On-Farm Flood Flow Capture for Groundwater Recharge

Investigating Solutions for Mitigating Chronic Groundwater Overdraft

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Bachand & Associates
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530-758-1336

Wednesday, May 4, 2011 | 9:15 am to 12:30 pm
Terranova Ranch | 16729 West Floral Ave | Helm, CA

Bachand & Associates
Terranova Ranch
Workshop Program

• 9:45 - 10:00 am Dave Krietemeyer, USDA NRCS:
  – Welcome/Introduction, CIG Program, Introduce Terranova Ranch FFC and GW recharge project and goals

• 10:00 - 10:20 am Richard Hoelzel, Kings River Conservation District:
  – Overview of GW conditions of the lower Kings River watershed, historical perspective

• 10:20 - 10:40 am Don Cameron, Terranova Ranch:
  – Overview of farm operation, local overdraft, FFC, McMullen Recharge Project and current CIG project

• 10:40 - 11:00 am Phil Bachand, Bachand & Associates:
  – Discuss Terranova Ranch GW recharge demonstration study, Findings to date and pending DWR Flood Corridor Project proposal

• 11:00 - 11:30 am Don Cameron and Phil Bachand:
  – Tour of Terranova Ranch, Kings River, Flood recharge in the bypass, recharge sites, canal, McMullen recharge, canal extensions, etc.
Histogram of Flow at the James Weir with focus on flows > 0 cfs

Note: Approximately 90% of flows at the James weir are measured to be < 250 cfs. The remaining flow evenly distributed from 500 to 5500 cfs.

cfs: N = 14572
Kings Basin Findings

• Chronic and Severe Groundwater Overdraft
  – 100,000 ac-ft overdrafted annually from the Lower Kings Basin (Kings IGSM model, WRIME, 2007)
  – ~10% of Annual Deliveries

• Flood Flows
  – High Variable in Freq and Magnitude
  – Expensive Damages along Kings and SJR
    • 1983 - $324M
    • 1995 - $193M
    • 1997 - $223M
  – 280,000 ac-ft pass James Weir last 6 weeks
    • 3000 – 4000 cfs
Targeted Program Benefits to Area Farmers

• Address Severe and Chronic Groundwater Overdraft in substantial and sustainable way

• Empower landowners

• Reduce Flood Risks upstream, adjacent and downstream James Bypass (including SJR).

• Targeting an economically self-sustaining approach
# Spatial Model

## On-Farm Flood Flow Capture Approach

<table>
<thead>
<tr>
<th>Direct</th>
<th><strong>In lieu Soil Moisture</strong></th>
<th><strong>In lieu Soil Moisture</strong></th>
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<tr>
<td><strong>In lieu Soil Moisture</strong></td>
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<td><strong>In lieu Soil Moisture</strong></td>
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<td><strong>In lieu Soil Moisture</strong></td>
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<tr>
<td><strong>In lieu Soil Moisture</strong></td>
<td><strong>In lieu Soil Moisture</strong></td>
<td>Direct</td>
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Costs

• Groundwater pumping $90/ac-ft
• Estimate to divert flood flow onto farm
  ~$30/ac-ft
Two Projects -

- USDA NRCS Grant Agreement #6891040128 –
  - Demonstrating Groundwater Recharge with Storm Flood Flows on Agricultural Lands using Best Management Practices to Mitigate Groundwater Overdraft
  - October 2010 – September 2012
  - $75K with +$90K Match

- DWR Flood Corridor Application
  - McMullen On-Farm Flood Capture and Recharge Project (Under Review)
Conceptual Model – Flow to Groundwater

- Flooded Fields
- Shallow Vadose/Root Zone
- Deep Vadose Zone
- Groundwater
Bottom Line

• Quantify On-Farm Flood Capture Recharge Rates

• Logistics and BMPs behind implementing a program
Flood Flow Thru the James Bypass

Winter Flooding of Row Crop Fields
Grape Fields
–
Staff Gauges, Pressure Transducers (Continuous Level), and Soil Moisture Probes
Manual Data Logging by Bachand & Associates and Terranova Ranch
USDA NRCS
Grant Agreement
#6891040128
Sample Data – Pressure Transducer Data for Flooded Fields
Moisture with Depth

Moisture Content %

Date

6 in (Ave)
24 in (Ave)
Moisture v EC Soils data

![Graph showing Moisture v EC Soils data]

- **m³/m³ VWC**
- **Bulk EC dS/m**

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<tr>
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phil@bachandassociates.com
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# Surface Water Quality Samples
## Kings River Vs Field Water Quality – January 2011 Field Recharge

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
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<tr>
<td>Kings R</td>
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<td>Field</td>
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Preliminary Data –
Infiltration Rates vs Elapsed Time
Continuous Flooding, Jan/Feb 2011

