Municipal wastewater treatment plant effluent is our next water supply: Implications for pesticides monitoring, modeling, mitigation, and product design

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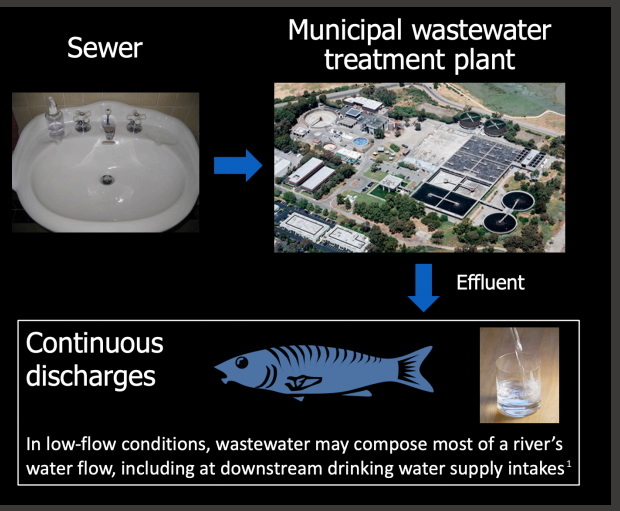
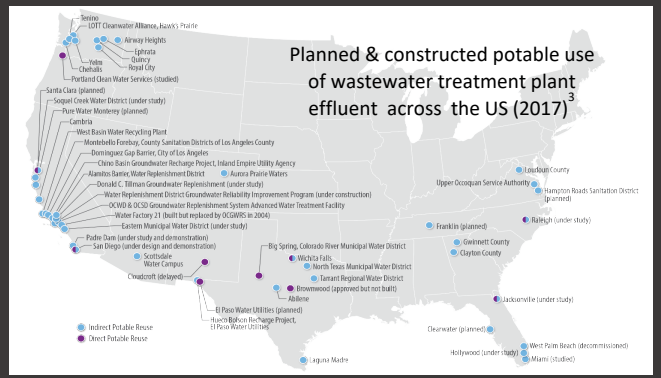
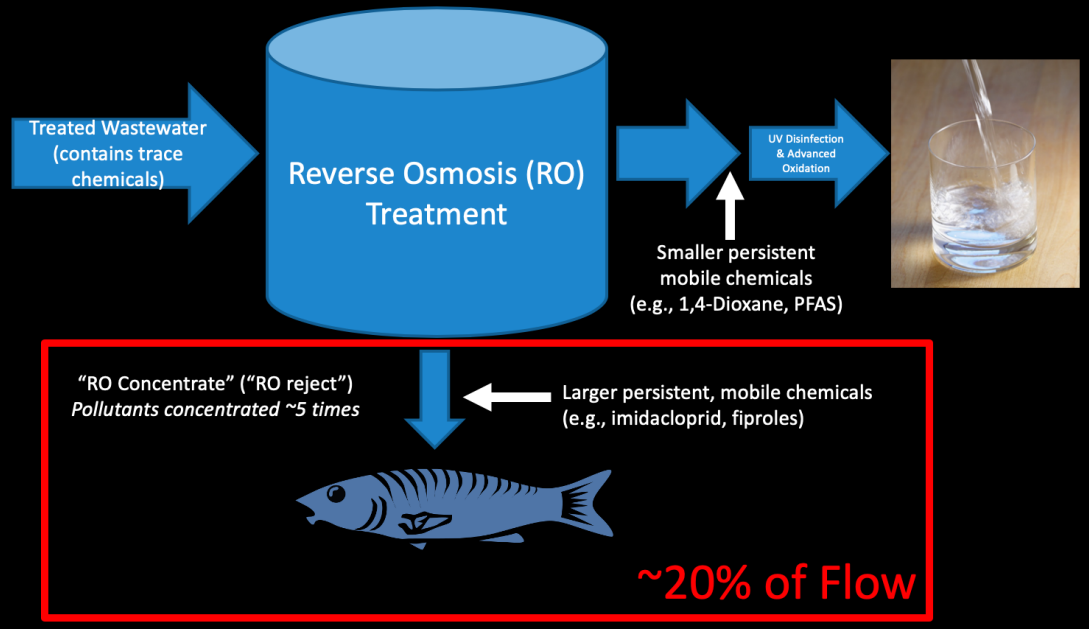


Pesticides flow into municipal wastewater directly and indirectly after uses like pet flea control, cooling water system treatment, cleaning and disinfection, treated textiles, and indoor pest control.[2] Even the most sophisticated wastewater treatment plants cannot fully remove many pesticide active ingredients, which pass through into effluents.[2] In almost all US states, wastewater and drinking water agencies cannot control sale or use of pesticides discharged to sewers.



Typical Wastewater Effluent Potable Reuse Treatment System



Due to large volumes – many millions of gallons per day – the intent is to discharge RO concentrate to surface waters, as other disposal options are very expensive. Treating RO concentrate would be costly and may be impractical, as it contains a mix of pesticides, each potentially needing a different treatment.

Pesticides in wastewater effluent and RO concentrate exceed aquatic life benchmarks

Pesticide levels in RO concentrate are likely to pose significant disposal challenges

Pesticide	US EPA Pesticides ALB (ng/L)	Wastewater Effluent (ng/L)			RO Concentrate (ng/L)		
		Range	Median	# Facilities	Range	Median	# Facilities
Imidacloprid	10	18.5–305	48.3–164	21	53-1080	534	5
Fipronil	11	<0.5–340	30–104	40	12-280	151	5
Bifenthrin	1.3	<0.1–14.1	<1–10.3	34		*5-50 (est.)*	n/a
Permethrin	1.4	<1–170	<1–21.4	34		*5-100 (est.)*	n/a

Source: Sutton et al 2019[2] (all values except RO Concentrate); King et al 2020[4] (RO concentrate); italicized values are estimates (effluent concentration x 5)
ALB = US EPA Office of Pesticide Programs Aquatic Life Benchmark (Chronic, Invertebrates)

Conclusions

1. US and international drinking water supplies will soon include municipal wastewater effluent
2. Municipal wastewater effluent already flows to drinking water intakes, at times composing up to 100% of the water supply
3. The byproduct of wastewater effluent potable reuse treatment – RO concentrate – could contain pesticides at concentrations that will prevent its discharge to surface water
4. The presence of pesticides in RO concentrate may increase cost or – in the most difficult cases – entirely prevent potable reuse of wastewater effluent
5. Modifying uses of persistent mobile pesticides in ways that avoid sewer discharges may be the best (and perhaps only) means to allow society to access this future water supply

Recommendations

1. Pesticides monitoring and modeling should include potable reuse of municipal wastewater effluent
2. Drinking water modeling and risk assessment should address surface water discharges of RO Concentrate
3. Risk management decisions should address economic and social costs associated with potable reuse, such as potential for pesticides to make RO concentrate disposal impractical

Informed product design, regulation and mitigation measures may be needed to allow society to obtain the full benefits of its soon-to-be necessary new urban water supplies.

References
1. Rice and Westerhoff (2015) *Environ Sci Technol* 49 (2) 982-989.
2. Sutton et al (2019) "Occurrence and Sources of Pesticides to Urban Wastewater and the Environment" in Goh et al. *Pesticides in Surface Water: Monitoring, Modeling, Risk Assessment, and Management*. ACS Symposium Series; American Chemical Society: Washington, DC, 2019.
3. US EPA Office of Water (2017) Potable Reuse Compendium.
4. King, J. F et al. (2020) *Water Res* 176: 115744.

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