (d) one-fourth of the transferable rainfall space, whichever is smaller.
 5. That portion of the gross reservation outside the rainfall reservation line may be reduced by (a) 80% of the empty space in Salt Springs Reservoir, including space behind the crest gates, remaining after deduction of space used within the rainfall reservation line, or (b) by three-fourths of the transferable space outside the rainfall reservation line, whichever is smaller. The gross reservation outside the rainfall reservation line may be further reduced by (c) 80% of the empty space in Lower Bear Reservoir remaining after deduction of space used within the rainfall reservation line, or (d) one-fourth of the transferable space outside the rainfall reservation line, whichever is smaller.
 6. The remaining amount of the gross reservation, but not more than 200,000 acre-feet, is required flood control space and may be divided in any proportion between Cananche and Pardee Reservoirs.
 7. If experience demonstrates that use of upstream space for flood control is not dependable, the District Engineer, after consideration of the operating agency's municipal yield requirements and after discussion with representatives of the operating agency, may reduce or eliminate credit for that empty space until use of that space becomes dependable. Provision is herein made for review of such reduction by higher authority within the Corps of Engineers upon request of the operating agency.
 8. At all times releases shall be restricted insofar as possible to quantities which will not cause flows in Mokelumne River at the gaging station below Cananche Dam to exceed the controlling flow rate of 5,000 cfs. When space available for flood control is less than required, as determined above, water shall be released from Cananche Reservoir as rapidly as possible without causing that controlling flow rate to be exceeded.

226 C

CAMANCHE DAM AND RESERVOIR
Mokelumne River, California

FLOOD CONTROL DIAGRAM
Prepared Pursuant to Flood Control Regulations
for Cananche Dam and Reservoir

APPROVED: *William J. Conroy*
Lieutenant General, Chief of Engineers

APPROVED: *Earl H. Morrison*
Chief Engineer, East Bay Municipal Utility District

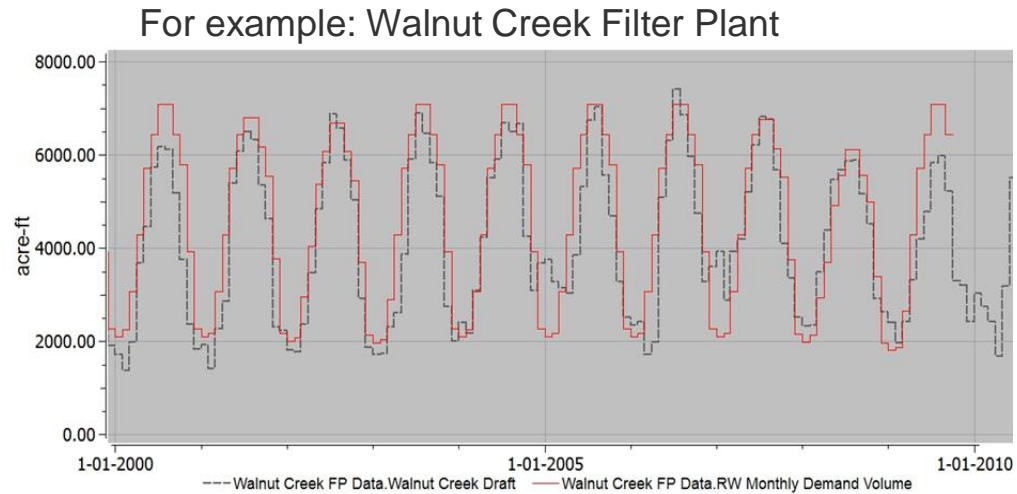
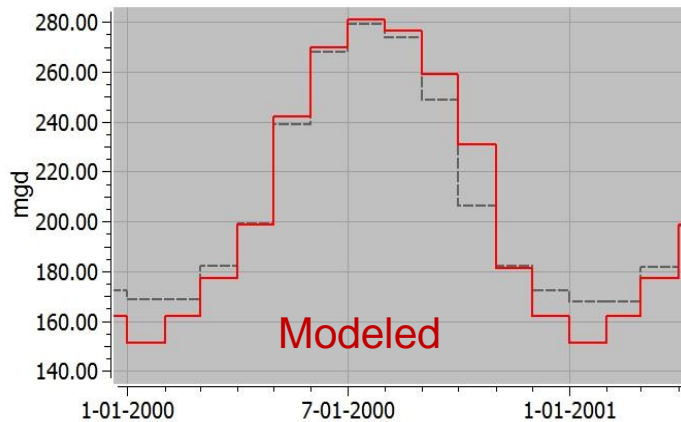
Effective Date: 23 Aug. 1965 File No. 5-26-127

Fixed Demand Model



- Level of Development
- Annual Average Demand

- Discretized into 5 treatment plants



Drought Contingency Planning

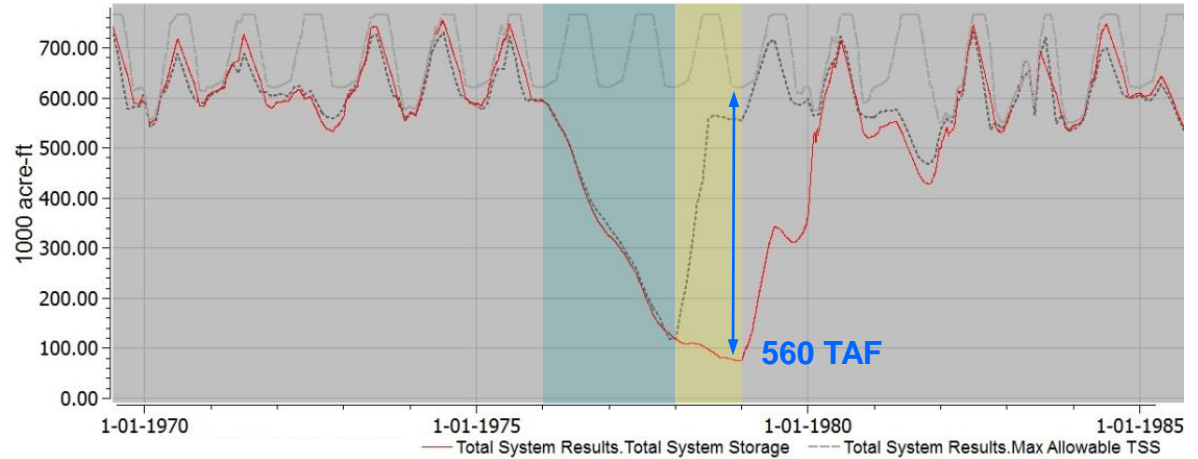


- Drought Planning Sequence
- Customer Demand Rationing
- Freeport Regional Water Project
 - CVP Drought Contingency Supply
- Need for Water
 - Transfers

Drought Planning Sequence



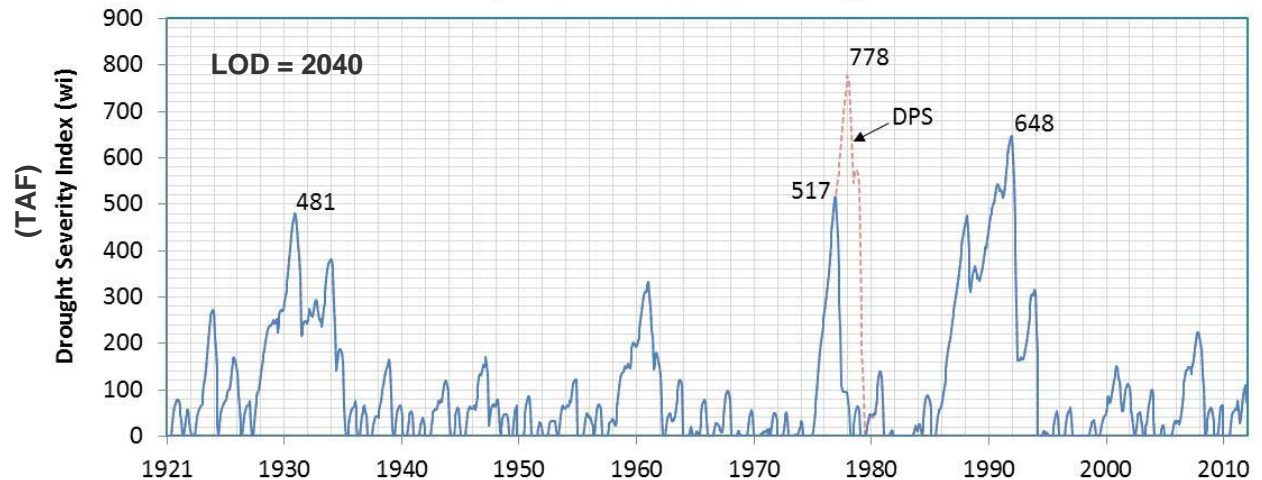
- 1976, 1977 and modified 1978



$$w_t = w_{t-1} + (D_t + R_t - q_t)$$

(No Supplemental Supplies, No Rationing)

- Which drought is more severe?



