Evaluation of Restoration and Recharge Within Butte County Groundwater Basins

Recharge Constraints Analysis
Dual Systems

GEI CONSULTANTS
DAVIDS ENGINEERING
ERA ECONOMICS
LAND IQ

SEPTEMBER 25, 2017
Topics

- Task 2 – Preliminary GIS Assessment of Recharge Potential
  - Recharge Constraints Mapping
- Task 4 – Economic Evaluation of In-Lieu Groundwater Recharge
  - Dual System Analysis
Task 2 – Preliminary GIS Assessment and Mapping of Potential Groundwater Recharge Areas

- Data compilation
- Criteria development
- Alternatives definition
- Draft maps
- Public review
- Report
Recharge Types

- **Direct Recharge**
  - Recharge Ponds
  - Field Flooding
  - Injection Wells

- **Indirect Recharge**
  - “In-Lieu” Recharge
Direct Recharge

Recharge Ponds

Considerations:

• Permeable soils
• Dedicated land area
• Recharges water table aquifer
  • Needs unsaturated area below
• Relatively low cost
• Operates year-round
Direct Recharge

Field Flooding

Considerations:
- Permeable soils
- May require special preparation
- Recharges water table aquifer
  - Needs unsaturated area below
- Relatively low cost
- Seasonal use
  - Ability to use farm equipment
Direct Recharge

Injection Wells

Considerations:
- Low land requirements
- Needs high-quality water
- Can recharge confined aquifer
- Relatively high cost
- Year-round operation
Indirect Recharge

In-Lieu Recharge

Considerations:
- Supply of surface water to areas using groundwater
- Can be both ag or urban
- Not restricted by soil type
- Recharges production aquifer
- Relatively low cost
- Seasonal use
- Conjunctive use of groundwater and surface water
DWR Land Use
Hydrologic Soils Group
Surrogate for subsidence potential

Subsidence can occur from the initial dewatering of fine-grained soils

If water levels are maintained above historical low levels, subsidence is not likely
Surrogate for subsidence potential

- Subsidence can occur from the initial dewatering of fine-grained soils
- If water levels are maintained above historical low levels, subsidence is not likely
Proximity to Conveyances
Landcover
Sensitive Species
• DWR CASGEM data
• Selected wells with a consistent measurement history, high quality well logs, and publicly available locations
• Sorted by into two depth categories
  • Well screens shallower than 350 feet (shallow wells, including domestic wells)
  • Well screens deeper than 350 feet (deep wells in lower semi-confined aquifer)
• General groundwater flow direction
  • Westerly in the area near Chico
  • Southwesterly in the southern area
Shallow Aquifer
GW Elevation
Fall 2015
Shallow Aquifer
GW Elevation
Spring 2015
Deep Aquifer
GW Elevation
Fall 2015
Groundwater Depth
Spring 2012
Groundwater Depth

Fall 2015
Preliminary Constraints Maps

- Recharge Ponds
- Field Flooding
- Injection Wells
- In-Lieu
# Recharge Criteria

## Spreading Basins/Field Flooding*

- Unconfined aquifer system
- Relatively large area (10+ acres)
- Permeable soils with no impermeable layers in near-surface
- Significant unsaturated depth below surface
- Hydraulic connection with production aquifers
- Ability to perform routine maintenance (e.g. scraping of pond sediments)
- Unsaturated permeable margin areas beyond pond boundaries
- Source supply compatible with native groundwater. No TDS constraint.
- Proximity to conveyances

## Injection/ASR

- Confined or semi-confined aquifer system
- Low land requirements (<1 acre)
- Transmissive target aquifer
- “Head room” in aquifer, i.e. pressure surface significantly below ground surface
- Number of wells within pressurized management zone
- High quality (drinking water or better) source required

## In-lieu

- No aquifer constraint
- Land presently irrigated with groundwater
- Ability to serve water during irrigation season / proximity to conveyances
- Water table below root zone
- Good quality supply suitable for agronomic application. Possible treatment for drip irrigation uses.

