THE FUTURE OF DIRECT POTABLE REUSE

Direct Potable Reuse in California
Specialty Seminar
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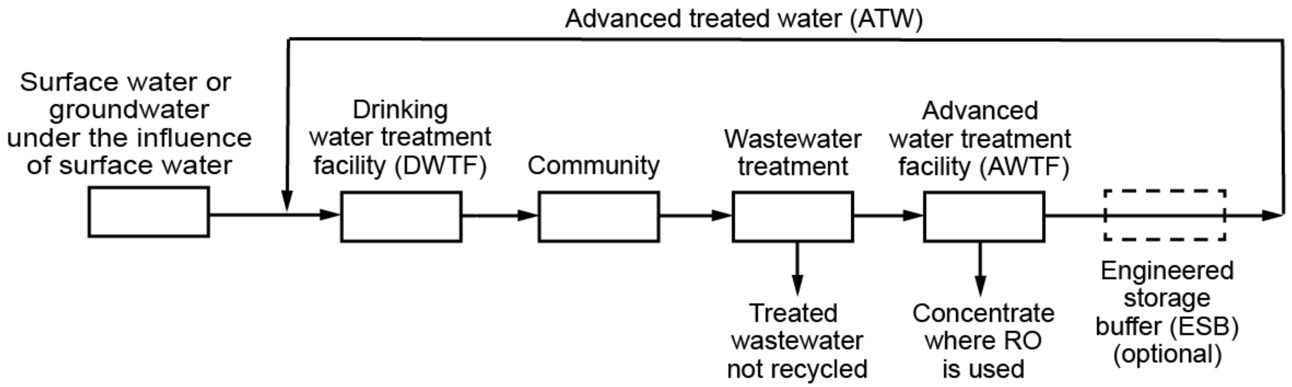
DISCUSSION TOPICS

What is Direct Potable Reuse
Some Historical Perspectives
Some Issues
Future Challenges

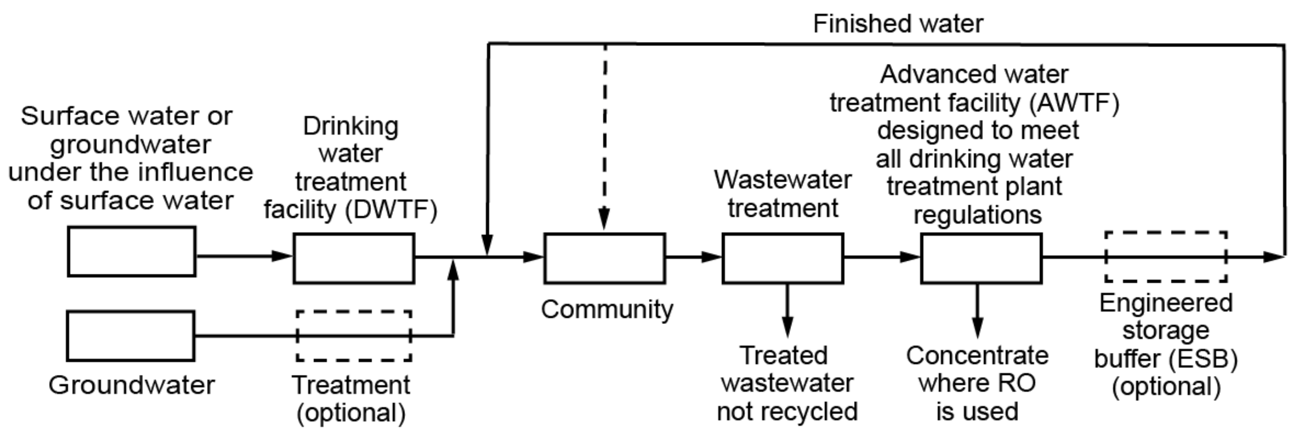
WHAT IS DIRECT POTABLE REUSE?

- DPR
- IPR
- De facto IPR
- Technologies
- Cost and energy usage versus other water sources and measures
- Where does potable reuse fit in the water portfolio

