

***Direct Potable Reuse:  
Current projects and activities***

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**The California State University**  
***WATER RESOURCES AND POLICY INITIATIVES***  
Annual Conference  
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## *Overview of Presentation*

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- Driving Forces for DPR (and IPR)
- Types of Projects: Overview
- Trends on Treatment Technology
- Brine Management for IPR and DPR
- Regulatory Requirements
- A DPR Case Study: Southern California
- Need for Common Accepted Vocabulary
- Closing thoughts

***DRIVING FORCES  
FOR DPR AND IPR***

## *Driving Forces for DPR and IPR*

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- The value of water will increase significantly in the future (3 and up to 5 times in some locations)
- Population growth, especially along coasts
- De facto indirect potable reuse is largely unregulated
- Climate change-severe water shortages
- Opposition to inter basin water transfers
- Limited alternative sources of water
- Stringent environmental regulations
- Environmental protection of aquatic species
- Infrastructure requirements limit reuse opportunities
- Less expensive than other water supply options

## ***Impact of Population Demographics***

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- By 2030, 60-70(?) percent of world's population will live near a coastal region
- Withdrawing water from inland areas, transporting it to urban population centers, treating it, using it once, and discharging it to the coastal waters is **unsustainable**.

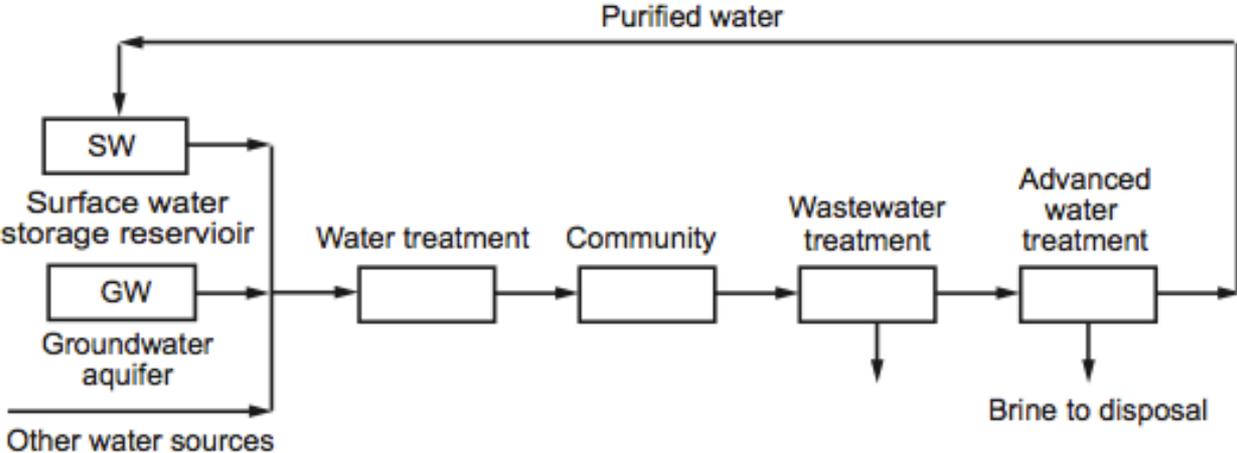
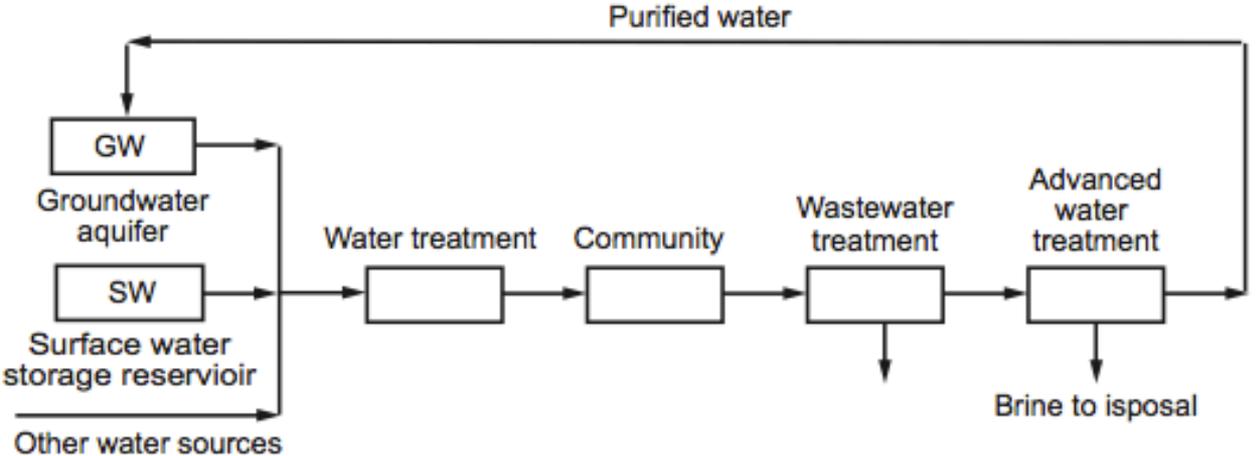
# Unregulated De Facto Indirect Potable Reuse