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*Uncropped during spreading or crops tolerant of flooding*
### Criteria Used for Recharge Constraints Maps

<table>
<thead>
<tr>
<th>Consideration</th>
<th>GIS Layer Source</th>
<th>Pond</th>
<th>Field Flooding</th>
<th>Recharge Type</th>
<th>In-lieu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use (Possible Score)</td>
<td>DWR Land Use 2015</td>
<td>(0 for Surface, 1 for Mixed Use, 2 for Groundwater)</td>
<td>(0 for Surface, 1 for Mixed Use, 2 for Groundwater)</td>
<td>(0 for Surface, 1 for Mixed Use, 2 for Groundwater)</td>
<td>(0 for Surface, 0 for Mixed Use, 5 for Groundwater)</td>
</tr>
<tr>
<td>Use Type</td>
<td>DWR Land Use 2015</td>
<td>(-2 for Urban, 0 for Commercial or unknown, 1 for Citrus, Deciduous, Vineyard, 2 for Truck, Field, Grain and Hay, 3 for Rice and Pasture, 4 for Rice and Pasture, 4 for Id and Native)</td>
<td>(-2 for Urban, 0 for Commercial or unknown, 1 for Citrus, Deciduous, 1 for Truck, Field, Grain and Hay, 3 for Rice and Pasture, 4 for Rice and Pasture, 4 for Id and Native)</td>
<td>0</td>
<td>(0 for Urban, Commercial, Idle, Native, Unknown, 2 for Citrus, Deciduous, Vineyard, Truck, Field, Grain and Hay, Rice, and Pasture)</td>
</tr>
<tr>
<td>Crop ET</td>
<td>combine DWR Land Use 2015 and Water Use Spreadsheet (2000-2015) from Davids Erg</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Percolation Rate (Possible Score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAGEI Mod Soil data (assumes that all soils with restrictive layers have been removed by deep tillage)</td>
<td>rot_pgp (Excellent, Good, Moderately Good, Poor, Very Poor)</td>
<td>Excellent:5 Good:4 Moderately Good:3 Poor:2 Very Poor:0</td>
<td>Excellent:5 Good:4 Moderately Good:3 Poor:2 Very Poor:0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bedrock Geology</td>
<td>CGS 2015 Statewide Geologic Map</td>
<td>4 for Oqe, 3 for O, 2 for Oea, 1 for Ec</td>
<td>4 for Oqe, 3 for O, 2 for Oea, 1 for Ec</td>
<td>4 for Oqe, 3 for O, 2 for Oea, 1 for Ec</td>
<td>0</td>
</tr>
<tr>
<td>Depth to groundwater</td>
<td>GEI</td>
<td>Shallow Aquifer GW Elevations 1 point per 20 contour (1-6) for Spring 2016 and Fall 2015</td>
<td>Shallow Aquifer GW Elevations 1 point per 20 contour (1-6) for Spring 2016 and Fall 2015</td>
<td>Deep Aquifer GW Elevations 1 point per 20 contour (1-6) for Spring 2016 and Fall 2015</td>
<td>0</td>
</tr>
<tr>
<td>Location (Possible Score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximity to Existing Conveyance</td>
<td>need to modify Hydrology layer provided by County</td>
<td>(5 for 2000 feet from conveyance, 3 for 1 mile, 2 for 1 to 3 miles, 1 for 3 to 5 miles, 0 =5 miles)</td>
<td>(5 for 2000 feet from conveyance, 3 for 1 mile, 2 for 1 to 3 miles, 1 for 3 to 5 miles, 0 =5 miles)</td>
<td>(5 for 2000 feet from conveyance, 3 for 1 mile, 2 for 1 to 3 miles, 1 for 3 to 5 miles, 0 =5 miles)</td>
<td>(5 for 2000 feet from conveyance, 3 for 1 mile, 2 for 1 to 3 miles, 1 for 3 to 5 miles, 0 =5 miles)</td>
</tr>
<tr>
<td>Minimum parcel size</td>
<td>County</td>
<td>(0 for &lt; 5 ac, 1 for 5 to 10 ac, 2 for 10 to 30 ac, 3 for 30 to 60 ac, 4 &gt;90ac)</td>
<td>(0 for &lt; 20 ac, 1 for 20 to 40 ac, 2 for 40 to 80 ac, 3 for 80 to 120 ac, 4 &gt;120ac)</td>
<td>(-5 for &lt; 0.25 ac)</td>
<td>(0 for &lt; 40 ac, 1 for 40 to 80 ac, 2 for 80 to 150 ac, 3 for 160 to 320 ac, 4 &gt;320ac)</td>
</tr>
<tr>
<td>Environmental Constraints (Possible Score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetlands or Sensitive Area</td>
<td>Land cover from GID2030 data</td>
<td>Vernal Pool, Welland, Woodlands, Chaparral, Riparian = -11 Woodland, vineyard, rce = -5 Grassland = -3 Urban, Developed = 1 Irrigated Crop/Pasture = -3 Disturbed = 5</td>
<td>Vernal Pool, Welland, etc. = -10 Woodlands, Chaparral = -5, -3 Urban, Developed = 1 Riparian, Erodation = 1 Cropland, Disturbed = 5</td>
<td>Vernal Pool, Welland = -5 Woodlands, Chaparral = 3 Riparian, Urban, Developed, Cropland, Disturbed = 5</td>
<td>0</td>
</tr>
<tr>
<td>Endangered Species</td>
<td>California Natural Diversity Database (CNDDB)</td>
<td>(-10 for Endangered, -1 for Threatened and Rare, 0 for No Status)</td>
<td>(-10 for Endangered, -1 for Threatened and Rare, 0 for No Status)</td>
<td>(-2 for Endangered, -1 for Threatened and Rare, 0 for No Status)</td>
<td>(-2 for Endangered, -1 for Threatened and Rare, 0 for No Status)</td>
</tr>
</tbody>
</table>

