

**Four Year WUE  
Comprehensive Review  
Ag Water Use Efficiency  
Draft Results**

**California Bay-Delta Authority  
August 2004**



# Agenda

- Background
  - Review Results, Models, Data and Assumptions
  - Discuss Issues
  - Questions and Discussion
  - Next Steps
- 

# Purpose of Workshop

Review work to date, discuss issues  
and establish next steps

Get your input and ideas



# Comprehensive Review Components

- ✓ Agricultural Water Use Efficiency
- ✓ Urban Water Use Efficiency
- ✓ Desalination
- ✓ Recycling

5 Investment  
Levels

Look Back at Past Activities

Projection of Potential

Synthesis

# Who's Using the Information

- ❖ Four Year WUE Checkup
  - ❖ Common Assumptions for Storage Investigations
  - ❖ Water Plan Bul 160 update
- 

# Agricultural WUE Approach

**I. Define geographic scope of analysis**

**II. Characterize current land and water use**

- ✓ water use
- ✓ land use
- ✓ field level irrigation system characterization
- ✓ district level system characterization

**III. Use target investments to achieve water quantity, water quality and in-stream flow and timing**

# Geographic Scope

- Statewide
- 56 Planning Areas (PA's) are highest resolution
- 23 Analysis Areas - PA's with similar land and water use
- CALFED Solution Area

# Projection Levels

- Policy
- Local and Statewide Investment
- Time step



# Projection Levels

| Description of Analysis  | Funding                                     |
|--|---|
| <b>1. REASONABLY FORESEEABLE:</b> Current trend of investment for locally cost effective practices, state investment in non-locally cost effective practices.                              | \$30m/ yr for 2003-6 (3 yrs: Prop 50)       |
| <b>2. LOCALLY COST EFFECTIVE PRACTICES:</b> Full implementation of locally cost effective practices and state investment in non locally cost effective practices.                          | \$30m/ yr for 2003-6 (3 yrs: Prop 50)       |
| <b>3. MODERATE INVESTMENT:</b> Current trend of investment for locally cost effective practices, state investment in non-locally cost effective practices.                                 | \$30m/ yr through 2030                      |
| <b>4. LOCALLY COST EFFECTIVE PRACTICES with MODERATE INVESTMENT:</b> Full implementation of locally cost effective practices and state investment in non locally cost effective practices. | \$30m/ yr through 2030                      |
| <b>5. LOCALLY COST EFFECTIVE PRACTICES with ROD FUNDING LEVELS:</b> Full implementation of locally cost effective practices and state investment in non locally cost effective practices.  | \$80m/ yrs. 1-10, \$20m/yrs through 2030    |
| <b>6. TECHNICAL POTENTIAL:</b> Full implementation of all WUE practices.   | funding not constrained                     |
| <b>ADDITIONAL PROJECTION: REGULATED DEFICIT IRRIGATION:</b> Full implementation of technology and management to achieve regulated deficit irrigation.                                      | agricultural only - funding not constrained |

# Projection Level 1

## Locally Cost Effective

- On-farm - adjustment over time to cost-effective mix
- District - locally cost-effective investment in infrastructure

## Statewide Investment

- On-farm and District actions that support CALFED Program

Prop 50 - \$15M/yr for Statewide Objectives (years 1-3)

# Ag WUE

## CALFED Bay-Delta Objectives

- In-stream Flow and Timing: Improve Aquatic Habitat
- Water Quality: Ag, Urban and Environmental Needs
- Water Quantity: Supply Reliability



# Allocation of Prop 50

- Across CALFED Program Objectives
  - Based on Targeted Benefits in each Analysis Area
  - Initial allocation, with possible iteration after improvement potential identified
- 

# Projection Level 2

Locally Cost Effective

- On-farm - same as Projection Level 1
- District - assumes all locally cost-effective EWMP's implemented

Statewide Objectives/Canals

Increase Water Ordering/Delivering Flexibility

• On-farm and District actions that support the CALFED Bay-Delta Program

Construct/Operate Tailwater and Spill Recovery System

Optimize Conjunctive Use

Automate Canal Structures

Prop 50 - \$15M/yr for Statewide Objectives (years 1-3)

# Projection Levels 3 & 4

Statewide Investment for On-farm and District actions that support statewide water management objectives:

water supply, water quality, levee system and ecosystem restoration:

\$15M/year through 2030



# Projection Level 5

Statewide Investment for On-farm and District actions that support CALFED Bay-Delta objectives:

in-stream flow and timing, water quality, water quality and water quantity

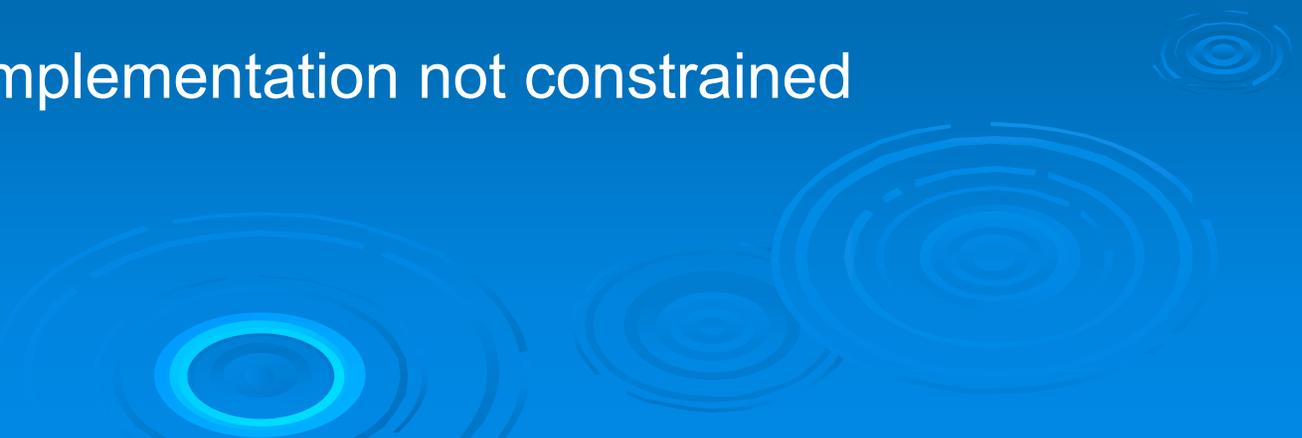
Reflects the CALFED Program Plan Full Funding Level \$40M years 1-10, \$10M out years

# Technical Potential\*

Full Implementation;

