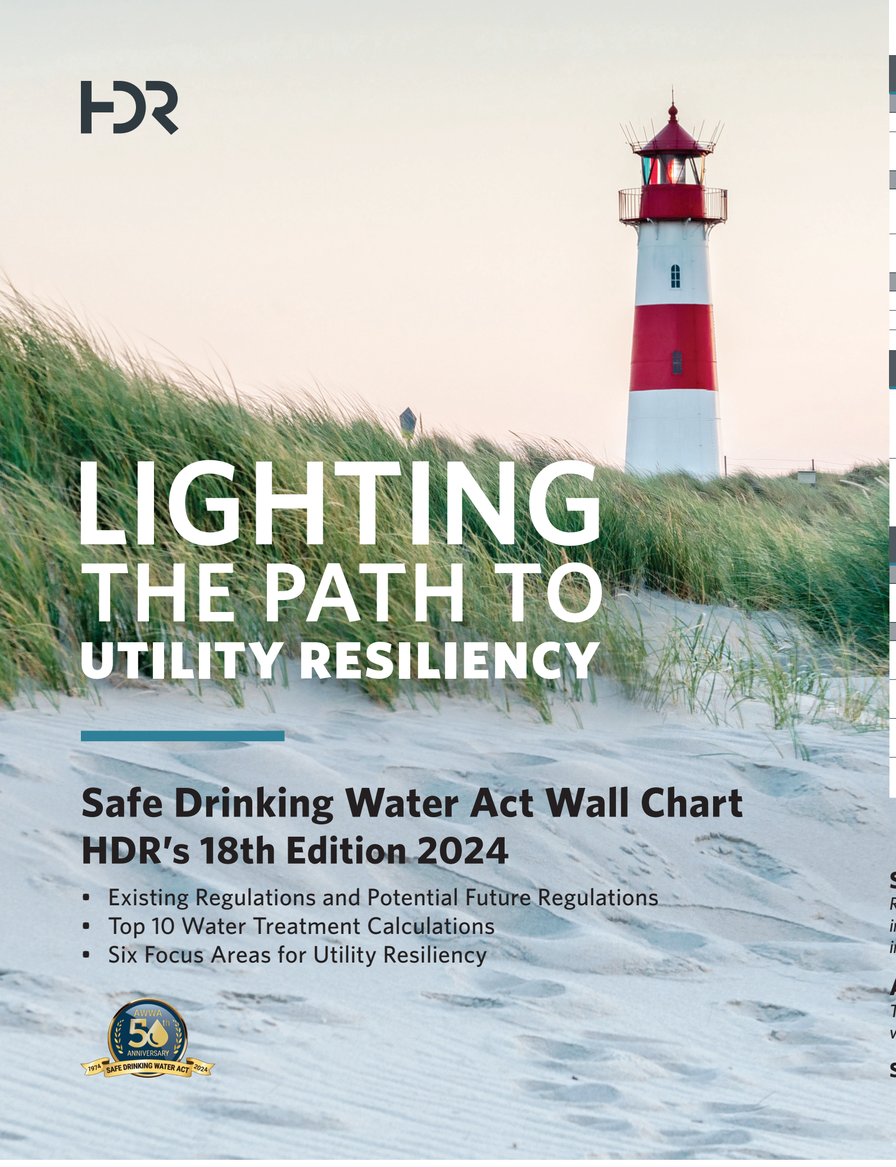

LIGHTING THE PATH TO UTILITY RESILIENCY

Safe Drinking Water Act Wall Chart HDR's 18th Edition 2024

- Existing Regulations and Potential Future Regulations
- Top 10 Water Treatment Calculations
- Six Focus Areas for Utility Resiliency

AWWA 50th ANNIVERSARY 1974 SAFE DRINKING WATER ACT 2024

TOP 10 TREATMENT AND SYSTEM CALCULATIONS

1. CHLORINE FEED CALCULATIONS

GAS CHLORINE FEED

Lbs/day = (Flow, MGD) x (Conc., mg/L) x (1 lb/453592 mg) x (3.785 L/gal) x (10^6 gal/MG)

Dosage, mg/L = (Lbs/day) / (Flow, MGD) x (1 lb/453592 mg) x (3.785 L/gal) x (10^6 gal/MG)

SODIUM HYPOCHLORITE

Chlorine Equivalent Lbs/gal = (Trade Percent Expressed as a Decimal) x (1000 g/L) x (3.785 L/gal) x (2.205 Lbs/1000 g)