Infiltration Rate (In/day) vs Elapsed Days

- F24
- F22
- F16

4 in/d
2 in/d
Acres to Infiltrate 10 CFS as dependent upon Infiltration Rates

<table>
<thead>
<tr>
<th>Flow cfs</th>
<th>Infiltration rate (in/d)</th>
<th>Acres Needed to infiltrate</th>
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<tr>
<td>10</td>
<td>2</td>
<td>119</td>
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<tr>
<td></td>
<td>2.5</td>
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<td></td>
<td>3</td>
<td>79</td>
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<td>4</td>
<td>60</td>
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Flood Flow Capture BMPS

- Farm Strategy – Integration with normal farm hydrologic practices
- High Rate Conveyance and Water Delivery
- Inexpensive and Low Risk Water Retention
- Relatively Rapid Response
- Economically Cost Effective for annual BMPS (berms, temporary conveyance, etc....)
- Appropriate crop selections
- Appropriate data collection / validation
- Appropriate Soil practices
Groundwater Impacts and Issues

• Chronic and Severe Overdraft
• Relatively High Rate Application of High Quality Flood Flows
  – Dilution of salts and nitrate
  – Saturated conditions promoting denitrification
• Salts flushing from root zone
• Minimize GW impacts likely requires adjusting crops and crop BMPs to minimize transport of mobile contaminants
• Nutrient mgmt of fields under recharge
  – Nutrient analyses to manage fertilizer applications
  – Fields under drip and micro sprinkler efficient nutrient uptake
• Groundwater gradient
• Other Issues? Likely
Potential Soil and Wildlife Benefits

• Soil
  – Nematodes and Soil Pathogen Control
  – Higher Soil organic content
  – Promoting soil fertility
  – Reducing salts, nitrates

• Wildlife
  – Waterfowl
Figure 1.  Proposed Phases for McMullen On-Farm Flood Capture and Recharge Project
Total proposed project area for the project is approximately 16,000 acres.  Area shown represents the proposed boundaries of the McMullen Flood Flow Capture District.
Phase 1 area and Needed Structural (Conveyance) Infrastructure.
MFFCD
McMullin Flood Flow Capture District

• Self funded based upon Economics
  – Cost of Irrigation
    • From groundwater pumping
    • From Flood Capture
  – Cost of Direct Recharge

• Legal Entity
  – governing bylaws
  – MOUs to coordinate flood flow capture,
  – Protocols for in perpetuity mgmt

• Coordination with KRCD and its member agencies
## Phase 1 Expected Flood Flow Capture

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Units</th>
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<tr>
<td><strong>Winter Direct Recharge</strong></td>
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<tr>
<td>Infiltration Rate</td>
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<td>in/d</td>
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<td>Acreage</td>
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<td>Acres</td>
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<td>Flow</td>
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<td>cfs</td>
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<tr>
<td></td>
<td><strong>313</strong></td>
<td><strong>ac-ft/d</strong></td>
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<td>May</td>
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<td></td>
<td>0.075</td>
<td>0.135</td>
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<tr>
<td>Flow</td>
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<td>34</td>
</tr>
<tr>
<td></td>
<td><strong>38</strong></td>
<td><strong>68</strong></td>
</tr>
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</table>

¹ Estimating Crop Water Use for grapes - UCCE LAWR
DWR Flood Corridor Project Goals

- **Substantial, Sustainable and Self Funded** Flood Flow Capture Program at the James Bypass

- Standardized On-Farm Practices for Direct Recharge, In Lieu Recharge and Moisture Profile Replenishment

- **Reduce Groundwater Overdraft by enlisting 16,000** or more acres in the program with about 1/3 of acres to accept flood flows for direct recharge efforts

- **In perpetuity** program through easements and economic incentives

- **Coordinated** with efforts throughout Kings River Basin
DWR Letters of Support to:

• Earl Nelson, Program Manager
• Flood Protection Corridor Program
• Department of Water Resources
• 3310 El Camino Avenue, Room 140
• Sacramento, CA 95821
A WORKSHOP ON:

On-Farm Flood Flow Capture for Groundwater Recharge

Investigating Solutions for Mitigating Chronic Groundwater Overdraft

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TOPICS WILL INCLUDE:
- Grower’s perspective on storm flood flow capture (FFC) and his on-farm FFC program for groundwater (GW) recharge management
- Cost effective agricultural Best Management Practices to retain and infiltrate storm water
- Preliminary findings achieved in 2011 of infiltration rates and the effectiveness of this approach
- Current and historical information on GW conditions and chronic overdraft in the Kings River area
- Funding opportunities for these and other environmentally beneficial practices

REGISTER WITH JOE CHOPERENA AT JCHOPERENA@SUSCON.ORG OR (415) 977-0380 EXT. 320

WORKSHOP PROGRAM:

9:15 - 9:45 am Arrival/ Snacks and Coffee
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11:30 am - 12:30 pm Lunch