Northern Sacramento Valley Conjunctive Water Management Program

A Collaborative Planning Effort Co-Sponsored by
Glenn Colusa Irrigation District and the Natural Heritage Institute

Funded by the Bureau of Reclamation and
California Department of Water Resources

Final Report Public Briefing

Introductory Perspectives

- Motivating Factors
- Regional Responses
- The Role of Groundwater

Motivating Factors: External Pressures

- Is Region Sustainable?
  - Environmental, Economic, Social
- The Delta
  - SWRCB Water Quality Control Plan Update (Flow Report stated Sac River 75% unimpaired flow to the Delta November-June)
  - Delta Species (smelt) dominate; Longfin Smelt Listing
  - Delta Stewardship Council
  - Bay Delta Conservation Plan
- System Re-operation:
  - SB x2-1 directs DWR to investigate climate change and conjunctive operations (see http://wwwdwr.water.ca.gov/system_reop/)
- Groundwater
  - State interest in groundwater regulation
  - Latest National Research Council recommended more regulation of groundwater
  - Scott Valley/Siskiyou County Groundwater Pumping Lawsuit

Regional Reponses

- Define Desired Regional Outcome
  - Sustainability of water, environment, economy
- Understand risks and pressures to region
  - Delta Flow Report, Export needs, Delta Plan
- Develop Regional Response and Solutions
  - IRWM, Stakeholder processes, Others?
- Develop Projects/Policies/Positions
- Understand outcomes of Solutions and weigh to Original Risk, Adaptive Management
- Response – Implement Solutions or Plan B?

The Role of Groundwater

- Sacramento Valley water demands have been satisfied for decades through conjunctive *use*
- Regional sustainability depends on conjunctive *management* in some form
- Groundwater investigations will happen, like surface water, how will regional interest and collaboration happen?

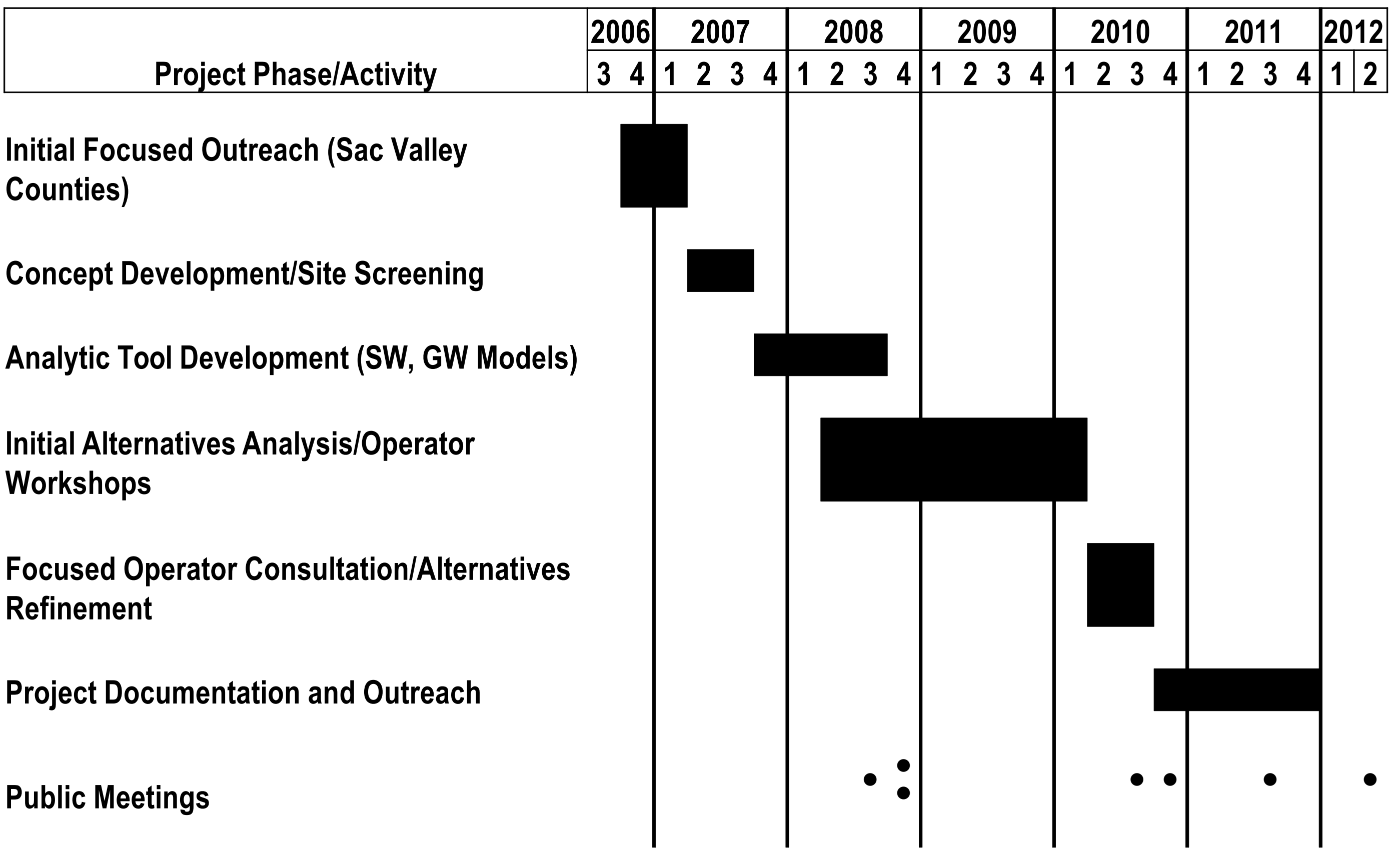
Briefing Topics

- High-Level Overview
- Core Conjunctive Management Concept
- Project Objectives and Principles
- Technical Approach and Analytic Tools
- Project Benefits
- Project Impacts
- Project Economics
- Conclusions and Recommendations

Overview:
Sponsors and Funding

- Jointly sponsored by Glenn-Colusa Irrigation District and the Natural Heritage Institute
- Funded by State and Federal grants:
  – Dept. of Water Resources: $500,000
  – Bureau of Reclamation: $700,000

Overview: Project Timeline



Overview: What Was Studied?

