

APPENDIX R

EPA GUIDELINES FOR WATER REUSE SUMMARY TABLES

APPENDIX R: EPA Guidelines for Water Reuse Summary Tables

EPA Recommended Limits for Constituents in Reclaimed Water for Irrigation

TRACE HEAVY METALS			
Constituent	Long-Term Use (mg/L)	Short-Term Use (mg/L)	Remarks
Aluminum	5.0	20	Can cause non-productiveness in acid soils, but soils at pH 5.5 to 8.0 will precipitate the ion and eliminate toxicity.
Arsenic	0.10	2.0	Toxicity to plants varies widely, ranging from 12 mg/L for Sudan grass to less than 0.05 mg/L for rice.
Beryllium	0.10	0.5	Toxicity to plants varies widely, ranging from 5 mg/L for kale to 0.5 mg/L for bush beans.
Boron	0.75	2.0	Essential to plant growth, with optimum yields for many obtained at a few-tenths mg/L in nutrient solutions. Toxic to many sensitive plants (e.g. citrus) at 1 mg/L. Usually sufficient quantities in reclaimed water to correct soil deficiencies. Most grasses relatively tolerant at 2.0 to 10 mg/L.
Cadmium	0.01	0.05	Toxic to beans, beets, and turnips at concentrations as low as 0.1 mg/L in nutrient solution. Conservative limits recommended.
Chromium	0.1	1.0	Not generally recognized as essential growth element. Conservative limits recommended due to lack of knowledge on toxicity to plants.
Cobalt	0.05	5.0	Toxic to tomato plants at 0.1mg/L in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Copper	0.2	5.0	Toxic to a number of plants at 0.1 to 1.0 mg/L in nutrient solution.
Fluoride	1.0	15.0	Inactivated by neutral and alkaline soils.
Iron	5.0	20.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of essential phosphorus and molybdenum.
Lead	5.0	10.0	Can inhibit plant cell growth at very high concentrations.
Lithium	2.5	2.5	Tolerated by most crops at concentrations up to 5 mg/L; mobile in soil. Toxic to citrus at a low doses – recommended limit is 0.075 mg/L.
Manganese	0.2	10.0	Toxic to a number of crops at a few-tenths to a few mg/L in acidic soils.
Molybdenum	0.01	0.05	Nontoxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high levels of available molybdenum.
Nickel	0.2	2.0	Toxic to a number of plants at 0.5 to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
Selenium	0.02	0.02	Toxic to plants at low concentrations and to livestock if forage is grown in soils with low levels of selenium.
Tin, Tungsten, & Titanium	-	-	Effectively excluded by plants; specific tolerance levels unknown.
Vanadium	0.1	1.0	Toxic to many plants at relatively low concentrations.
Zinc	2.0	10.0	Toxic to many plants at widely varying concentrations; reduced toxicity at increased pH (6 or above) and in fine-textured or organic cells.
OTHER PARAMETERS			
Constituent	Recommended Limit	Remarks	
pH	6.0	Most effects of pH on plant growth are indirect (e.g., pH effects on heavy metals' toxicity described above).	
TDS	500-2,000 mg/L	Below 500 mg/L, no detrimental effects are usually noticed. Between 500 and 1,000 mg/L, TDS in irrigation water can affect sensitive plants. At 1,000 to 2,000 mg/L, TDS levels can affect many crops and careful management practices should be followed. Above 2,000 mg/L, water can be used regularly only for tolerant plants on permeable soils.	
Free Chlorine Residual	<1 mg/L	Concentrations greater than 5 mg/l causes severe damage to most plants. Some sensitive plants may be damaged at levels as low as 0.05 mg/l.	

Source: EPA, Guidelines for Water Reuse, September 2004, EPA/625/R-04/108; Table 2-7, page 25.