Gal/day = (Process Flow, MGD) x (Dose mg/L) x (1 lb/453592 mg) x (3.785 L/gal) x (10^6 gal/MG) / Chlorine Equivalent (Lbs/gal)

DOSAGE/DEMAND/RESIDUAL

Dosage, mg/L = (Demand, mg/L) + (Residual, mg/L)

Demand, mg/L = (Dosage, mg/L) - (Residual, mg/L)

Residual, mg/L = (Dosage, mg/L) - (Demand, mg/L)

2. CHEMICAL DOSING

Feed, Lbs/day = (Flow, MGD) x (Dosage, mg/L) x (1 lb/453592 mg) x (3.785 L/gal) x (10^6 gal/MG) x { % Active Ingredient / 100 x % Chemical / 100 }

Dosage, mg/L = { Feed, lbs/day x % Active Ingredient / 100 x % Chemical / 100 } / (Flow, MGD) x (1 lb/453592 mg) x (3.785 L/gal) x (10^6 gal/MG)

3. CHEMICAL FEED

CHEMICAL FEED PUMPS

GPD = (Flow, MGD) x (Dosage, mg/L) x (1 lb/453592 mg) x (3.785 L/gal) x (10^6 gal/MG) / (Dry lbs/gal)

CHEMICAL FEED RATE

GPD = (Feed, mL/min) x (1,440 min/day) / (1,000 mL/L) x (3.785 L/gal)

GPM = (Feed, mL/min) / (3,785 mL/gal)

mL/min = (GPD) x (1,000 mL/L) x (3.785 L/gal) / (1,440 min/day)

mL/min = (GPM) x (3,785 mL/gal)

4. PUMPS AND PUMPING

PUMP SIZE

Brake Horsepower (BHp) = (GPM) x (Total Dynamic Head, ft) / (3,960) x (Efficiency*)

Overall Efficiency (Pump/Motor/Drive) = (Motor Efficiency*) x (Pump Efficiency*) x (Drive Efficiency*)
**Efficiency expressed as decimal*

PUMPING COSTS

Cost, $ = (BHp) x (0.746 kW/hp) x (Operating Hrs) x ($/kW-Hr)

WELLS

Drawdown, ft = (Pumping Level, ft) - (Static Level, ft)

Specific Capacity, GPM/ft = Well Yield, GPM / Drawdown, ft

5. CT CALCULATIONS

CT_{calc} = Disinfectant Residual Concentration (mg/L) x Disinfectant Contact Time (min)

$CT_{99.9}$ (3-log) = Can be read from tables E-1 through E-13 (EPA, 1991**) in Surface Water Treatment Rule Guidance Manual using pH and temperature of water

$CT_{required}$ = (Log Inactivation Required) x ($CT_{99.9}$) / 3.0

LOG INACTIVATIONS ARE ADDITIVE, e.g., 0.5 LOG + 1.0 LOG = 1.5 LOG

Inactivation Ratio $CT_{calc}/CT_{99.9}$		Log Inactivation		Percent Inactivation
0.17	=	0.5 log	=	68.4%
0.33	=	1.0 log	=	90%
0.50	=	1.5 log	=	96.8%
0.67	=	2.0 log	=	99%
0.83	=	2.5 log	=	99.7%
1.00	=	3.0 log	=	99.9%
1.33	=	4.0 log	=	99.99%

***Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources, EPA, 1991*

6. FILTRATION

FILTER FLOW RATE

Filtration Rate, GPM = (Filter Area, sq ft) x (Filtration Loading Rate, GPM/sq ft)

Filtration Loading Rate, GPM/sq ft = (Filtration Rate, GPM) / (Filter Area, sq ft)

Filtration Rate, GPD = (Filter Area, sq ft) x (Filtration Loading Rate, GPM/sq ft) x (1,440 min/day)

BACKWASH RATE

Backwash Pumping Rate, GPM = (Filter Area, sq ft) x (Backwash Rate, GPM/sq ft)

Rate of Rise, ft/min = (Backwash Rate, GPM/sq ft) / (7.48 gal/cu ft)

7. STANDARD MEMBRANE CALCULATIONS

FLUX (J)

Flux (J), GFD = (Feed Flow, GPD) / (Membrane Surface Area, sq ft)