- On-farm - all systems to highest performing (drip & LEPA) level
- District - all convert to pressurized pipe

Funding and implementation not constrained



# Regulated Deficit Irrigation

- Based on an ET reduction estimate
  - Component of all Projection Levels
  - Implementation rate
  - Informed by July 2004 workshop
- 

# On-farm WUE Activities

- Proven technologies (return systems, drip, LEPA)
  - Low, Medium and High management levels
  - By crop category
  - Connection between on-farm improvements and district flexibility
- 

# District WUE Activities

- Proven technologies
  - Cost and performance by action
  - Connection between on-farm upgrades and district flexibility
    - Flexibility (labor, control)
    - Canal lining
    - Seepage Recovery
    - Interceptors
    - Regulating Reservoirs
    - Pipelines
- 

# Results



# PL 1 On-farm

| Hydrologic Region | Annual Cost (M\$/yr) | Present Value of Annual Cost (M\$) | One-Time Capital Conversion Cost (M\$) | Savings in Recov. Loss (taf) | Savings in Irrecov. Loss (taf) |
|-------------------|----------------------|------------------------------------|--|------------------------------|--------------------------------|
| 1                 | (0.0)                | \$0.00                             | \$0.39                                 | 1.8                          | 25.1                           |
| 2                 | (0.0)                | \$0.00                             | \$0.06                                 | 0.0                          | 4.0                            |
| 3                 | 0.0                  | \$0.00                             | \$0.15                                 | 1.2                          | 8.2                            |
| 4                 | (0.0)                | \$0.00                             | \$0.01                                 | 0.1                          | 15.1                           |
| 5                 | 0.0                  | \$0.01                             | \$14.85                                | 73.1                         | 77.3                           |
| 6                 | (0.0)                | \$0.00                             | \$6.94                                 | 24.8                         | 40.2                           |
| 7                 | 0.0                  | \$0.00                             | \$17.89                                | 45.4                         | 69.7                           |
| 8                 | 0.0                  | \$0.00                             | \$0.13                                 | 0.4                          | 16.9                           |
| 10                | (0.0)                | \$0.00                             | \$4.98                                 | 24.5                         | 148.3                          |
| <b>Total</b>      | <b>0.0</b>           | <b>\$0.0</b>                       | <b>\$45.4</b>                          | <b>171.4</b>                 | <b>404.8</b>                   |

# PL 1 On-farm



# PL 1 District

| Hydrologic Region | Irrigated Acres (thous.) | Annual Cost (M\$/yr) | Present                    |                              |                                |
|-------------------|--------------------------|----------------------|----------------------------|------------------------------|--------------------------------|
|                   |                          |                      | Value of Annual Cost (M\$) | Savings in Recov. Loss (taf) | Savings in Irrecov. Loss (taf) |
| 1                 | 274.5                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 2                 | 56.9                     | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 3                 | 605.0                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 4                 | 275.7                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 5                 | 2,267.9                  | \$1.74               | \$23.95                    | 4.2                          | 1.5                            |
| 6                 | 1,776.7                  | \$0.82               | \$11.28                    | 0.0                          | 0.0                            |
| 7                 | 3,212.0                  | \$0.35               | \$4.87                     | 0.0                          | 0.0                            |
| 8                 | 92.7                     | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 10                | 718.8                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| Total             | 9,280.2                  | \$2.9                | \$40.1                     | 4.2                          | 1.5                            |

# PL 1 District



# PL 3 On-farm



# PL 3 On-farm



# PL 3 District

| Hydrologic Region | Irrigated Acres (thous.) | Annual Cost (M\$/yr) | Present                    | Savings in Recov. Loss (taf) | Savings in Irrecov. Loss (taf) |
|-------------------|--------------------------|----------------------|----------------------------|------------------------------|--------------------------------|
|                   |                          |                      | Value of Annual Cost (M\$) |                              |                                |
| 1                 | 274.5                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 2                 | 56.9                     | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 3                 | 605.0                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 4                 | 275.7                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 5                 | 2,267.9                  | \$4.05               | \$55.70                    | 19.2                         | 7.4                            |
| 6                 | 1,776.7                  | \$1.91               | \$26.24                    | 0.1                          | 3.0                            |
| 7                 | 3,212.0                  | \$0.82               | \$11.32                    | 0.0                          | 0.0                            |
| 8                 | 92.7                     | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 10                | 718.8                    | \$0.72               | \$9.97                     | 3.3                          | 1.4                            |
| Total             | 9,280.2                  | \$7.5                | \$103.2                    | 22.6                         | 11.8                           |

# PL 3 District



# PL 5 On-farm

| Hydrologic Region | Annual Cost (M\$/yr) | Present Value of Annual Cost (M\$) | One-Time Capital Conversion Cost (M\$) | Savings in Recov. Loss (taf) | Savings in Recov. Loss (taf) |
|-------------------|----------------------|------------------------------------|--|------------------------------|------------------------------|
| 1                 | 0.5                  | \$6.29                             | \$0.39                                 | 8.6                          | 36.4                         |
| 2                 | 0.2                  | \$3.23                             | \$0.06                                 | 0.0                          | 10.1                         |
| 3                 | 1.0                  | \$13.15                            | \$0.16                                 | 32.0                         | 13.5                         |
| 4                 | 0.5                  | \$6.53                             | \$0.02                                 | 12.9                         | 30.5                         |
| 5                 | 6.3                  | \$86.86                            | \$13.52                                | 467.8                        | 77.6                         |
| 6                 | 3.0                  | \$40.92                            | \$6.98                                 | 151.5                        | 69.8                         |
| 7                 | 2.3                  | \$32.00                            | \$17.92                                | 142.1                        | 97.3                         |
| 8                 | 0.1                  | \$1.95                             | \$0.13                                 | 5.5                          | 17.1                         |
| 10                | 1.1                  | \$15.55                            | \$5.00                                 | 43.6                         | 220.9                        |
| <b>Total</b>      | <b>15.0</b>          | <b>\$206.5</b>                     | <b>\$44.2</b>                          | <b>864.0</b>                 | <b>573.2</b>                 |