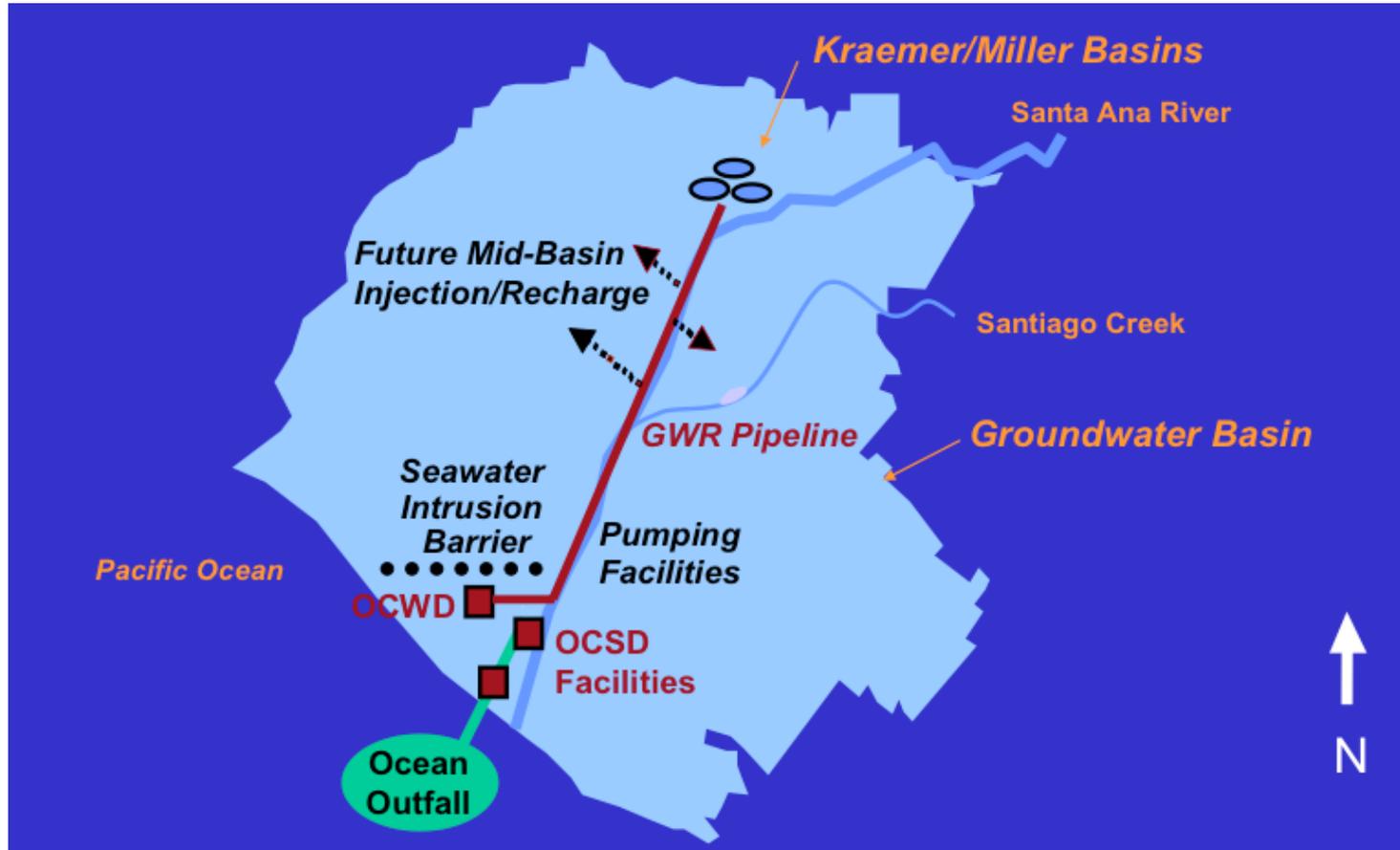
Courtesy City of San Diego

# ***TYPES OF IPR and DPR PROJECTS***

# Overview Indirect Potable Reuse



# Orange County Water District: Groundwater Augmentation By Injection and Surface Spreading



Courtesy OCWD

## ***Kraemer/Miller Spreading Basins, OCWD***



# *Infiltration Basin, Florida, USA*

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28.49 N, 81.62 W



Image © 2006 DigitalGlobe  
© 2006 Europa Technologies

© 2006 Google

# *Barrier Injection Wells*

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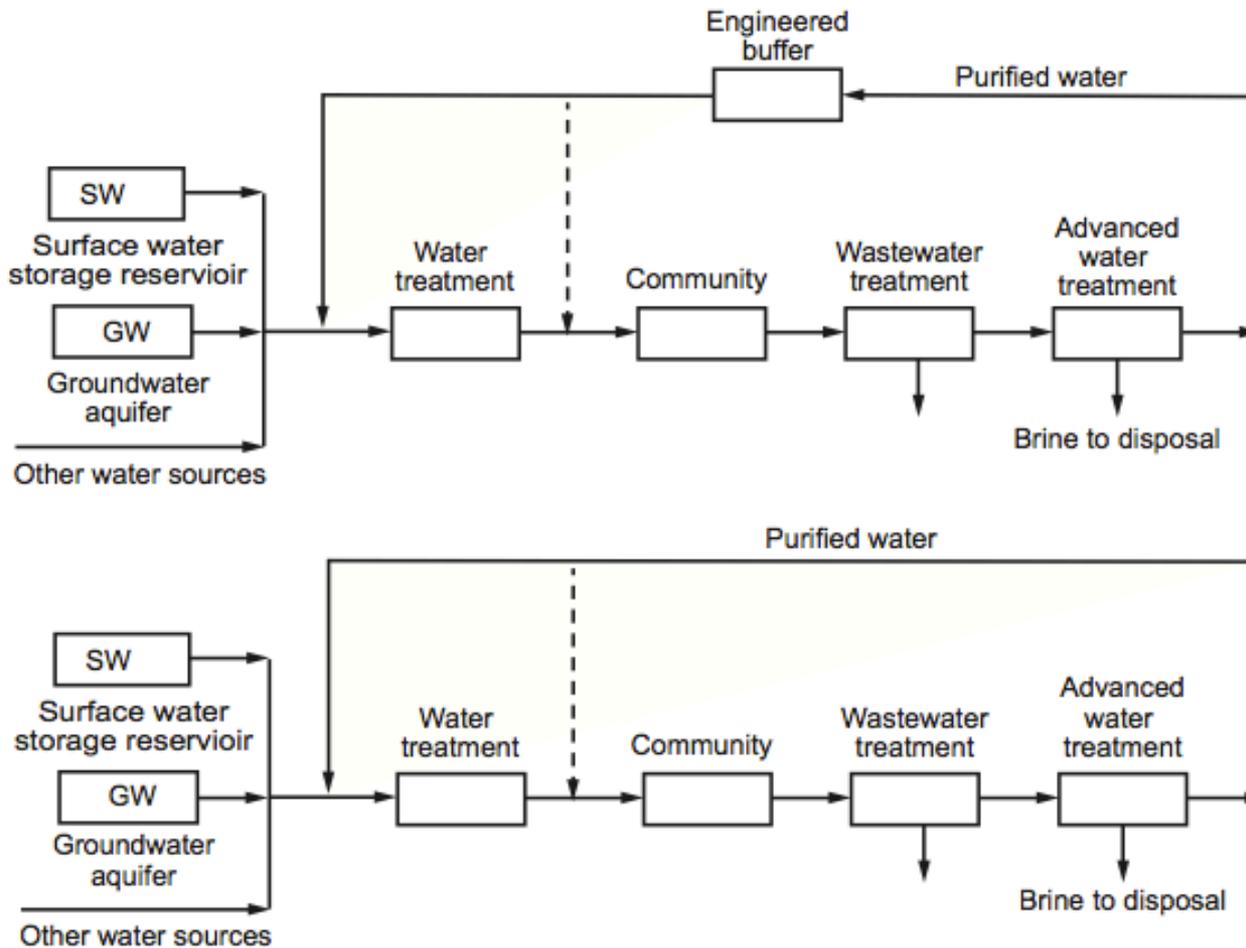


## ***San Vicente Reservoir, San Diego County***

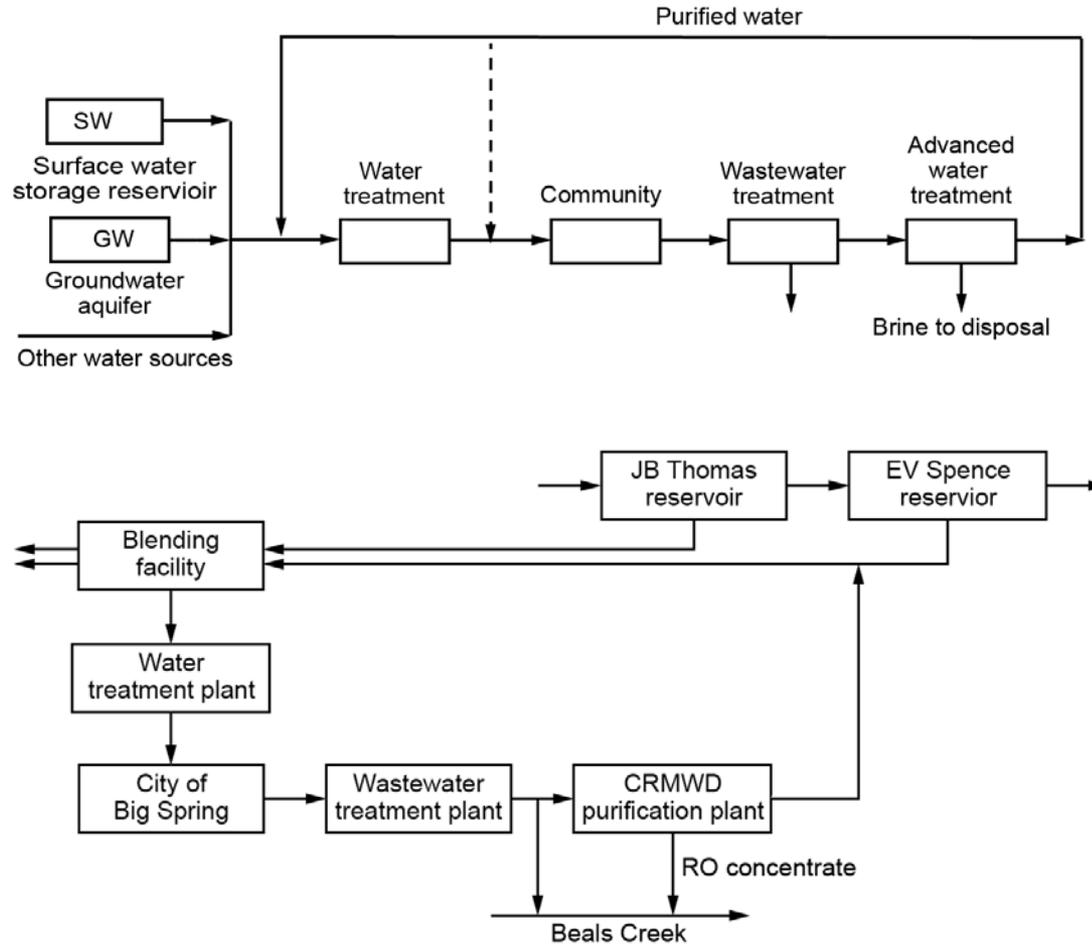
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# Overview Direct Potable Reuse