OVERVIEW: DIRECT POTABLE REUSE

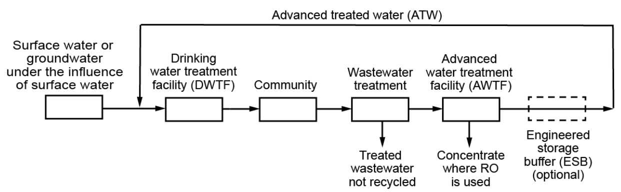


DPR with *advanced treated water (ATW)*

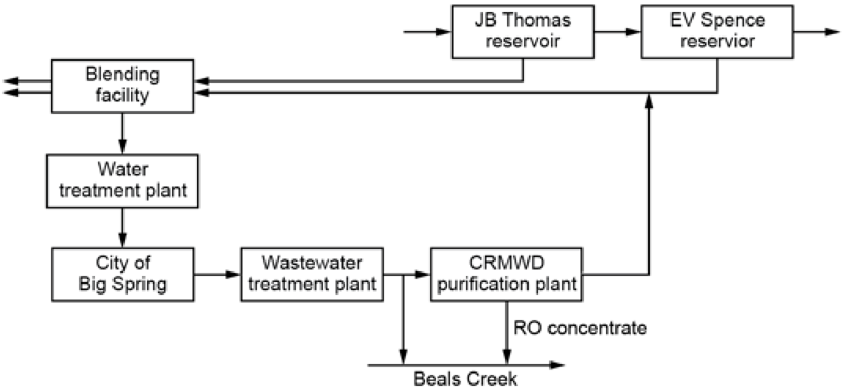


DPR with *finished water*

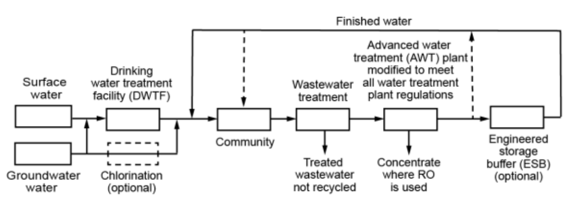
EXAMPLES OF DPR



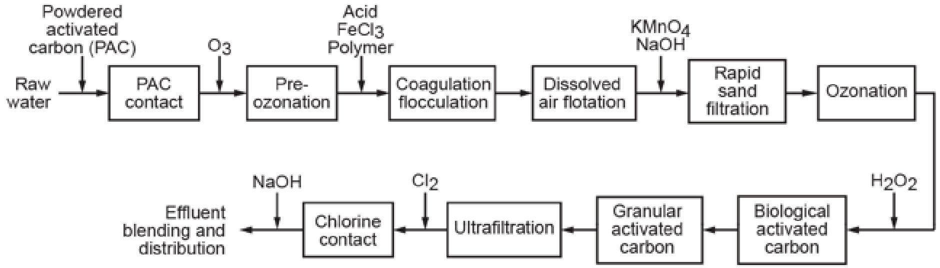
DPR with *advance treated water (ATW)*



Big Spring, Texas

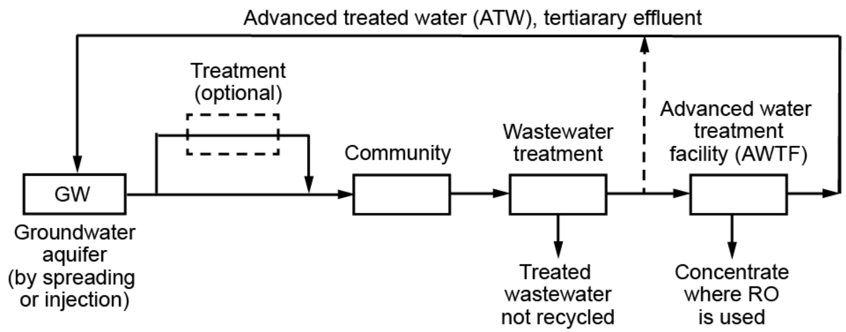


DPR with *finished* water

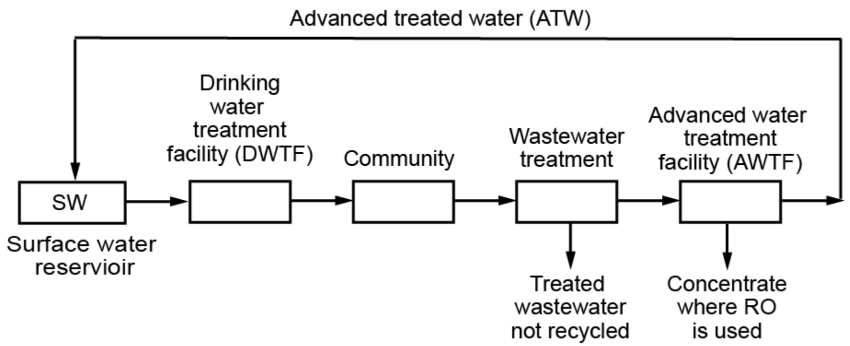


Windhoek, Namibia

OVERVIEW: INDIRECT POTABLE REUSE



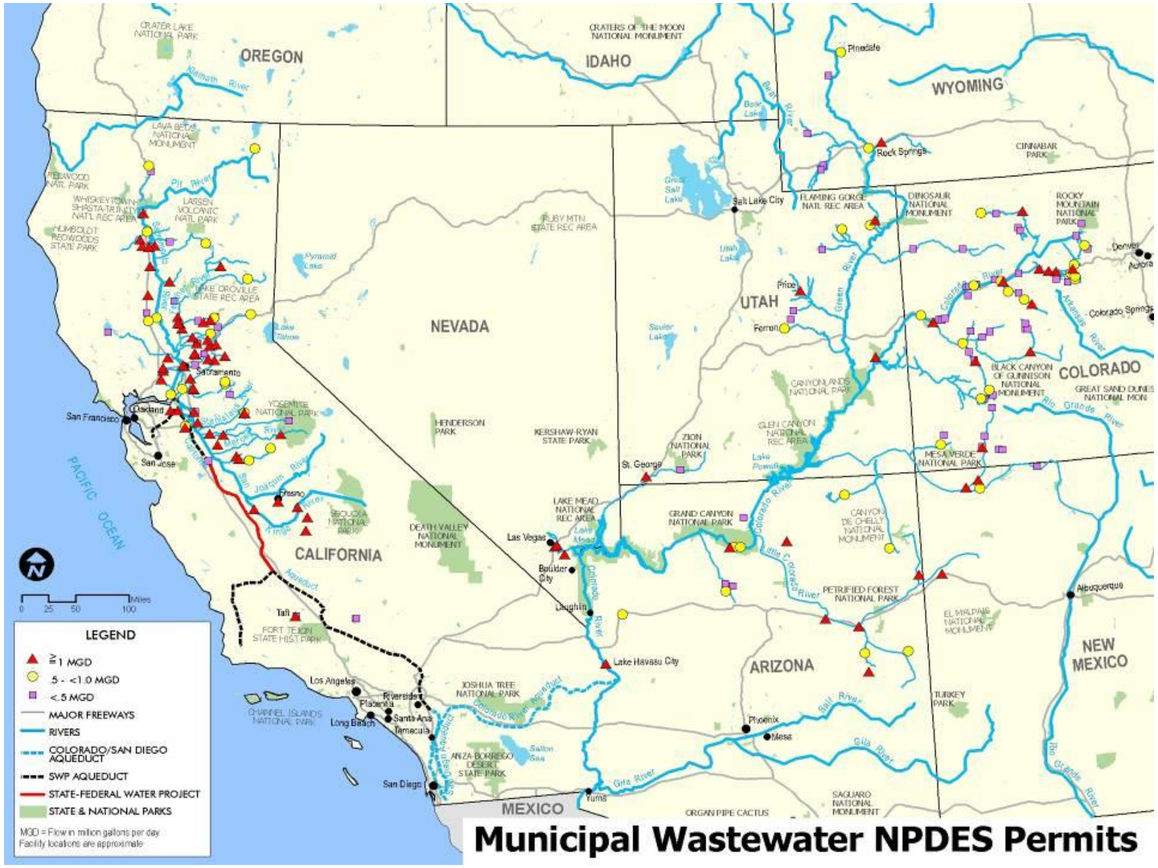
Typical injection well - OCWD



San Vicente reservoir, San Diego, CA

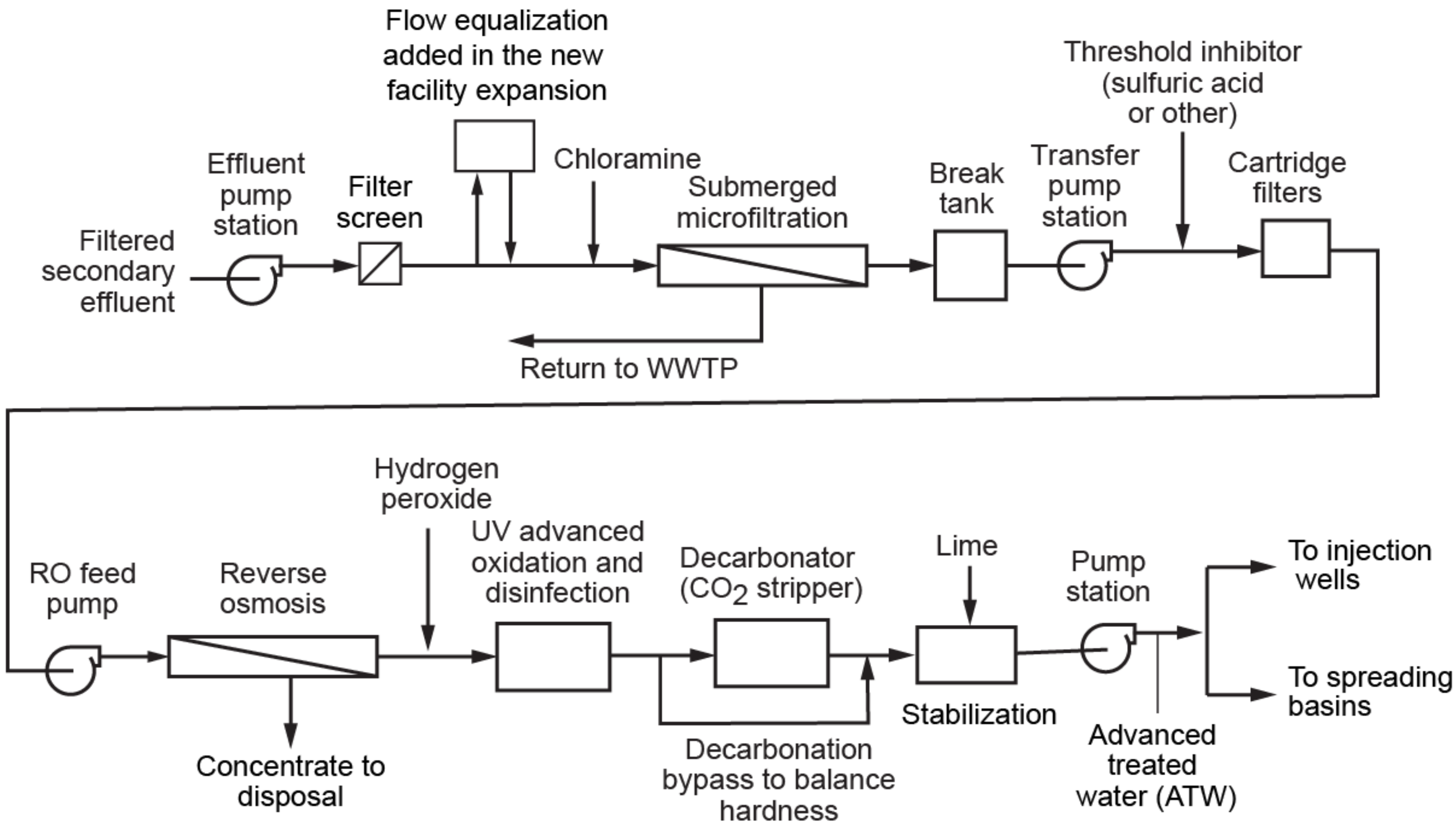
OVERVIEW: DE FACTO INDIRECT POTABLE REUSE