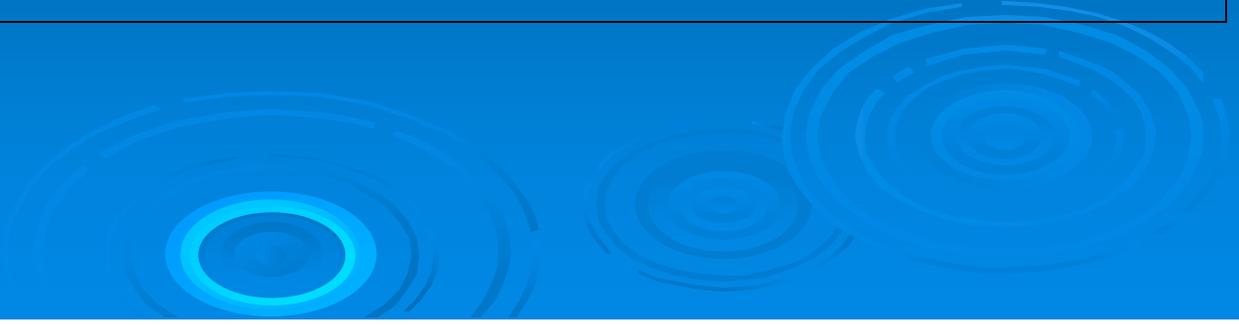
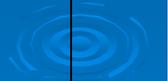
# PL 5 On-farm



# PL 5 District

| Hydrologic Region | Irrigated Acres (thous.) | Annual Cost (M\$/yr) | Present                    |                              | Savings in Irrecov. Loss (taf) |
|-------------------|--------------------------|----------------------|----------------------------|------------------------------|--------------------------------|
|                   |                          |                      | Value of Annual Cost (M\$) | Savings in Recov. Loss (taf) |                                |
| 1                 | 274.5                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 2                 | 56.9                     | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 3                 | 605.0                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 4                 | 275.7                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 5                 | 2,267.9                  | \$8.09               | \$111.40                   | 55.1                         | 22.3                           |
| 6                 | 1,776.7                  | \$3.81               | \$52.48                    | 2.8                          | 21.9                           |
| 7                 | 3,212.0                  | \$1.65               | \$22.65                    | 0.0                          | 0.3                            |
| 8                 | 92.7                     | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 10                | 718.8                    | \$1.45               | \$19.94                    | 6.6                          | 3.5                            |
| Total             | 9,280.2                  | \$15.0               | \$206.5                    | 64.5                         | 48.1                           |

# PL 5 District



# PL 6 On-farm

| Hydrologic Region | Annual Cost (M\$/yr) | Present Value of Annual Cost (M\$) | One-Time Capital Conversion Cost (M\$) | Savings in Recov. Loss (taf) | Savings in Recov. Loss (taf) |
|-------------------|----------------------|------------------------------------|--|------------------------------|------------------------------|
| 1                 | 16.2                 | \$222.33                           | \$2.06                                 | 86.8                         | 65.7                         |
| 2                 | 2.3                  | \$31.49                            | \$0.30                                 | 0.0                          | 17.2                         |
| 3                 | 59.2                 | \$814.76                           | \$1.85                                 | 185.9                        | 71.5                         |
| 4                 | 14.6                 | \$200.46                           | \$0.56                                 | 77.2                         | 129.5                        |
| 5                 | 210.1                | \$2,891.84                         | \$39.83                                | 1252.4                       | 215.2                        |
| 6                 | 213.2                | \$2,935.33                         | \$38.75                                | 875.9                        | 361.8                        |
| 7                 | 432.5                | \$5,952.81                         | \$86.08                                | 1267.9                       | 834.9                        |
| 8                 | 12.8                 | \$176.56                           | \$3.74                                 | 56.8                         | 18.9                         |
| 10                | 107.1                | \$1,474.72                         | \$22.02                                | 126.6                        | 713.3                        |
| <b>Total</b>      | <b>1,068.0</b>       | <b>\$14,700.3</b>                  | <b>\$195.2</b>                         | <b>3929.6</b>                | <b>2428.0</b>                |

# PL 6 On-farm



# PL 6 District

| Hydrologic Region | Irrigated Acres (thous.) | Annual Cost (M\$/yr) | Present                    | Savings in Recov. Loss (taf) | Savings in Irrecov. Loss (taf) |
|-------------------|--------------------------|----------------------|----------------------------|------------------------------|--------------------------------|
|                   |                          |                      | Value of Annual Cost (M\$) |                              |                                |
| 1                 | 274.5                    | \$24.11              | \$331.84                   | 10.9                         | 25.1                           |
| 2                 | 56.9                     | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 3                 | 605.0                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 4                 | 275.7                    | \$0.00               | \$0.00                     | 0.0                          | 0.0                            |
| 5                 | 2,267.9                  | \$244.80             | \$3,369.67                 | 469.1                        | 212.4                          |
| 6                 | 1,776.7                  | \$165.65             | \$2,280.14                 | 22.5                         | 319.3                          |
| 7                 | 3,212.0                  | \$182.64             | \$2,514.05                 | 0.0                          | 436.4                          |
| 8                 | 92.7                     | \$10.78              | \$148.32                   | 4.6                          | 8.5                            |
| 10                | 718.8                    | \$62.66              | \$862.54                   | 100.0                        | 115.7                          |
| <b>Total</b>      | <b>9,280.2</b>           | <b>\$690.6</b>       | <b>\$9,506.6</b>           | <b>607.0</b>                 | <b>1117.4</b>                  |

# PL 6 District



# Statewide Totals

| Level         | Annual Cost<br>(M\$/yr) | Savings in<br>Recov.<br>Loss (taf) | Savings<br>in Irrecov.<br>Loss (taf) |
|---------------|-------------------------|------------------------------------|--------------------------------------|
| PL 1 Farm     | 0.0                     | 171.4                              | 404.8                                |
| PL 1 District | 2.9                     | 4.2                                | 1.5                                  |
| PL 3 Farm     | 7.5                     | 551.6                              | 494.1                                |
| PL 3 District | 7.5                     | 55.8                               | 25.7                                 |
| PL 5 Farm     | 15.0                    | 864.0                              | 573.2                                |
| PL 5 District | 15.0                    | 120.7                              | 88.6                                 |
| PL 6 Farm     | 1,068.0                 | 3,929.6                            | 2,428.0                              |
| PL 6 District | 690.6                   | 607.0                              | 1,117.4                              |

# Statewide Totals



# Statewide Costs



# Targeted Benefits



# Targeted Benefits



# Data and Modeling Approach



# Analysis Steps

## Raw Data

Ag Demand  
Data from  
Water Plan

Irrigation  
Methods from  
Water Plan

Cropping  
Data from  
Water Plan

Cost Data

## Manipulate Data

Supplier Data:

Inflow from river  
Outflow to fields and losses

Field Level Data:

Inflow from supplier, GW  
Outflow to crops and losses

Align Irrigation Methods  
by Planning Area

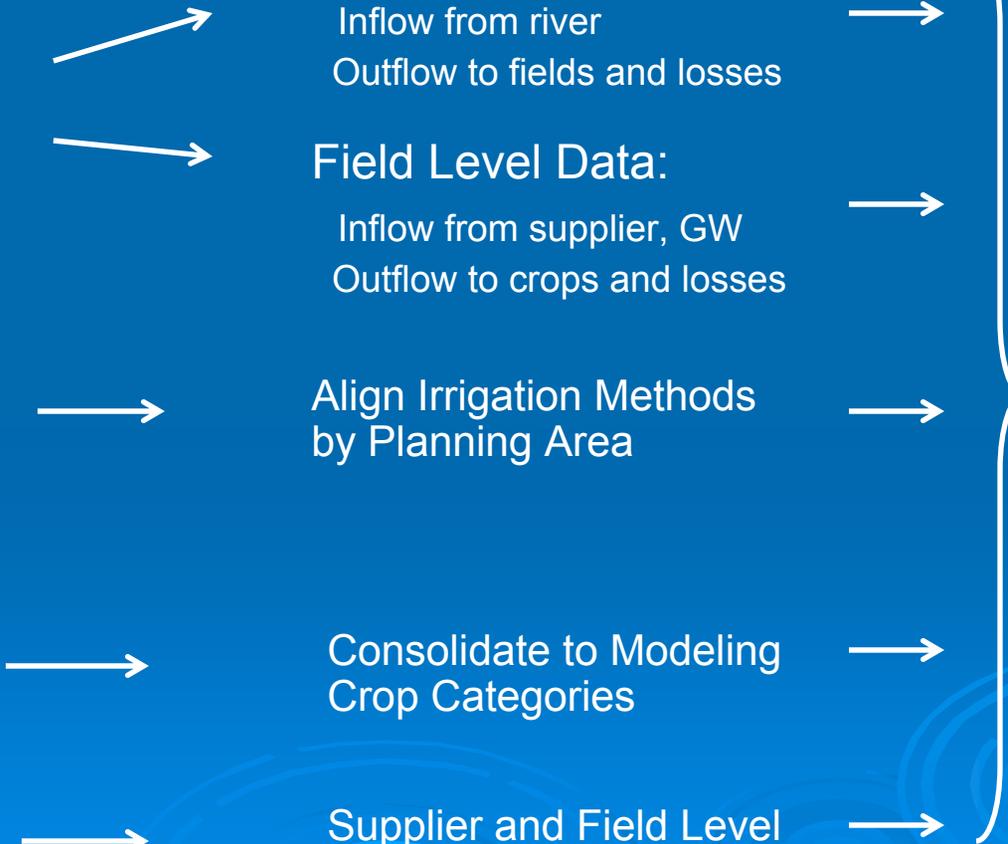
Consolidate to Modeling  
Crop Categories

Supplier and Field Level

Apply  
Assumptions  
& Process

Calibration &  
Modeling

Results



# Irrigated Acreage

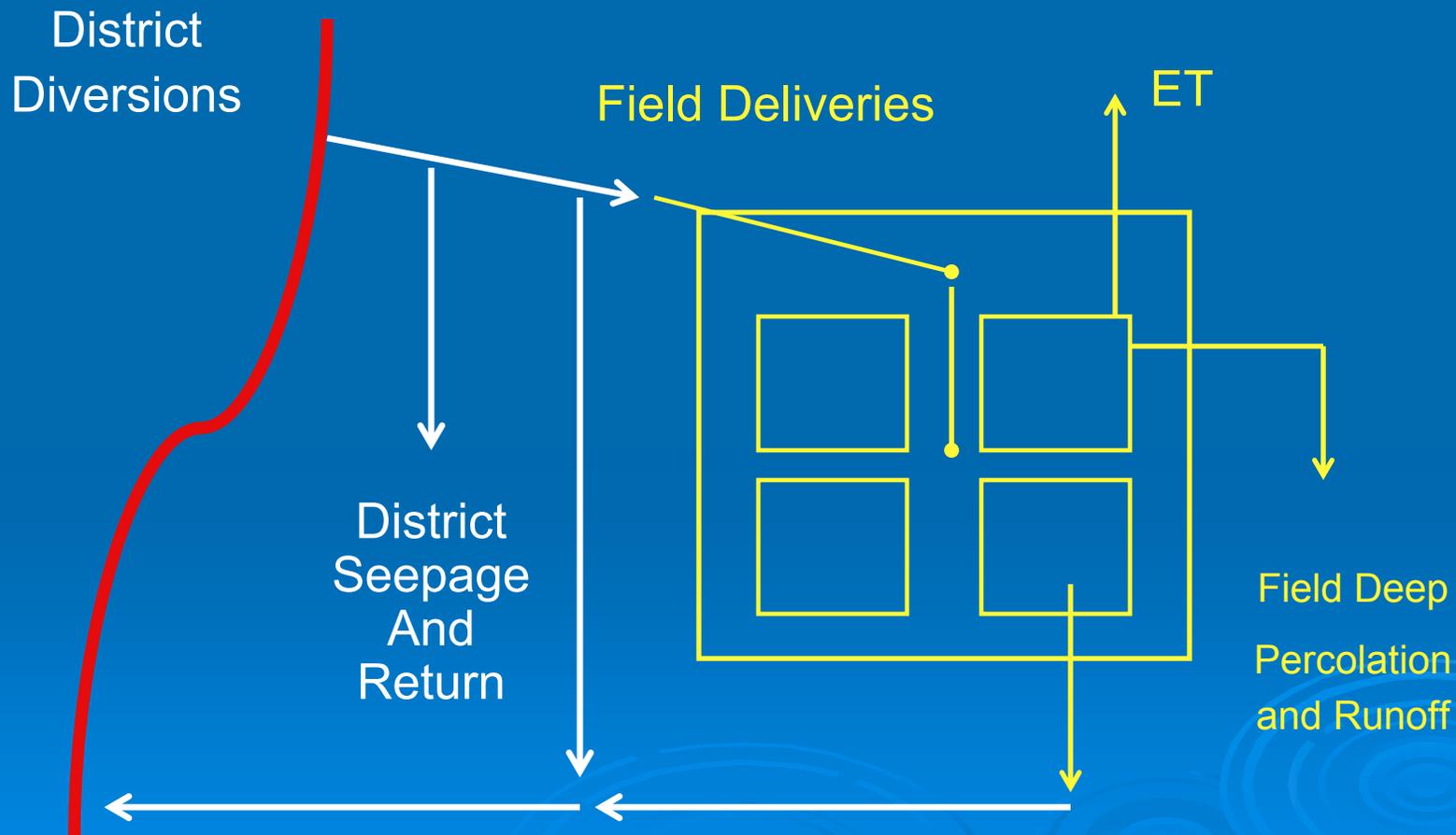


# Water Accounting

- Based on data from Water Plan
- Reported on a DWR Planning Area (or combination of PA's) basis
- Data organized to serve development of WUE estimates