Rationing Guidelines



Drought Stage	Projected End-of-September Total System Storage (TAF)	Rationing Goal
Normal	500 TAF or more	None
Moderate	500 - 425 TAF	0 to 10% - Voluntary
Significant	425 - 390 TAF	10% to 15% - Voluntary
Severe	390 - 325 TAF	15% to 20% - Mandatory
Critical	Less than 325 TAF	20% - Mandatory

Freeport Regional Water Project

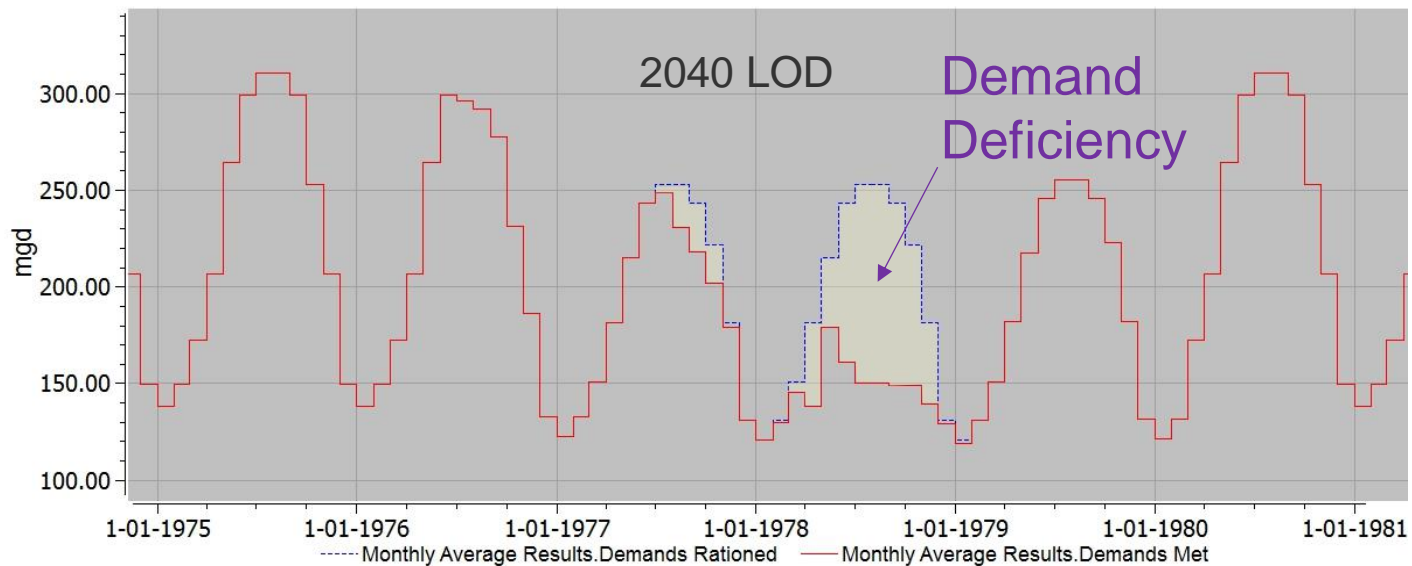


- Eligible when EOS-TSS < 500 TAF
- Contract limits (1-year, 3-year)

Drought Year	First Year July Start at 85.4 cfs	First Year July Start at 110 cfs
1 st	41 TAF	53 TAF
2 nd	62 TAF	80 TAF
3 rd	62 TAF (165 TAF limit)	32.4 TAF (165 TAF limit)
4 th	Repeat pattern	Repeat pattern
etc.		

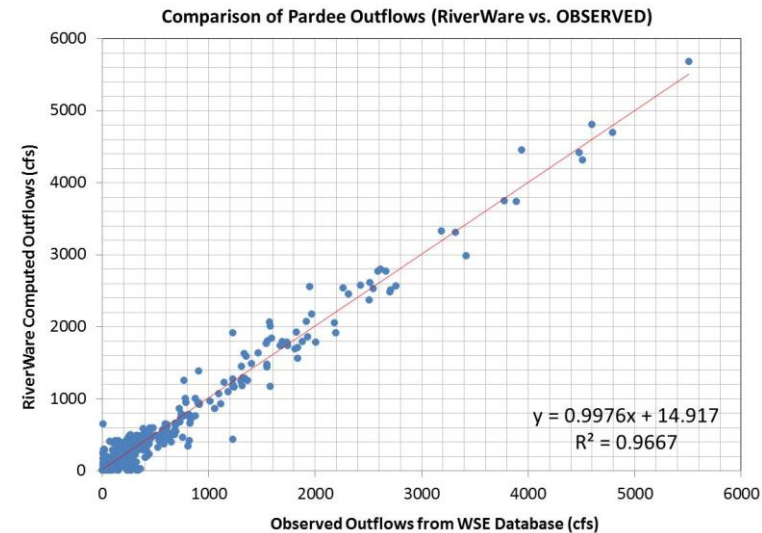
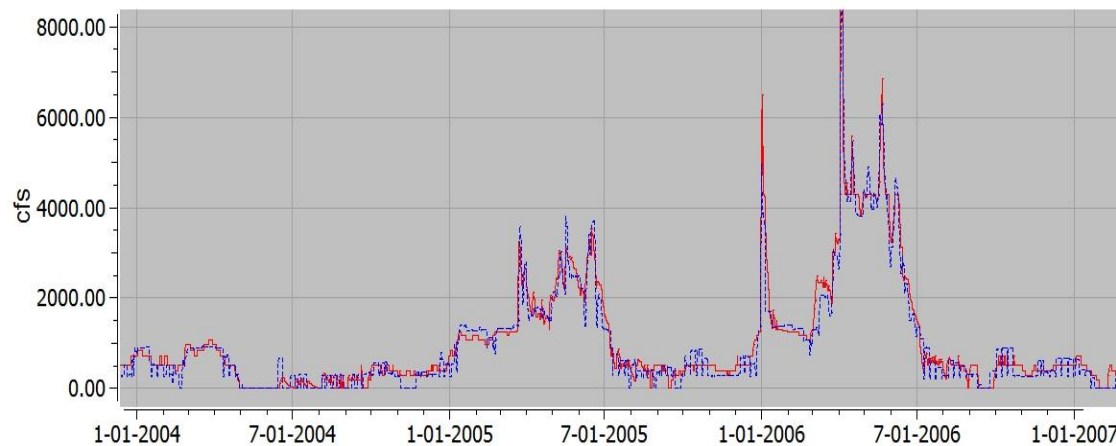
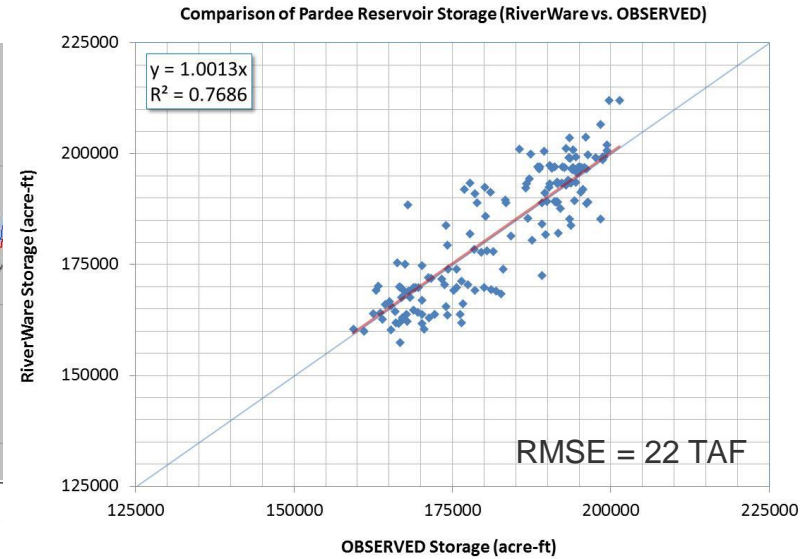
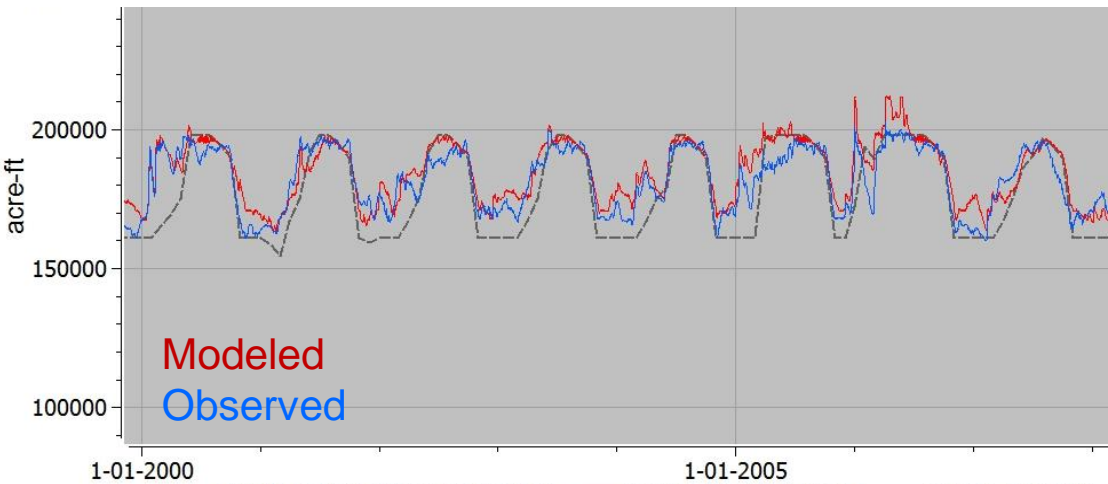
Need for Water