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TYPES OF REUSE	TREATMENT	RECLAIMED WATER QUALITY ¹	RECLAIMED WATER MONITORING	SETBACK DISTANCE ²	COMMENTS
<p style="text-align: center;"><i>Urban Reuse</i></p> <p>All types of landscape irrigation, (e.g., golf courses, parks, cemeteries) – also vehicle washing, toilet flushing, use in fire protection systems and commercial air conditioners, and other uses with similar access or exposure to the water.</p>	<ul style="list-style-type: none"> • Secondary³ • Filtration⁴ • Disinfection⁵ 	<ul style="list-style-type: none"> • pH = 6 – 9 • ≤ 10 mg/l BOD⁶ • ≤ 2 NTU⁷ • No detectable fecal coli/100 ml^{8,9} • 1 mg/l Cl₂ residual (minimum)¹⁰ 	<ul style="list-style-type: none"> • pH – weekly • BOD – weekly • Turbidity – continuous • Coliform – daily • Cl₂ residual – continuous 	<ul style="list-style-type: none"> • 50 ft (15 m) to potable water supply wells 	<ul style="list-style-type: none"> • At controlled access irrigation sites where design and operational measures significantly reduce the potential or public contact with reclaimed water, a lower level of treatment, e.g., secondary treatment and disinfection to achieve <14 fecal coli/100 ml, may be appropriate. • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. • The reclaimed water should not contain measurable levels of viable pathogens.¹³ • Reclaimed water should be clear and odorless. • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • A chlorine residual of 0.5 mg/l or greater in the distribution system is recommended to reduce odors, slime, and bacterial regrowth.
<p style="text-align: center;"><i>Restricted Access Area Irrigation</i></p> <p>Sod farms, silviculture sites, and other areas where public access is prohibited, restricted, or infrequent</p>	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ 	<ul style="list-style-type: none"> • pH = 6 – 9 • ≤ 30 mg/l BOD⁶ • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml^{8, 11, 12} • 1 mg/l Cl₂ residual (minimum)¹⁰ 	<ul style="list-style-type: none"> • pH – weekly • BOD – weekly • TSS – daily • Coliform – daily • Cl₂ residual – continuous 	<ul style="list-style-type: none"> • 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation) 	<ul style="list-style-type: none"> • If spray irrigation, TSS less than 30 mg/l may be necessary to avoid clogging of sprinkler heads.
<p style="text-align: center;"><i>Agricultural Reuse – Food Crops Not Commercially Processed¹⁴</i></p> <p>Surface or spray irrigation of any food crop, including crops eaten raw.</p>	<ul style="list-style-type: none"> • Secondary³ • Filtration⁴ • Disinfection⁵ 	<ul style="list-style-type: none"> • pH = 6 – 9 • ≤ 10 mg/l BOD⁶ • ≤ 2 NTU⁷ • No detectable fecal coli/100 ml^{8,9} • 1 mg/l Cl₂ residual (minimum)¹⁰ 	<ul style="list-style-type: none"> • pH – weekly • BOD – weekly • Turbidity – continuous • Coliform – daily • Cl₂ residual – continuous 	<ul style="list-style-type: none"> • 50 ft (15 m) to potable water supply wells 	<ul style="list-style-type: none"> • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. • The reclaimed water should not contain measurable levels of viable pathogens.¹³ • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • High nutrient levels may adversely affect some crops during certain growth stages.