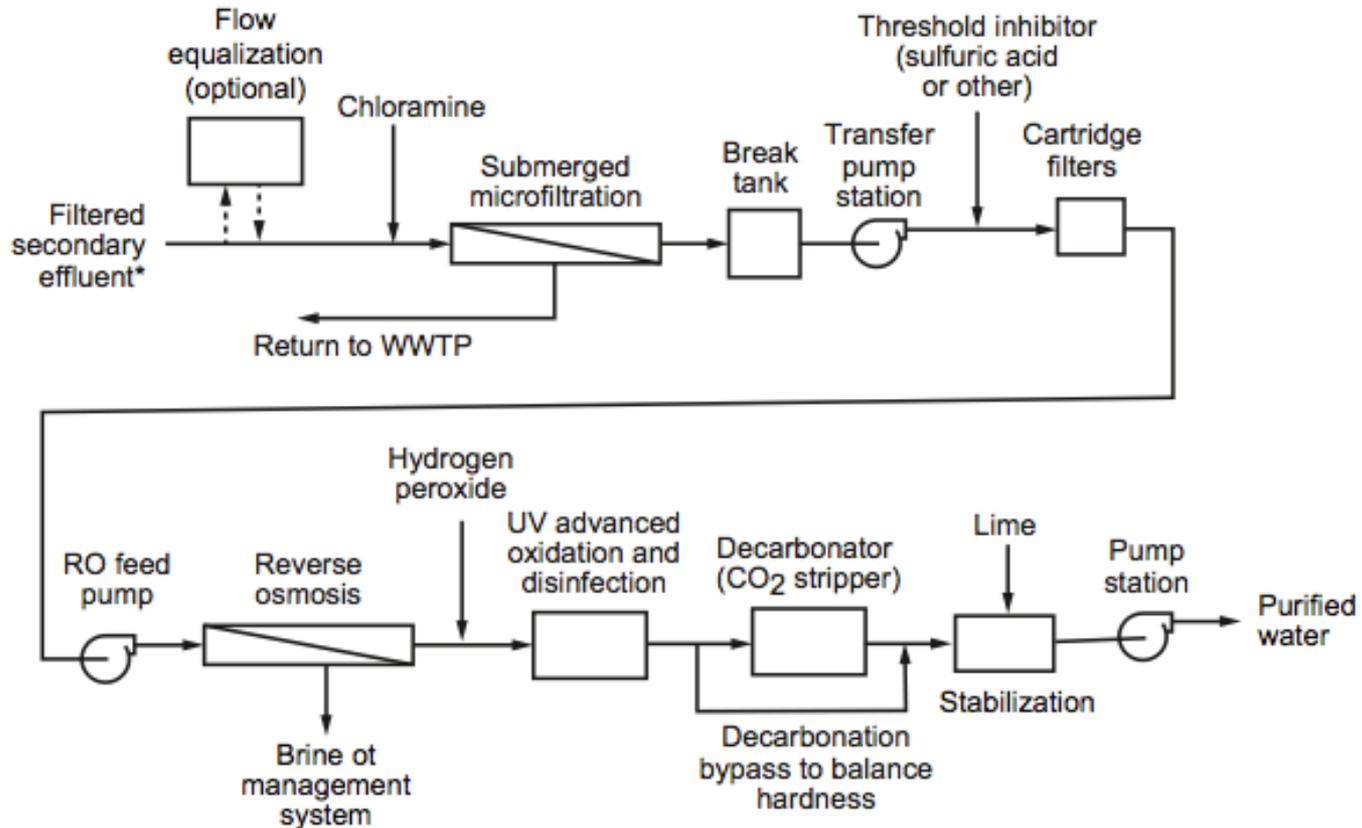
# Overview: Big Spring, TX Reuse Project



Adapted from Big Spring, TX

# ***TRENDS IN TREATMENT TECHNOLOGIES***

# OCWD Technology for Indirect and Direct Potable Reuse



\*If the secondary effluent is unfiltered, it may be necessary to add effluent filter screens

Adapted from OCWD

# ***Technologies at OCWD: Microfiltration, Cartridge Filters, Reverse Osmosis, and Advanced Oxidation (UV)***

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# *Ongoing Research at OCWD*

## *Testing of New Membrane Modules*

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***Orange County Water  
District, OCWD***

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***Lime Saturator  
(pH adjustment)***

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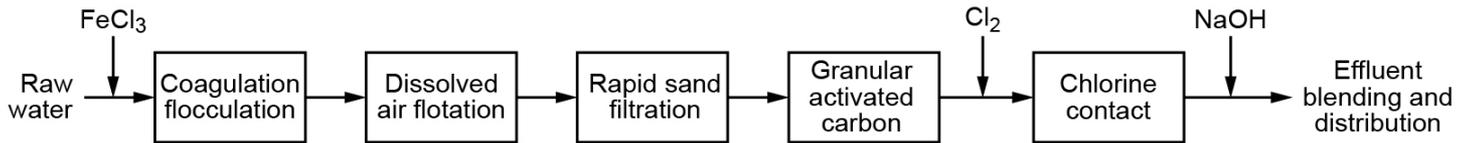


***Decarbonator  
(CO<sub>2</sub> Stripping)***

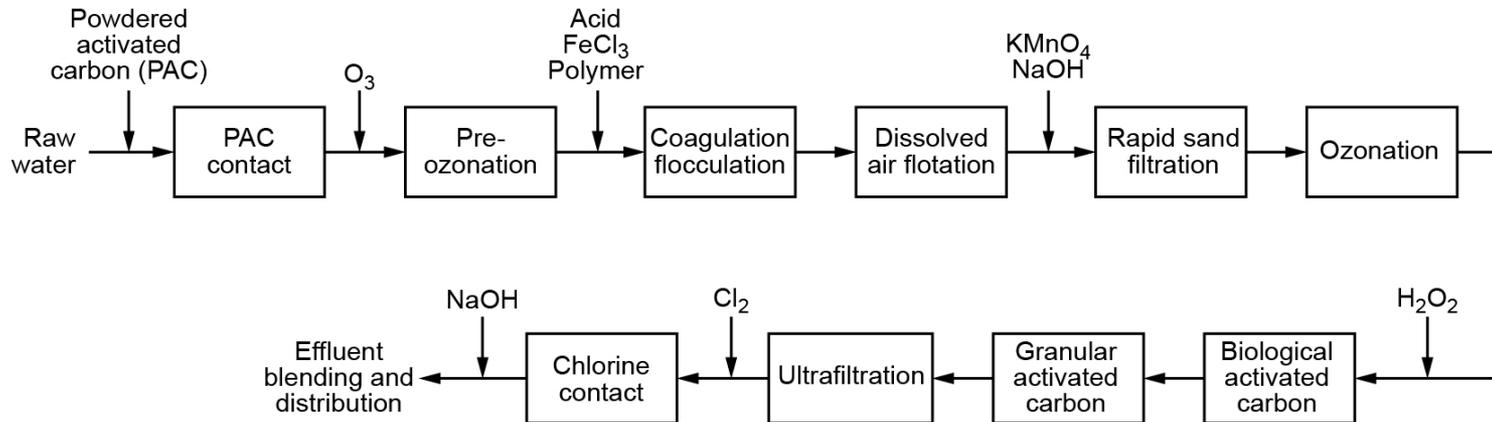
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# Alternative Process Flow Diagram Without Reverse Osmosis - Windhoek, Namibia