- Example Demand Reduction

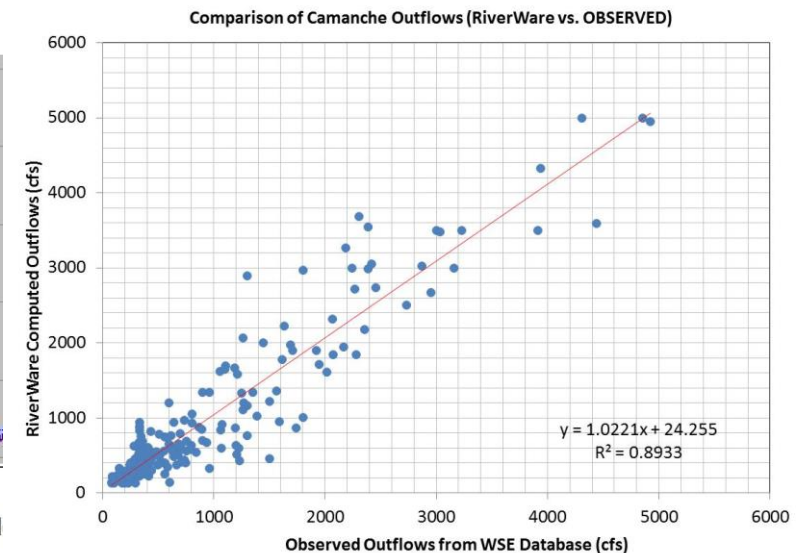
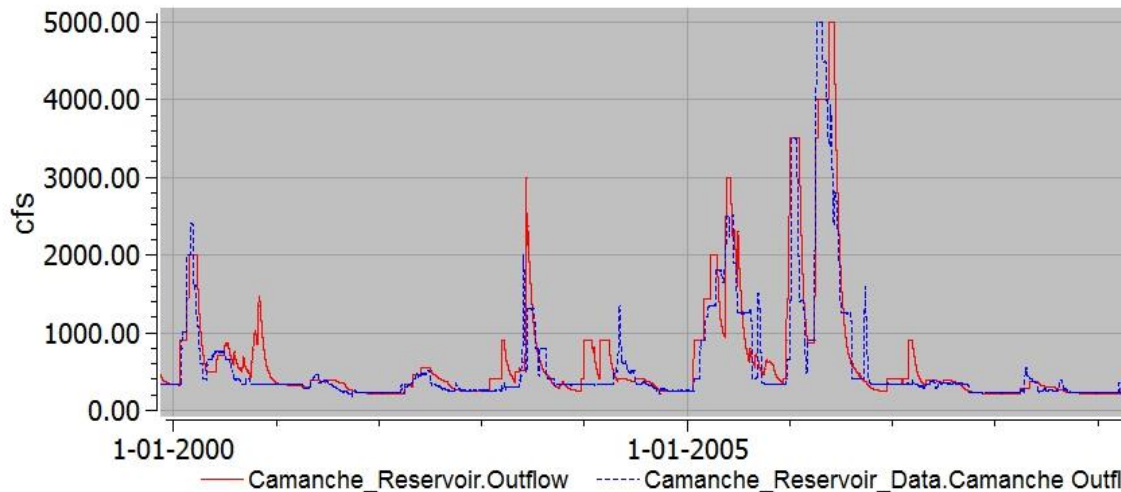
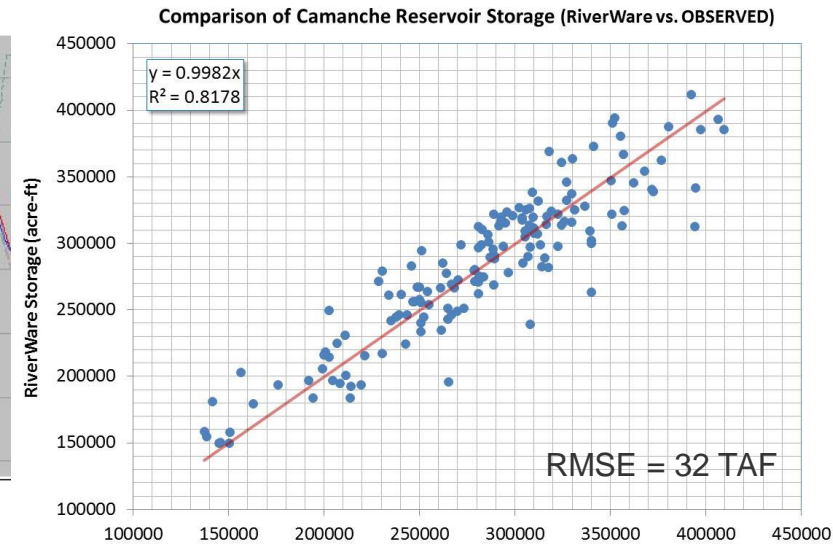
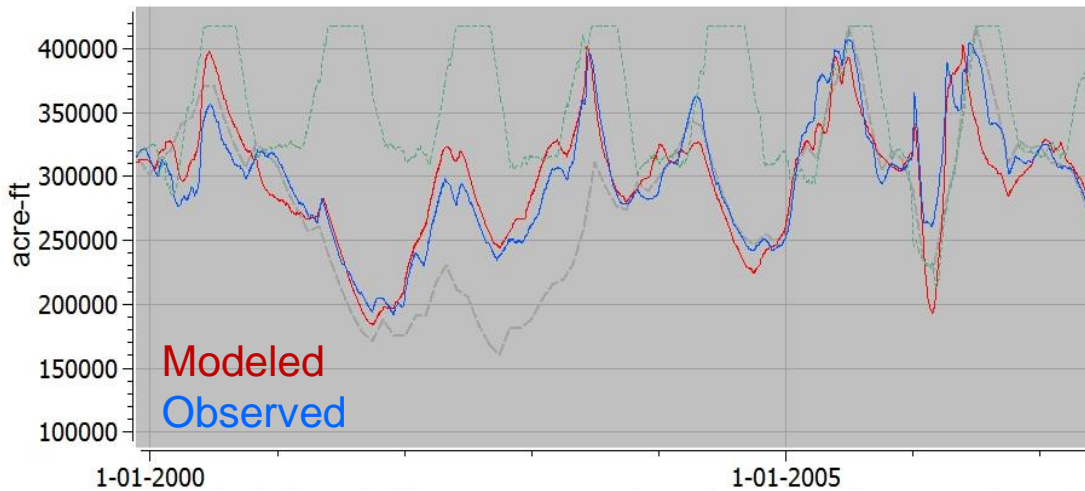