TEMPERATURE CORRECTED FLUX 20°C

Flux ($J_{20°C}$), GFD = (J, GFD) x ($e^{-0.0239 (T \text{ in } °C - 20)}$)

TRANSMEMBRANE PRESSURE

Transmembrane Pressure, PSI = (Feed Pressure, PSI) - (Filtrate Pressure, PSI)

PERMEABILITY

Permeability, GFD/PSI = ($J_{20°C}$, GFD) / (Transmembrane Pressure, PSI)

REJECTION

Rejection, % = { 1 - Filtrate Concentration, mg/L / Feed Concentration, mg/L } x 100

RECOVERY

Recovery, % = { Beneficial Use Flow, GPM / Feed Flow, GPM } x 100

8. VELOCITY

Flow (Q), cfs = (Area, sq ft) x (Velocity, fps)

Velocity, fps = (Q, cfs) / (Area, sq ft)

Area, sq ft = (Q, cfs) / (Velocity, fps)

9. HARDNESS

Calcium Hardness, mg/L as $CaCO_3$ = (2.5) x (Calcium, mg/L)

Magnesium Hardness, mg/L as $CaCO_3$ = (4.12) x (Magnesium, mg/L)

Total Hardness, mg/L as $CaCO_3$ = Calcium Hardness as $CaCO_3$ + Magnesium Hardness as $CaCO_3$

CONVERT HARDNESS FROM MG/L TO GRAINS/GALLON

Grains/gallon = (Total Hardness, mg/L as $CaCO_3$) / { 17.1 mg/L / grains/gal }

10. JAR TESTING

Dosage, mg/L = (Stock Volume, mL) x (1,000 mg/gram) x (Stock conc., grams/L) / (Sample Size, mL)

Dosage, lbs/MG = (Dosage, mg/L) x (3.785 L/gal) x (10^6 gal/MG) / (1,000 mg/g) x (454 g/lbs)