- Can additional water supplies be generated for use within the Sacramento Valley through the conjunctive management of existing surface water reservoirs and groundwater aquifers?
  – Lake Shasta and Lake Oroville
  – Intermediate aquifer and deep aquifer
  – Water used for environmental enhancement in the Sac and Feather Rivers and for agricultural water supply

Overview: What Was Learned?

- Traditional groundwater banking…storing surplus surface water underground and extracting it when needed…is not workable in the Sacramento Valley
  – Available aquifer storage capacity is inadequate
- Re-operation of existing storage reservoirs to draw them down further going into the refill season can generate additional water supplies
  – Evacuated reservoir space captures surplus stream flow
  – Reservoir “payback” is needed infrequently, when surplus stream flow is inadequate

Overview: What Was Learned?

- Reservoir “payback” by not making reservoir releases that would otherwise be made and pumping groundwater instead is feasible
  – Groundwater pumping required very infrequently
- Reservoir payback by temporarily idling crops to reduce reservoir demands is not efficient or cost-effective
  – Timing issues/idling cannot be turned on/off

Overview: Benefits to Groundwater

Scenario	Groundwater Pumping Capacity (thousand acre-feet)			
	Project	New Yield to Ag	Groundwater Pumped	**Net Gain to Groundwater**
1,3,4	CVP	1,148	246	**902**
1,3,4	SWP	820	246	**574**
2	CVP	1,804	738	**1,066**
2	SWP	1,886	574	**1,312**

Overview: What Was Learned?

- Impacts to existing groundwater users and streams is negligible
  - Payback pumping appreciable but required very infrequently
- As evaluated, the conjunctive management alternatives evaluated are not economically feasible
  - Benefits based solely on “in-Valley” value of water
  - No monetary value attached to the environmental benefits

Overview: Conclusions

- Further investigation is warranted but depends on regional interest and collaboration
  - Potential component of Integrated Regional Water Management Plans?
- Certain technical refinements recommended if further investigation undertaken, including climate change sensitivity

Core Concept: Re-operate Existing Reservoirs

- Draw reservoirs down further going into the winter refill season
  - Produce additional water supply by capturing surplus surface flows
  - Increases risk that reservoirs will not refill
- When they do not refill, recover reservoirs by substituting alternative supplies or reducing water demands
  - Referred to as “reservoir payback”

Reservoir Payback Mechanisms

- Extract groundwater “banked” in prior years (not feasible)
- Reduce reservoir releases that would otherwise be made from reservoirs
  - Substitute with pumped groundwater
  - Temporary crop idling (on a voluntary, compensated basis)

Project Objectives

- Enhance ecosystem functions in the Sacramento and Feather Rivers by making additional reservoir releases for specific purposes
- Improve local (in-Valley) water supply reliability, particularly during times of scarcity
  - Reduce reliance on groundwater pumping
  - Reduce water shortages/lost production

Enhance Ecosystem Functions

- Geomorphic processes: sediment transport, bed mobilization and scour, etc.
- Floodplain inundation: provide habitat for rearing of juvenile salmon
- Spring pulse flows: enhance rearing and out-migration of juvenile salmon
- Riparian habitat

Specific flow rates, timing and durations developed for each objective, along with dynamic prioritization

Improve In-Valley Water Supply

- Historical unmet agricultural surface water demands <u>used as surrogates</u> for additional in-Valley water needs
  - Central Valley Project (CVP) water supply contractors along Tehama-Colusa Canal
  - Feather River water rights holders subject to shortages in dry years
  - Minimize crop idling and groundwater pumping

Additional water supplies could be used for any purpose.

Project Principles

- Honor all existing CVP and SWP obligations and operational requirements
- Achieve net environmental benefits recognizing potential for tradeoffs
- Hold existing groundwater users harmless by avoiding, minimizing, mitigating impacts
- Try to generate net positive economic benefits

Technical Approach and Analytic Tools

- Site screening and selection
- Groundwater and surface water models
- Project scenarios