(a)



(b)

# Treatment Process Flow Diagram

## Pure Cycle Corporation (c.a. late 1970s)

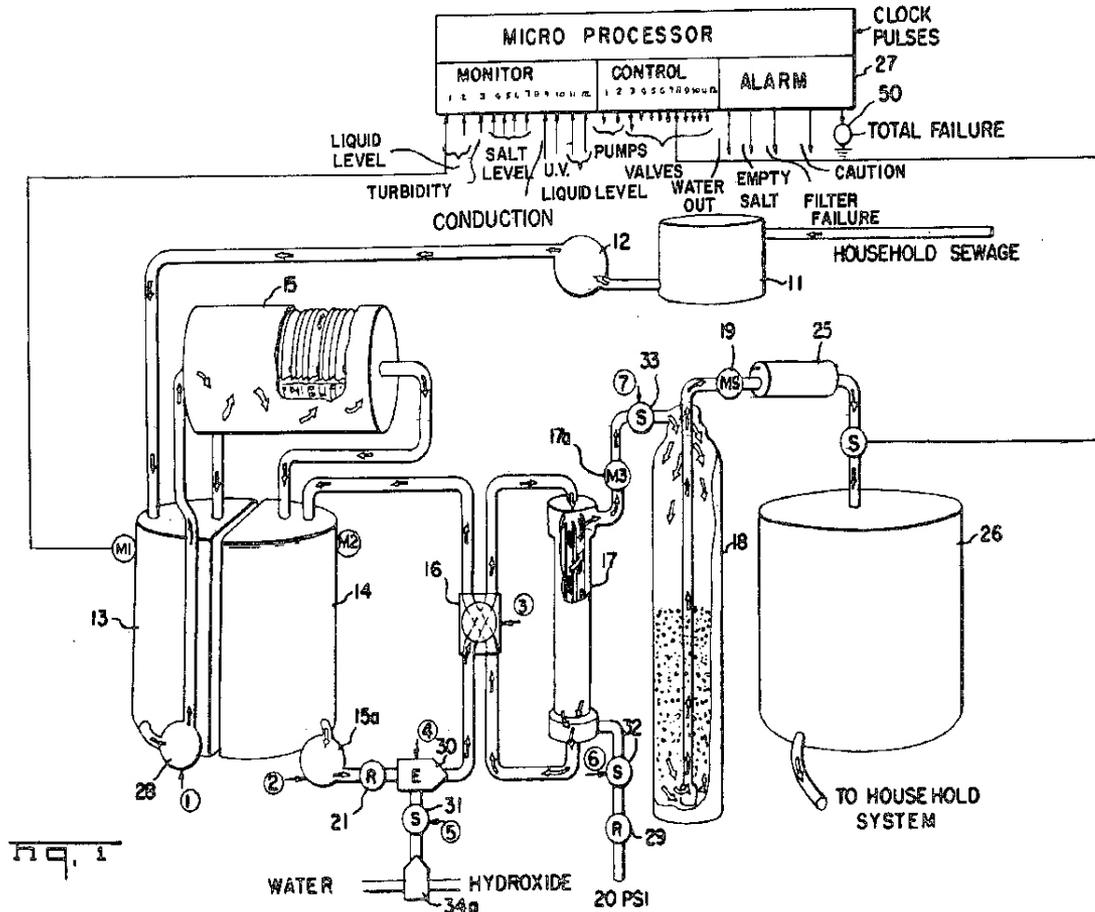
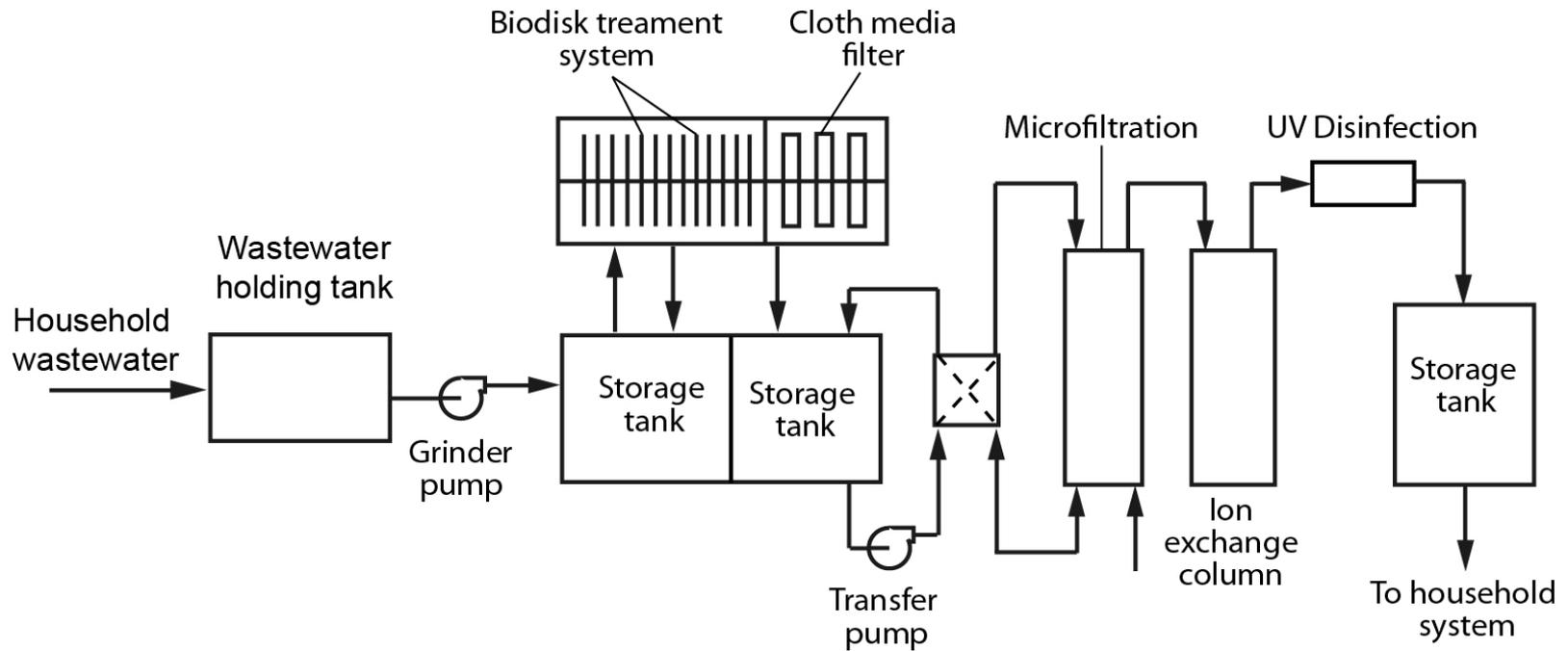