Drought Planning Sequence

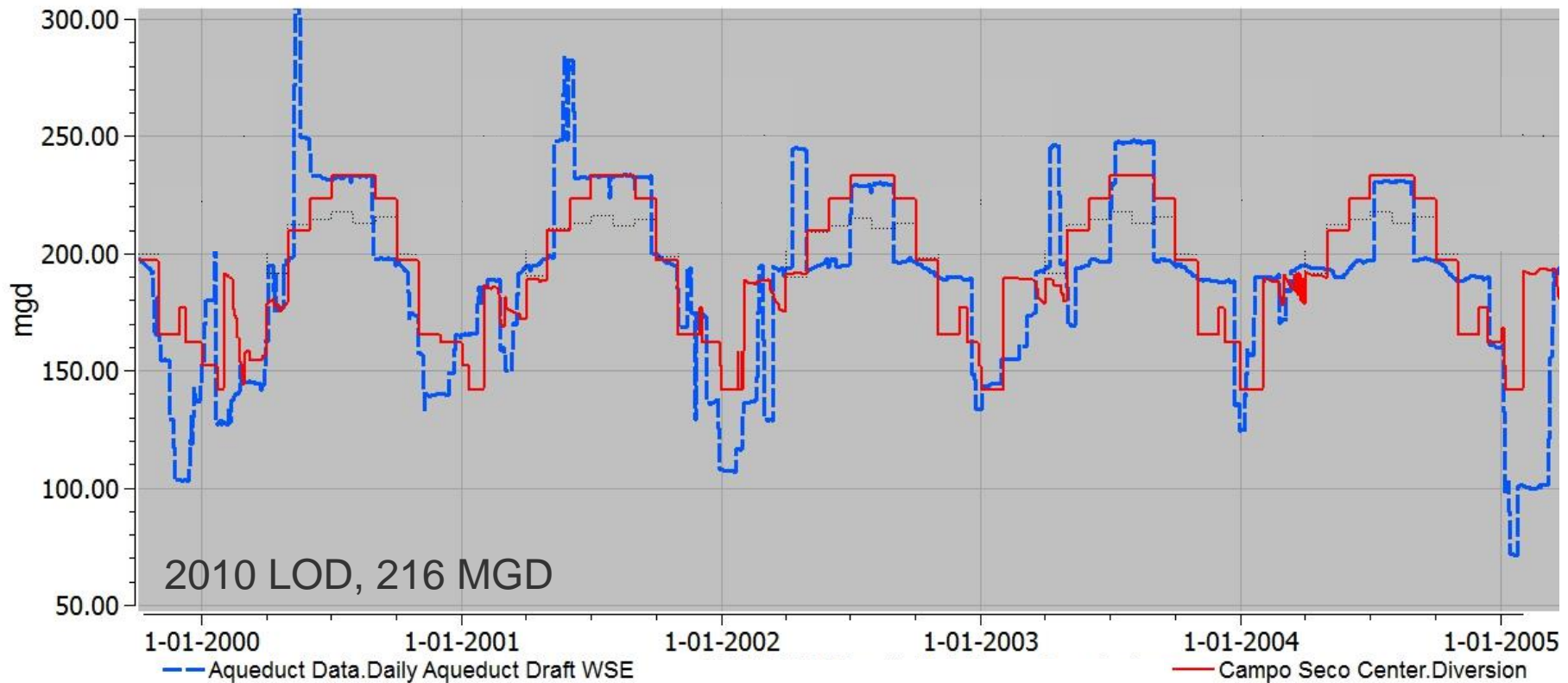
Pardee Reservoir



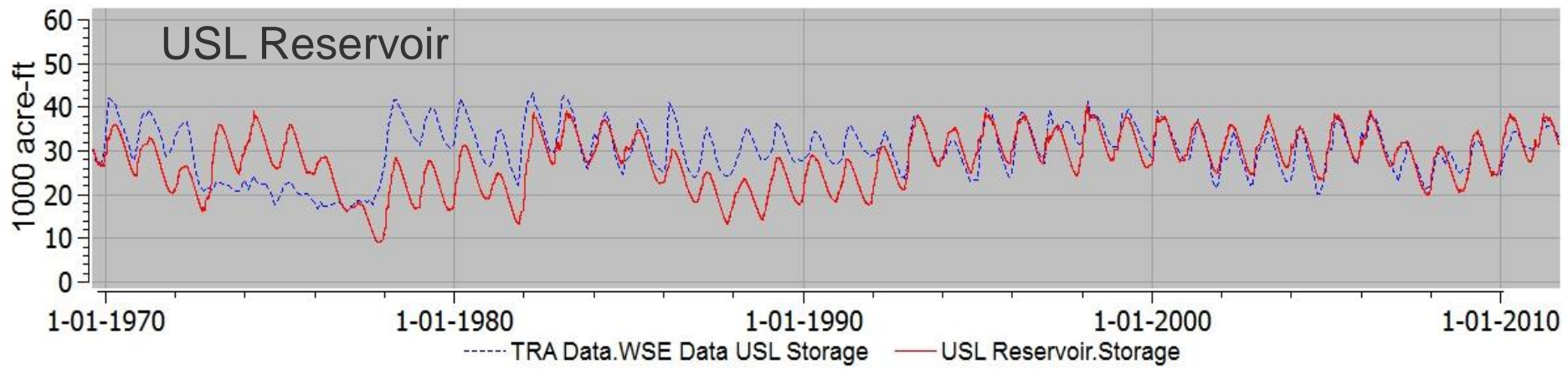
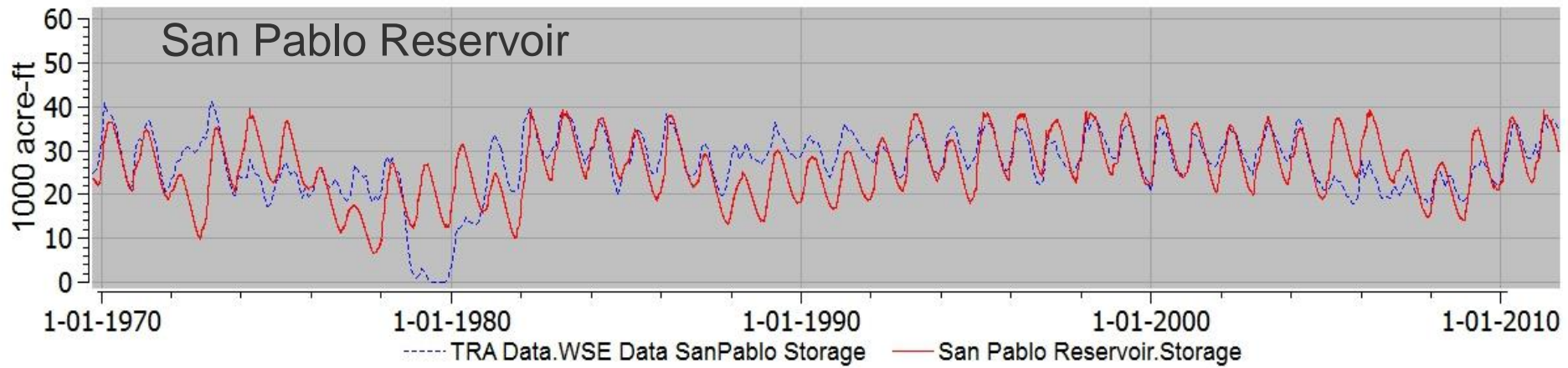
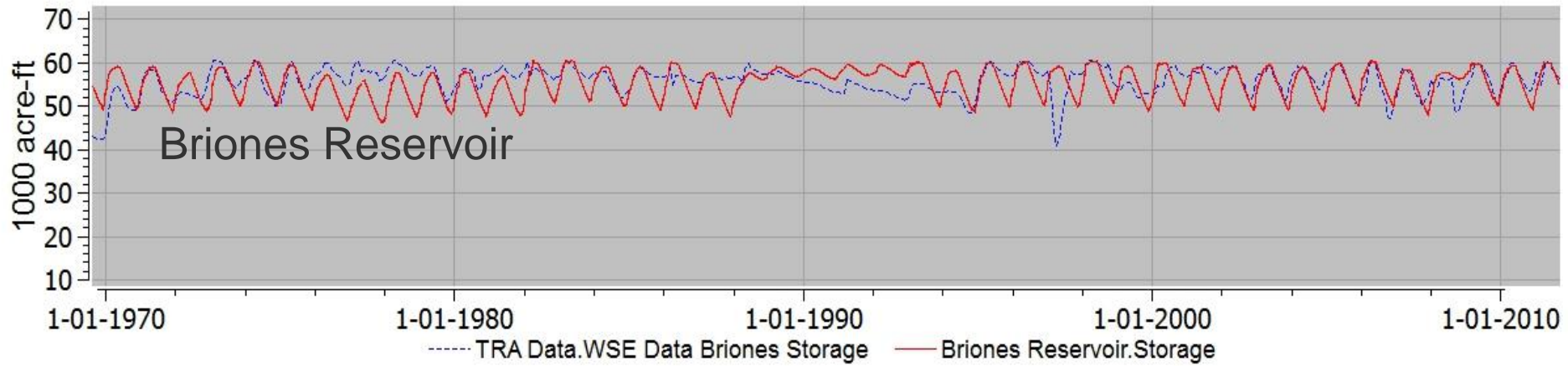
Camanche Reservoir



Mokelumne Aqueduct Draft from Pardee Reservoir



Comparison to **OBSERVED** daily data





EAST BAY MUNICIPAL UTILITY DISTRICT

Questions?