Initial Site Screening

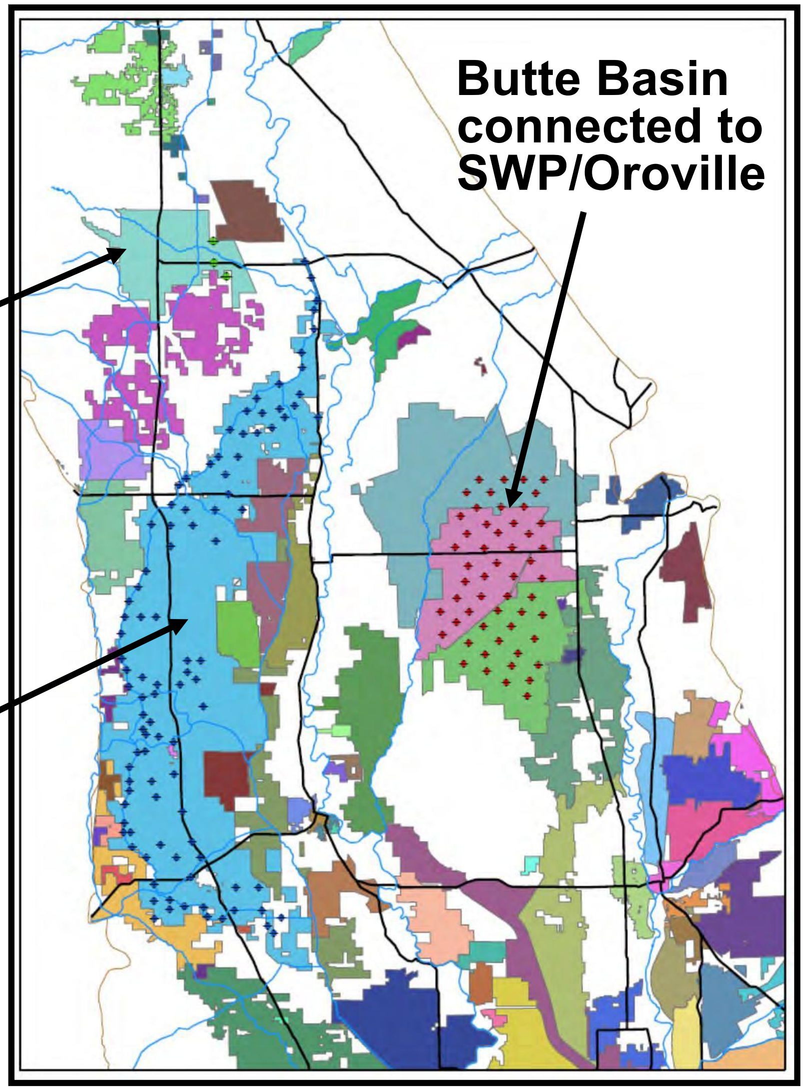
Attractive Site Features

- Groundwater conditions
  - Available aquifer storage space
  - Viable recharge mechanism
  - Productive groundwater wells
  - Suitable GW quality
- Surface water conditions
  - Reliable surface water supplies
  - Connection to CVP, SWP or other reservoirs that could be re-operated
  - Dual SW and GW use option
- Impacts/mitigation
  - Isolation from important surface streams
  - Isolation from existing groundwater production wells
  - Ability to mitigate or compensate impacts that cannot be avoided

Nine Sites Evaluated; Three Promising Sites Identified

Orland Unit connected to Stony Creek Reservoirs

Glenn-Colusa ID connected to CVP/Shasta



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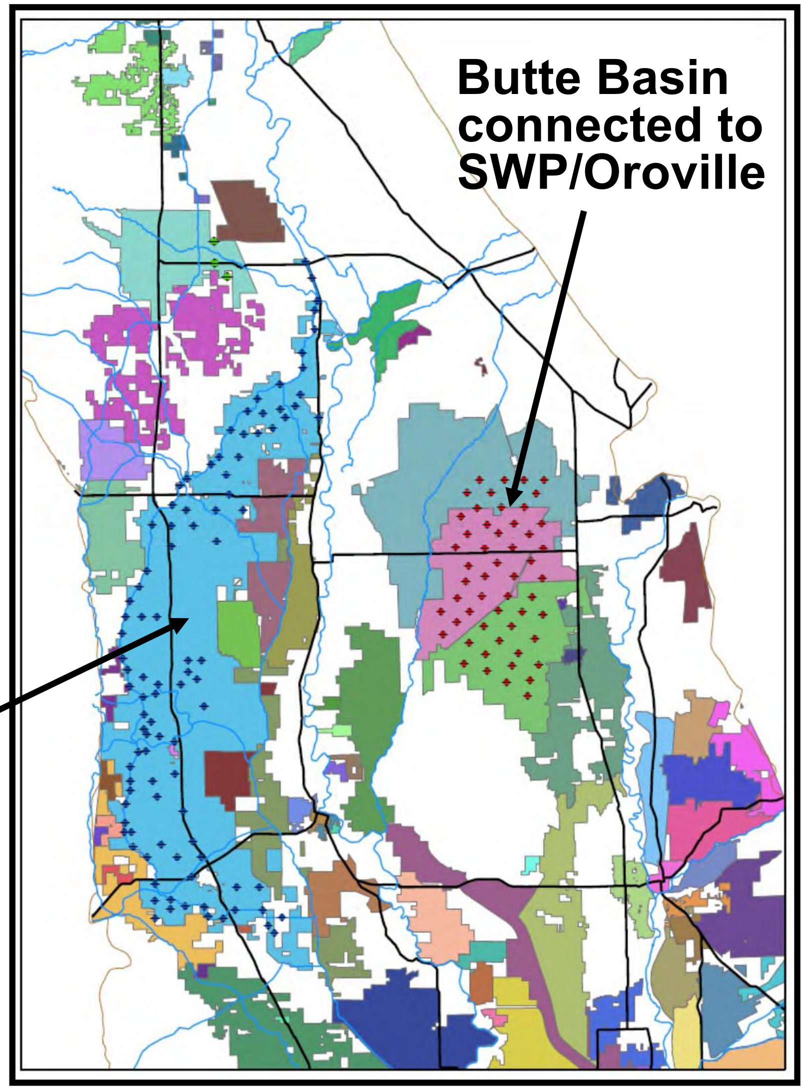
Two Sites Selected for Modeling



Glenn-Colusa ID connected to CVP/Shasta

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Modeling Requirements

- Honor existing CVP and SWP operations
- Account for stream-aquifer interaction and impacts to existing pumpers
- Fast and flexible model operation
  - Test many configurations and scenarios
  - "Gaming" with Project Operators

Conclusion: Use separate but coordinated SW and GW models.