FIG. 1

# ***Treatment Process Flow Diagram***

## ***Pure Cycle Corporation (c.a. late 1970s)***

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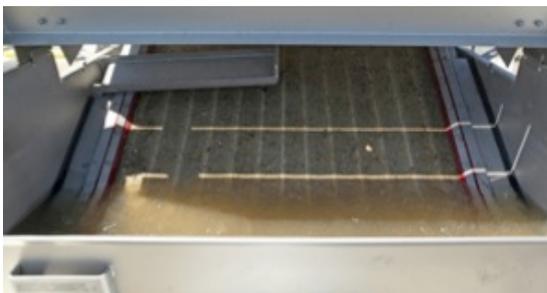
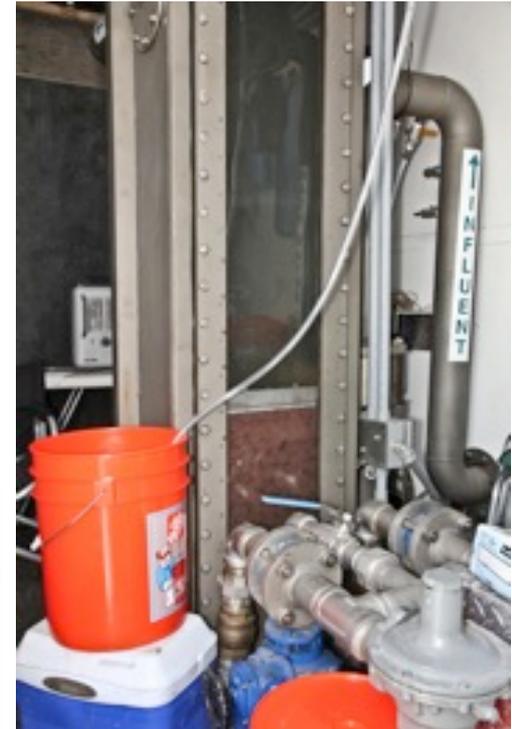
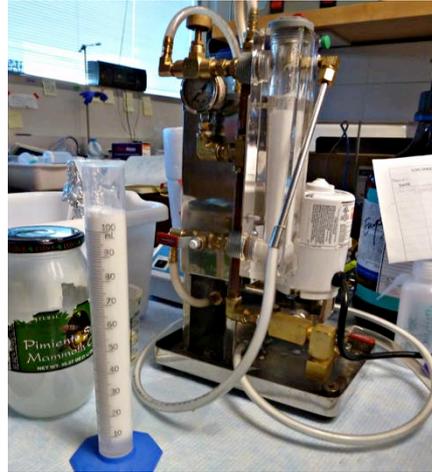
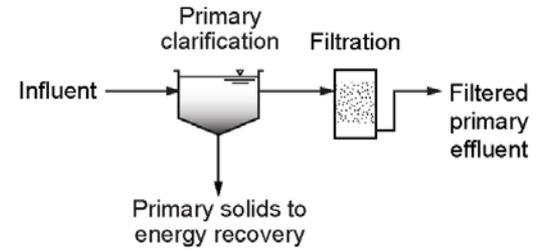
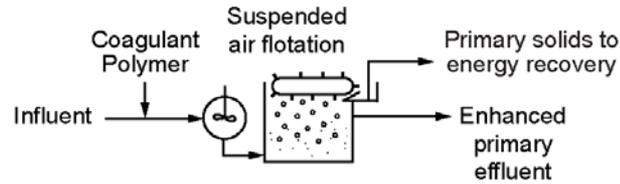
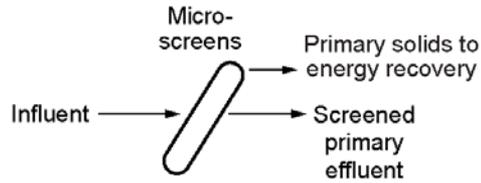


# *Impact of DPR and IPR on Future WWTP Design*

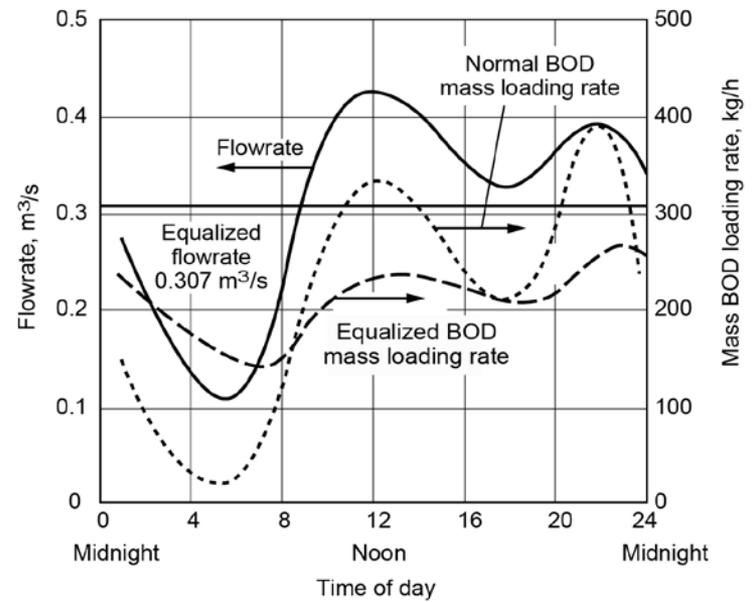
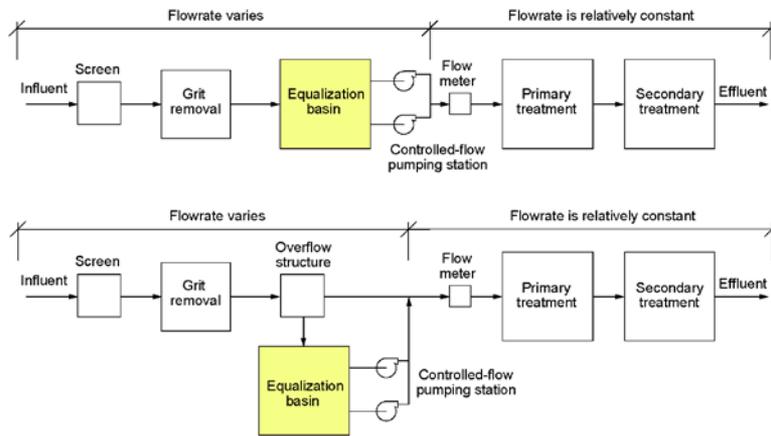
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- Targeted Source Control Program
- Modification of Raw Wastewater Characteristics
- Plant and Return Flow Equalization
- Elimination or Treatment of Process Return Flows
- Alternative End Point for Biological Process Design
- Chaos theory is operative at low concentrations
- Alternative (non biological) Treatment Processes
- Improved Design and Monitoring
- Ongoing Pilot Testing

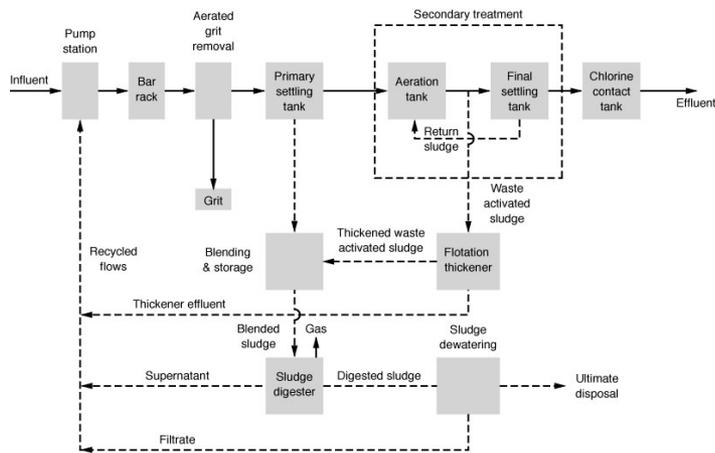
# Alternative Technologies for Altering Characteristics of Raw Wastewater before Biological Treatment