The downstream use of surface water as a source of drinking water that is subject to upstream wastewater discharges.



Courtesy City of San Diego

TECHNOLOGIES FOR THE INDIRECT AND DIRECT POTABLE REUSE



Adapted from OCWD

WHAT DOES DPR COST?

Supply option	Cost, $\$/10^{3}$ gal ($/AF)			
	Treatment	Residuals management	RO concentrate management	Conveyance facilities
ATW with RO	2.10 – 2.76 (685 – 900)	0.03 – 0.15 (10 – 50)	0.21 – 2.38 (70 – 775)	0.31 – 3.07 (100 – 1,000)
ATW without RO	1.23 – 2.15 (400 –700)	0.03 – 0.15 (10 – 50)	n.a.	0.31 – 3.07 (100 – 1,000)
Brackish groundwater desalination (inland)	2.76 – 3.84 (900 – 1,250)	0.06 – 0.31 (20 – 100)	0.21 – 2.15 (70 – 700)	0.92 – 6.14 (300 – 2,000)
Seawater desalination	5.52 – 6.44 (1,800 – 2,100)	0.06 – 0.31 (20 – 100)	0.31 – 0.61 (100 – 200)	1.23 – 9.21 (400 – 3,000)
Retail cost of treated imported surface water	1.23 – 3.99 (400 – 1,300)		n.a.	0.31 – 1.84 (100 – 600)
Water use efficiency, conservation, and use restrictions	1.38 – 2.92 (450 – 950)			0.31 – 1 .23 (100 – 400)

OCWD unsubsidized cost

DPR ENERGY USAGE

	Energy required			Carbon footprint kg $CO_{2e}/10^3$ gal
Technology/water source	Range, kWh/10^3 gal	Typical		
		kWh/10^3 gal	kWh/m^3	
Secondary treatment without nutrient removal	1.35 – 1.05	1.25	0.33	0.63
Tertiary treatment with nutrient removal effluent filtration	1.95 – 1.60	1.85	0.49	0.93
Advanced water treatment	3.25 – 3.50	3.30	0.87	1.65
Ocean desalination	9.50 – 14.75	12.00	3.17	6.00
Brackish water desalination	3.10 – 6.20	5.85	1.55	2.93
Interbasin transfer of water, California State Water Project	7.92 – 9.92	9.20	2.43	4.60
Interbasin transfer of water, Colorado River water	6.15 – 7.40	6.15	1.62	3.07
Conventional water treatment	0.30 – 0.40	0.37	0.10	0.19
Membrane-based water treatment	1.00 -1.50	1.25	0.33	0.63

OCWD actual energy usage

WHERE DOES POTABLE REUSE FIT IN THE WATER PORTFOLIO?

WATER SOURCES

- Local surface water
- Local groundwater
- Imported water
- Potable reuse
- Desalination (brackish and sea water)

OTHER MEASURES

- Centralized non-potable reuse (e.g., purple pipe)
- Decentralized non-potable reuse (e.g.,greywater)
- Conservation and curtailments

SOME HISTORICAL PERSPECTIVE

Individuals

- A. (Allen) Hazen (1914)
- R. F. Goudey (1930)

Three Important Workshops

Four Useful Documents

ALLEN HAZEN (1914)
"CLEAN WATER AND HOW TO GET IT"

"Looking at the whole matter as one great engineering problem, it is clear and unmistakably better to purify the water supplies taken from rivers than to purify the sewage before it is discharged into them. It is very much cheaper to do it this way. The volume to be handled is less and the per million gallons the cost of purifying water is much less than the cost of purifying sewage"

R. F. GOUDEY (TALK, October 30, 1930)*
RECLAMATION OF TREATED SEWAGE

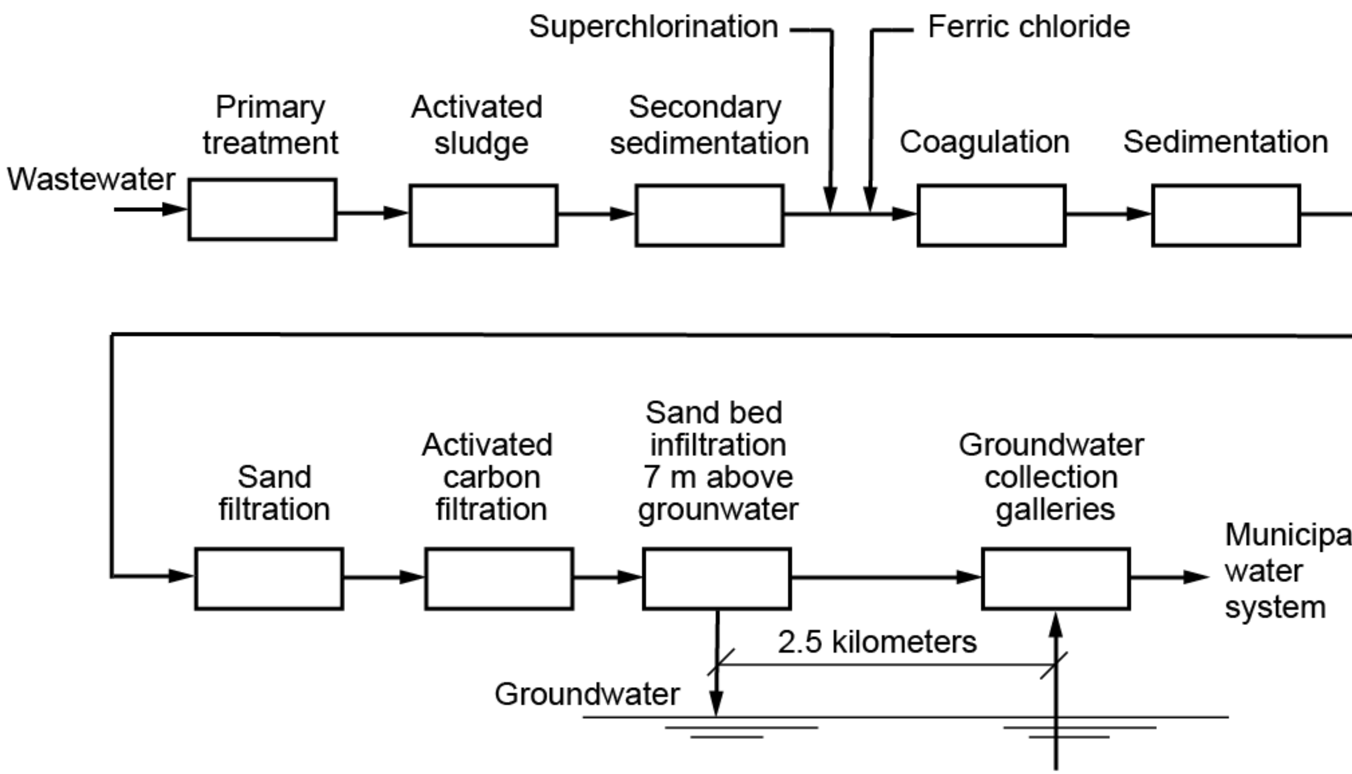
"Reclamation of sewage in Southern California, is coming whether we like it or not. It is not a. question of sewage disposal, but one directly related to a legitimate increase in water supply."