### Possible Range of Values
- Pond: -14 to 48
- Field Flooding: -14 to 48
- Recharge Type: -3 to 35
- In-lieu: -7 to 22
Recharge Ponds
Field Flooding
In-Lieu Recharge
Discussion
Task 4 – Economic Evaluation of In-Lieu Groundwater Recharge

- Dual System Analysis
Cost/Benefit Evaluation of Dual Source Irrigation Systems

- Dual Source Irrigation Systems:
  
  On-farm irrigation systems capable of using groundwater or surface water
Evaluation Tasks

- Characterize Dual Source Systems
- Develop Cost Estimates for Dual Systems
- Evaluate Agronomic Factors Related to Dual Systems
- Assess Regional Benefits
Evaluation Approach

- Inspected Dual Source Systems
  - Sacramento Valley: Butte County, Glenn County, Colusa County, Yuba County
  - San Joaquin Valley: San Joaquin County, Stanislaus County

- Documented System Components
- Met with Growers, Suppliers, U.C. Cooperative Extension, Professional Agronomists
- Developed Framework for General, Representative Characterization of Dual Source Systems
Evaluation Approach (continued)

- Evaluated Costs to Growers for:
  - “Typical” field across range of surface water costs and depth to groundwater
  - Population of fields using groundwater county-wide

- Caveats
  - Reconnaissance level estimates
  - Every field is different, as are grower preferences
  - Actual costs will differ
Evaluation Approach (continued)

- Yet To Be Done
  - Evaluate regional benefits (energy savings and risk reduction)
  - Refine agronomic assessment
  - Prepare report and grower outreach materials
Dual System Components

- Turnout and Pre-Screening
- Conveyance to Booster Pump & Filter
- Booster Pump & Filter
- Conveyance to System Tie-In
Dual System Example (Butte County)

Vertical Turbine Pump to Pressurize Canal Water.

Sump Constructed of 48” Corrugated Metal Pipe.

Screen Filters to Filter Canal Water.
Combined Discharges of Pressure Pump and Well.

Groundwater Well.

Vertical Turbine Pressure Pump.

Horizontal Screen Filter.

