History and Prospects for Water Reuse in the U.S.

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Interdisciplinary Webinar "Wastewater Reuse in the United States and Australia: Obstacles and Solutions
April 15, 2021
You Asked That I Address Two Topics

1. What were the obstacles to wastewater reuse in the United States and how were they identified?
2. How were these obstacles addressed and to what extent were they addressed?
To Respond Let Me Make These Point

• Many Forms of Reuse are Available and Used
• Water Reuse is a Long-Term and Growing Practice in U.S.
• Water Reuse is Common, Even When Not Recognized
• Reuse is Becoming Recognized as Essential Component of Water Supply Portfolio in Many Locations
• Non-Potable Reuse is Widely Accepted and Practiced
• Potable Reuse is Practiced and is Becoming More Widely Accepted
• Technology is No Longer a Constraint to Water Reuse
• Acceptance of Water Reuse Depends on Non-Technical Factors
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Wide Range of Uses for Reclaimed Water Available

<table>
<thead>
<tr>
<th>Category of Use</th>
<th>Specific Types of Use</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| Landscape Irrigation             | Parks, playgrounds, cemeteries, golf courses, roadway rights of way, school grounds, greenbelts, residential and other lawns | • Dual distribution system costs
• Uneven seasonal demand
• High TDS reclaimed water can adversely affect plant health |
| Agricultural irrigation          | Food crops, fodder crops, seed crops, nurseries, sod farms, silviculture, frost protection | • Use of source are often some distance apart
• Dual distribution system costs
• Uneven seasonal demand
• High TDS reclaimed water can adversely affect plant health |
| Non-potable urban uses (other than irrigation) | Toilet and urinal flushing, fire protection, air conditioner chiller water, commercial laundries, vehicle washing, street cleaning, decorative fountains and other water features | • Dual distribution system costs
• Building level dual plumbing may be required
• Greater burden on cross-connection control |
| Industrial Use                   | Cooling, boiler                                                                       | • Dual distribution system costs based on proximity
• Treatment required depends on end use |
| Impoundments                     | Ornamental, recreational (including full-body contact)                                 | • Dual distribution system costs
• Nutrient removal required to prevent algal growth
• Appropriate hydrogeological conditions may be required
• Potential ecological impacts depending on reclaimed water quality and sensitivity of species |
| Environmental uses               | Stream augmentation, irrigation, reclaimed water                                        | • Appropriate hydrogeological conditions needed
• High level of treatment may be required |
| Groundwater recharge             | Aquifer storage and recovery, seawater intrusion control, ground subsidence control    | • Requires post-treatment storage
• Can be energy intensive |
| Potable water supply augmentation | Water supply                                                                            | |
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Illustrated by Potable Water Reuse History

Table 1.7. Treatment Technologies Employed at Operational Potable Reuse Plants

<table>
<thead>
<tr>
<th>Project</th>
<th>Geographic Location</th>
<th>Type of Potable Reuse</th>
<th>Year First Operational</th>
<th>Capacity</th>
<th>Current Advanced Treatment Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mometello Forebay, Suisun Drainage Districts of Los Angeles County, CA</td>
<td>Coastal</td>
<td>Groundwater recharge via spreading basins</td>
<td>1962</td>
<td>44 mgd (105 mld)</td>
<td>CSiM + Cl₂ + SAT (spreading basins)</td>
</tr>
<tr>
<td>Windhoek, Namibia</td>
<td>Inland</td>
<td>Direct potable reuse</td>
<td>1968</td>
<td>5.5 mgd (21 mld)</td>
<td>O₃ + Coag + DAF + GMF + O₃/H₂O₂ + HAC + GAC + UF + Cl₂ (process as of 2002)</td>
</tr>
<tr>
<td>Upper Ocoee Service Authority, Centerville, V.T.</td>
<td>Inland</td>
<td>Surface water augmentation</td>
<td>1978</td>
<td>54 mgd (204 mld)</td>
<td>Lime + GMF + GAC + Cl₂</td>
</tr>
<tr>
<td>Huaca Bolson Recharge Project, El Paso, TX</td>
<td>Inland</td>
<td>GW recharge via direct injection and spreading basins</td>
<td>1985</td>
<td>10 mgd (38 mld)</td>
<td>Lime + GMF + Ozone + GAC + Cl₂</td>
</tr>
<tr>
<td>Clayton County Water Authority, GA</td>
<td>Inland</td>
<td>Surface water augmentation</td>
<td>1985</td>
<td>18 mgd (68 mld)</td>
<td>Cl₂ + UV disinfection + SAT (wetlands)</td>
</tr>
<tr>
<td>West Basin Water Recycling Plant, CA</td>
<td>Coastal</td>
<td>GW recharge via direct injection</td>
<td>1993</td>
<td>12.5 mgd (47 mld)</td>
<td>MF + RO + UVAOAP</td>
</tr>
<tr>
<td>Scottsdale Water Campus, AZ</td>
<td>Inland</td>
<td>GW recharge via direct injection</td>
<td>1999</td>
<td>20 mgd (76 mld)</td>
<td>MF + RO + Cl₂</td>
</tr>
<tr>
<td>Gwinnett County, GA</td>
<td>Inland</td>
<td>Surface water augmentation</td>
<td>2000</td>
<td>60 mgd (227 mld)</td>
<td>Coag/flocc/UF + Ozone + GAC + Ozone</td>
</tr>
<tr>
<td>NEWater, Singapore</td>
<td>Coastal</td>
<td>Surface water augmentation</td>
<td>2000</td>
<td>146 mgd (5 plants)</td>
<td>MF + RO + UV disinfection</td>
</tr>
<tr>
<td>Los Alamitos Seawater Intrusion Barrier, Long Beach, CA</td>
<td>Coastal</td>
<td>GW recharge via direct injection</td>
<td>2006</td>
<td>3.0 mgd (11 mld)</td>
<td>MF + RO + UV disinfection</td>
</tr>
<tr>
<td>Chino Basin Groundwater Recharge Project, Chino, CA</td>
<td>Inland</td>
<td>GW recharge via spreading basins</td>
<td>2007</td>
<td>18 mgd (68 mld)</td>
<td>GMF + Cl₂ + SAT (spreading basins)</td>
</tr>
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<td>Groundwater Replenishment System, Orange County, CA</td>
<td>Coastal</td>
<td>GW recharge via direct injection and spreading basins</td>
<td>2008</td>
<td>70 mgd (265 mld)</td>
<td>MF + RO + UVAOAP + SAT (spreading basins for a portion of the flow)</td>
</tr>
<tr>
<td>Western Corridor Recycled Water Scheme; Queensland, Australia</td>
<td>Coastal</td>
<td>Surface water augmentation</td>
<td>2009</td>
<td>66 mgd via three plants (250 mld)</td>
<td>MF + RO + UVAOAP</td>
</tr>
<tr>
<td>Cloudcroft, NM</td>
<td>Inland</td>
<td>Direct potable reuse through spring water augmentation</td>
<td>2009</td>
<td>0.1 mgd (0.4 mld)</td>
<td>MF + RO + UVAOAP</td>
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<tr>
<td>Arapahoe County/Cottonwood, CO</td>
<td>Inland</td>
<td>GW recharge via spreading</td>
<td>2009</td>
<td>9 mgd (34 mld)</td>
<td>SAT (via RBF) + RO + UVAOAP</td>
</tr>
<tr>
<td>Big Spring Reclamation Project; TX</td>
<td>Inland</td>
<td>Direct potable reuse through raw water blending</td>
<td>2013</td>
<td>1.8 mgd (6.8 mld)</td>
<td>MF + RO + UVAOAP</td>
</tr>
</tbody>
</table>