*Sanitary Engineer, Department of Water and Power, Los Angeles, CA. Formally, with the Bureau of Sanitary Engineering, Department of Public Health.

R. F. GOUDEY (TALK, October 30, 1930)
RECLAMATION OF TREATED SEWAGE

"California likewise need have no fear of eastern criticism, for it is in the east where one finds the most primitive methods of reclamation being practiced with no thought of their being questionable or repulsive. What else is it than reclamation where city after city discharges crude sewage into streams used by cities below for water supply intakes. But it is uncontrolled and unreliable reclamation."

GOUDEY'S TREATMENT SYSTEM



Politicians noted that Los Angeles would have to drink sewage if the bond issue to bring Colorado River water to Los Angeles did not pass

THREE IMPORTANT WORKSHOPS

March, 1975, U.S. EPA Workshop on *Research Needs for the Potable Reuse of Municipal Wastewater*. (Three years after passage of CWA and five years after establishment of EPA)

July, 1980, U.S. EPA Workshop on *Protocol Development: Criteria and Standards for Potable Reuse and Feasible Alternatives*.

April, 2010, WateReuse California Workshop *on Direct Potable Reuse.* The report *Potable Reuse: A Path Forward* evolved out of the workshop.

FOUR USEFUL DOCUMENTS

NRC (1998) *Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies With Reclaimed Water*.

NRC (2012) *Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater*.

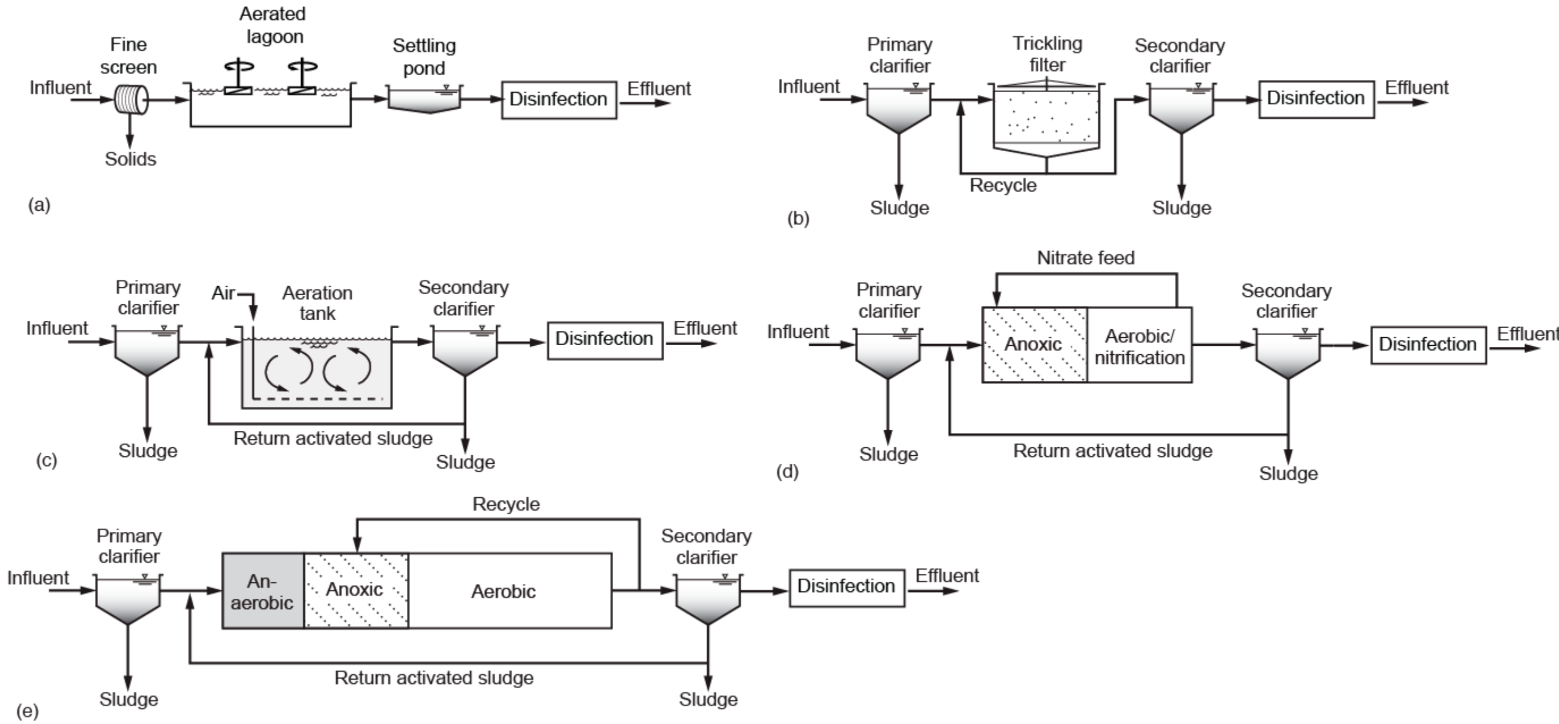
WateReuse (2011) *Direct Potable Reuse: A Path Forward.*

WateReuse, AWWA, WEF, and NWRI (2015) *Framework for Direct Potable Reuse*.

ISSUES THAT MAY IMPACT DPR AND IPR

- Suitability of typical wastewater treatment processes for DPR (and IPR)
- Impact of climate change
- Impact of conservation

ARE ALL SECONDARY WASTEWATER TREATMENT PROCESSES SUITABLE FOR DPR?