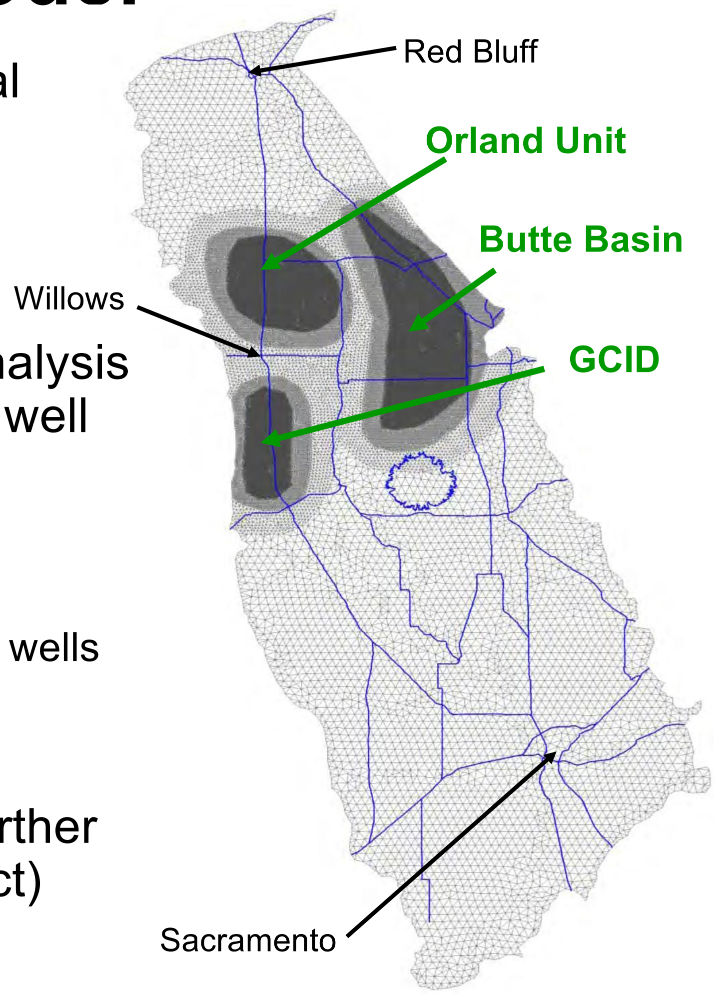
Surface Water Model

- Spreadsheet-based model designed for incremental analysis of CALSIM II outputs
  – Honor existing CVP and SWP operations
- Based on 1922 through 2003 hydrology
  – Climate variability not evaluated at this stage of study
- Simulations “driven” by additional target deliveries
  – Ecosystem flow targets in Sacramento and Feather Rivers
  – Unmet Sacramento Valley agricultural demands
- Uses generalized SW-GW interaction functions derived from GW model

Groundwater Model

- Regional scale with high spatial detail
  - 5,950 square miles
  - 88,922 surface nodes
  - 7 vertical layers
- Aquifer properties based on analysis of more than 1,000 production well records
- Calibration
  - Static calibration for year 2000
  - Water levels from 257 monitoring wells
- 1982 - 2003 hydrology

(Model has been developed further since being used for this project)



Parameters Defining Project Scenarios

- Maximum reservoir “payback” capacity
  - Maximum volume of groundwater pumping to be called on, as needed, to repay reservoirs when they don’t refill with surplus runoff
  - Defines the scale of the conjunctive operation
- Groundwater pumping period
  - “Summer” (May through August)
  - “Fall” (September through November)
  - “Summer and Fall” (May through November)
  - Influences the intensity of pumping and nature of impacts

Project Scenarios Evaluated

Scenario	Groundwater Pumping Capacity (thousand acre-feet)			Pumping Season
	GCID (CVP)	Butte Basin (SWP)	Total	
1	100	50	150	summer
2	200	100	300	summer
3	100	50	150	fall
4	100	50	150	summer & fall

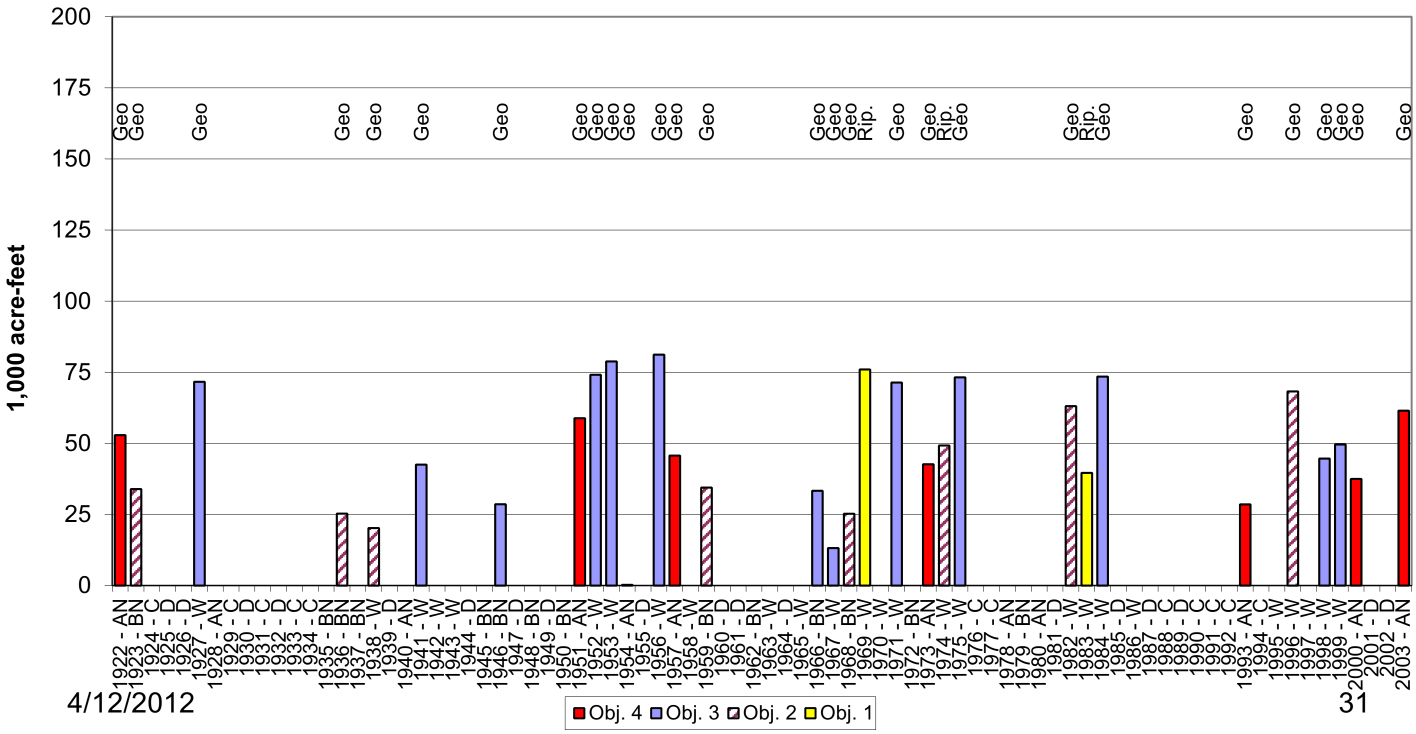
All scenarios modeled with an existing (shallow) and new (deep) well field to reveal range of potential impacts to streams and existing pumpers.

