

Table S1. Health-based targets for recycled water use in agriculture (modified from [60]).

Exposure Scenario	Health-Based Target (DALY per Person Per Year)	E. coli (cfu/100mL)	Log <sub>10</sub> Pathogen Reduction Needed <sup>a</sup>	Number of Helminth Eggs Per Liter
<b>Unrestricted irrigation</b>				
Leaf crops (e.g., lettuce)	≤10 <sup>-6a</sup>	≤10 <sup>4</sup>	6	≤1 <sup>b,c</sup>
		≤10 <sup>3</sup>	7	≤1 <sup>b,c</sup>
Root crops (e.g., onion)		≤10 <sup>5</sup>	5	Not recommended <sup>d</sup>
		≤10 <sup>3</sup>	7	≤1 <sup>c</sup>
High growing crops (drip)				
Low-growing crops (drip)				
<b>Restricted irrigation</b>				
Highly mechanized	≤10 <sup>-6a</sup>	≤10 <sup>5</sup>	3	≤1 <sup>b,c</sup>
		≤10 <sup>4</sup>	4	≤1 <sup>b,c</sup>
Labor intensive				

<sup>a</sup> Rotavirus reduction. The health-based target can be achieved, for unrestricted and localized irrigation, by a 6–7 log unit pathogen reduction (obtained by a combination of wastewater treatment and other health protection measures, including an estimated 3–4 log unit pathogen reduction as a result of the natural die-off rate of pathogens under field conditions and the removal of pathogens from irrigated crops by normal domestic washing and rinsing); for restricted irrigation, it is achieved by a 2–3 log unit pathogen reduction. <sup>b</sup> when children under 15 are exposed, additional health protection measures should be used (e.g., treatment to ≤0.1 Egg/L, protective equipment such as gloves or shoes/boots or chemotherapy). <sup>c</sup> An arithmetic mean should be determined throughout the irrigation season. The mean value of ≤ 1 egg per liter should be obtained for at least 90% of samples in order to allow for the occasional high-value sample (i.e., with >10 Egg/L). With some wastewater treatment processes (e.g., waste stabilization ponds), the hydraulic retention time can be used as a surrogate to assure compliance with ≤ 1 Egg/L. <sup>d</sup> No crops to be picked up from the soil.

Table S2. Water quality for irrigation (adapted from [67]).

Potential Irrigation Problem	Units	Degree of Restriction on Use		
		None	Slight to Moderate	Severe
<b>Salinity</b>				
EC <sup>1</sup> <sub>w</sub>	dS/m	<0.7	0.7–3.0	>3.0
or TDS <sup>2</sup>	mg/L	<450	450–2000	>2000
<b>Infiltration</b>				
SAR = 0–3 and EC <sub>w</sub>		>0.7	0.7–0.2	<0.2
3–6		>1.2	1.2–0.3	<0.3
6–12		>1.9	1.9–0.5	<0.5
12–20		>2.9	2.9–1.3	<1.3
20–40		>5.0	5.0–2.9	<2.9
<b>Specific Ion Toxicity</b>				
<b>Sodium (Na)</b>				
Surface irrigation	SAR	<3	3–9	>9
Sprinkler irrigation	me/L	<3	>3	
<b>Chloride (Cl<sup>-</sup>)</b>				
Surface irrigation	me/L	<4	4–10	>10
Sprinkler irrigation	m <sup>3</sup> /L	<3	>3	
<b>Boron (B)</b>	mg/L	<0.7	0.7–3.0	>3.0
<b>Miscellaneous Effects</b>				
Nitrogen (NO <sub>3</sub> -N)	mg/L	<5	5–30	>30
Bicarbonate (HCO <sub>3</sub> )	me/L	<1.5	1.5–8.5	>8.5
pH		Normal range 6.5–8		

<sup>1</sup> Electric conductivity. <sup>2</sup> Total dissolved solids.

Table S3. EPA guideline for agricultural water reuse (adopted from [11]).

Requirements	Agricultural Water Reuse Category	
	Food crops: crops which are consumed raw by human.	Processed food crops: crops which are processed before human consumption.
Treatment	- Secondary <sup>1</sup> - Filtration <sup>2</sup> - Disinfection <sup>3</sup>	- Secondary - Filtration - Disinfection
Recycled water quality	- pH = 6.0–9.0 - BOD <sub>5</sub> ≤ 10 mg/L - Turbidity ≤ 2 NTU - Fecal Coliforms = 0/100 mL <sup>4,5,6</sup> -Cl <sub>2</sub> residual ≤ 1 mg/L <sup>7</sup>	- pH = 6.0–9.0 - BOD <sub>5</sub> ≤ 30 mg/L - Total suspended solids ≤ 2 NTU - Fecal Coliforms ≤ 200/100 mL <sup>4,5,6</sup> -Cl <sub>2</sub> residual ≤ 1 mg/L <sup>7</sup>
Recycled water monitoring	- pH [weekly] - BOD <sub>5</sub> [weekly] - Turbidity [continuous] - Fecal Coliform [daily] - Cl <sub>2</sub> residual [continuous]	- pH [weekly] - BOD <sub>5</sub> [weekly] - Total suspended solids [continuous] - Fecal Coliform [daily] - Cl <sub>2</sub> residual [continuous]
Setback distances	- 50 ft (15 m) to potable water supply wells - 100 ft (30 m) when located in porous media	- 300 ft (90 m) to potable water supply wells - 100 ft (30 m) to areas accessible to the public (if spray irrigation)