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510-287-2068

bbray@ebmud.com

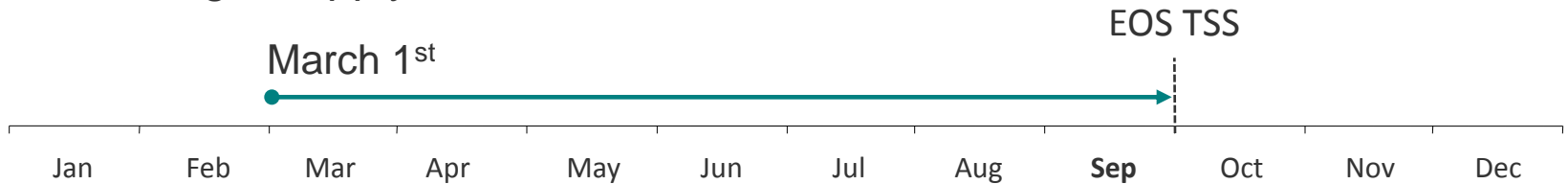
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Forecasting Future Storage

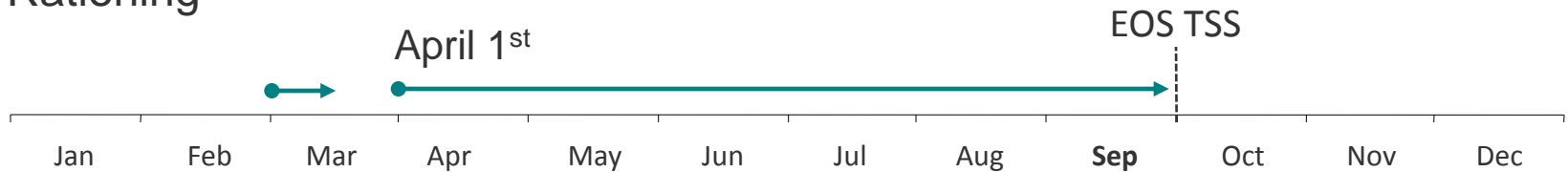


Carryover Storage

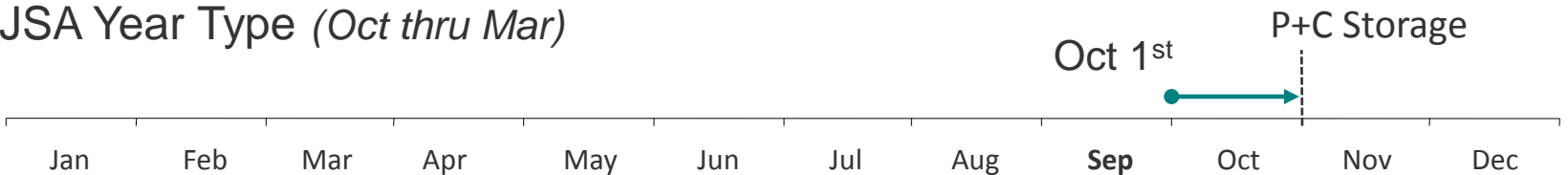
CVP drought supply



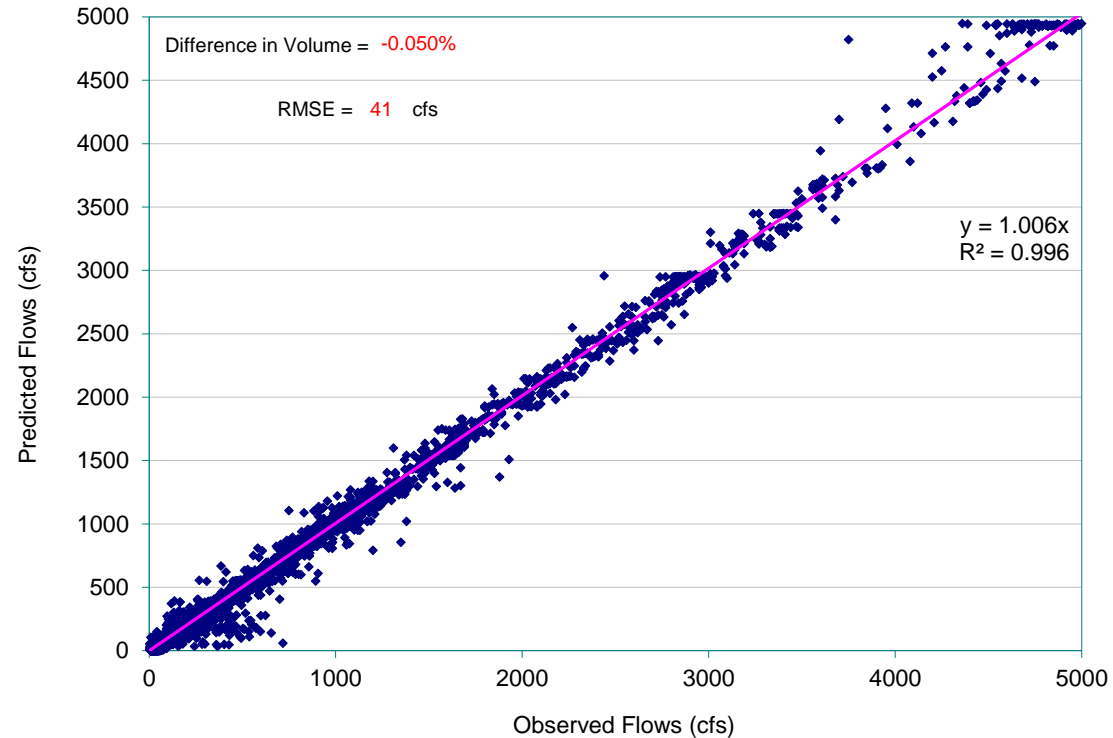
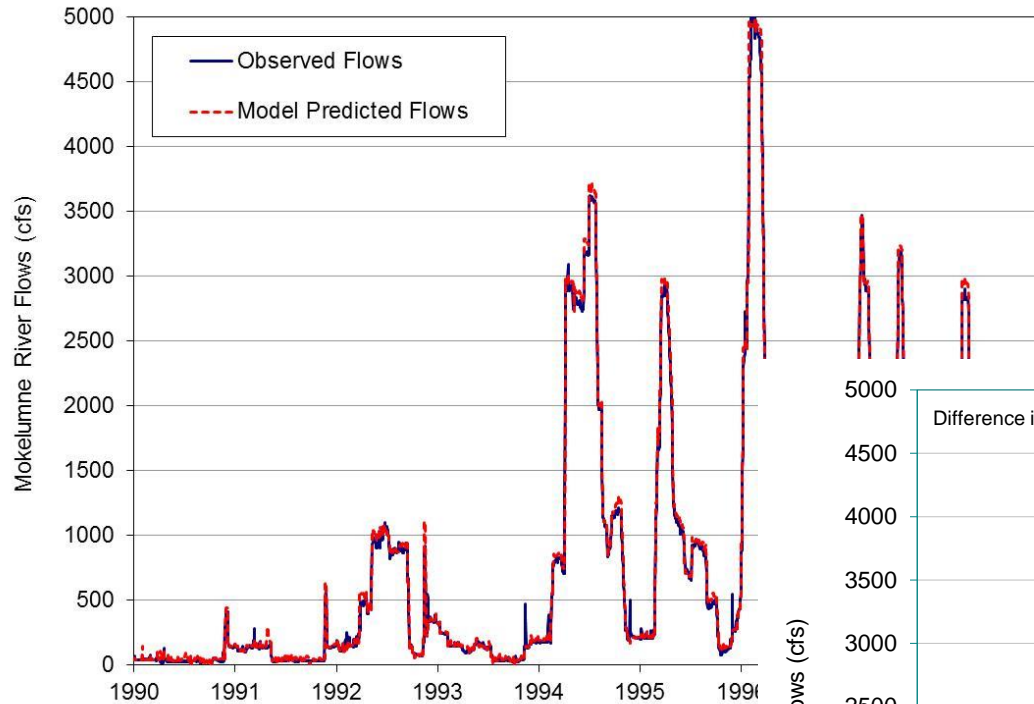
Rationing