Rotating, Self-Cleaning Screen on Sump Inlet.
Dual System Example (Stanislaus County)
Dual System Example (Yuba County)
Dual System Costs

- Data Sources
  - Butte County Resource Conservation District, NRCS Payment Schedules, Davids Engineering Internal Database

- Cost Estimation Tool
  - 16 Selectable Parameters
  - Initial and Amortized Capital Costs
  - Annual Maintenance and Operations
  - Marginal Dual System Costs
  - Ability to Evaluate Multiple Scenarios and Marginal Cost Sensitivity to Input Parameters
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>NA</td>
<td>Used to estimate irrigation demands.</td>
<td>Walnuts</td>
</tr>
<tr>
<td>Field Size</td>
<td>Acres</td>
<td>Used to estimate required flow rate, pipe size, pump size, filter size, etc.</td>
<td>100</td>
</tr>
<tr>
<td>Distance from Surface Water Source</td>
<td>Feet</td>
<td>Used to estimate pipe lengths and friction losses.</td>
<td>50</td>
</tr>
<tr>
<td>Elevation Difference Between Field and Surface Water Source</td>
<td>Feet</td>
<td>Used to estimate pump size.</td>
<td>5</td>
</tr>
<tr>
<td>Irrigation System Type</td>
<td>NA</td>
<td>Used to estimate filtration and pressure requirements.</td>
<td>Sprinkler</td>
</tr>
<tr>
<td>Existing Turnout</td>
<td>NA</td>
<td>Indicates whether a turnout is already present. Used to estimate turnout cost.</td>
<td>FALSE</td>
</tr>
<tr>
<td>Percent of Demand Met by Surface Water</td>
<td>%</td>
<td>Used to estimate surface water and groundwater amounts and costs.</td>
<td>100%</td>
</tr>
<tr>
<td>Static Depth to Groundwater</td>
<td>Feet</td>
<td>Used to estimate required lift for groundwater and associated costs.</td>
<td>50</td>
</tr>
<tr>
<td>Specific Capacity</td>
<td>Gallons per Minute per Foot</td>
<td>Used to estimate required lift for groundwater and associated costs.</td>
<td>50</td>
</tr>
<tr>
<td>Surface Water Purchase Cost</td>
<td>$ per Acre-Foot</td>
<td>Used to estimate surface water costs.</td>
<td>$5</td>
</tr>
<tr>
<td>Distance from Pressure Pump to Tie-In with Irrigation System</td>
<td>Feet</td>
<td>Used to estimate pipe lengths and friction losses.</td>
<td>1000</td>
</tr>
<tr>
<td>Peak Crop Water Demand</td>
<td>Gallons per Minute per Acre</td>
<td>Used to estimate irrigation system capacity.</td>
<td>12</td>
</tr>
<tr>
<td>Overall Pumping Plant Efficiency</td>
<td>%</td>
<td>Used to estimate pump size and energy costs.</td>
<td>65%</td>
</tr>
<tr>
<td>Energy Cost</td>
<td>$ per Kilowatt-Hour</td>
<td>Used to estimate pumping costs.</td>
<td>$0.25</td>
</tr>
<tr>
<td>Contingencies and Indirect Costs</td>
<td>%</td>
<td>Used to mark up capital costs to reflect unlisted items and uncertainties.</td>
<td>30%</td>
</tr>
<tr>
<td>Maximum well drawdown</td>
<td>Feet</td>
<td>Used to avoid overestimating lift for large fields or ranches where more than one well would likely be present.</td>
<td>60</td>
</tr>
</tbody>
</table>
## Capital & Maintenance Costs

### Cost Estimation Tool Results:

**Annual Capital and Maintenance Costs**

<table>
<thead>
<tr>
<th>Input Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>Walnuts</td>
</tr>
<tr>
<td>Field size (Acres)</td>
<td>100</td>
</tr>
<tr>
<td>Field distance from canal (ft)</td>
<td>50</td>
</tr>
<tr>
<td>Field elevation above canal (ft)</td>
<td>5</td>
</tr>
<tr>
<td>Electrical connection distance (ft)</td>
<td>50</td>
</tr>
<tr>
<td>System type</td>
<td>Sprinkler</td>
</tr>
<tr>
<td>Turnout Present</td>
<td>FALSE</td>
</tr>
</tbody>
</table>