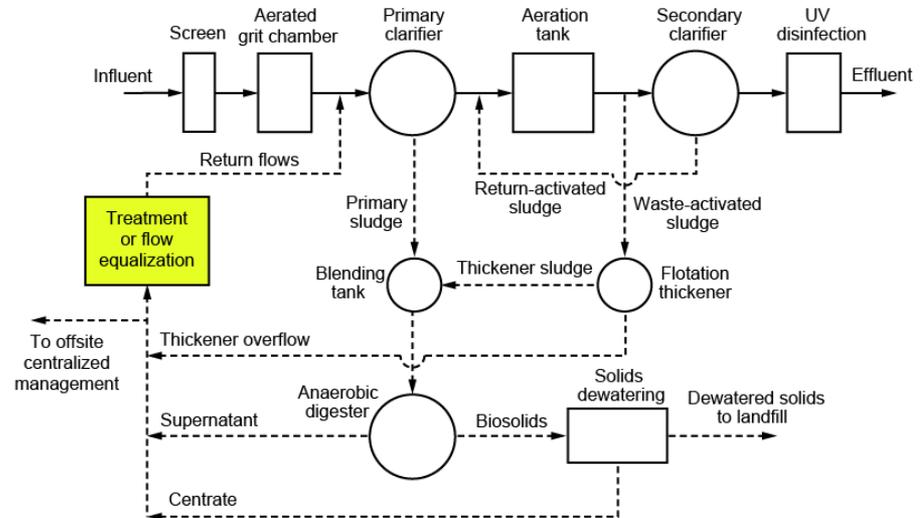
# ***In-Line and Off-Line Equalization For Enhanced Treatment Performance***



# Management of Return Flows, Flow Equalization, or Treatment

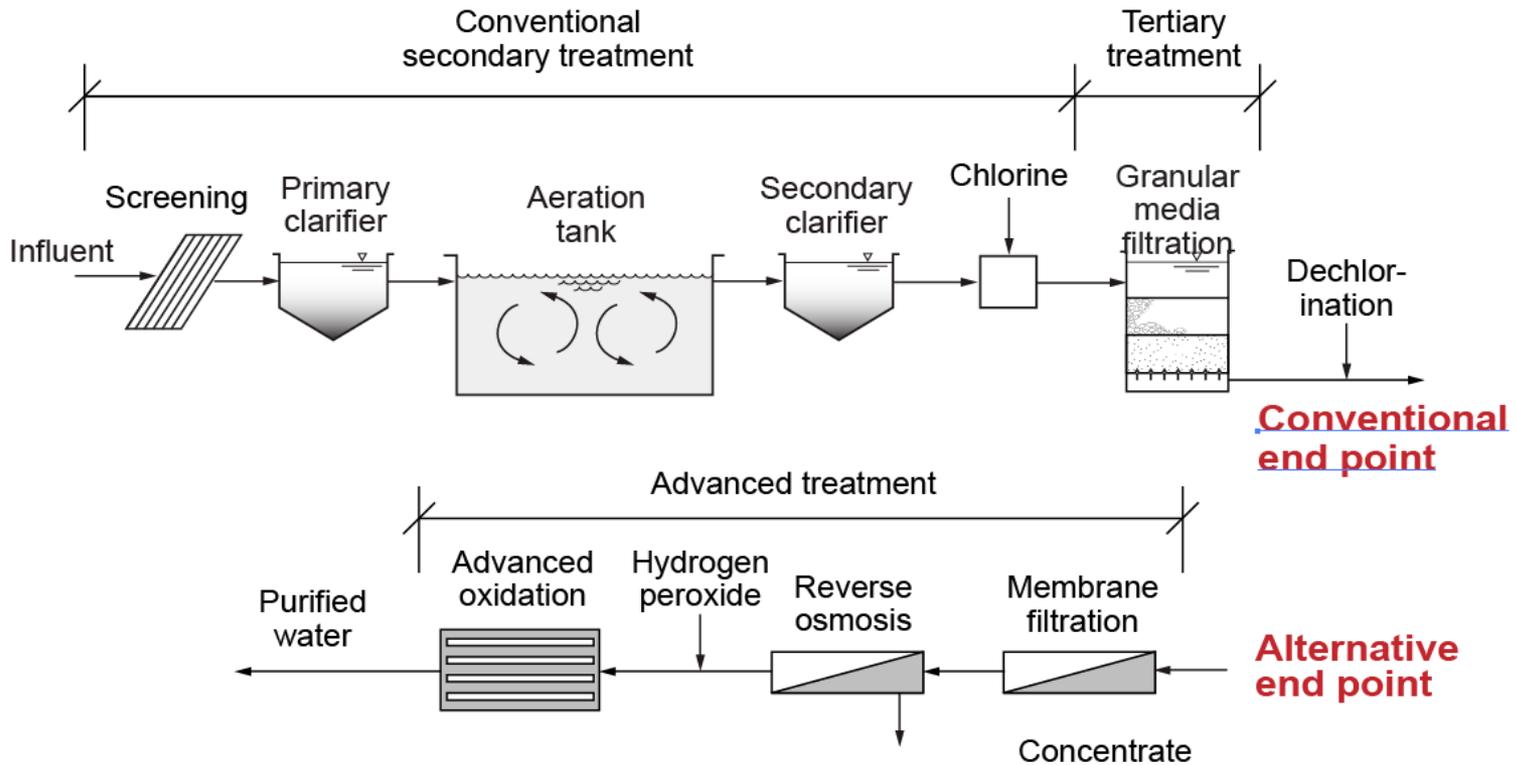


Conventional practice



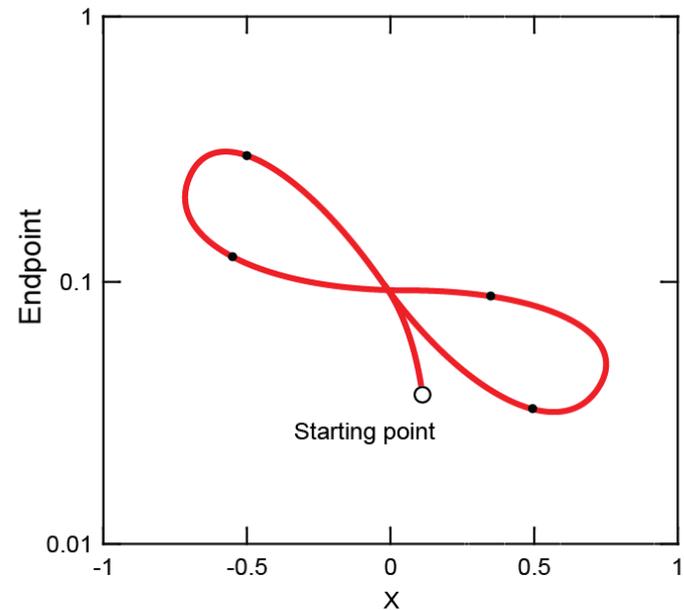
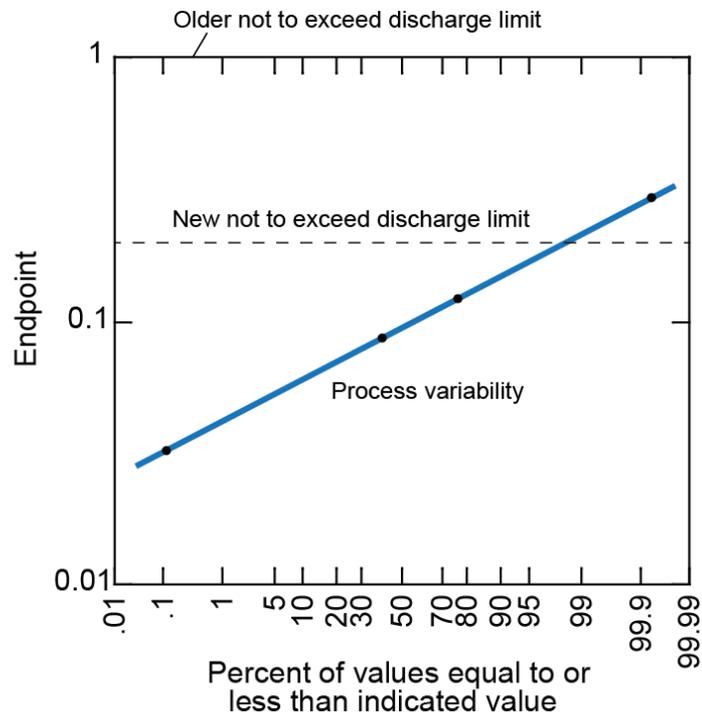
Process optimization with flow equalization and/or treatment