Source: Adapted from Drees & Kahn (2010); Assan et al. (2007)

Notes: AR = Activated Recharge and Recovery; BAC = Biological Activated Carbon filtration; Cl₂ = Chlorine Disinfection; Coag = Coagulation; DAF = Dissolved Air Flotation; CAC = Granular Activated Carbon; GMF = granular media filtration; GW = groundwater; H₂O₂ = Hydrogen Peroxide; MF = Microfiltration; O₃ = Ozone; RBF = riverbank filtration; RO = Reverse Osmosis; SAT = Soil Aquifer Treatment; UF = Ultrafiltration; UV = Ultraviolet; UVAOAP = UV Advanced Oxidation Process

- First Recorded Installation 1962
  - California Groundwater Recharge
- Increasing Pace of Application with Growing Acceptance
- Technology Varies with Location
  - Coastal vs. Inland

Schimmoller and Kealy, 2014
Water Reuse Growing Exponentially in U.S.
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In Fact, deFacto Water Reuse is Ubiquitous

Trinity River Basin, showing Dallas/Fort Worth in the headwaters of the water supply for the city of Houston.


US National Academies, 2012, Table 2.2
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Why is Reuse Essential Component of Portfolio?

- Portfolio Approach to Drought-Proofing Water Supplies Becoming Well Accepted:
  - Reuse is Proven Component of Such Systems
- Superior Economics for Reuse Compared to Other, Similar Options
  - Desalination
- More Complete Wastewater Treatment (BNR) Becoming Widely Applied
- Relevant Management/Monitoring Procedures Well Proven:
  - Source Control to Manage Industrial and Commercial Discharges
  - Advanced Water Quality Monitoring to Assure Quality Control
- Methodologies for Outreach to Gain Public Support are Becoming More Well Developed and Can be More Successfully Applied
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U.S. Reuse Projects
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Current and Planned Potable Reuse Projects in U.S.
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Using the Appropriate Words is Crucial for Public Acceptance

![Bar chart showing the percentage of respondents willing to drink different types of water, with and without information.]
Discussions on REUSE typically start here...

...when they actually need to start HERE!
Recommendations From 2018 Study Can Guide Implementation

- Assess the utility’s reputation among customers and decision makers before investing in project planning;
- Create and execute a comprehensive strategic communication, outreach, and involvement strategy to build trust and credibility (and consider enlisting the assistance of a communications consultant);
- Use an external expert body to advise on the design and implementation, and support monitoring and evaluation of projects (especially in places where potable water reuse is still perceived as a novel practice);
- Assess the community needs driving consideration of a project, articulate how a project responds to those needs, and how different stakeholders may be impacted;
- Take an integrated water management approach, understand the motivating drivers, and be prepared to navigate applicable governance structures that will influence development of a project;
- Develop a comprehensive financing plan that considers community interests, long-term capital improvement and asset management needs, as well as alternative financing mechanisms;
- Work actively with state primacy agencies to establish workable regulatory approaches that are protective of public health;
- Introduce potable water reuse as a potential water supply option early in state-wide or local water planning processes;
- Foster collaboration and integration among drinking water and wastewater utilities through watershed-based integrated resource management processes;
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You Asked That I Address Two Topics

1. What were the obstacles of wastewater reuse in the United States and how were they identified?
   a. Institutional Capacity to Successfully Implement Reuse Systems
   b. Public Perception of “Pristine” Water Supplies

2. How were these obstacles addressed and to what extent, they were addressed?
   a. Water Reuse Undertaken by Competent Utilities That Were also Competent Actors Within Their Communities
   b. Effective Communication with Public Using Proper Language Over Extended Period of Time
Some Key References