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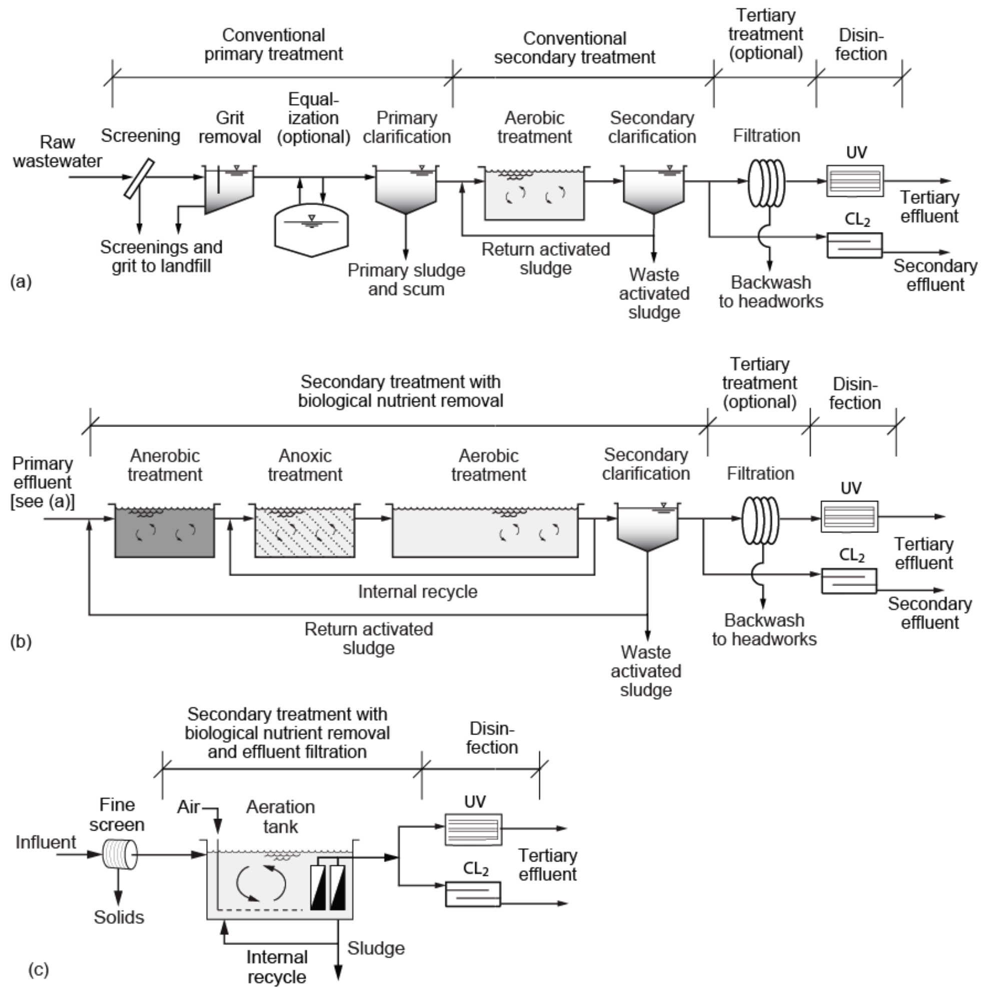
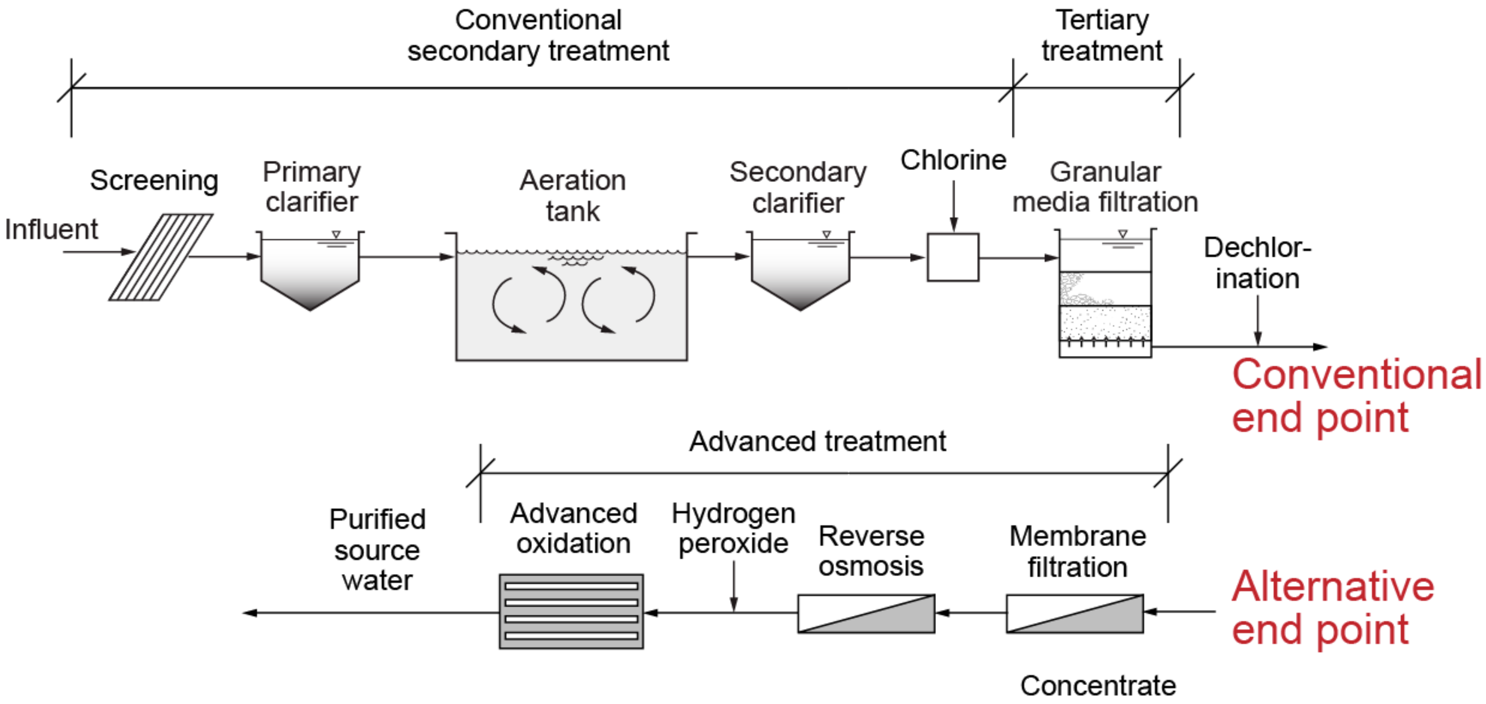