# Water Use and Supply



# Water Plan Data

Ag Demand Data from Water Plan:  
Provided by DWR District Offices by Planning Area

Collected for 21 Categories

## Supplier Level Data:

District Diversions  
Recoverable Flows  
    return & canal seepage  
Irrecoverable Flows (saline sinks  
& ET)  
    return & canal seepage  
Groundwater pumping\*

## Field Level Data:

- ET of Applied Water
- Groundwater pumping\*
- Applied Water
- Recoverable Flows  
    surface runoff & deep percolation
- Irrecoverable Flows (saline sinks)  
    surface runoff & deep percolation

(cultural practices are a portion of  
recoverable and irrecoverable flows)

# Water Suppliers



# District Use



# Upper Valley East: PA 607



# Field Level Water



# Irrigation Methods



# RDI Workshop Conclusions

- Existing acreage under RDI is not known
- Potential for implementation is not well understood
- RDI routines are well established for wine grapes
- Numerous RDI routines for other crops
- Extra monitoring of water potential and nutrients
- Costs are not well known
- Requires district provide a flexible service

# RDI Method

Existing and New  
Drip Acres of:

Almonds &  
Pistachios  
Citrus  
Prunes  
Peaches  
Apples,  
Pears and  
Olives

Grapes and  
walnuts are not  
included

Assume 2"/Ac  
of ET  
reduction

Implementation  
Rate of 27 years

Volume of ET Reduction  
due to RDI



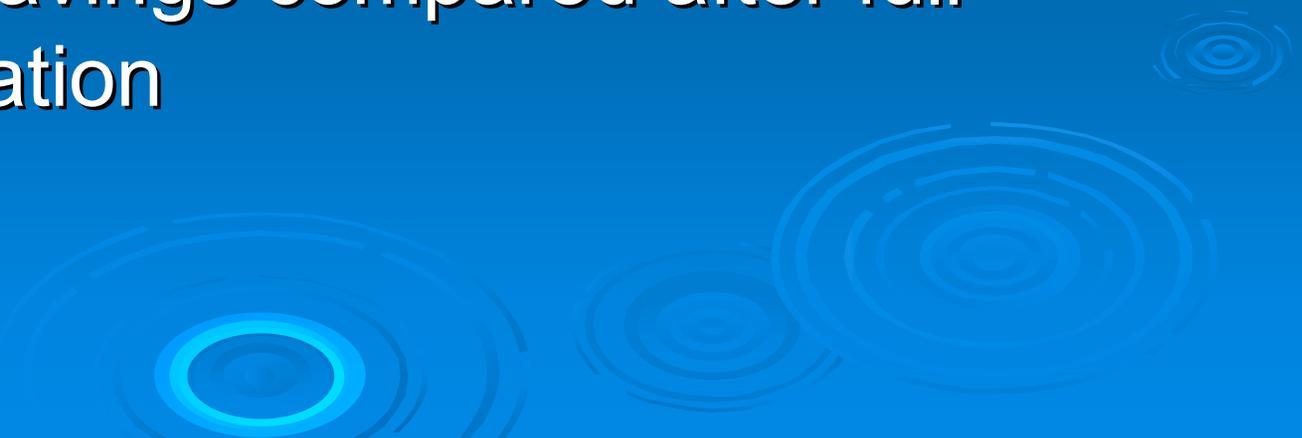
# Cost Information



# Allocation of Investments

- Across Program Objectives
- Regionally
- District-level investments vs. on-farm investments

# Key Assumptions for Draft Estimates

- No change in real cost (value) of water relative to irrigation system costs
  - Year 2000 cropping pattern
  - Unit costs of system conversion similar for all acres of a given crop
  - Cost and savings compared after full implementation
- 

# **District Cost Estimates**

**Data, Assumptions, and Methods**



# District Cost Estimates

- Estimate costs for discrete categories of improvements
  - Assess current conditions by Analysis Areas
  - For each Projection Level, assign improvements that
    - Meet target investment
    - Are needed to support on-farm improvements
  - For technical potential: assume pressurized pipe delivery
- 

# District Improvement Categories

- **Delivery flexibility – labor, central control, regulating reservoirs**
  - **Canal lining and seepage recovery**
  - **Regulating reservoirs with automation**
  - **Interceptors**
  - **Pressurized pipe**
- 

# Unit Cost Estimates for District Improvements

| District Improvement  | Capital Cost (Amortized)               |          |          | O&M              |
|---|--|----------|----------|------------------|
|   | Low                                    | Avg      | High     |                  |
|   | <i>Cost per year per af of savings</i> |          |          |                  |
| Canal lining  | \$ 29.9                                | \$ 81.5  | \$ 169.9 | \$ -             |
| Canal seepage recovery  | \$ 21.9                                | \$ 43.8  | \$ 65.8  | incl. in Capital |
| Regulating Reservoirs w/automation  | \$ 23.3                                | \$ 46.5  | \$ 69.8  | \$ 8.8           |
| Interceptors  | \$ 29.1                                | \$ 58.1  | \$ 87.2  | \$ 37.2          |
|   | <i>Cost per year per acre served</i>   |          |          |                  |
| Delivery Flexibility - labor only   |  |          |          | \$ 3.9           |
| Delivery Flexibility - labor plus central control                           | \$ 1.4                                 | \$ 2.8   | \$ 5.7   | \$ 7.0           |
| Delivery Flexibility - labor plus central control and regulating reservoirs | \$ 3.3                                 | \$ 6.5   | \$ 13.0  | \$ 10.9          |
|   | <i>Cost per year per acre served</i>   |          |          |                  |
| Pressurized Pipe Delivery-Small Parcels                                     |  | \$ 116.0 |          | incl. in Capital |
| Pressurized Pipe Delivery-Large Parcels                                     | \$ -                                   | \$ 87.0  | \$ -     | incl. in Capital |
| Return Flow Pumpback System   | \$ -                                   | \$ 29.0  | \$ -     | incl. in Capital |