Results for Butte Basin—Scenario 2 (100 TAF Project Pumping Capacity)

- Environmental flow releases
- Agricultural deliveries
- Reservoir refill from surplus surface water and from groundwater pumping
- Oroville storage

Results for Butte Basin—Scenario 2 (100 TAF Project Pumping Capacity)

Environmental Flow Releases



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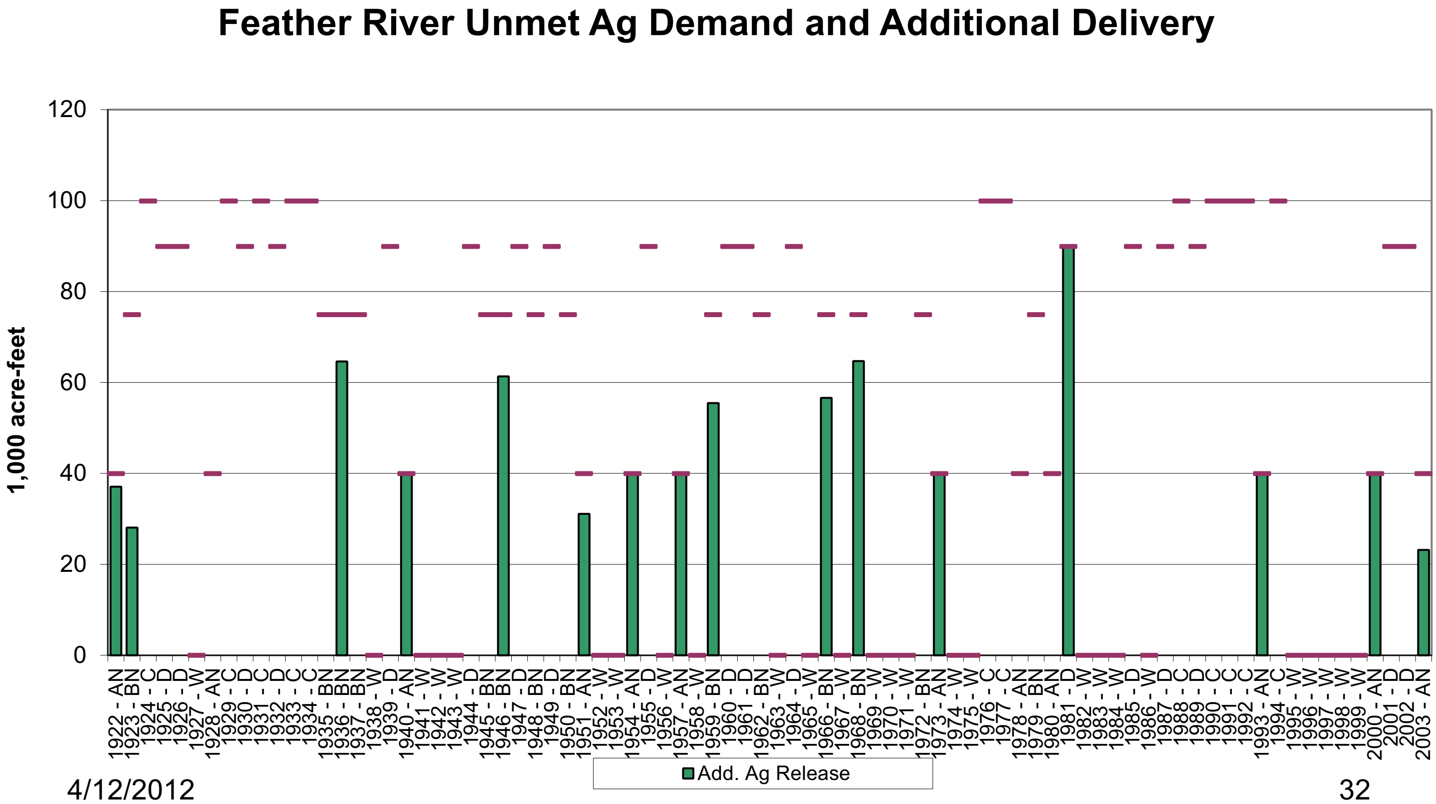