### Calculated Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (gpm)</td>
<td>1,200</td>
</tr>
<tr>
<td>Lift (ft)</td>
<td>5</td>
</tr>
<tr>
<td>Raw Pipe Dia. (in)</td>
<td>10</td>
</tr>
<tr>
<td>Nominal Pipe diameter (in)</td>
<td>10</td>
</tr>
<tr>
<td>Actual Pipe diameter (in)</td>
<td>10.2</td>
</tr>
<tr>
<td>Friction loss (ft)</td>
<td>7</td>
</tr>
<tr>
<td>Filter loss (psi)</td>
<td>3</td>
</tr>
<tr>
<td>Field Pressure (psi)</td>
<td>50</td>
</tr>
<tr>
<td>Water Velocity (ft/s)</td>
<td>4.7</td>
</tr>
<tr>
<td>SW TDH (ft)</td>
<td>135</td>
</tr>
<tr>
<td>Screen filter present</td>
<td>TRUE</td>
</tr>
<tr>
<td>Media filter present</td>
<td>FALSE</td>
</tr>
<tr>
<td>Pump power (hp)</td>
<td>63</td>
</tr>
</tbody>
</table>

### Item Description

<table>
<thead>
<tr>
<th>Item Description</th>
<th>QTY</th>
<th>UNIT</th>
<th>Unit Cost</th>
<th>Extended Cost</th>
<th>Equivalent Annual Cost</th>
<th>Annual Maint.</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnout</td>
<td>1</td>
<td>ea</td>
<td>$2,400</td>
<td>$2,400</td>
<td>$139</td>
<td>$24</td>
<td>$163</td>
</tr>
<tr>
<td>Supply Connection Pipeline</td>
<td>50</td>
<td>ft</td>
<td>$32</td>
<td>$1,600</td>
<td>$93</td>
<td>$16</td>
<td>$109</td>
</tr>
<tr>
<td>Pressure Pump</td>
<td>1</td>
<td>ea</td>
<td>$18,800</td>
<td>$18,800</td>
<td>$1,691</td>
<td>$564</td>
<td>$2,255</td>
</tr>
<tr>
<td>Screen Filter(s)</td>
<td>1</td>
<td>ea</td>
<td>$6,000</td>
<td>$6,000</td>
<td>$540</td>
<td>$180</td>
<td>$720</td>
</tr>
<tr>
<td>Media Filter(s)</td>
<td>0</td>
<td>ea</td>
<td>$12,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>On-Field Connection Pipeline</td>
<td>1,000</td>
<td>ft</td>
<td>$32</td>
<td>$32,000</td>
<td>$1,851</td>
<td>$320</td>
<td>$2,171</td>
</tr>
<tr>
<td>Flow Meter</td>
<td>1</td>
<td>ea</td>
<td>$4,300</td>
<td>$4,300</td>
<td>$387</td>
<td>$129</td>
<td>$516</td>
</tr>
<tr>
<td>Electrical Line Extension</td>
<td>50</td>
<td>ft</td>
<td>$30</td>
<td>$1,500</td>
<td>$70</td>
<td>$15</td>
<td>$85</td>
</tr>
</tbody>
</table>

### Subtotal of Pay Items

$66,600

### Contingencies and Indirect Costs

30% $19,980 $374 $1,805

### Project Cost

$86,580 $6,200 $1,622 $7,822

**Project Cost =**

\[
\text{Project Cost} = \text{Subtotal of Pay Items} + \text{Contingencies and Indirect Costs}
\]

\[
\text{Project Cost} = $66,600 + $19,980 = $86,580
\]

\[
\text{Annual Maintenance} = \frac{\text{Project Cost} \times 30\%}{100} = \frac{86,580 \times 0.30}{100} = $25,974
\]

\[
\text{Equivalent Annual Cost} = \frac{\text{Project Cost} \times 30\%}{100} = \frac{86,580 \times 0.30}{100} = $25,974
\]

\[
\text{Annual Cost} = \frac{\text{Project Cost}}{100} = \frac{86,580}{100} = $865.80
\]

\[
\text{Cost} = \text{Cost Estimation Tool Results: Capital & Maintenance Costs}
\]
## Annual Operating Costs