DIFFERENCES IN EFFLUENT QUALITY BETWEEN ACCEPTED SECONDARY TREATMENT PROCESSES

Constituent	Unit	Untreated wastewater	Range of effluent quality after indicated treatment					
			Conventional activated sludge	Conventional activated sludge with filtration	Activated sludge with BNR	Activated sludge with BNR and filtration	Membrane bioreactor
Total suspended solids (TSS)	mg/L	130 - 389	5 - 25	2 - 8	5 - 20	1 - 4	<1 - 5
Turbidity	NTU	80 - 150	2 - 15	1 –5	1 - 5	1 - 5	<1 - 2
Biochemical oxygen demand (BOD)	mg/L	133 - 400	5 - 25	< 5 - 20	5 - 15	1 - 5	<1 - 5
Chemical oxygen demand (COD)	mg/L	339 - 1016	40 - 80	30 - 70	20 - 40	20 - 30	<10 - 30
Total organic carbon (TOC)	mg/L	109 - 328	20 - 40	15 - 30	10 - 20	1 - 5	<0.5 - 5
Ammonia nitrogen	mg N/L	14 - 41	1 - 10	1 - 6	1 - 3	1 - 2	<1 - 5
Nitrate nitrogen	mg N/L	0 - trace	5 - 30	5 - 30	<2 - 8	1 - 8	<8[c]
Nitrite nitrogen	mg N/L	0 - trace	0 - trace	0 - trace	0 - trace	0.001 - 0.1	0 - trace
Total nitrogen	mg N/L	23 - 69	15 - 35	15 - 35	3 - 8	2 - 5	<10[d]
Total phosphorus	mg P/L	3.7 - 11	3 - 10	3 - 8	1 - 2	≤2	<0.3[d] - 5
Volatile organic compounds (VOCs)	mg/L	<100 – >400	10 – 40	10 - 40	10 – 20	10 - 20	10 - 20
Iron and Manganese	mg/L	1 – 2.5	1 – 1.5	1 - 1.4	1 - 1.5	1 - 1.5	trace
Surfactants	mg/L	4 - 10	0.5 - 2	0.5 - 1.5	0.1 - 1	0.1 - 1	0.1 - 0.5
Totals dissolved solids (TDS)	mg/L	374 - 1121	374 - 1121	374 - 1121	374 - 1121	374 - 1121	374 - 1121
Trace constituents	mg/L	10 - 50	5 to 40	5 - 30	5 - 30	5 - 30	0.5 - 20
Total coliform	No./100 mL	$10^6 – 10^{10}$	$10^4 - 10^5$	$10^3 - 10^5$	$10^4 - 10^5$	$10^4 - 10^5$	<100
Protozoan cysts and oocysts	No./100 mL	$10^1 – 10^5$	$10^1 - 10^2$	0 -10	0 -10	0 -1	0 - 1
Viruses	PFU/100 mL	$10^1 – 10^4$	$10^1 - 10^3$	$10^1 - 10^3$	$10^1 - 10^3$	$10^1 - 10^3$	$10^0 - 10^3$

DESIGN OF BIOLOGICAL TREATMENT PROCESS FOR ALTERNATIVE END POINT



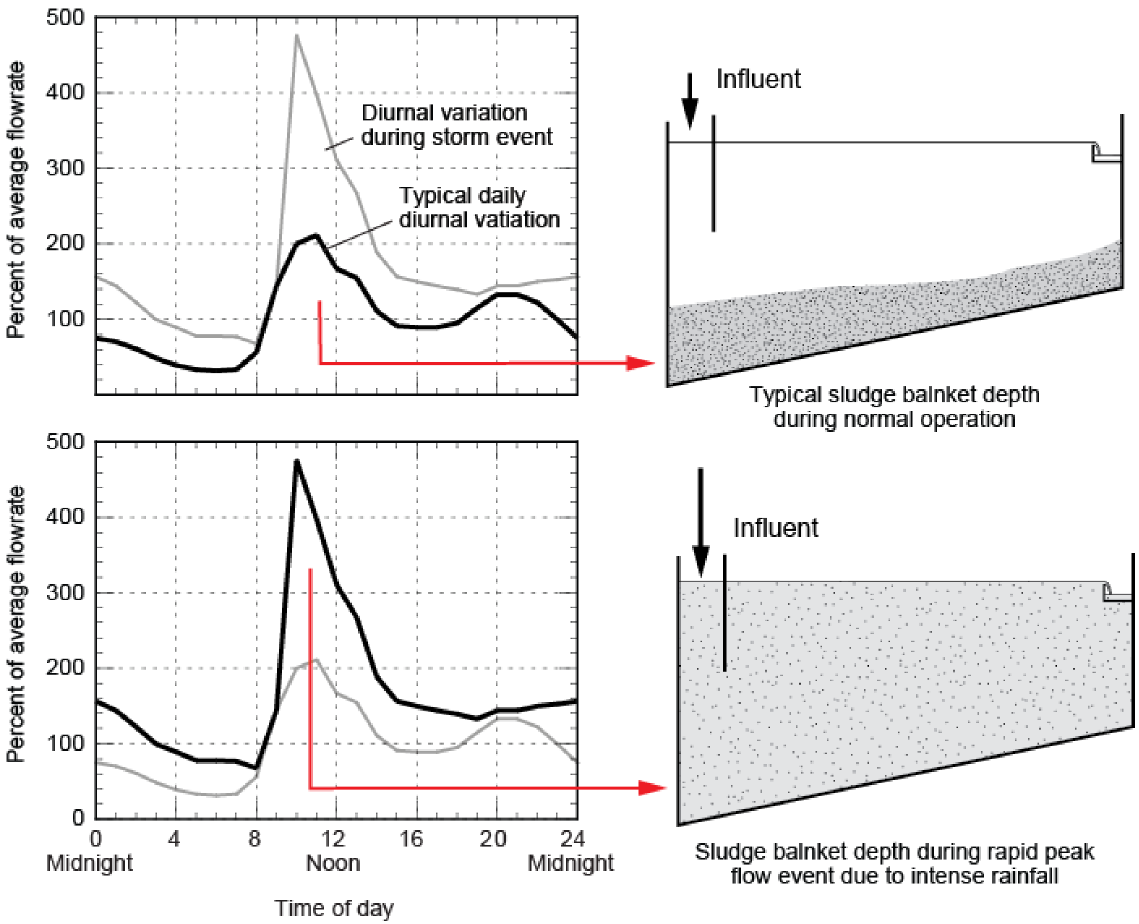
It is time to rethink wastewater treatment

MEASURES TO IMPROVE PERFORMANCE AND ENHANCE RELIABILITY OF EXISTING WWTPs

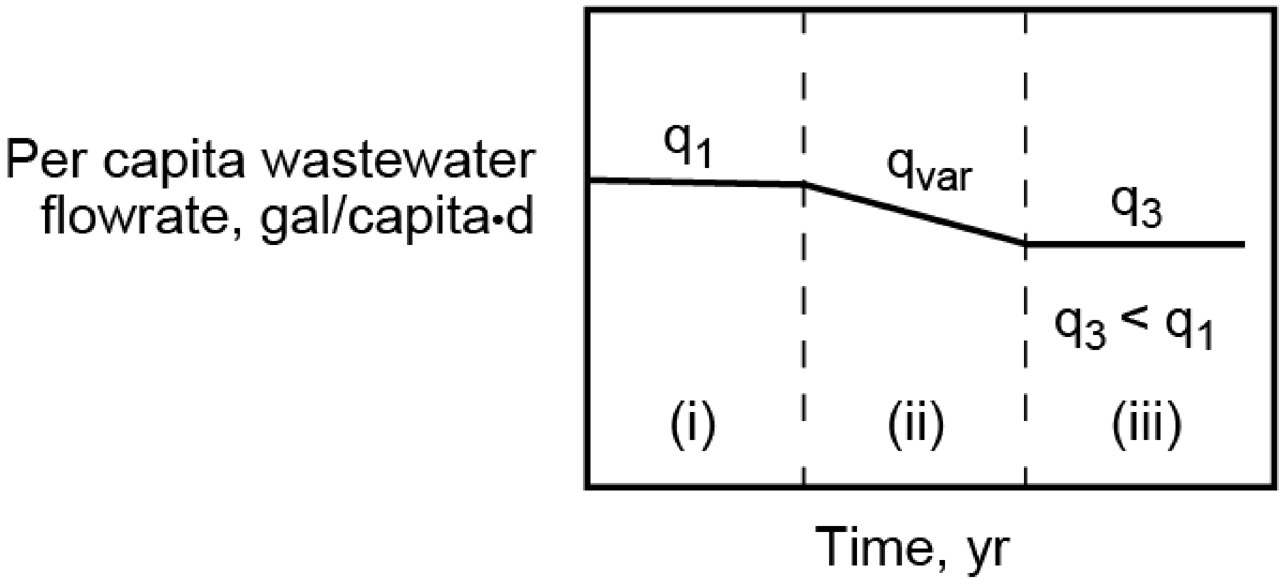
Measure	Value of each measure[a]
Enhanced screening process and possibly fine screening (2 to 6 mm)	Efficiency, reliability
Influent flow and load equalization	Efficiency, water quality, reliability
Elimination (or equalization) of untreated return flows	Water quality, reliability
Operational mode for biological treatment process	Water quality, reliability
Effluent filtration and disinfection	Water quality, reliability
Improved process monitoring	Water quality, reliability