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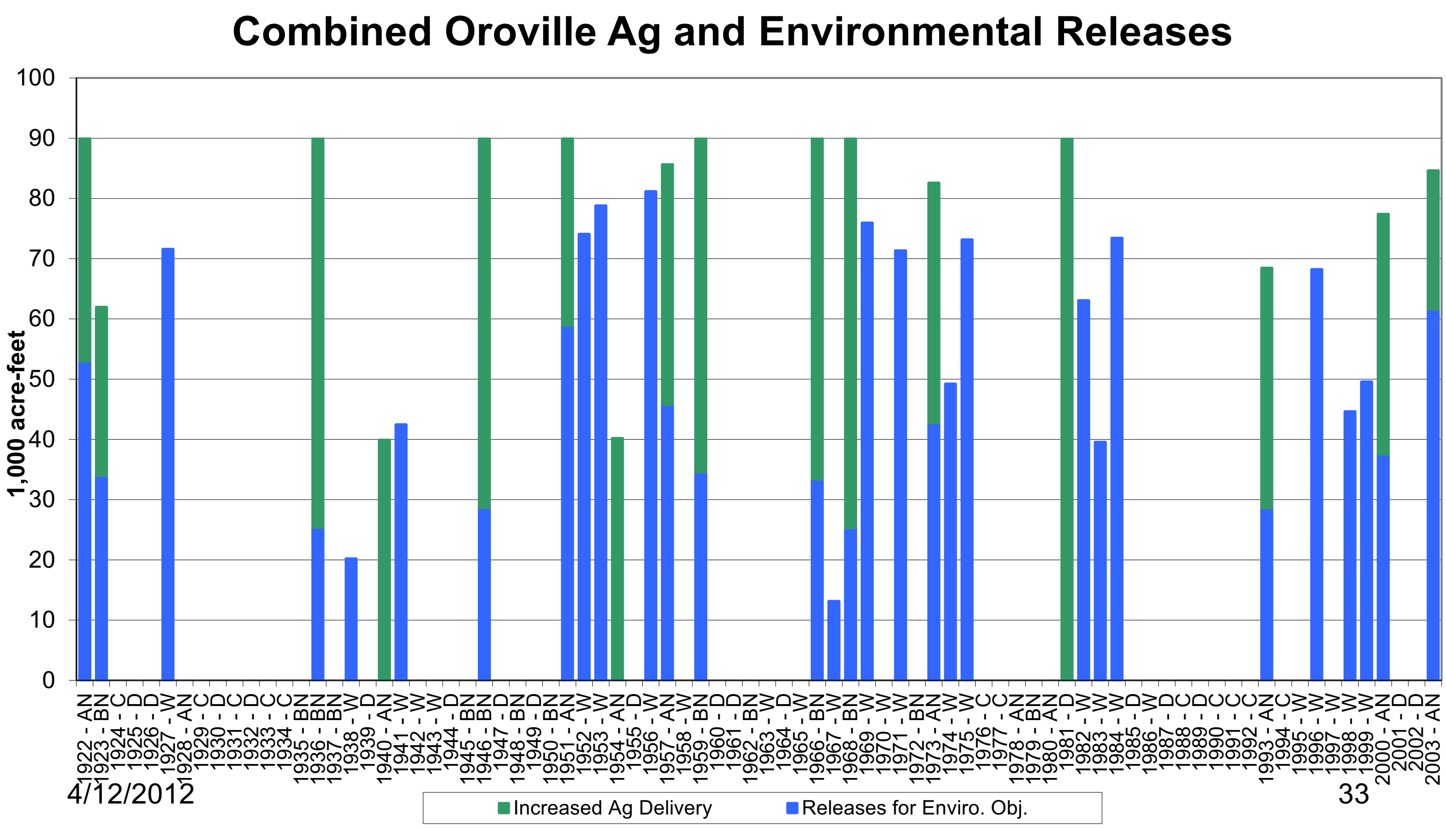

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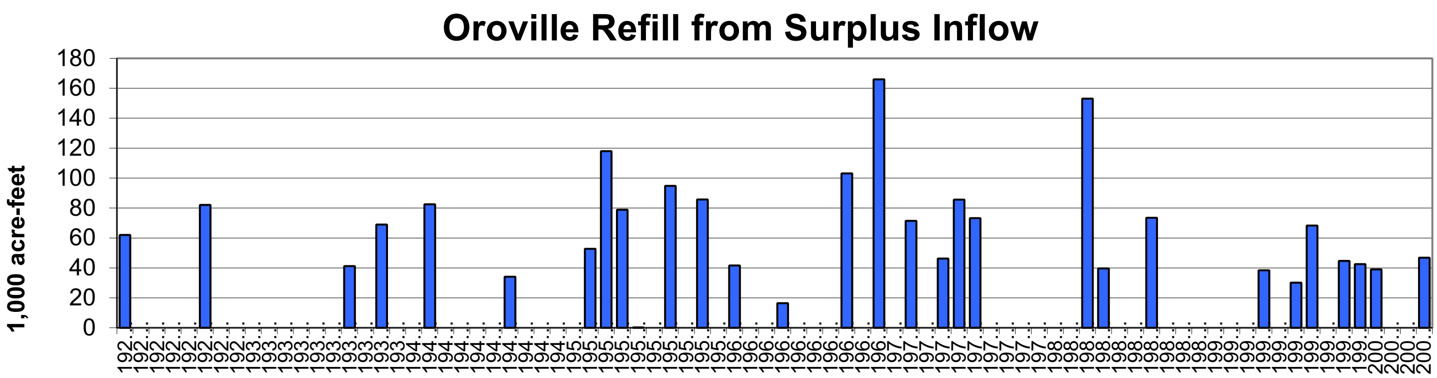