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EXISTING NATIONAL PRIMARY DRINKING WATER REGULATIONS

REGULATIONS	NAME OF CONTAMINANT	MCL / MCLG (mg/L unless noted)	HEALTH EFFECTS OF CONTAMINANT	MONITORING REQUIREMENTS / COMMENTS Refer to Code of Federal Regulations or contact your primacy agency for additional details.
Inorganic Chemicals (IOCs)	Antimony	0.006 / 0.006	Increase in blood cholesterol; decrease in blood sugar	For IOCs: Once a year for surface waters. Once every 3 years for ground water (not including Asbestos, Lead and Copper, Nitrate, Nitrite, and Radionuclides). Minimize monitoring costs by using historical data, waivers, susceptibility waivers, and/or making composite samples.
	Asbestos (fiber length > 10 micrograms)	7 MFL / 7 MFL	Increased risk of developing benign intestinal polyps	Once every 9 years.
	Barium	2 / 2	Increase in blood pressure	For IOCs: See Antimony for same monitoring requirements.
	Beryllium	0.004 / 0.004	Intestinal lesions	
	Cadmium	0.005 / 0.005	Kidney damage	
	Chromium (total)	0.1 / 0.1	Allergic dermatitis	
	Copper (revisions and clarifications)	TT (AL = 1.3) / 1.3	Gastrointestinal/liver/kidney problems	See Lead for same monitoring requirements.
	Cyanide (as free cyanide)	0.2 / 0.2	Thyroid/neurological effects	For IOCs: See Antimony for same monitoring requirements.
	Fluoride	4.0 / 4.0	Bone disease: Children may get mottled teeth	
	Lead (revisions and clarifications)	TT (AL = 0.015) / 0	Kidney problems; high blood pressure; physical or mental development delays in infants and children	Sample taken at the kitchen or bathroom sink tap. ALs must be met in 90% of the samples. Follow-up monitoring every 6 months after corrosion controls initiated or optimized. Reduced monitoring for systems consistently meeting AL. An AL exceedance can trigger water quality parameter monitoring, corrosion control treatment, source water monitoring/treatment, and lead service line replacement. Systems exceeding Lead AL must provide public notification to affected populations.
	Mercury (inorganic)	0.002 / 0.002	Kidney damage	For IOCs: See Antimony for same monitoring requirements.
	Nitrate (as N)	10 / 10	Methemoglobinemia (blue baby syndrome)/diuresis	Ground water annually; surface water quarterly initially, then annually.
	Nitrite (as N)	1 / 1	Methemoglobinemia (blue baby syndrome)/diuresis	One sample during first 3-year compliance period. Repeat frequency determined by primacy agency.
	Selenium	0.05 / 0.05	Hair or fingernail loss; numbness of fingers or toes; circulatory problems	For IOCs: See Antimony for same monitoring requirements.
	Thallium	0.002 / 0.0005	Hair loss; changes in blood; kidney/liver/intestinal problems	
	Arsenic Rule			Same as IOCs. Applies to CWS and NTNCWS.
	Arsenic	0.010 / 0	Cancer risk/cardiovascular and dermal problems	
	Radionuclides			Sample point is the distribution system entry point that is representative of all sources being used. Four consecutive quarterly samples must be taken at all sample points. Rule applies to CWS only.
	Combined Radium-226 and Radium-228	5 pCi/L / 0	Cancer risk	
	Gross Alpha (excluding radon and uranium)	15 pCi/L / 0	Cancer risk	
	Beta Particles and Photon Emitters	4 mrem/year / 0	Cancer risk	Primacy agency must designate vulnerable systems. Once deemed vulnerable, quarterly samples are required for beta emitters and annual samples for Tritium and Strontium-90 at entry to distribution system. Compliance is based on the running annual average of four quarterly samples taken at each sample point.
	Uranium	0.030 / 0	Kidney problems; cancer risk	Same as Combined Radium and Gross Alpha.
Organic Chemicals	**Synthetic Organic Chemicals (SOCs)**			For SOCs: Four consecutive quarterly samples during first compliance period. Compliance is based on annual average of quarterly samples. If no detections are found during initial round, two quarterly samples are required each year for systems serving > 3,300; one sample is required every 3 years for smaller systems. With the completion of source water assessments, primacy agencies are allowed to develop alternative monitoring requirements. Contact your local primacy agency for further information. Applies to CWS and NTNCWS.
	2,3,7,8-TCDD (Dioxin)	0.00000003 / 0	Cancer risk; reproductive system problems	
	2,4,5-TP (Silvex)	0.05 / 0.05	Liver problems	
	2,4-D	0.07 / 0.07	Adrenal gland/liver/kidney problems	
	Acrylamide	TT / 0	Cancer risk; nervous system/blood problems	
	Alachlor	0.002 / 0	Cancer risk; eye/liver/kidney/spleen problems/anemia	
	Atrazine	0.003 / 0.003	Cardio problems; reproductive system problems	
	Benzo(a)pyrene (PAHs)	0.0002 / 0	Cancer risk; reproductive system problems	
	Carbofuran	0.04 / 0.04	Blood/nervous/reproductive system problems	
	Chlordane	0.002 / 0	Cancer risk; liver/nervous system problems	
	Dalapon	0.2 / 0.2	Kidney problems	
	Di(2-ethylhexyl) adipate	0.4 / 0.4	Liver/weight loss/reproductive system problems	
	1,2-Dibromo-3-chloropropane (DBCP)	0.0002 / 0	Cancer risk; reproductive system problems	
	Di(2-ethylhexyl) phthalate (DEHP)	0.006 / 0	Cancer risk; liver/reproductive system problems	
	Dinoseb	0.007 / 0.007	Reproductive system problems	
	Diquat	0.02 / 0.02	Ocular problems	
	Endothall	0.1 / 0.1	Stomach/intestinal problems	
	Endrin	0.002 / 0.002	Liver problems	
	Epichlorohydrin	TT / 0	Cancer risk; stomach problems	