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<p><i>Agricultural Reuse – Food Crops Commercially Processed</i>¹⁴</p> <p>Surface irrigation of Orchards and Vineyards</p>	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ 	<ul style="list-style-type: none"> • pH = 6 – 9 • ≤ 30 mg/l BOD⁶ • ≤ 30 mg/l TSS • < 200 fecal coli/100 ml^{8,11,12} • 1 mg/l Cl₂ residual (minimum)¹⁰ 	<ul style="list-style-type: none"> • pH – weekly • BOD – weekly • TSS – daily • Coliform – daily • Cl₂ residual – continuous 	<ul style="list-style-type: none"> • 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation) 	<ul style="list-style-type: none"> • If spray irrigation, TSS less than 30 mg/l may be necessary to avoid clogging of sprinkler heads. • High nutrient levels may adversely affect some crops during certain growth stages.
<p><i>Agricultural Reuse – Non-Food Crops</i></p> <p>Pasture for milking animals; fodder, fiber and seed crops.</p>	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ 	<ul style="list-style-type: none"> • pH = 6 – 9 • ≤ 30 mg/l BOD⁶ • ≤ 30 mg/l TSS • < 200 fecal coli/100 ml^{8,11,12} • 1 mg/l Cl₂ residual (minimum)¹⁰ 	<ul style="list-style-type: none"> • pH – weekly • BOD – weekly • TSS – daily • Coliform – daily • Cl₂ residual – continuous 	<ul style="list-style-type: none"> • 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation) 	<ul style="list-style-type: none"> • If spray irrigation, SS less than 30 mg/l may be necessary to avoid clogging of sprinkler heads. • High nutrient levels may adversely affect some crops during certain growth stages. • Milking animals should be prohibited from grazing for 15 days after irrigation ceases. A higher level of disinfection, e.g., to achieve ≤14 fecal coil/100ml, should be provided if this waiting period is not adhered to.
<p><i>Recreational Impoundments</i></p> <p>Incidental contact (e.g., fishing and boating) and full body contact with reclaimed water allowed</p>	<ul style="list-style-type: none"> • Secondary³ • Filtration⁴ • Disinfection⁵ 	<ul style="list-style-type: none"> • pH = 6 – 9 • ≤ 10 mg/l BOD⁶ • ≤ 2 NTU⁷ • No detectable fecal coli/100 ml^{8,9} • 1 mg/l Cl₂ residual (minimum)¹⁰ 	<ul style="list-style-type: none"> • pH – weekly • BOD – weekly • Turbidity – continuous • Coliform – daily • Cl₂ residual – continuous 	<ul style="list-style-type: none"> • 500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed. 	<ul style="list-style-type: none"> • Dechlorination may be necessary to protect aquatic species of flora and fauna. • Reclaimed water should be non-irritating to skin and eyes. • Reclaimed water should be clear and odorless. • Nutrient removal may be necessary to avoid algae growth in impoundments. • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. • The reclaimed water should not contain measurable levels of viable pathogens.¹³ • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • Fish caught in impoundments can be consumed.
<p><i>Landscape Impoundments</i></p> <p>Aesthetic impoundments where public contact with reclaimed water is not allowed.</p>	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ 	<ul style="list-style-type: none"> • ≤ 30 mg/l BOD⁶ • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml^{8,11,12} • 1 mg/l Cl₂ residual (minimum)¹⁰ 	<ul style="list-style-type: none"> • pH – weekly • TSS – daily • Coliform – daily • Cl₂ residual – continuous 	<ul style="list-style-type: none"> • 500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed. 	<ul style="list-style-type: none"> • Nutrient removal may be necessary to avoid algae growth in impoundments. • Dechlorination may be necessary to protect aquatic species of flora and fauna.

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<p style="text-align: center;"><i>Groundwater Recharge</i></p> <p>By spreading or injection into aquifers not used for public water supply</p>	<ul style="list-style-type: none"> • Site-specific and use dependent • Primary (minimum) for spreading • Secondary³ (minimum) for injection 	<ul style="list-style-type: none"> • Site-specific and use dependent 	<ul style="list-style-type: none"> • Depends on treatment and use 	<ul style="list-style-type: none"> • Site-specific 	<ul style="list-style-type: none"> • Facility should be designed to ensure that no reclaimed water reaches potable water supply aquifers. • For spreading projects, secondary treatment may be needed to prevent clogging. • For injection projects, filtration and disinfection may be needed to prevent clogging.
<p style="text-align: center;"><i>Indirect Potable Reuse</i></p> <p>Groundwater recharge by spreading into potable aquifers</p>	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ • May also need filtration⁴ and/or advanced wastewater treatment¹⁵ 	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ • Meet drinking water standards after percolation through vadose zone 	<p>Includes, but not limited to, the following:</p> <ul style="list-style-type: none"> • pH – daily • Coliform – daily • Cl₂ residual – continuous • Drinking water standards – quarterly • Other¹⁶ – depends on constituent • BOD – weekly • Turbidity – continuous 	<ul style="list-style-type: none"> • 500 ft (150 m) to extraction wells. May vary depending on treatment provided and site-specific conditions. 	<ul style="list-style-type: none"> • The depth to groundwater (i.e. thickness to the vadose zone) should be at least 6 feet (2m) at the maximum groundwater mounding point. • The reclaimed water should be retained underground for at least 6 months prior to withdrawal. • Recommended treatment is site-specific and depends on factors such as type of soil, percolation rate, thickness of vadose zone, native groundwater quality, and dilution. • Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. • The reclaimed water should not contain measurable levels of viable pathogens after percolation through the vadose zone.¹³
<p style="text-align: center;"><i>Indirect Potable Reuse</i></p> <p>Groundwater recharge by injection into potable aquifers</p>	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ • Filtration⁴ • Advanced wastewater treatment¹⁵ 	<p>Includes, but not limited to, the following:</p> <ul style="list-style-type: none"> • pH = 6.5 – 8.5 • ≤ 2 NTU⁷ • No detectable total coli/100 ml^{8,9} • 1 mg/l Cl₂ residual (minimum)¹⁰ • ≤ 3 mg/l TOC • ≤ 0.2 mg/l TOX • Meet drinking water standards 	<p>Includes, but not limited to, the following:</p> <ul style="list-style-type: none"> • pH – daily • Turbidity – continuous • Total Coliform – daily • Cl₂ residual – continuous • Drinking water standards – quarterly • Other¹⁶ – depends on constituent • BOD – weekly 	<ul style="list-style-type: none"> • 2000 ft (600 m) to extraction wells. May vary depending on site-specific conditions. 	<ul style="list-style-type: none"> • The reclaimed water should be retained underground for at least 9 months prior to withdrawal. • Recommended quality limits should be met at the point of injection • Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. • The reclaimed water should not contain measurable levels of viable pathogens after percolation through the vadose zone.¹³ • A higher chlorine residual and/or a longer contact time may be necessary to assure virus and protozoa inactivation.