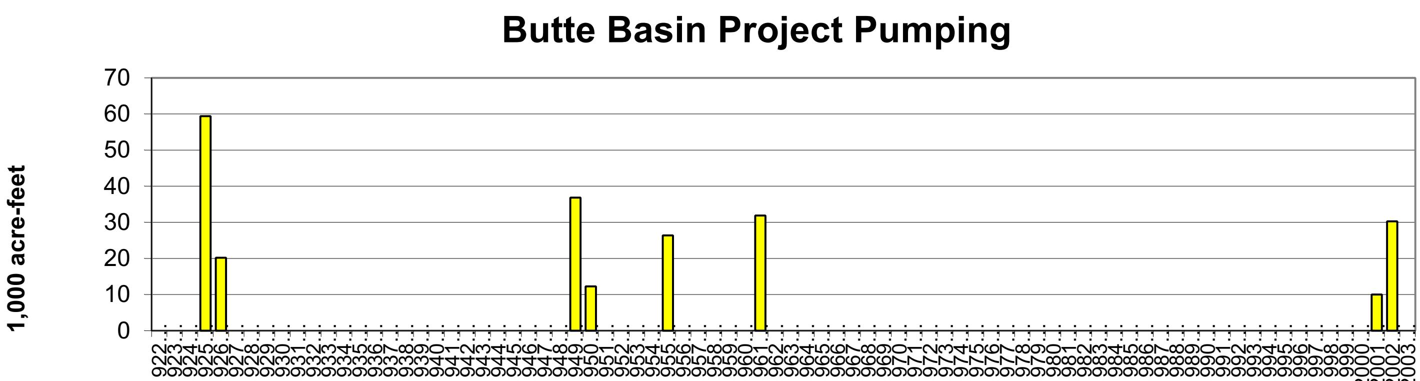

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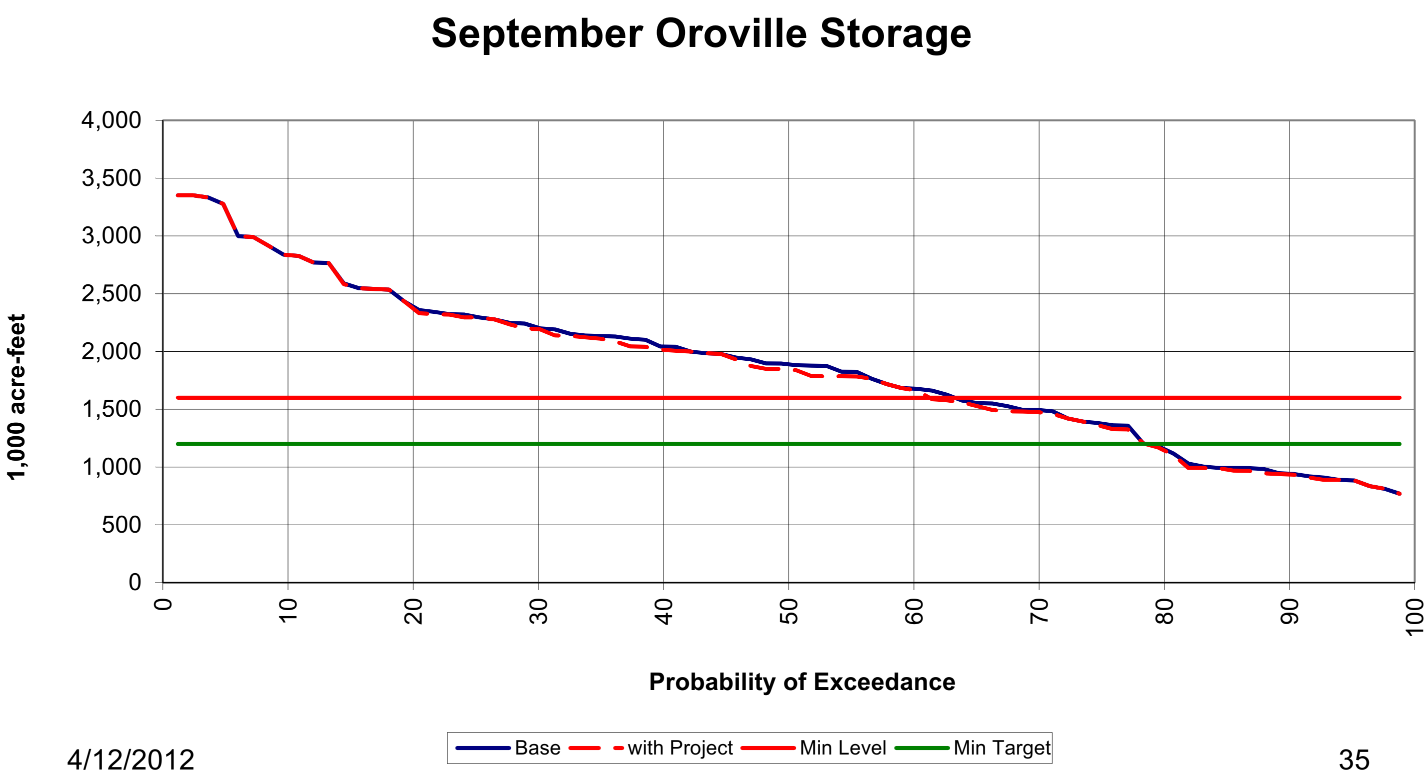


Summary of Model Results
Project Benefits

Scenario(s)	Project/System	Payback Pumping Capacity (TAF)	Environmental Benefits: Number of Years	Environmental Benefits: Avg in Yrs of Occurrence (TAF)	Environmental Benefits: Avg Over All Yrs (TAF)	Agricultural Benefits: No. Yrs.	Agricultural Benefits: Avg in Yrs of Occurrence (TAF)	Agricultural Benefits: Avg Over All Yrs (TAF)
1, 3 and 4	GCID/CVP Lake Shasta-Sac R	100	23	46	13	24	46	14
1, 3 and 4	Butte Basin/SWP Lake Oroville-Feather R	50	28	21	7	30	27	10
2	GCID/CVP Lake Shasta-Sac R	200	40	96	47	24	75	22
2	Butte Basin/SWP Lake Oroville-Feather R	100	44	43	23	30	52	20

Summary of Model Results
Reservoir Refill

Scenario(s)	Project/System	Payback Pumping Capacity (TAF)	Surplus Surface Water: Number of Years	Surplus Surface Water: Avg in Yrs of Occurrence (TAF)	Surplus Surface Water: Avg Over All Yrs (TAF)	Project Groundwater Pumping: No. Yrs.	Project Groundwater Pumping: Avg in Yrs of Occurrence (TAF)	Project Groundwater Pumping: Avg Over All Yrs (TAF)	Project Groundwater Pumping: Maximum Year (TAF)
1, 3 and 4	GCID/CVP Lake Shasta-Sac R	100	29	70	24	4	70	4	98
1, 3 and 4	Butte Basin/SWP Lake Oroville-Feather R	50	37	32	14	6	44	3	50
2	GCID/CVP Lake Shasta-Sac R	200	35	139	58	6	123	9	198
2	Butte Basin/SWP Lake Oroville-Feather R	100	43	72	36	8	75	7	100