# Biological Process Design for Alternative End Point or Points



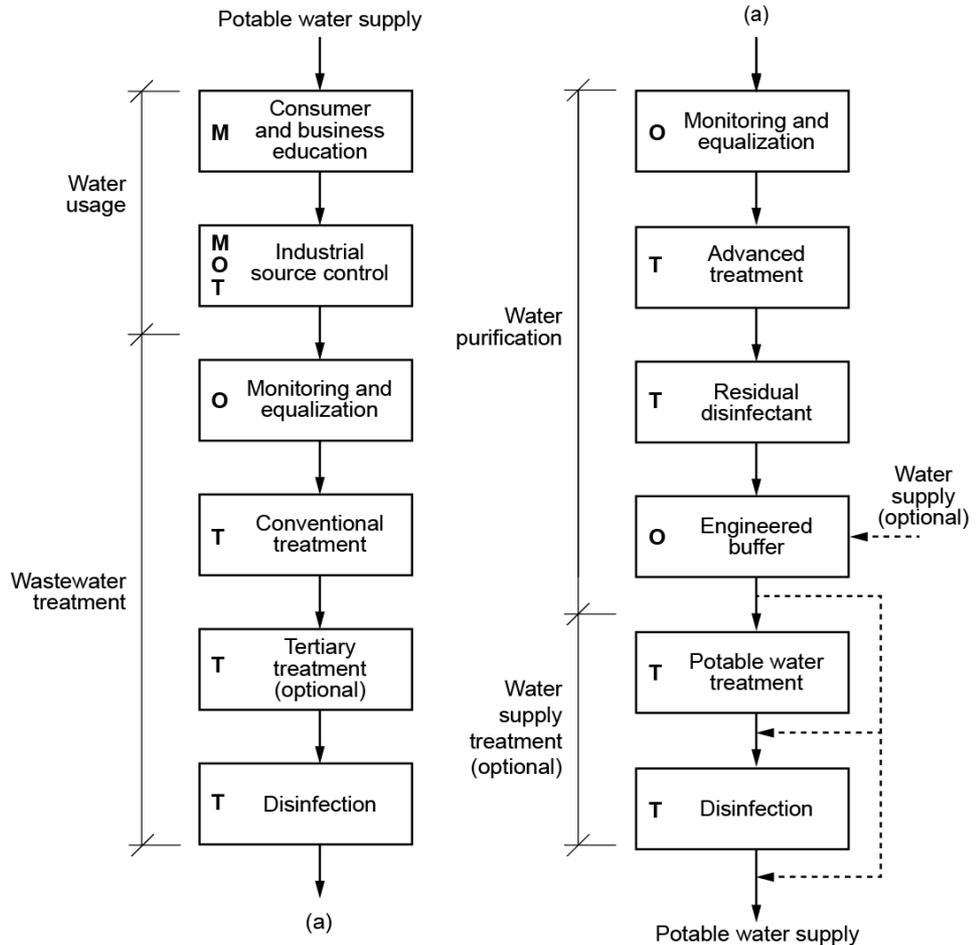
# Impact of Chaos Theory on Achieving Low Constituent Concentrations

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***Overall  
System Management***

# Management Operational, and Technological Barriers



## LEGEND

- M** = Management barrier
- O** = Operational barrier
- T** = Technological barrier

***BRINE MANAGEMENT  
FOR IPR AND DPR***

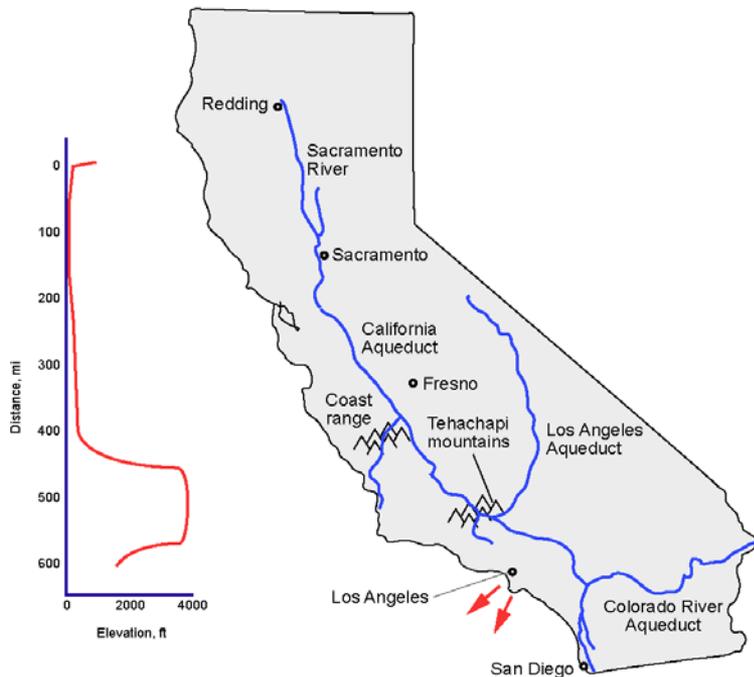
# ***Technologies for Brine Treatment and Ultimate Disposal Options***

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Treatment before disposal	Ultimate disposal
Multistage reverse osmosis	Surface water discharge (1)
Falling film evaporators	Discharge to wastewater collection system (2)
Crystallizers	Deepwell injection (3)
Forward osmosis	Evaporation ponds (without and with greenhouse) (4)
Membrane distillation	Land application (5)
Solar evaporators	Brine line to ocean
Spray dryers	
Vapor compression evaporators	
Evaporation/crystallization	