[a]*Efficiency* – increases the overall cost efficiency of operation. *Water quality* – increases the final potable water quality. *Reliability* – increases the overall stability and performance of the treatment train.

IMPACT OF CLIMATE CHANGE ON RAINFALL INTENSITY AND OPERATION OF WWTPS



IMPACT OF CONSERVATION ON OPERATION OF COLLECTION SYSTEMS, WWTPS, AND POTABLE REUSE



(i) Pre-1992

(ii) Improved water conservation

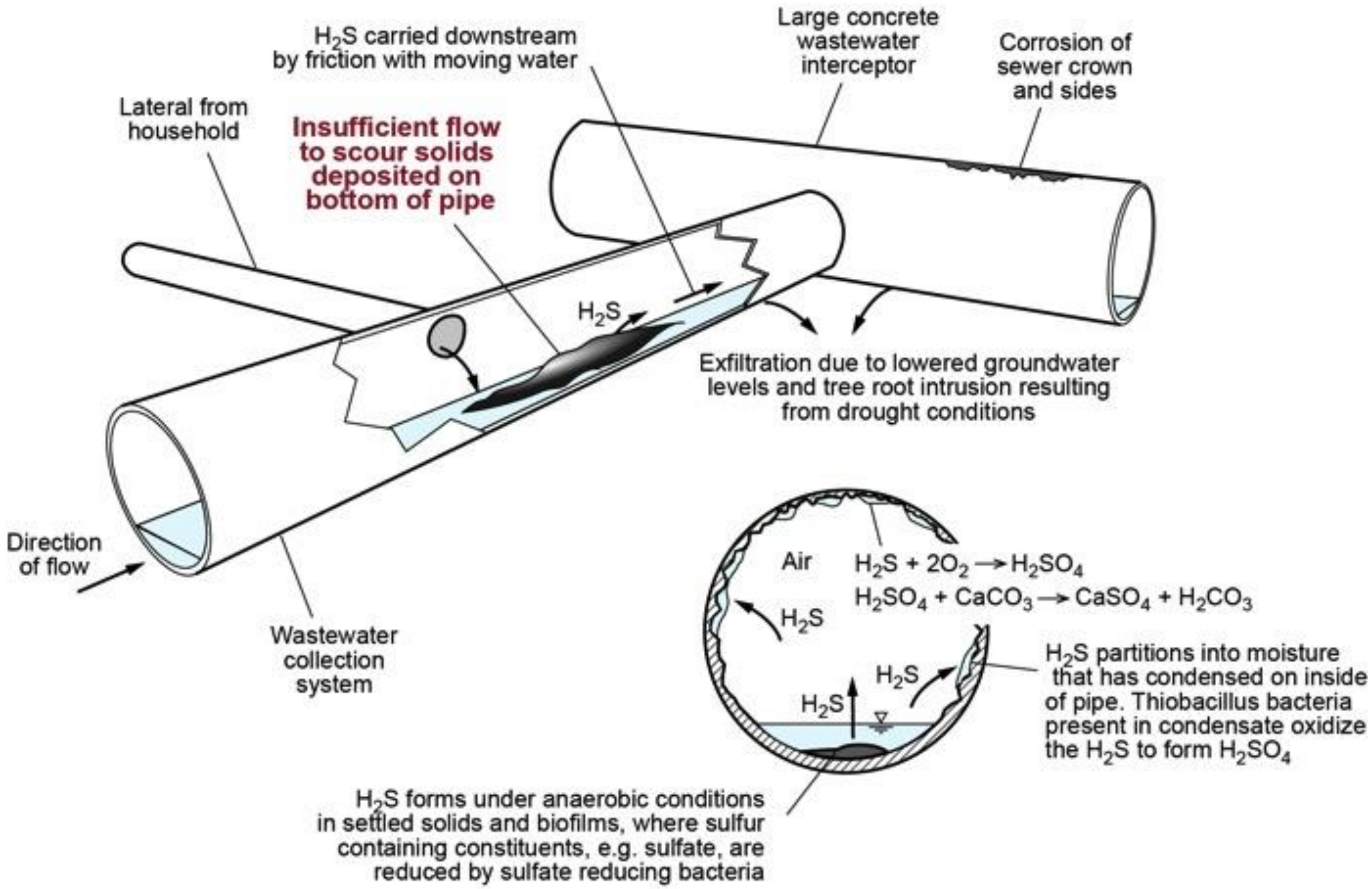
(iii) Maximum water conservation

CURRENT AND PROJECTED PER CAPITA WATER USE IN THE UNITED STATES

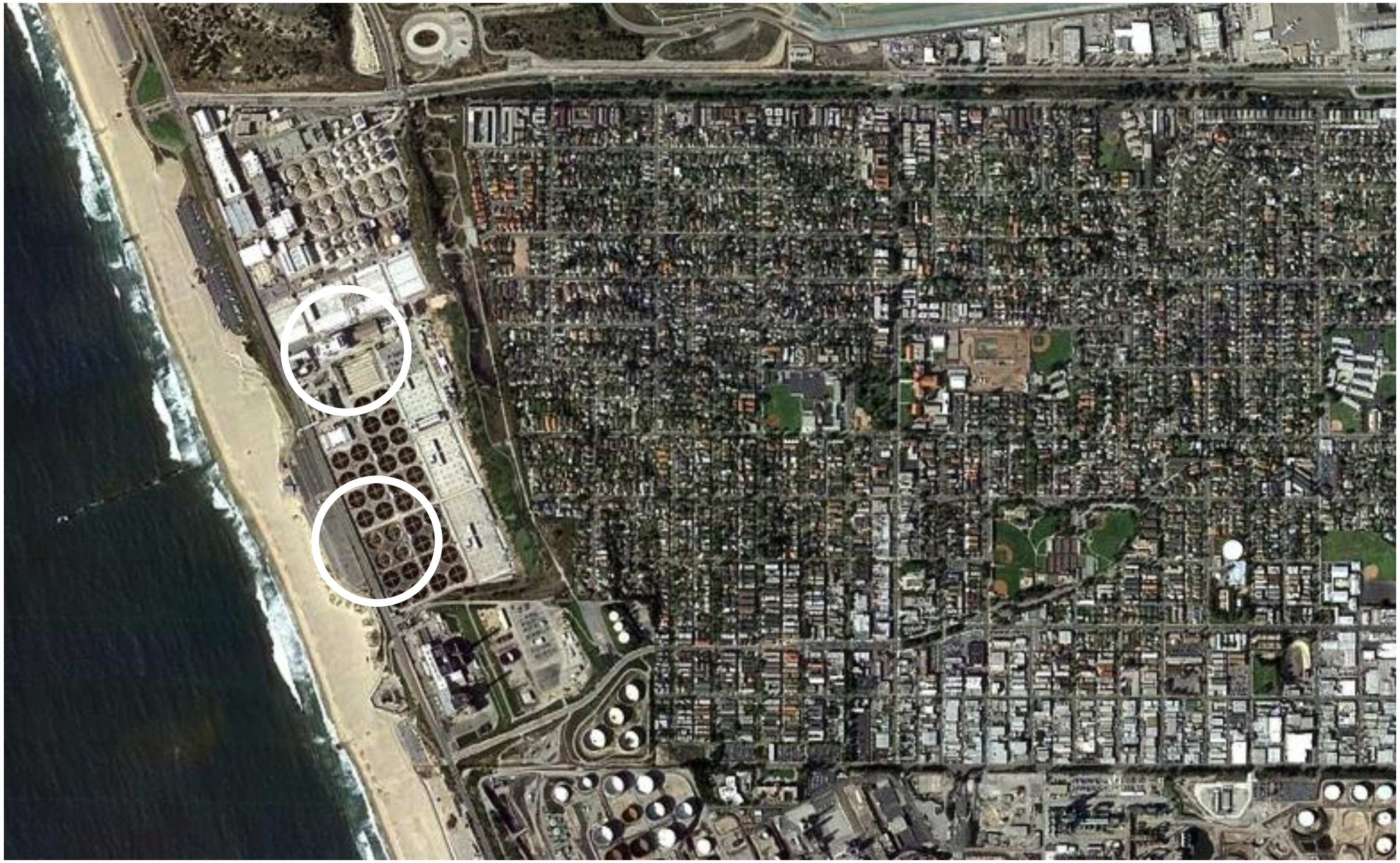
	Flow, gal/capita•d					
	2013		2020		2030	
Use	Range	Typical	Range	Typical	Range	Typical
Domestic						
Indoor use	40 - 80	60	35 - 65	55	30 - 60	45
Outdoor use	16 - 50	35	16 - 50	35	16 - 50	35
Commercial	10 - 75	40	10 - 70	35	10 - 65	30
Public	15 - 25	20	15 - 25	18	15 - 25	15
Loss and waste	15 - 25	20	15 - 25	18	15 - 25	15
Total	96 - 255	175		161		138

84 gal/capita•d in Bay Area to 584 gal/capita•d Northern San Diego

IMPACT OF WATER CONSERVATION AND DROUGHT: SOLIDS DEPOSITION, H_2S FORMATION, AND DOWNSTREAM CORROSION DUE TO REDUCED FLOWS



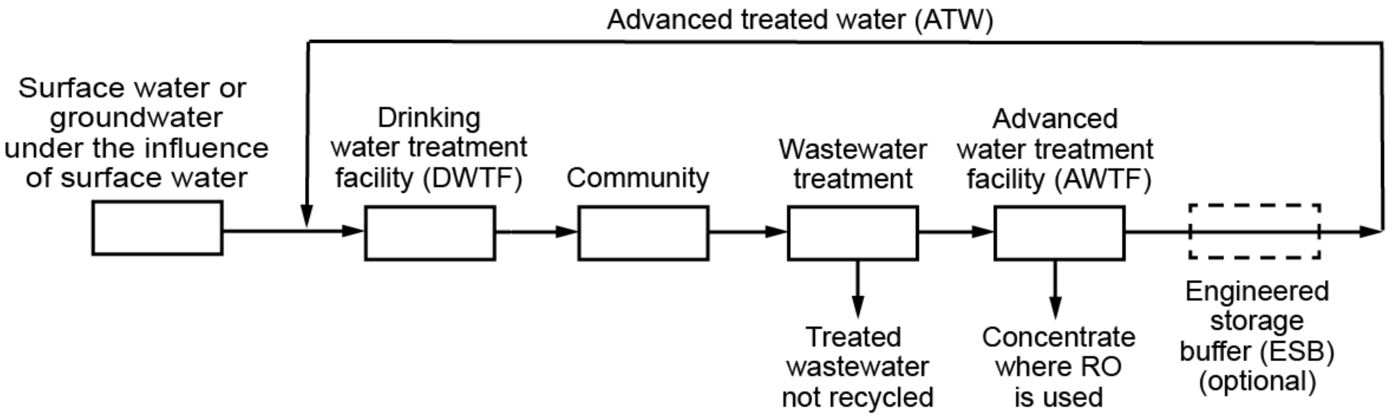
Impacts of Water Conservation on Treatment Plant Capacity (Approximately 30 Percent Excess Tankage Available, but not Distributed Uniformly)



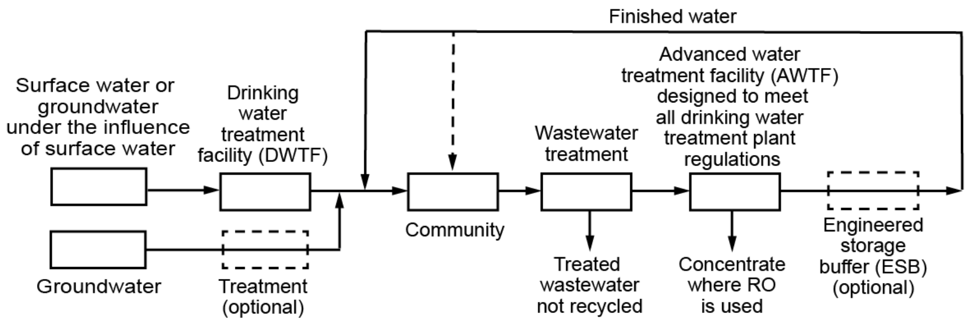
THE FUTURE

- Lets move ahead with DPR
- Regulatory needs
- Technology needs