Project Impacts Due to Additional Groundwater Pumping

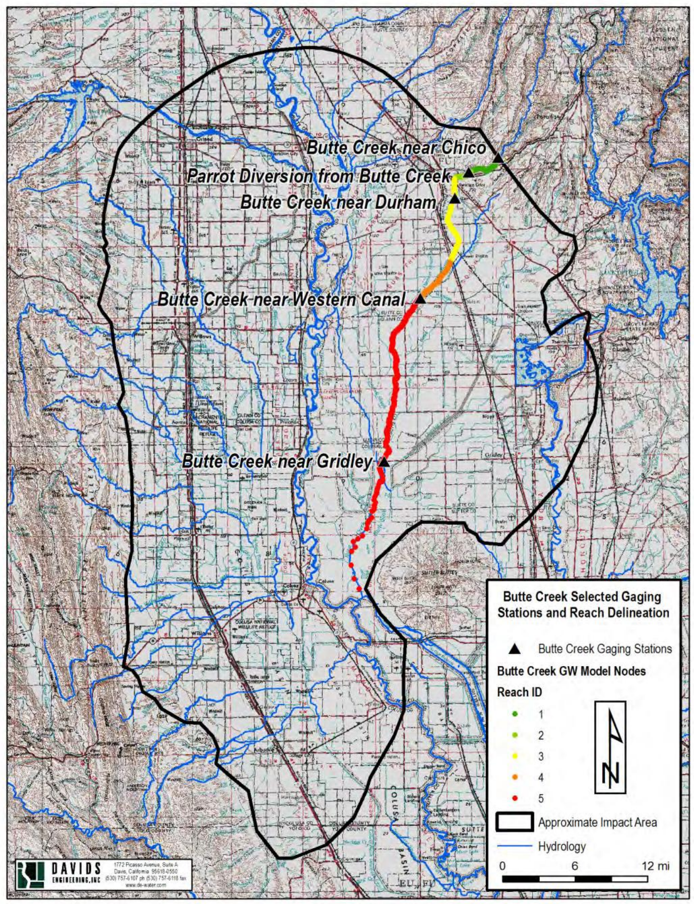
- Stream flow reduction
  - Butte Creek in affected area
  - Other critical streams not in affected areas
  - Ephemeral streams not analyzed
- Groundwater levels and existing wells
  - Well yield impacts
  - Incremental pumping costs (due to additional lift)

Peak Monthly Effects on Streamflow from Payback Pumping

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Stream	**Existing (cfs)**	**New (cfs)**	**Existing (cfs)**	**New (cfs)**	**Existing (cfs)**	**New (cfs)**	**Existing (cfs)**	**New (cfs)**
All Streams[a]	54	53	111	105	80	90	64	65
Butte Creek	13	12	72	69	50	48	39	33
Sacramento River – GCID to Wilkins Slough	42	37	32	28	16	18	16	15
Feather River	3	3	6	6	4	4	4	4
Little Chico Creek	3	3	6	5	4	3	4	3
Salt River	1	5	5	8	2	5	2	5
Stone Coral Creek	6	9	11	15	7	10	6	9
Stony Creek	4	5	7	7	4	6	4	4

Butte Creek Streamflow Reduction

- Develop baseline flow from available gauging stations
- Synthesize “with-project” flows based on cumulative reductions in streamflow from changes in stream leakance from GW model



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Butte Creek Impacts

- No impact in upper reaches (primary spawning and holding areas)
- Greatest flow reduction in Jan. – Mar.
  - During times of highest discharge
- Greatest % reduction in summer/early fall
  - Spring-run have already migrated
  - Steelhead just beginning to enter stream
- Rarely drops below in-stream standards
  - June during early ‘90s drought
- Tradeoffs between Butte Creek impacts and main stem benefits
- Potential to Reoperate with PGE and increase releases from into Butte Creek, exchange reoperated flows from Oroville to PGE Projects

Interference Drawdown Due to Project Pumping

Pumping Scenario	Interference Drawdown (ft) Min	Max	Mean	Median	Std. Dev.
300 TAF Summer Pumping, New Well Field	0.0	13.6	0.5	0.3	0.7
300 TAF Summer Pumping, Existing Well Field	0.0	8.3	0.4	0.2	0.6
150 TAF Summer Pumping, New Well Field	0.0	6.2	0.3	0.2	0.4
150 TAF Summer Pumping, Existing Well Field	0.0	5.4	0.3	0.2	0.4
150 TAF Fall Pumping, New Well Field	0.0	7.0	0.4	0.2	0.4
150 TAF Fall Pumping, Existing Well Field	0.0	6.1	0.4	0.2	0.5
150 TAF Summer & Fall Pumping, New Well Field	0.0	5.9	0.4	0.2	0.4
150 TAF Summer & Fall Pumping, Existing Well Field	0.0	5.0	0.4	0.2	0.5

Conclusions

- Traditional groundwater banking…storing surplus surface water underground and extracting it when needed…is not workable in the Sacramento Valley
  – Available aquifer storage capacity is inadequate
- Re-operation of existing storage reservoirs to draw them down further going into the refill season can generate additional water supplies
  – Evacuated reservoir space captures surplus streamflow
  – Reservoir “payback” is needed infrequently, when surplus streamflow is inadequate

Conclusions, (cont.)

- Reservoir “payback” by not making reservoir releases that would otherwise be made and pumping groundwater instead is feasible
  - Groundwater pumping required very infrequently
- Reservoir payback by temporarily idling crops to reduce reservoir demands is not efficient
  - Timing issues/idling cannot be turned on/off

Conclusions, (cont.)

- Impacts to existing groundwater users and streams appear to be manageable
  - Payback pumping appreciable but required very infrequently
- As evaluated, the conjunctive management alternatives evaluated are not economically feasible
  - Benefits based solely on “in-Valley” value of water
  - No monetary value attached to the environmental benefits

Conclusions, (cont.)

- Further investigation may be warranted but depends on regional interest and collaboration
  – Potential component of Integrated Regional Water Management Plans?

Recommended Further Study

- Reconcile tradeoffs among environmental water uses in reservoir operations
- Refine reservoir operation rules
- Refine payback strategies and costs
- Develop system-wide accounting conventions
- Update models
- Evaluate effects of climate change/variability

Questions?