### Input Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of demand met by surface water</td>
<td>100%</td>
</tr>
<tr>
<td>Static depth to water (ft)</td>
<td>50</td>
</tr>
<tr>
<td>Specific capacity (gpm/ft)</td>
<td>50</td>
</tr>
<tr>
<td>Surface water purchase cost ($/af)</td>
<td>$5</td>
</tr>
<tr>
<td>GW extraction cost ($/af)</td>
<td>$0</td>
</tr>
</tbody>
</table>

## Calculated Parameters (See Global Parameter Calcs for Assumptions)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water pumping cost ($/af)</td>
<td>$53</td>
</tr>
<tr>
<td>Surface water total cost ($/af)</td>
<td>$58</td>
</tr>
<tr>
<td>Well Drawdown (ft)</td>
<td>105</td>
</tr>
<tr>
<td>GW Lift (ft)</td>
<td>155</td>
</tr>
<tr>
<td>GW Friction Losses (ft)</td>
<td>15</td>
</tr>
<tr>
<td>GW TDH (ft)</td>
<td>292</td>
</tr>
<tr>
<td>Groundwater pumping cost ($/af)</td>
<td>$115</td>
</tr>
<tr>
<td>Groundwater total cost ($/af)</td>
<td>$115</td>
</tr>
</tbody>
</table>

## Month-wise Application of Water

<table>
<thead>
<tr>
<th>Month</th>
<th>Applied Water (ac-ft)</th>
<th>Applied Surface Water (ac-ft)</th>
<th>Applied Groundwater (ac-ft)</th>
<th>Surface Water Cost ($)</th>
<th>GW Cost ($)</th>
<th>Total Water Cost ($)</th>
<th>GW Only Cost ($)</th>
<th>Change in Cost from Using Surface Water ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>3.8</td>
<td>3.8</td>
<td>0.0</td>
<td>$218</td>
<td>$71</td>
<td>$289</td>
<td>$218</td>
<td>$215</td>
</tr>
<tr>
<td>February</td>
<td>1.2</td>
<td>1.2</td>
<td>0.0</td>
<td>$71</td>
<td>$71</td>
<td>$142</td>
<td>$71</td>
<td>$70</td>
</tr>
<tr>
<td>March</td>
<td>2.6</td>
<td>2.6</td>
<td>0.0</td>
<td>$152</td>
<td>$152</td>
<td>$304</td>
<td>$152</td>
<td>$150</td>
</tr>
<tr>
<td>April</td>
<td>14.0</td>
<td>14.0</td>
<td>0.0</td>
<td>$810</td>
<td>$810</td>
<td>$1,620</td>
<td>$810</td>
<td>$799</td>
</tr>
<tr>
<td>May</td>
<td>42.5</td>
<td>42.5</td>
<td>0.0</td>
<td>$2,464</td>
<td>$2,464</td>
<td>$4,928</td>
<td>$2,464</td>
<td>($2,430)</td>
</tr>
<tr>
<td>June</td>
<td>57.1</td>
<td>57.1</td>
<td>0.0</td>
<td>$3,306</td>
<td>$3,306</td>
<td>$6,612</td>
<td>$3,306</td>
<td>($3,306)</td>
</tr>
<tr>
<td>July</td>
<td>59.1</td>
<td>59.1</td>
<td>0.0</td>
<td>$3,426</td>
<td>$3,426</td>
<td>$6,852</td>
<td>$3,426</td>
<td>($3,376)</td>
</tr>
<tr>
<td>August</td>
<td>50.3</td>
<td>50.3</td>
<td>0.0</td>
<td>$2,914</td>
<td>$2,914</td>
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Cost Estimation Tool Results: Variable Pumping Depth and SW Purchase Cost