JSA Year Type (*Oct thru Mar*)



Comparison of Flows at Golf



Year Type Designation



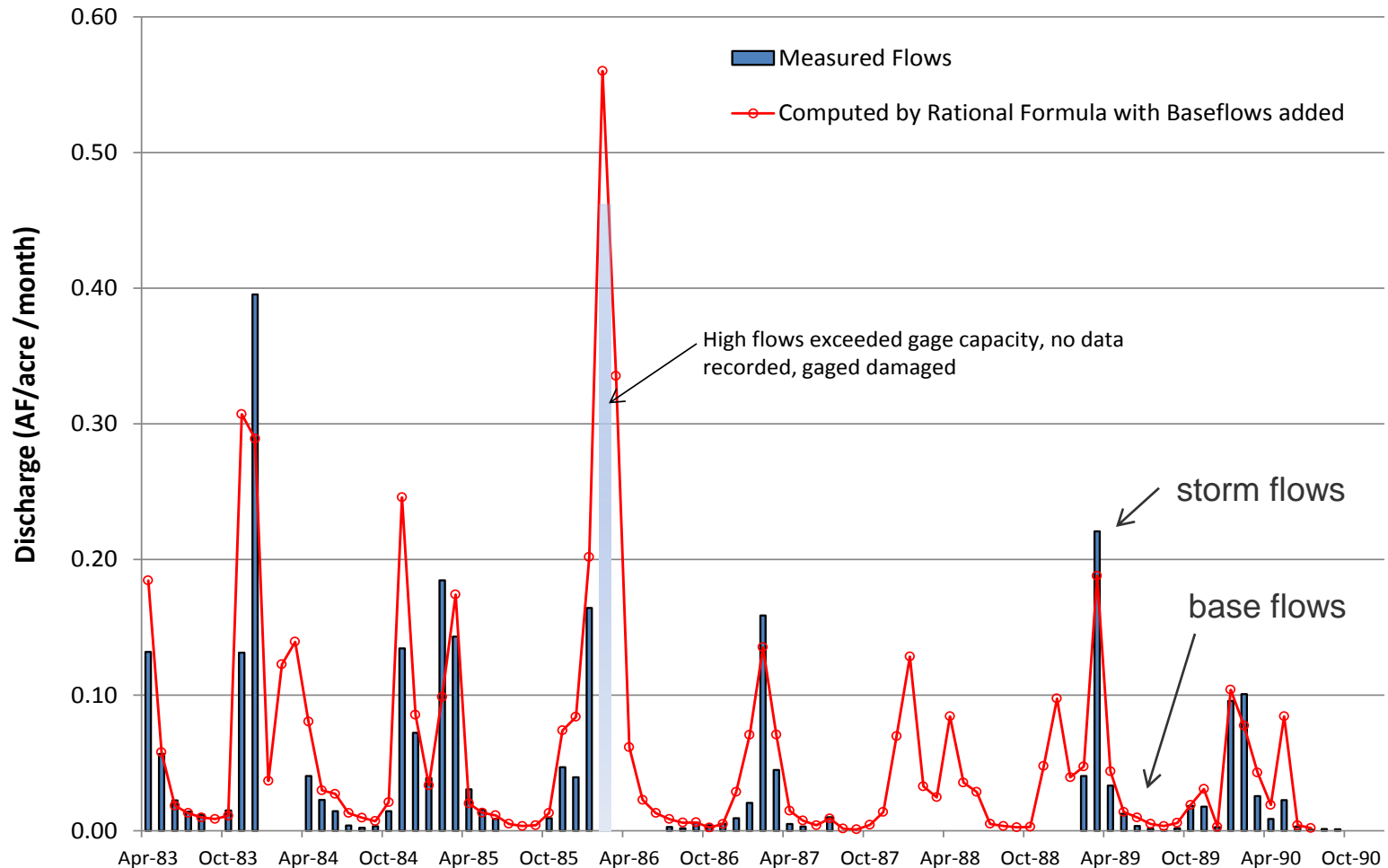
- Environmental Flow Requirements (JSA)
 - AN, BN, Dry, Critical
 - April thru September (*runoff from Oct thru Sept*)
 - October thru March
 - Oct 1st: forecast Nov 5th Pardee+Camanche storage
- Riparian & Senior Appropriators Diversions
 - Runoff volume (*runoff from Oct thru June*)
 - RSA year type (*< or ≥ 250 TAF*)
- Woodbridge Irrigation District/Lodi Diversions
 - Pardee Inflows (*Oct thru Sept*)
 - WID year type (*< or ≥ 375 TAF*)

TRA Calibration – Runoff

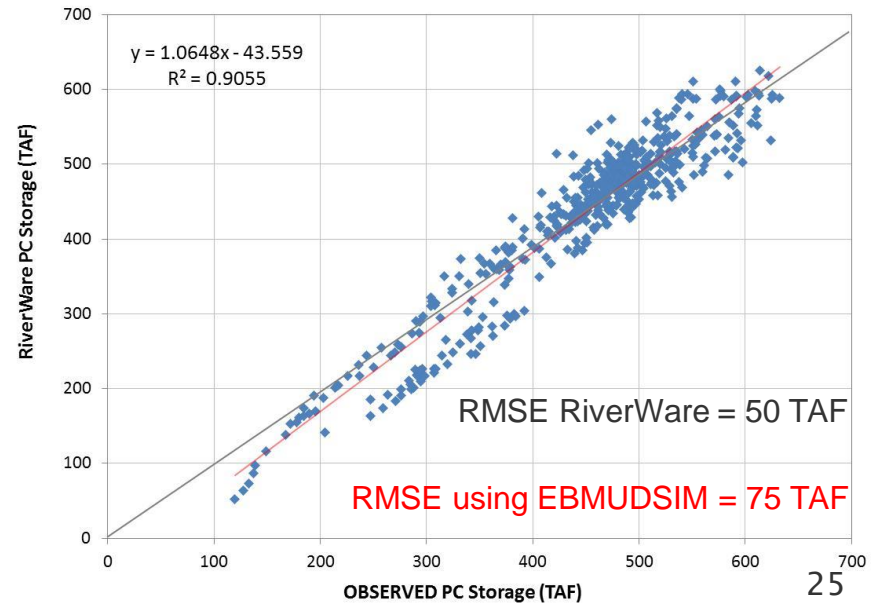
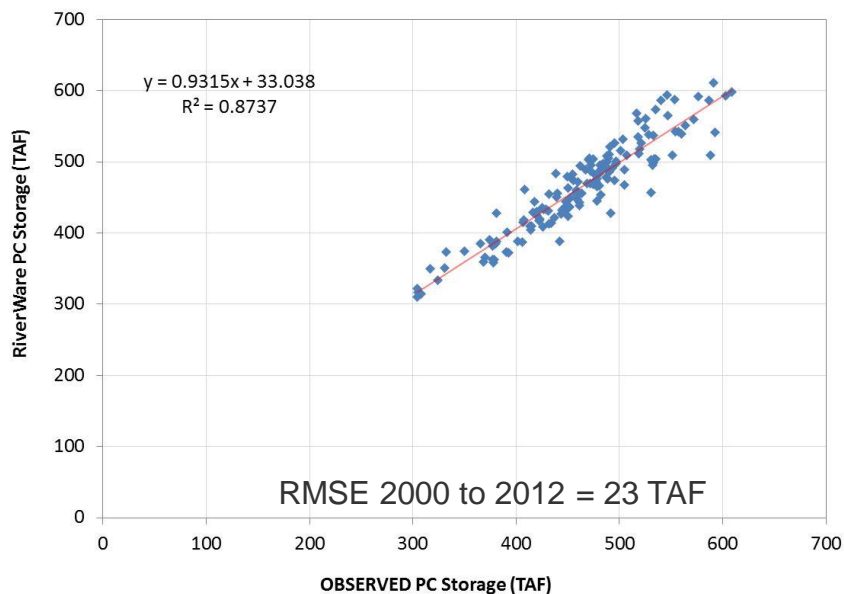
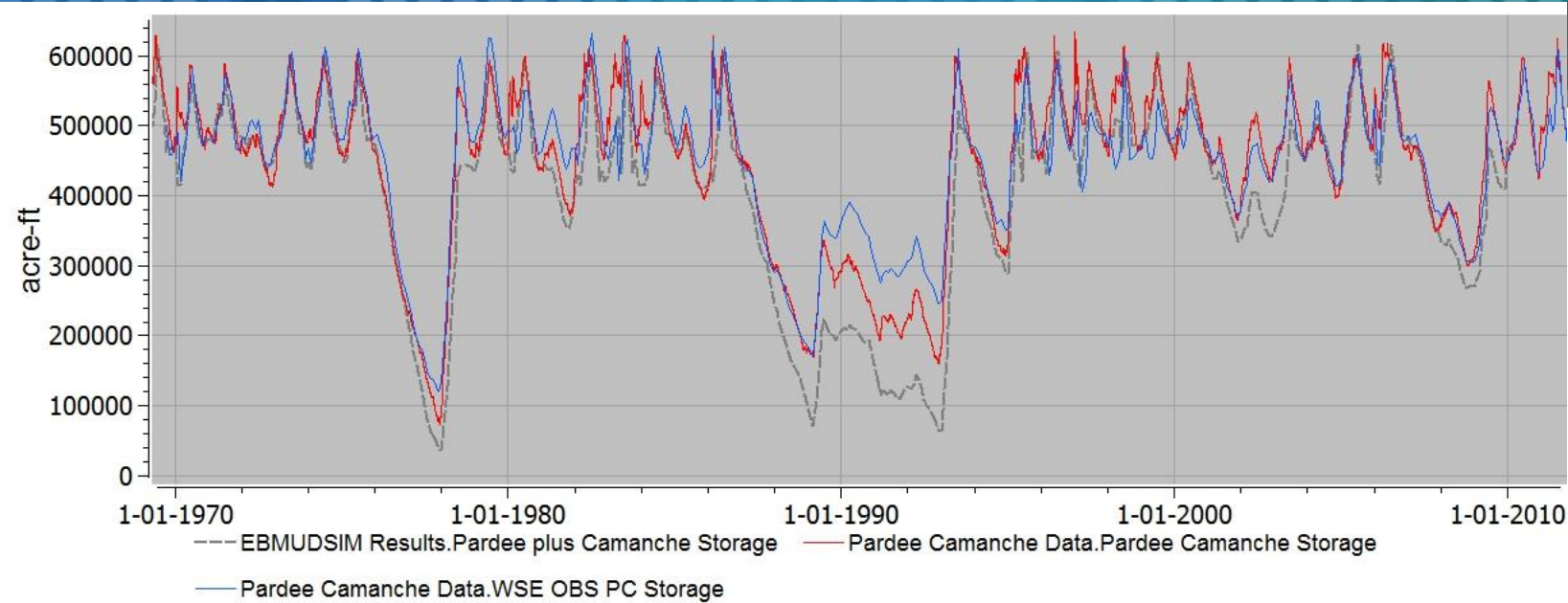
(base flows and storm flows)



