Agricultural Water Reuse: Impediments and Incentives

WRFF 15-08

Anne Thebo
Senior Research Associate
Pacific Institute

Kara Nelson
Professor
UC Berkeley

Bahman Sheikh
Water Reuse Consultant
Water Reuse Consulting
Co-Authors

• Ted Gardner
• Jim Kelly
• Brent Haddad
• Avner Adin
• Shannon Spurlock
• Ryujiro Tsuchihashi

Partners

• Monterey Regional Water Pollution Control Agency
• OceanMist Farms
• City of Santa Rosa
• Dublin San Ramon Services District
• Denver Water
• Denver Urban Gardens
• Idaho Department of Environmental Quality
• Water Environment and Reuse Foundation
  • Kristan VandenHeuvel, Project Officer

Technical Advisors: Prof. Takashi Asano, Prof. Rafael Mujeriego
Project Sponsors
Project Objectives

• Define Status of Use of Recycled Water in Agriculture
• Identify impediments and incentives to agricultural reuse
• Assess opportunities to increase agricultural reuse in US
• Recommend strategies to facilitate agricultural reuse
Agriculture Use of Recycled Water

- **Israel**: 8% Agricultural, 92% Non-Agricultural
- **Idaho**: 8% Agricultural, 92% Non-Agricultural
- **Florida**: 23% Agricultural, 77% Non-Agricultural
- **Hawai'i**: 29% Agricultural, 71% Non-Agricultural
- **California 2009**: 38% Agricultural, 62% Non-Agricultural
- **California 2015**: 30% Agricultural, 70% Non-Agricultural

The chart shows the percentage of recycled water use in different states between 2009 and 2015, with a breakdown into agricultural and non-agricultural sectors.
Approach

Diverse Methods
• Literature Review
• Stakeholder workshop and break-out sessions
• Review of utility documentation
• Detailed interviews
• National geospatial assessment

Broad Geographic Scope
• United States
  • California
  • Idaho
  • Florida
• Australia
• Israel and Middle East
• Japan
Presentation Overview

• Status of Agricultural Use of Recycled Water

• Spatial Analysis (GIS)

• Case Studies
  • Impediments, Challenges, Obstacles
  • Incentives, Drivers, Subsidies, Encouragements

• Conclusions and Recommendations
Motivation for a National Assessment of Agricultural Reuse

• Water reuse is an important component of the sustainable management of: Water Quantity **AND** Water Quality

• Drivers and impediments spatially heterogeneous

• No nationally consistent inventory of water reuse
  • A few high quality state inventories (CA, AZ, FL)

• Agriculture is a major of consumptive use
What is the current extent of reuse for irrigation in the US?

41/50 states
What is the potential for agricultural use of recycled water?
Defining Metrics for Evaluating Potential for Agricultural Reuse

Utilities

• Is there demand for recycled water in local agriculture?
• What is the distance to potential customers? (cost of distribution)
• Can installed technology meet WQ needs/regulations?
• What financing is available for infrastructure?

Growers

• How much recycled water can be supplied?
• What crops can be grown with recycled water?
• What is the cost and reliability of recycled water?
• What is the quality of recycled water relative to existing sources?

What are the state regulations governing agricultural reuse?
Where is treated wastewater discharged across the United States?

Total Daily Discharge: 33,000 MGD

Data: 2012 EPA Clean Watersheds Needs Survey
What quantities of effluent are discharged via methods with a high potential for reuse?

<table>
<thead>
<tr>
<th>Discharge Method</th>
<th>n</th>
<th>Flow Discharged (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaporation</td>
<td>939</td>
<td>166</td>
</tr>
<tr>
<td>Ocean Discharge</td>
<td>183</td>
<td>3104</td>
</tr>
<tr>
<td>Spray Irrigation</td>
<td>638</td>
<td>586</td>
</tr>
</tbody>
</table>

1 MGD = 3785 m³/d = 1120.1 AFY
Where are irrigated croplands located relative to POTWs?

Average Quantity of Water Applied (AFY/ac)

Ratio of Unallocated Flow to Irrigated Cropland Area

44% within 5 mi
80% within 10 mi

1 MGD = 3785 m³/d = 1120.14 AFY
Potential for Increased Agricultural Reuse in California

<table>
<thead>
<tr>
<th>Discharge Method</th>
<th>n</th>
<th>Existing Flow (MGD)</th>
<th>Existing Flow (MAFY)</th>
<th>% RW Mandate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaporation</td>
<td>117</td>
<td>71</td>
<td>0.08</td>
<td>9.1</td>
</tr>
<tr>
<td>Ocean Discharge</td>
<td>35</td>
<td>1,330</td>
<td>1.50</td>
<td>171.5</td>
</tr>
<tr>
<td>Spray Irrigation</td>
<td>80</td>
<td>110</td>
<td>0.12</td>
<td>14.2</td>
</tr>
<tr>
<td>Surface Water</td>
<td>104</td>
<td>744</td>
<td>0.83</td>
<td>95.9</td>
</tr>
<tr>
<td>Potentially Unallocated</td>
<td>376</td>
<td>2,315</td>
<td>2.60</td>
<td>298.4</td>
</tr>
<tr>
<td>All Existing Effluent</td>
<td>499</td>
<td>3,516</td>
<td>3.94</td>
<td>453.2</td>
</tr>
</tbody>
</table>