- 100-Acre “Typical” Walnut Orchard
- Marginal Operating Cost
- Static Depth to GW from 10 to 100 feet
- SW Purchase cost from $5/af to $75/af
Cost Estimation Tool Results: Variable Pumping Depth and SW Purchase Cost

- 100-Acre “Default” Walnut Orchard
- Net Annual Cost
- Static Depth to GW from 10 to 100 feet
- SW Purchase cost from $5/af to $75/af
County-Wide Cost Analysis

- What is likely range of costs to growers County-wide?

**Approach**

- Identify groundwater dependent fields from 2015 DWR land use survey
- Estimate groundwater pumping costs based on depth to groundwater and well drawdown data provided by BCDWRC
- Apply cost estimation tool to estimate on-farm costs to growers of implementing dual systems
  - Includes on-farm costs for capital, maintenance, and operations
  - **Does not** include cost of purchasing surface water and conveying to the field
~3,200 Fields Representing 108,000 Acres

Estimated Pumping of 325,000 acre-feet per year

Cost of Installing and Maintaining Dual System Components

Annual Capital and Maintenance ~$75 to $175 per acre per year, typically
County-Wide Dual System Costs: Net Operating Costs

- ~3,200 Fields Representing 108,000 Acres
- Estimated Pumping of 325,000 acre-feet per year
- Net Cost Savings from Reduced Energy Requirements
- Annual Net Operating Cost Savings ~$25 to $150 per acre per year, typically
County-Wide Dual System Costs: Net Costs

- ~3,200 Fields Representing 108,000 Acres
- Estimated Pumping of 325,000 acre-feet per year
- Combines Capital and Maintenance Costs with Operating Cost Savings
- Annual Net Cost ~ -$75 to $175 per acre per year, typically
Factors Affecting Decision Whether to Use Surface Water

- What factors influence the decision to use groundwater when surface water is available?

- Potential Factors
  - Cost
  - Flexibility
  - Water Quality
  - Disease Risk
  - Others
Factors: Cost

- Installation of a dual system represents an investment in capital for system components and ongoing maintenance costs.
- Operation of the system represents an opportunity for cost savings due to reduced energy costs (electrical, Diesel, natural gas).
- In many cases, operations cost savings may not offset capital and maintenance costs under current conditions.
Factors: Flexibility

- Surface water may not be available at the frequency, rate, and duration needed
- Examples:
  - Frost protection
  - Early season irrigation
  - Late season irrigation
  - Wet/dry ditches
- Orchard growers often need a well to meet these needs and maximize production; dual systems represent an added cost
Factors: Water Quality

- Surface water tends to have greater organic and inorganic matter, requiring prescreening and filtration.
- Modern technology can overcome these challenges, but represents an added cost.
- Other water quality considerations include potential infiltration issues and disease risk (next slide).
Factors: Disease Risk

- Phytophthora (root rot) and other pathogens can be transmitted through surface water
- Grading, berms, and spray guards can help avoid risk of disease
- Many growers with dual systems use groundwater to establish a healthy orchard, and transition to surface water once mature
Factors: Other

- Other factors also influence the decision whether to use available surface water.
- Decisions are made on a field by field or ranch by ranch basis.
- Other factors may include complexity, convenience, surface water pricing structures, etc.
Regional Benefits

- Benefits to growers of dual systems may increase under SGMA, particularly if costs of groundwater pumping increase.

- Regional benefits of additional surface water use to remaining groundwater users may include:
  - Avoided drawdown and increased energy requirements
  - Avoided risk of curtailment to pumping to avoid undesirable results
Discussion
Task 3 – Site Prioritization

- Preliminary Project List
Identified Potential Water Sources

- Oro-Chico Canal
- Pipeline from Oroville to Chico
- Construction of recharge basins over Lower Tuscan Aquifer recharge area
- Diversion of water from Sacramento River
- Improvements to Cherokee Canal