<sup>1</sup> Secondary treatment process include activated sludge processes, trickling filters, rotating biological contractors, and may stabilization pond systems. Secondary treatment should produce effluent in which both the BOD and SS do not exceed 30 mg/L. <sup>2</sup> Filtration means; the passing of wastewater through natural undisturbed soils or filter media such as sand and/or anthracite; or the passing of wastewater through microfilters or other membrane processes. <sup>3</sup> Disinfection means the destruction, inactivation, or removal of pathogenic microorganisms by chemical, physical, or biological means. Disinfection may be accomplished by chlorination, ozonation, other chemical disinfectants, UV, membrane processes, or other processes.

<sup>4</sup> Unless otherwise noted, recommended coliform limits are median values determined from the bacteriological results of the last 7 days for which analyses have been completed. Either the membrane filter or fermentation tube technique may be used.

<sup>5</sup>The number of fecal coliform organisms should not exceed 800/100 mL in any sample. <sup>6</sup> Some stabilization pond systems may be able to meet this coliform limit without disinfection. <sup>7</sup> This recommendation applies only when chlorine is used as the primary disinfectant. The total chlorine residual should be met after a minimum actual modal contact time of at least 90 min unless a lesser contact time has been demonstrated to provide indicator organism and pathogen reduction equivalent to those suggested in these guidelines. In no case should the actual contact time be less than 30 min.

**Table S4.** Water quality for irrigation in California’s regulation (adapted from Title 2.2: California Water Recycling Criteria [55]).

<b>Irrigation Type</b>	<b>Disinfected Tertiary Recycled Water</b>	<b>Disinfected Secondary 2.2 Recycled Water</b>	<b>Disinfected Secondary 23 Recycled Water</b>	<b>Undisinfected Secondary Recycled Water</b>
Food crops where recycled water contacts the edible portion of the crop, including all root crops	✓	×	×	×
Parks and playgrounds	✓	×	×	×
School grounds	✓	×	×	×
Residential landscaping	✓	×	×	×
Unrestricted-access golf courses	✓	×	×	×
Any other irrigation uses not specifically prohibited by other provisions of the California Code of Regulations	✓	×	×	×
Food crops, surface-irrigated, above-ground edible portion, not contacted by recycled water	✓	✓	×	×
Cemeteries	✓	✓	✓	×
Freeway landscaping	✓	✓	✓	×
Restricted-access golf courses	✓	✓	✓	×
Ornamental nursery stock and sod farms with unrestricted public access	✓	✓	✓	×
Pasture for milk animals for human consumption	✓	✓	✓	×
Nonedible vegetation with access control to prevent use as a park,	✓	✓	✓	×

playground or school grounds				
Orchards with no contact between edible portion and recycled water	✓	✓	✓	✓
Vineyards with no contact between edible portion and recycled Water	✓	✓	✓	✓
Non-food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest	✓	✓	✓	✓
Fodder and fiber crops and pasture for animals not producing milk for human consumption	✓	✓	✓	✓
Seed crops not eaten by humans	✓	✓	✓	✓
Food crops undergoing commercial pathogen-destroying processing before consumption by humans	✓	✓	✓	✓
Ornamental nursery stock, sod farms not irrigated less than 14 days before harvest	✓	✓	✓	✓

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✓ Allowed, ✗ Not allowed.

**Table S5.** The E.U. commission proposal for minimum recycled water quality in order to use in agriculture (adapted from [125]).

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>Crop category</b>	Root crops consumed raw; food crops, where the edible part is in direct contact with reclaimed water; other food crops	Food crops consumed raw, where the edible part is produced above ground and is not in direct contact with recycled water; processed food crops; non-food crops, including crops to feed milk- or meat-producing animal		Industrial, energy, and seeded crops
<b>Irrigation method</b>	All methods	All methods	Drip irrigation only	All methods
<b>Treatment</b>	Secondary, tertiary and advanced treatment	Secondary and tertiary treatment	Secondary and tertiary treatment	Secondary and tertiary treatment
<b>E. Coli (cfu/100 mL)</b>	≤10	≤100	≤1000	≤10,000
<b>BOD<sub>5</sub> (mg/L)</b>	≤10	25	25	25
<b>TSS (mg/L)</b>	≤10	35	35	35
<b>Turbidity (NTU)</b>	≤5	NS <sup>1</sup>	NS	NS
<b>Other</b>	Legionella spp.: <1000 cfu/L where there is risk of aerosolisation in greenhouses Intestinal nematodes (Helminth eggs): ≤1 Egg/L for irrigation of pastures or forage			

<sup>1</sup> Not specified.