	Ethylene Dibromide (EDB)	0.00005 / 0	Cancer risk; liver/kidney/stomach/reproductive system problems	
	Glyphosate	0.7 / 0.7	Kidney/reproductive system problems	
	Heptachlor	0.0004 / 0	Cancer risk; liver problems	
	Heptachlor Epoxide	0.0002 / 0	Cancer risk; liver problems	
	Hexachlorobenzene	0.001 / 0	Cancer risk; liver/reproductive system problems	
	Hexachlorocyclopentadiene (HEX)	0.05 / 0.05	Kidney/stomach problems	
	Lindane	0.0002 / 0.0002	Kidney/liver problems	
	Methoxychlor	0.04 / 0.04	Reproductive system problems	
	Oxamyl (Vydate)	0.2 / 0.2	Nervous system problems	
	Pentachlorophenol	0.001 / 0	Cancer risk; liver/kidney problems	
	Picloram	0.5 / 0.5	Liver problems	
	Polychlorinated Biphenyls (PCBs)	0.0005 / 0	Cancer risk; thymus gland/immune deficiencies/ reproductive or nervous system problems	
	Simazine	0.004 / 0.004	Problems with blood	
	Toxaphene	0.003 / 0	Cancer risk; liver/kidney/thyroid problems	
	Volatile Organic Chemicals (VOCs)			For VOCs: Four consecutive quarterly samples during first compliance period. Compliance is based on annual average of quarterly samples. If no detections are found during initial round, two quarterly samples are required each year for systems serving > 3,300; one sample is required every 3 years for smaller systems. With the completion of source water assessments, primacy agencies are allowed to develop alternative monitoring requirements. Contact your local primacy agency for further information. Applies to CWS and NTNCWS.
	1,1,1-Trichloroethane	0.2 / 0.2	Liver/circulatory/nervous system problems	
	1,1,2-Trichloroethane	0.005 / 0.003	Kidney/liver/immune system problems	
	1,1-Dichloroethylene	0.007 / 0.007	Liver problems	
	1,2,4-Trichlorobenzene	0.07 / 0.07	Adrenal gland problems	
	1,2-Dichloroethane	0.005 / 0	Cancer risk	
	1,2-Dichloropropane	0.005 / 0	Cancer risk	
	Benzene	0.005 / 0	Cancer risk; anemia/blood problems	
	Carbon Tetrachloride	0.005 / 0	Cancer risk; liver problems	
	Chlorobenzene	0.1 / 0.1	Kidney/liver problems	
	Cis-1,2-Dichloroethylene	0.07 / 0.07	Liver problems	
	Dichloromethane	0.005 / 0	Cancer risk; liver problems	
	Ethylbenzene	0.7 / 0.7	Kidney/liver problems	
	Ortho-Dichlorobenzene	0.6 / 0.6	Kidney/liver/circulatory system problems	
	Para-Dichlorobenzene	0.075 / 0.075	Kidney/liver/spleen/circulatory system problems	
	Styrene	0.1 / 0.1	Liver/kidney/circulatory system problems	
	Tetrachloroethylene (PCE)	0.005 / 0	Cancer risk; liver problems	
	Toluene	1 / 1	Kidney/liver/nervous system problems	
	Trans-1,2-Dichloroethylene	0.1 / 0.1	Liver problems	
	Trichloroethylene (TCE)	0.005 / 0	Cancer risk; liver problems	
	Vinyl Chloride	0.002 / 0	Cancer risk	
	Xylenes (total)	10 / 10	Nervous system problems	
Disinfectants and Disinfection Byproducts	**Stage 1 Disinfectants/Disinfection Byproducts Rule (D/DBPR) Disinfectants**			Applies to all CWS and NTNCWS that treat water with a chemical disinfectant for primary or residual treatment.
	Chlorine	4.0 (as Cl_2) MRDL / 4 MRDLG	Eye/nose irritation; stomach discomfort	Monitor at the same sample locations as the Total Coliform Rule. Compliance based on running annual arithmetic average of monthly averages. Daily sample at distribution system entry point.
	Chloramines	4.0 (as Cl_2) MRDL / 4 MRDLG	Eye/nose irritation; stomach discomfort; anemia	
	Chlorine Dioxide	0.8 (as ClO_2) MRDL / 0.8 MRDLG	Anemia; nervous system problems	Daily sample at distribution system entry points. Four quarterly distribution system samples. Compliance based on running annual average of quarterly average.
	Disinfection Byproducts			
	Total Trihalomethanes (TTHMs)	0.080	See Stage 2 D/DBPR (below) for health effects.	See Stage 2 D/DBPR (below) for compliance.
	Haloacetic Acids (HAA5)	0.060	See Stage 2 D/DBPR (below) for health effects.	
	Chlorite	1.0 / 0.8	Anemia; nervous system problems	Systems that add chlorine dioxide required to take daily sample at distribution system entry point.
	Bromate	0.010 / 0	Cancer risk	One sample per month (ozone systems only). Compliance based on running annual average.
	Total Organic Carbon (TOC)	TT		Source and treated water TOC sampled once a month. Compliance based on running annual average of TOC removal ratios.
	Stage 2 Disinfectants/Disinfection Byproducts Rule (D/DBPR) Disinfection Byproducts			Applies to all CWS and NTNCWS that add a primary residual disinfectant other than UV or deliver water that has been disinfected.
	Total Trihalomethanes (TTHMs) Chloroform Bromodichloromethane (BDCM) Bromoform Dibromochloromethane (DBCM)	0.080 / 0.07 / 0 / 0 / 0.06	Cancer risk; liver/kidney/nervous system problems; potential reproductive system effects; potential adverse pregnancy outcomes	Compliance Monitoring: Locational Running Annual Average (LRAA) of quarterly samples (yearly for very small surface water and small ground water systems) taken at locations determined by Initial Distribution System Evaluation (IDSE). Compliance sites are locations in the distribution system where TTHMs are high, HAA5s are high, and at average detention time sites. The number of sites is based on the type of source water and population served.
	Haloacetic Acids (HAA5) Monochloroacetic Acid (MCAA) Dichloroacetic Acid (DCAA) Trichloroacetic Acid (TCAA) Bromoacetic Acid Dibromoacetic Acid	0.060 / 0.07 / 0 / 0.02 / – / –	Cancer risk; potential adverse pregnancy outcomes	