SWRCB Recycled Water Mandates
2020: 1.169 MAF
2030: 2.525 MAF
POTWs with a High Potential for Agricultural Reuse
Number of States and Territories by Allowable Uses:
Food + Non-Food: 26; Non-Food: 19; Not Allowed: 7
### Regulation of Agricultural Reuse in California

<table>
<thead>
<tr>
<th>Agricultural Uses of Recycled Water</th>
<th>Disinfected Tertiary Recycled Water</th>
<th>Disinfected Secondary 2.2 Recycled Water</th>
<th>Disinfected Secondary 23 Recycled Water</th>
<th>Undisinfected Secondary Recycled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food crops where recycled water contacts the edible portion of the crop, including all root crops</td>
<td>Allowed</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>Food crops, surface-irrigated, above-ground edible portion, not contacted by recycled water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ornamental nursery stock and sod farms with unrestricted public access</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture for milk animals for human consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orchards and vineyards with no contact between edible portion and recycled water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fodder and fiber crops and pasture for animals not producing milk for human consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed crops not eaten by humans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food crops undergoing commercial pathogen-destroying processing before consumption by humans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ornamental nursery stock, sod farms not irrigated less than 14 days before harvest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Increasing Levels of Treatment (and Energy Requirements)**

**Agricultural Irrigation 220,000 AFY**

- **Source:** 2015 CA RW Survey (DWR - 2017 IWA Reuse Conference)

**Treatment of Recycled Water Used for Different Purposes**
Types of Crops that Could be Irrigated with Existing WW Treatment Infrastructure

Note: 2012 EPA Guidelines for Water Reuse were used to define acceptable combinations of unit processes for irrigation of food or non-food crops. Not all POTWs reported details on unit processes.

2012 EPA Treatment Guidelines for Ag Reuse:

Food = Filtration + Secondary + Disinfection

Non-Food = Secondary + Disinfection

Suitability Classification of POTW for Food and Non-Food Crop Irrigation Based on 2012 EPA Guidelines for Water Reuse:

- Food crop irrigation (n=164)
- Non-food crop irrigation (n=4475)
- Disinfection not reported (n=9972)
Summary Statistics

• 41/50 states report some reuse for irrigation
• 33,000 MG of wastewater produced daily
• ~2% of wastewater currently used for irrigation
• 80% of irrigated croplands within 10 mi of POTW
• Existing unallocated flows in CA could meet RW targets several times over
What causes potential to become a project in the ground?

Case Studies
Case study: Monterey, CA

- **Impediments:**
  - Safety Perceptions
  - Soil/Crop Health
  - Sales Impact Concerns

- **Drivers:**
  - Over-drafted Groundwater
  - Seawater Intrusion
  - Saline Well-Water

- **Incentives:** Pilot Project, CWA Grant Funding

- **Crops:** Cauliflower, Broccoli, Lettuce, Celery, Artichokes, Strawberries
Case study: Modesto, CA

- **Impediments:**
  - Local Farmers’ Senior Water Rights

- **Drivers:**
  - N Discharge To San Joaquin River
  - Water Scarcity

- **Incentive:**
  - Financing From Prop 1, SRF

- **Crops:** Nuts, Stone Fruit, Citrus

- **Treatment:** BNR, MBR, UV

- **Unique Features:**
  - Delta Mendota Canal to Convey RW (Reduces Purple Pipe) (CVP)
Case study: Hayden, ID

• **Impediments:**
  - Separate Permits for Reuse

• **Driver:**
  - Discharge Limits to Spokane River
  - Nitrogen Management

• **Incentives:**
  - Farmer Pays $55/Acre

• **Treatment:**
  - Oxid. Ditch, BNR, UF, Chlorination

• **Crops:**
  - Alfalfa, Poplar Trees

• **Unique Features:**
  - City-Owned Farmland
Case study: Oxnard, CA

- **Impediments:**
  - Resistance from Farmers

- **Drivers:**
  - Reduce Dependence on Imported Water

- **Incentives:**
  - Lowered Salinity of Recycled Water

- **Treatment:** MF-RO-AOP

- **Crops:**
  - Lettuce, Broccoli, Strawberries...

- **Unique Features:**
  - IPR + Ag Irrigation
Recommendations and Conclusions

- Peer utility and grower example
- Water quality (nutrient limits) are becoming a major driver for reuse
- Significant potential to expand agricultural reuse in CA and non-traditional regions
- Many opportunities for reuse are located in small or disadvantaged communities
  - Need for funding assistance, consolidation, and/or economically sustainable treatment technologies
- Conjunctive management with groundwater recharge can help manage seasonal demand for RW in agriculture
- Better matching of recycled water quality to agronomic conditions is needed
Thank You!

Questions?

Anne Thebo
athebo@pacinst.org