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<p><i>Indirect Potable Reuse</i></p> <p>Augmentation of surface supplies</p>	<ul style="list-style-type: none"> • Secondary³ • Disinfection⁵ • Filtration⁴ • Advanced wastewater treatment¹⁵ 	<p>Includes, but not limited to, the following:</p> <ul style="list-style-type: none"> • pH = 6.5 – 8.5 • ≤ 2 NTU⁷ • No detectable total coli/100 ml^{8,9} • 1 mg/l Cl₂ residual (minimum)¹⁰ • ≤ 3 mg/l TOC • Meet drinking water standards 	<p>Includes, but not limited to, the following:</p> <ul style="list-style-type: none"> • pH – daily • Turbidity – continuous • Total coliform – daily • Cl₂ residual – continuous • Drinking water standards – quarterly • Other¹⁶ – depends on constituent 	<ul style="list-style-type: none"> • Site-specific 	<ul style="list-style-type: none"> • Recommended level of treatment is site-specific and depends on factors such as receiving water quality, time and distance to point of withdrawal, dilution and subsequent treatment prior to distribution for potable uses. • The reclaimed water should not contain measurable levels of viable pathogens.¹³ • A higher chlorine residual and/or a longer contact time may be necessary to assure virus and protozoa inactivation.
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1. Unless otherwise noted, recommended quality limits apply to the reclaimed water at the point of discharge from the treatment facility.
2. Setback distances are recommended to protect potable water supply sources from contamination and to protect humans from unreasonable health risks due to exposure to reclaimed water.
3. Secondary treatment processes include activated sludge processes, trickling filters, rotating biological contactors, and many stabilization pond systems. Secondary treatment should produce effluent in which both the BOD and SS do not exceed 30 mg/l.
4. Filtration means the passing of wastewater through natural undisturbed soils or filter media such as sand and/or anthracite.
5. 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 radiation, membrane processes, or other processes.
6. As determined from the 5 day BOD test.
7. The recommended turbidity limit should be met prior to disinfection. The average turbidity should be based on a 24 hour time period. The turbidity should not exceed 5 NTU at any time. If SS is used in lieu of turbidity, the average SS should not exceed 5 mg/l.
8. 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.
9. The number of fecal coliform organisms should not exceed 14 100 ml in any sample.
10. Total chlorine residual after a minimum contact time for 30 minutes.
11. The number of fecal coliform organisms should not exceed 800/100 ml in any sample.
12. Some stabilization pond systems may be able to meet this coliform limit without disinfection.
13. It is advisable to fully characterize the microbiological quality of the reclaimed water prior to implementation of a reuse program.
14. Commercially processed food crops are those that, prior to sale to the public or others, have undergone chemical or physical processing sufficient to destroy pathogens.
15. Advanced wastewater treatment processes include chemical clarification, carbon adsorption, reverse osmosis and other membrane processes, air stripping, ultrafiltration, and ion exchange.
16. Monitoring should include inorganic and organic compounds, or classes of compounds, that are known or suspected to be toxic, carcinogenic, teratogenic, or mutagenic and are not included in the drinking water standards.

Source: EPA, *Guidelines for Water Reuse*, September 2004, EPA/625/R-04/108; Table 4-13, pages 167-170.