- Public outreach needs
- Role of the DPR Framework Document (Presented and discussed in following presentation)

LETS MOVE AHEAD WITH DPR



Focus on DPR with *advanced treated water (ATW)*



Continue to work on DPR with *finished water*

FUTURE REGULATORY NEEDS

- National guidelines and regulations
- National framework for integrating the CWA and SDWA for permitting DPR projects
- Consideration of advanced treated water (ATW) as a third water source (i.e., surface water, groundwater, and ATW)
- Development of consistent training programs
- Operator training and certification?

FUTURE TECHNOLOGY NEEDS

- Better understanding of treatment processes to reduce overly conservative designs
- Improved understanding of relationship between multiple barriers
- Improved monitoring methods to capture failure and other events of interest
- Full-scale demonstration of advanced water treatment facility without reverse osmosis
- Development of technologies for satellite and decentralized AWTFs

FUTURE PUBLIC OUTREACH

- We already have a lot of tools
- Develop appropriate and consistent terminology
- Clear message about potable reuse–
  what it is and what it is not.

WASTEWATER MANAGEMENT IN THE 21ST CENTURY

A PARADIGM SHIFT

Wastewater is a renewable recoverable source of potable water, resources, and energy

A FUNDAMENTAL QUESTION

What is the optimal use of the carbon in wastewater–nutrient removal, product recovery, and/or energy recovery?

THANK YOU

FOR LISTENING