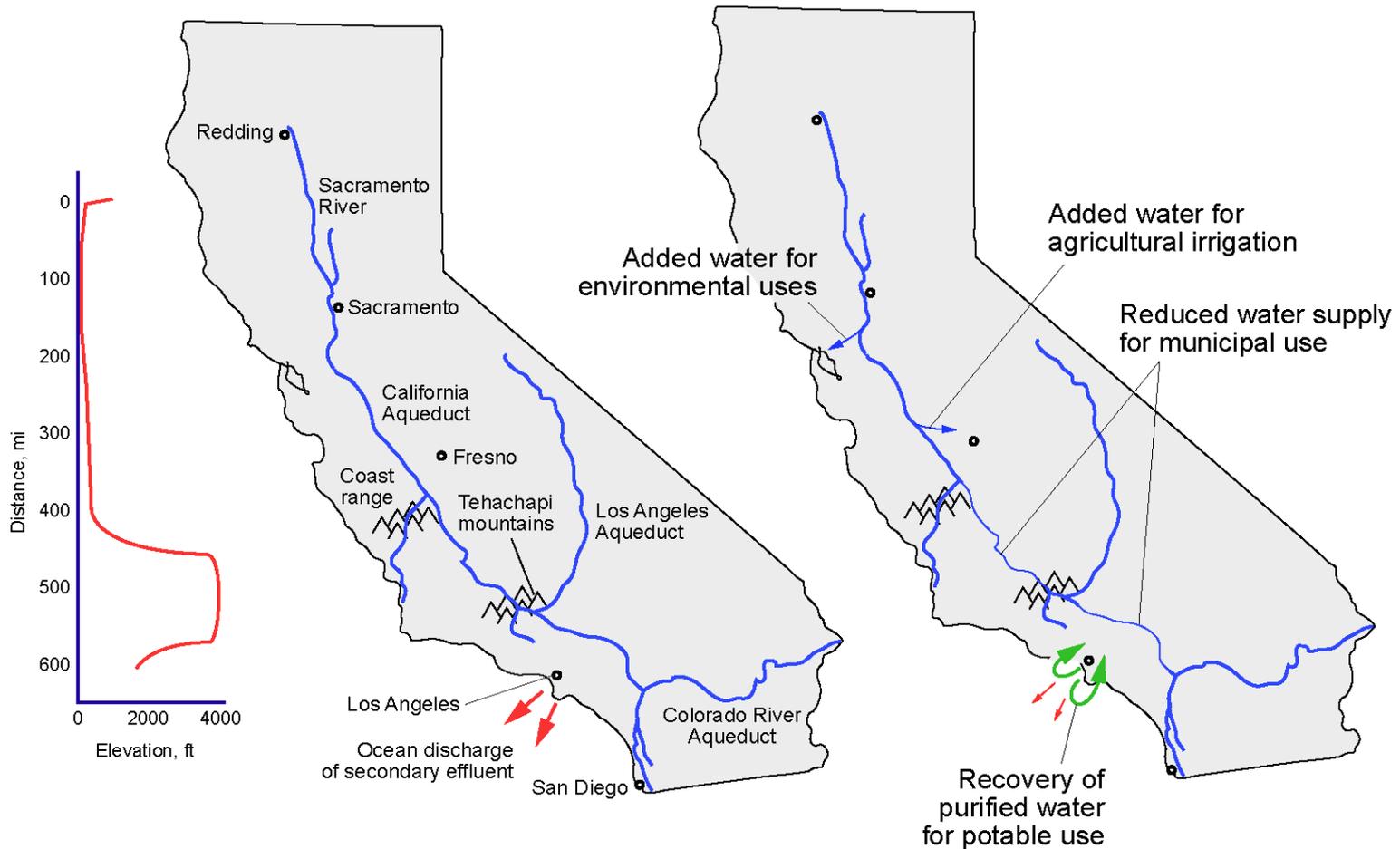
***A DPR CASE STUDY:  
SOUTHERN CALIFORNIA***

# Electric Power Consumption for Urban Water Systems in Northern and Southern CA



System	Power consumption, kWh/Mgal	
	Northern California	Southern California
Supply and conveyance	150	8,900
Water treatment	100	100
Distribution	1200	1200
Wastewater treatment	2,500	2,500
<b>TOTAL</b>	<b>3,950</b>	<b>12,700</b>

# Opportunities for the Future: The Southern California Example



# Wastewater Management Infrastructure - Potential Locations for Water Plants

## Legend

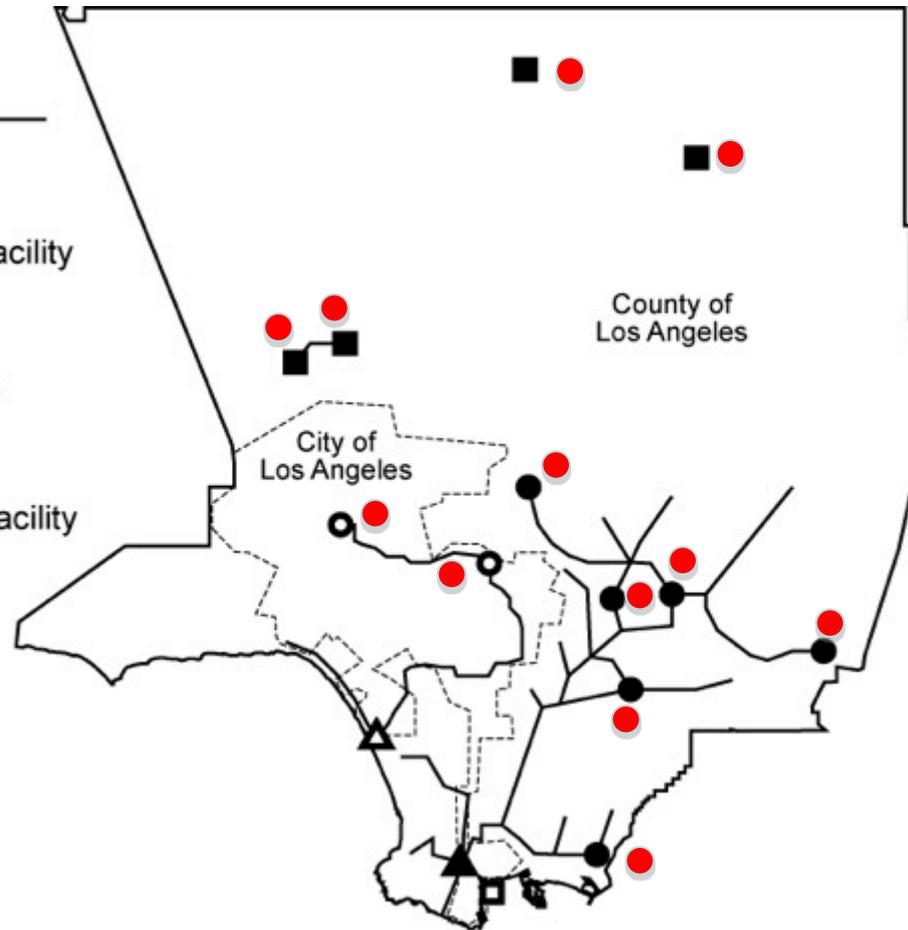
### City of Los Angeles

- ▲ Regional facility
- Satellite reclamation facility
- Distributed facility

### County Sanitation Districts of Los Angeles County

- ▲ Regional facility
- Satellite reclamation facility
- Distributed facility

- OCWD type plant



## ***Benefits of Southern California Example***

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- Reliable alternative source of supply, more secure from natural disasters
- Lower cost and reduced energy usage
- More water available for agricultural use, especially during drought periods
- Environmental benefits for bay delta habitat restoration

# ***REGULATORY REQUIREMENTS***

# *Science Versus Regulations*

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## **Pre 1880s**

Physical observations - No science - Common sense practices (regulations)

## **Enlightenment 1880-1980s**

Science develops - Semi-scientific, observational, and empirical regulations follow

## **Post 1980s**

Science leaps ahead - Science based regulations have evolved, but have not kept pace - **Semi-empirical and empirical legacy regulations persist.**

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***NEED FOR  
UNIFORM  
VOCABULARY***

# ***An Accepted Vocabulary is of Critical Importance for the Discussion of DPR***

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## **Issues**

- Not everyone agrees that direct or indirect potable reuse is acceptable
- Little standardization of terms (e.g., direct and indirect potable reuse)

## **Consequence**

- Everyone says whatever suits their particular interest
- The public is confused, especially about the safety of reclaimed water.

## **Approach**

- With a uniform vocabulary, DPR projects can be discussed rationally

***CLOSING THOUGHTS***

## *Closing Thoughts*

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Ultimately, **direct (and indirect) potable reuse** is inevitable in urban and other areas and will represent an essential element of a sustainable water future

- **Must think of wastewater differently**
- **Technology is not an issue**
- **The public is supportive**
- **To make it a reality, bold new planning must begin now!!**

## *The Future of DPR and IPR*

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Rather than regulations driving wastewater management as in the past, **THE VALUE OF POTABLE WATER, RESOURCES, and ENERGY** will propel developments in the 21<sup>st</sup> century.

***THANK YOU  
FOR LISTENING***