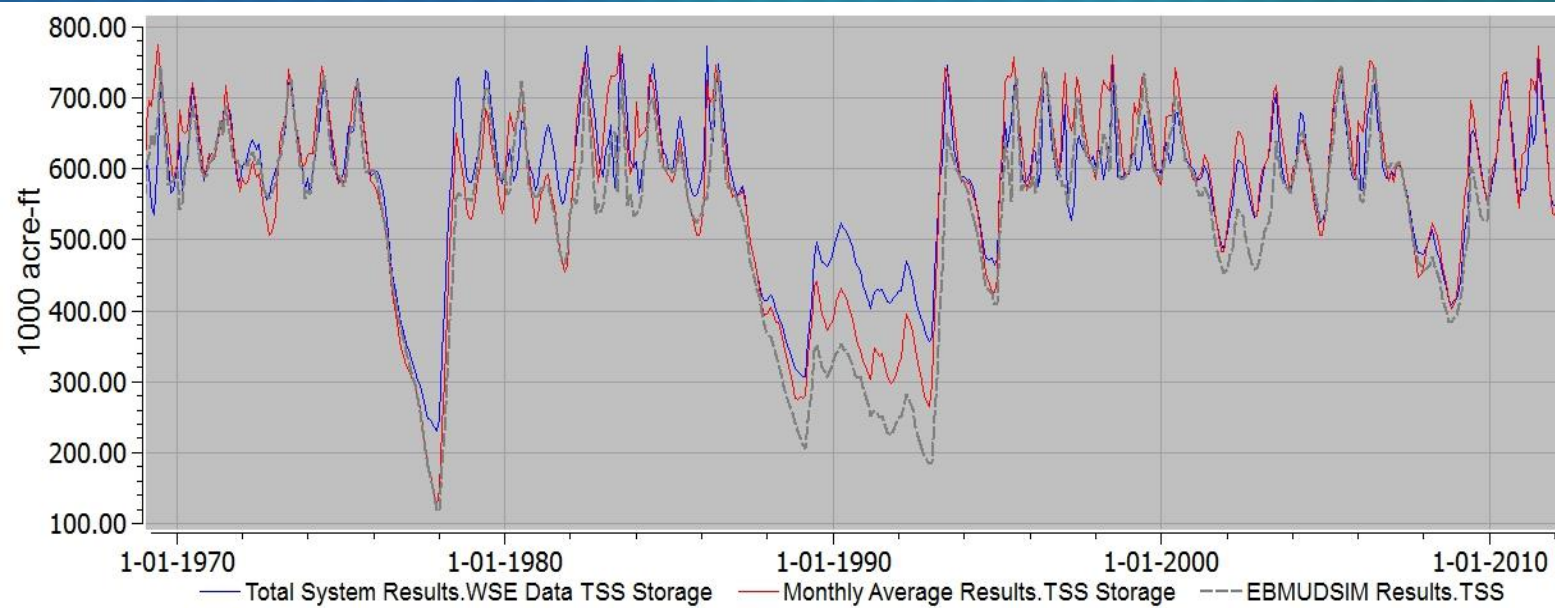
Comparison of Computed Local Runoff to Observed San Pablo Creek Flow



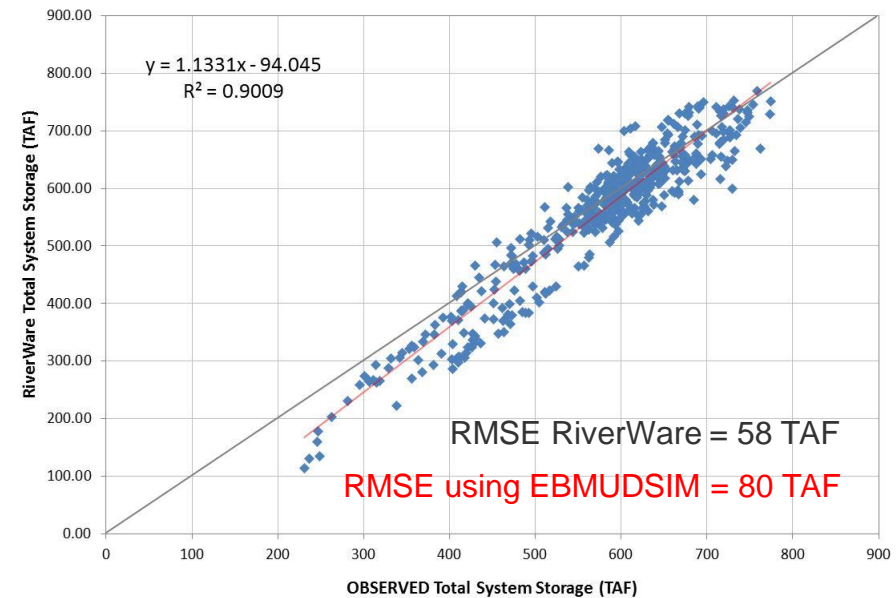
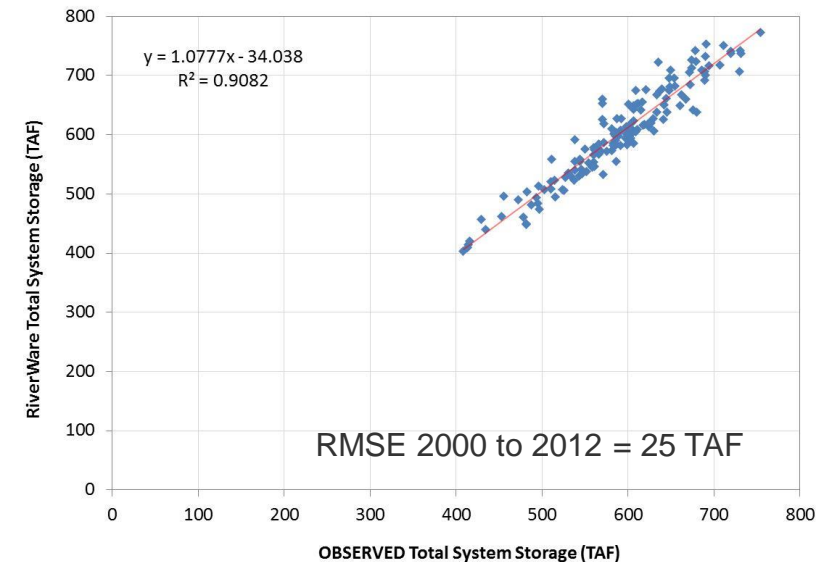
Pardee+Camanche Storage - OBSERVED