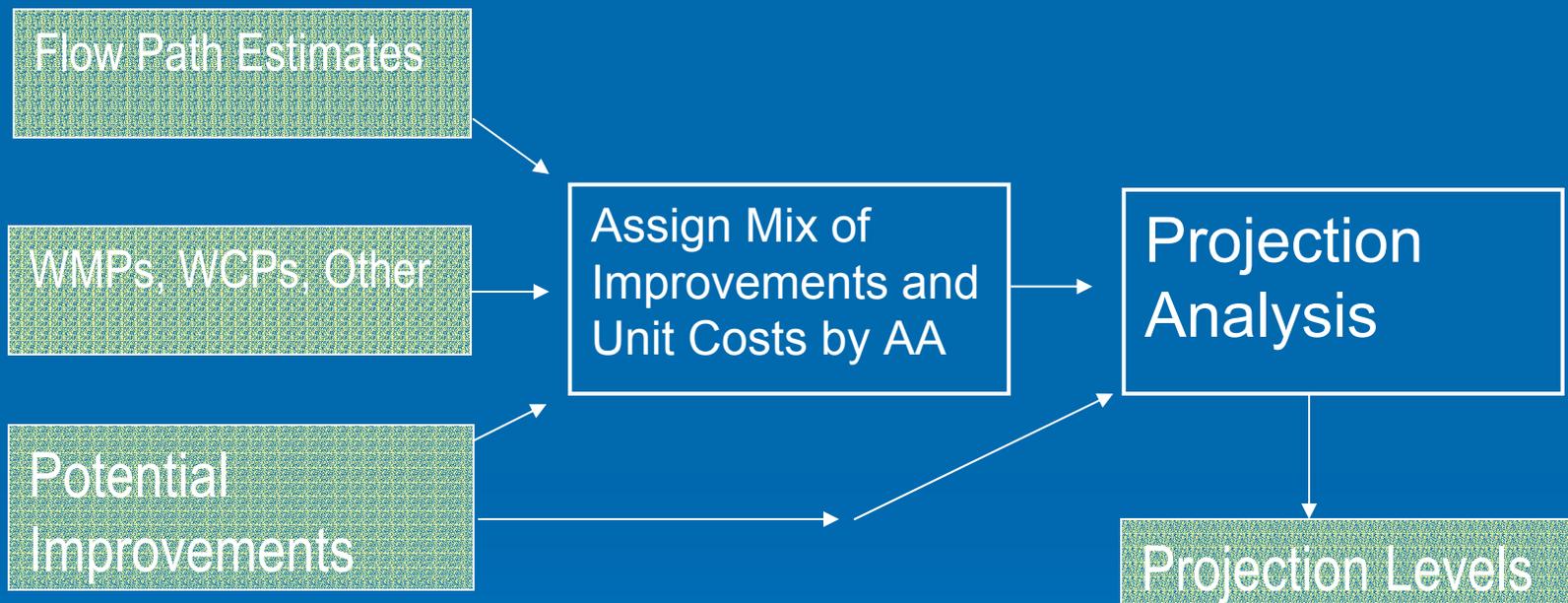
# Apply Potential District Delivery Improvements by Analysis Area

- **Assess current conditions by Analysis Areas**
  - DWR estimates of district efficiency/losses
  - Water conservation plans and ag. water management plans
  - UC survey (dated info)
  - Other
- **For each Analysis Area, assign reasonable mix of improvements**
  - Flexibility to enable on-farm improvements
  - Canal seepage and spill reduction
  - Pressurized pipe for technical potential

# Details of Assumed District Improvements

- See handout D-2

# District WUE Projections



# Summary of Key Assumptions for District Estimates

- **Current conditions and appropriate mix of improvements**
  - **Unit costs and savings from improvements**
  - **Initial spending on flexibility labor to enable on-farm WUE**
  - **Pressurized pipe delivery represents technical potential**
  - **Recoverable vs. irrecoverable**
- 

# **On-Farm Cost Estimates**

**Data, Assumptions, and Methods**



# On-Farm WUE Cost Estimates

- Update of 1994 study
- Feasible irrigation systems by crop type
- Efficiencies and loss estimates based on field assessments by Cal Poly and DWR
- System costs estimated by Ag. Engineers
  - Capital components
  - Labor, O&M
  - Management
- Result is feasible set of systems/management by crop