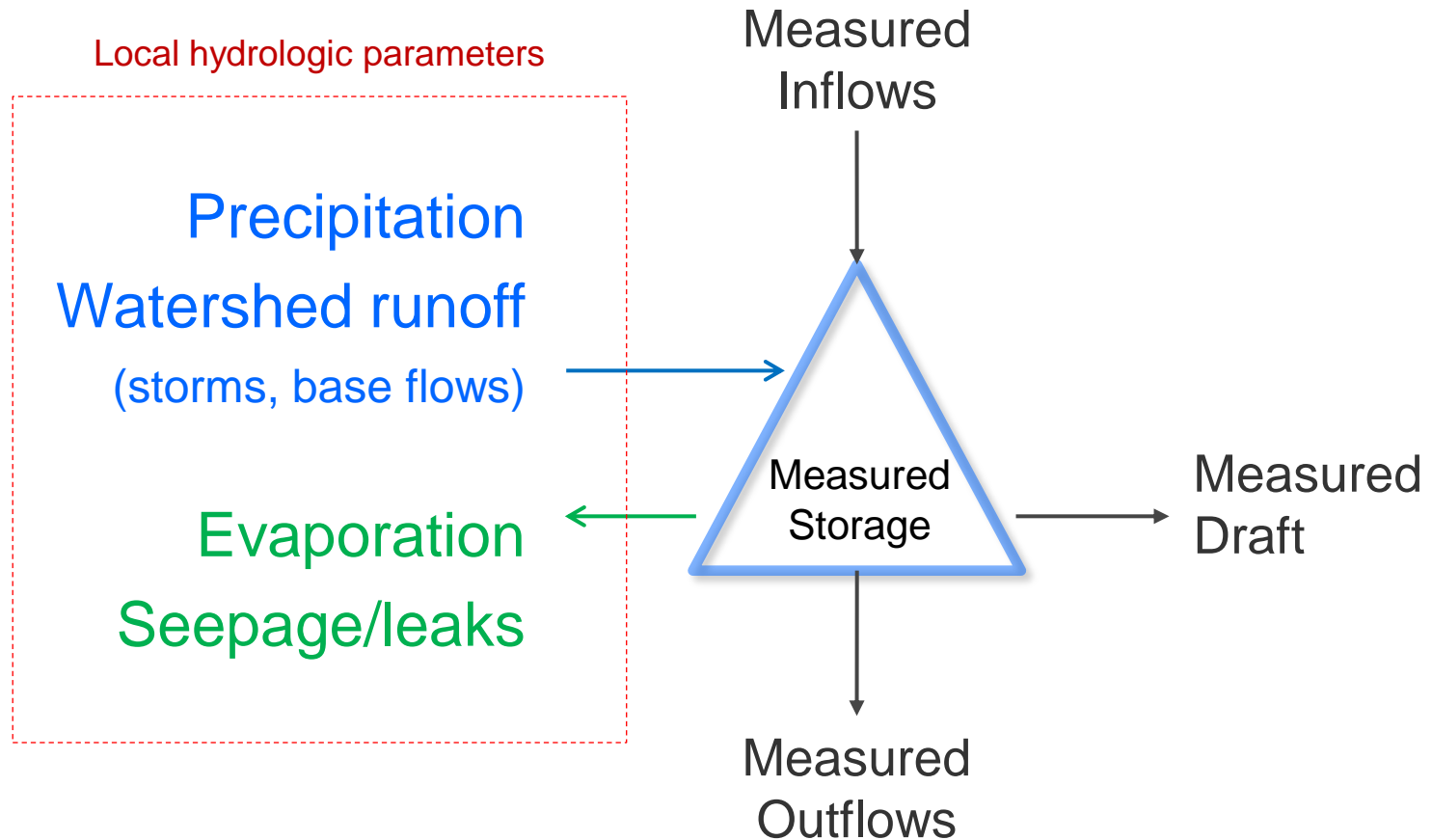
Total System Storage - OBSERVED



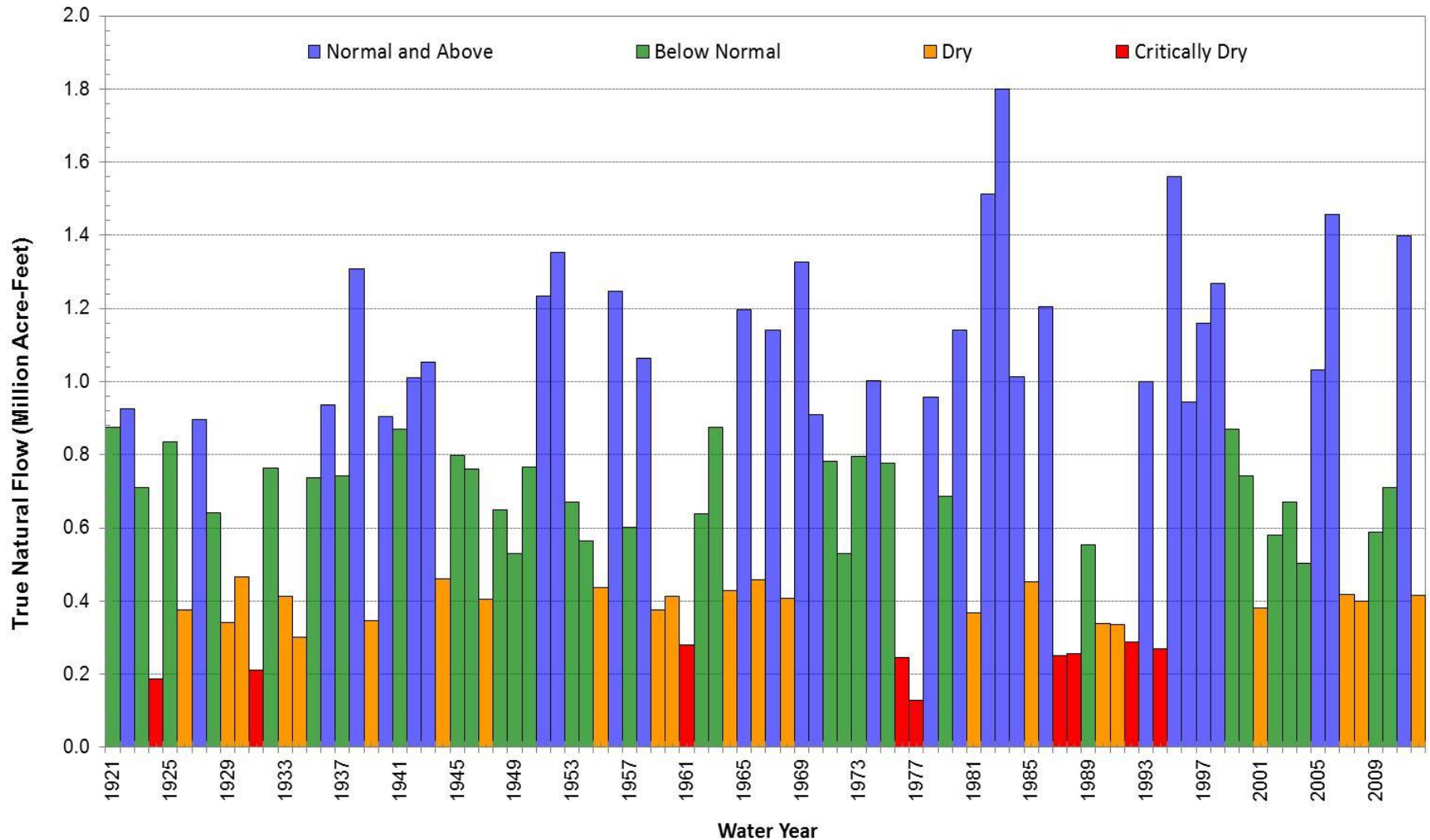
Comparison of Modeled TSS to OBSERVED TSS



TRA Calibration



True Natural Flow & Year Type



Calibration Procedure