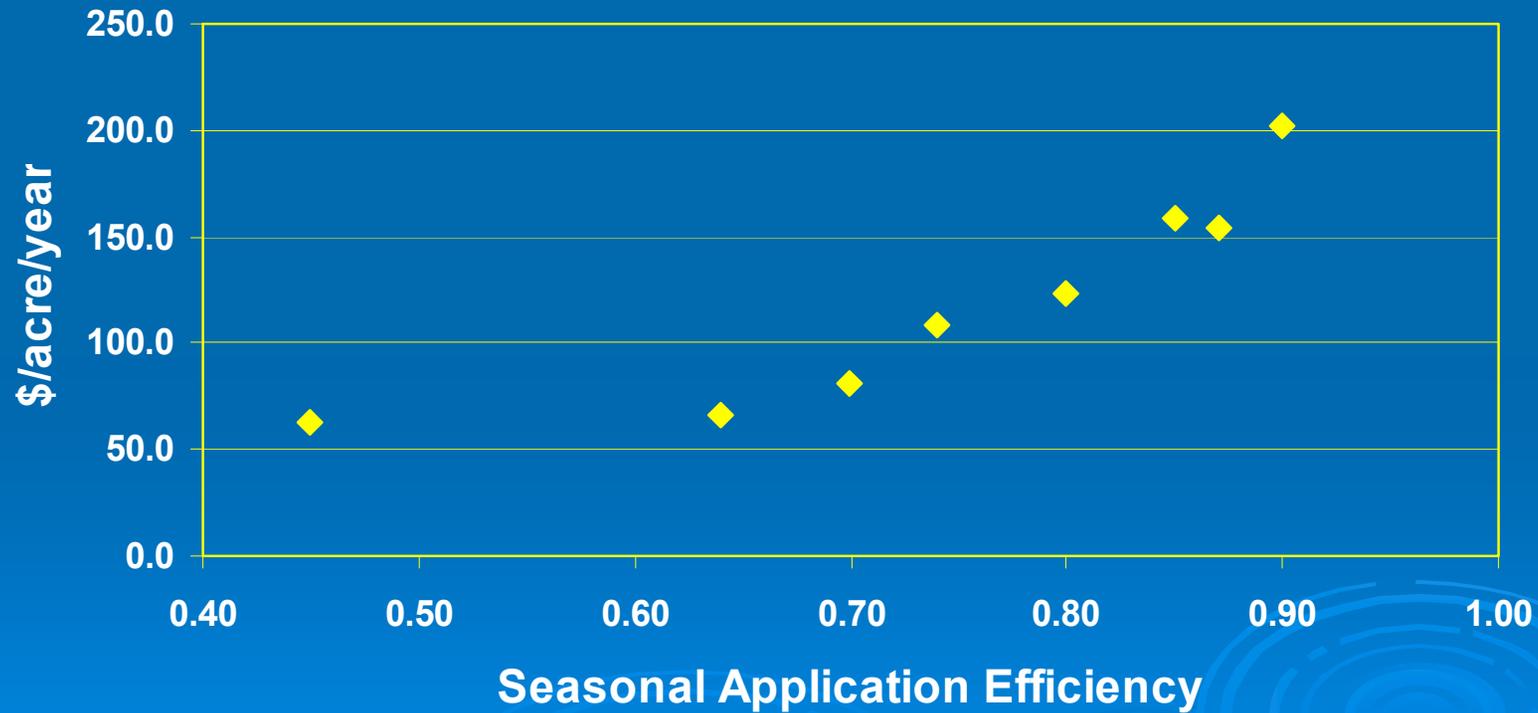
# Details of On-Farm Cost Estimates

- See handout F-1 & 2

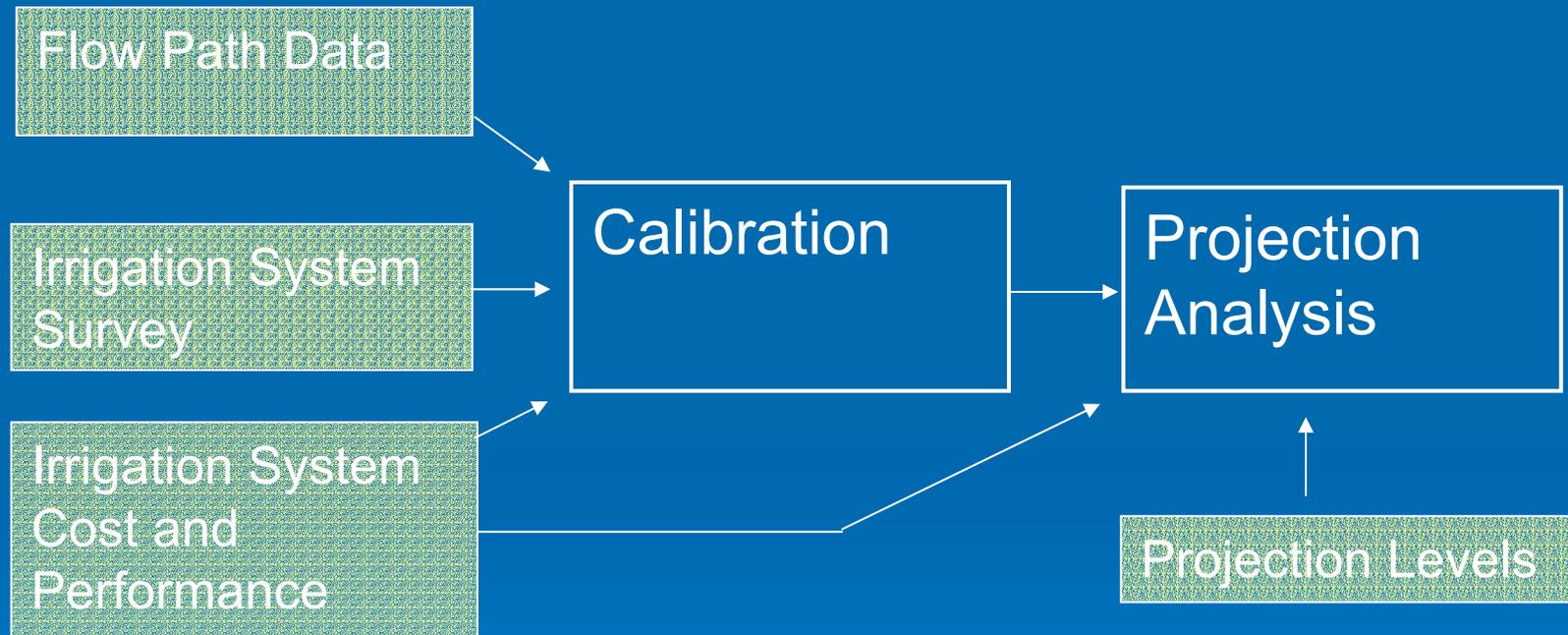


# Field Irrigation Potential

Irrigation System Annual Cost and SAE  
Orchard Crops



# On-Farm WUE Projections



# Summary of Key Assumptions for On-Farm Estimates

- **Current mix of systems and crops**
  - **No change in relative cost of water for projections**
  - **Unit costs and savings from improvements**
  - **“Optimized” mix of systems for each crop**
  - **Both hardware and management important to achieve and maintain savings**
  - **Recoverable vs. irrecoverable**
- 

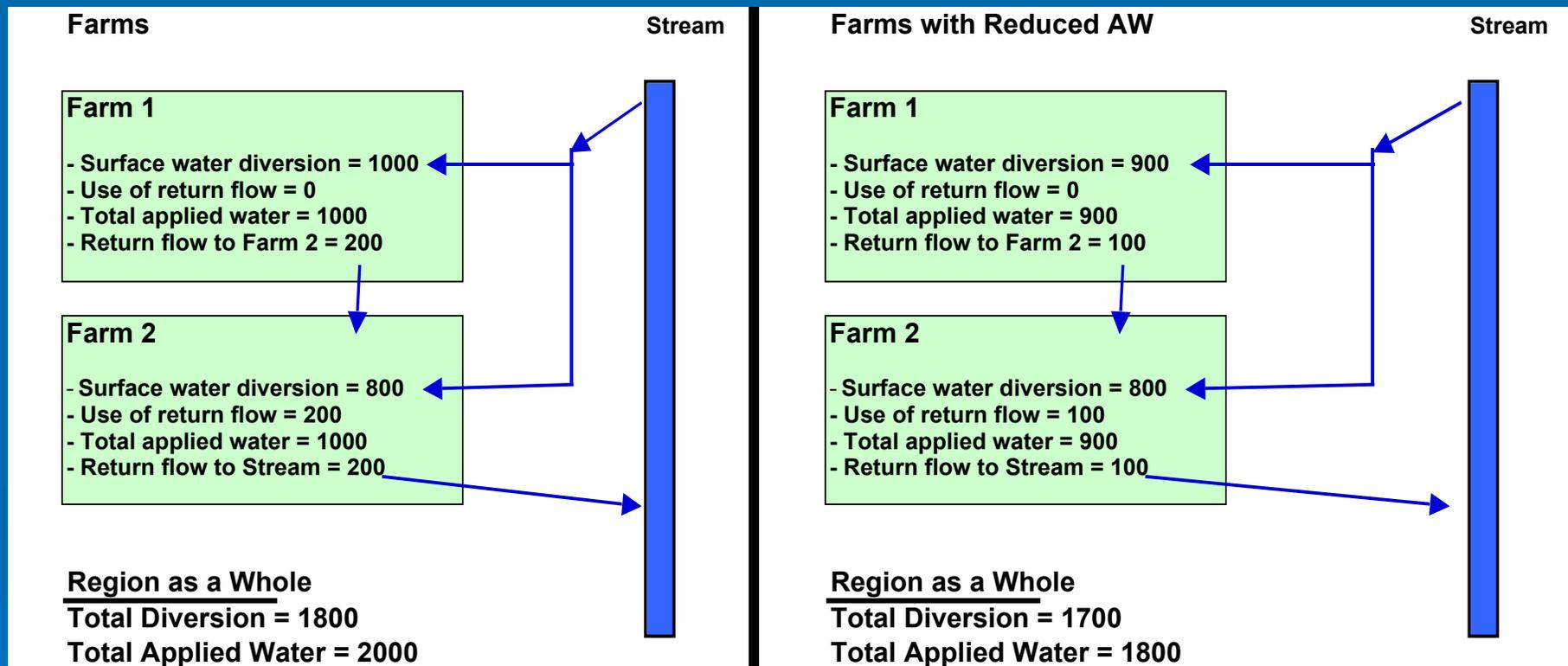
# Issues for Discussion

- Irrecoverable flows going to beneficial uses - Salton Sea, others?
  - Are all irrecoverable flows “realistic”
  - Adjustment of recoverable to account for reuse
  - Savings in recoverable losses can affect 3<sup>rd</sup> parties and may overstate benefit
- 

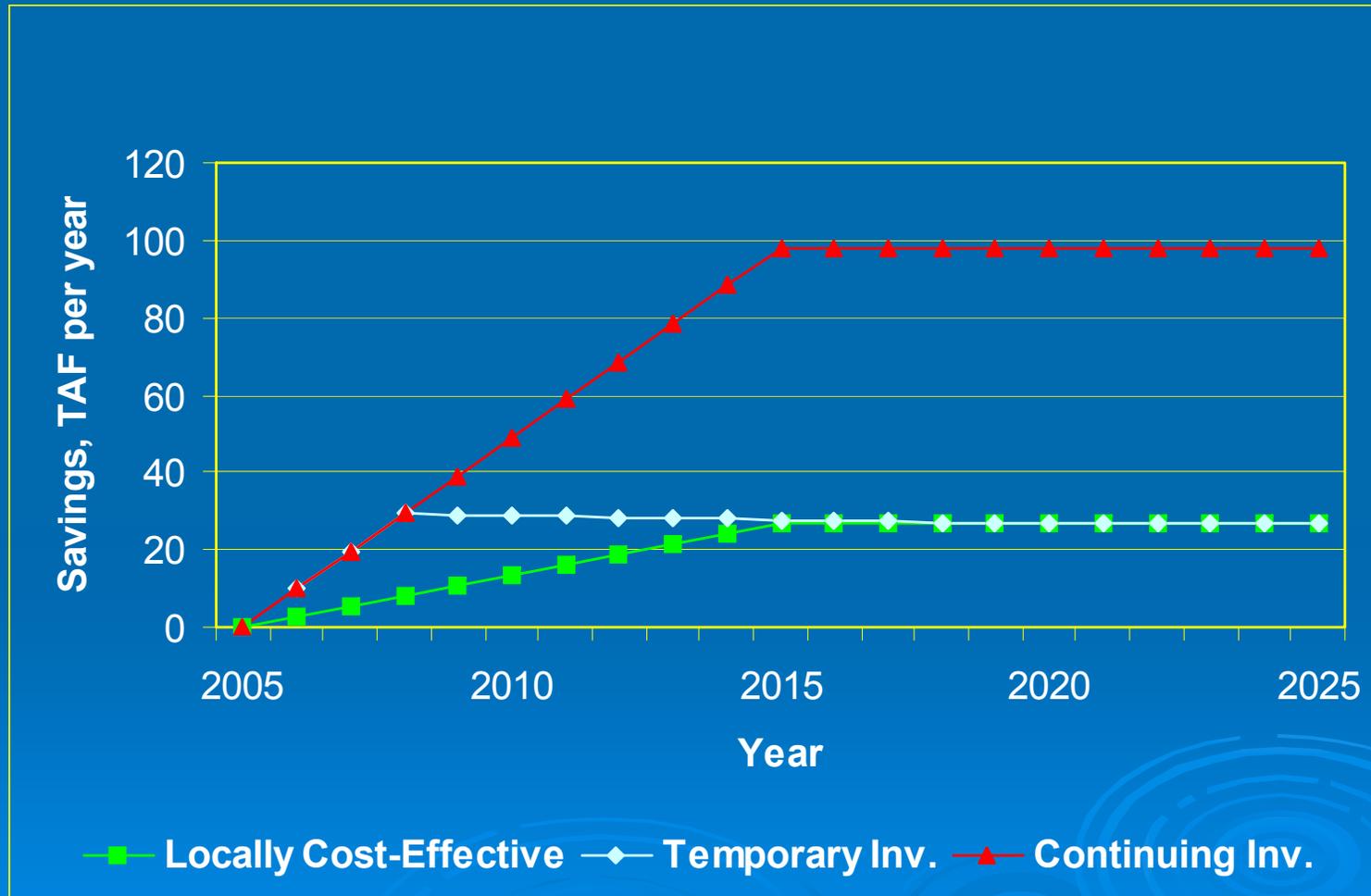
# Issues for Discussion

- Mechanism to fund long-term O&M
- Mechanism to fund on-farm improvements
- Draft results show “optimum” for given level of investment – account for ineffective investment?
- Monthly and annual time step for in-stream flows
- Combine On-farm and District or leave separate?

# Illustration of Regional vs. On-farm Savings



# Illustration of Temporary vs. Continuing Investment



# Next Steps

- **Incorporate comments and suggestions**
  - **Convert annual costs of on-farm improvements to time path of investment needs**
  - **Assess effects of crop mix trends, increasing relative cost (value) of water**
  - **Results presented to WUE Subcommittee Sept 04**
  - **Final report**
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