REGULATIONS	NAME OF CONTAMINANT	MCL / MCLG (mg/L unless noted)	HEALTH EFFECTS OF CONTAMINANT	MONITORING REQUIREMENTS / COMMENTS Refer to Code of Federal Regulations or contact your primacy agency for additional details.
Microbiological Contaminants	**Total Coliform Rule (TCR)**			Applies to all surface water and ground water systems. The total number and location of samples is based on the population served and a system-specific sampling plan. If 40 samples or more per month, no more than 5.0% positive; if less than 40 samples per month, no more than one positive for total coliforms.
	Total Coliforms Fecal Coliforms *E.coli*	MCL = See comments MCLG = 0 for all 3 indicators	Coliforms are bacteria that are naturally present in the environment and are used as an indicator that other, potentially harmful bacteria may be present or that a potential pathway exists through which contamination may enter the drinking water distribution system. The presence of *E.coli* may indicate potential contamination that can cause diarrhea, cramps, nausea, headaches, or other symptoms.	
	Revised Total Coliform Rule (RTCR)			RTCR applies to CWS and NCWS and specifies frequency and timing of microbial testing based on the population served and a system-specific sampling plan for total coliform. Systems must conduct assessments (Level 1 or 2) based on treatment technique triggers. Level 1 TT triggers: a) if taking 40 or more samples per month, system exceeds 5.0% total coliform-positive samples; b) if taking fewer than 40 samples per month, system has 2 or more total coliform-positive samples. Level 2 TT triggers: a) *E.coli* MCL violation; b) second Level 1 trigger in rolling 12 months; c) Level 1 trigger in 2 consecutive years. Acute violations are based on a positive *E.coli* (Tier 1 Public Notification) when a repeat sample is *E.coli*+ following Total Coliform positive (TC+) routine sample; a repeat sample is TC+ following *E.coli*+ routine sample; a system fails to take required repeat samples following an *E.coli*+ routine sample; or a system fails to test for *E.coli* when any repeat sample is TC+. Systems must measure disinfectant residual at least at same location and time as total coliform samples are sampled.
	E.coli	TT / 0		
	Total Coliforms	TT / 0		
	Surface Water Treatment Rule (SWTR)			Applies to all public water systems using surface water or ground water under the direct influence of surface water. Grab samples every four hours or continuous monitoring for turbidity. Continuous chlorine residual required for systems > 3,300. One to four grab samples per day are allowed for systems ≤ 3,300. Must maintain disinfectant residual ≥ 0.2 mg/L entering the distribution system. Performance requirements demonstrated through combination of removal via filtration and inactivation via disinfection. See IESWTR and LT1ESWTR for turbidity TT requirements.
	Turbidity	TT	None. Interferes with disinfection.	
	Giardia lamblia	TT / 0	Gastrointestinal illness; Giardiasis	Minimum three-log removal/inactivation of *Giardia* (99.9%).
	Enteric Viruses	TT / 0	Gastrointestinal and other viral infections	Minimum four-log removal/inactivation of viruses (99.99%).
	Legionella	TT / 0	Legionnaires' disease, a type of pneumonia	No limit. Rule assumes if virus and *Giardia* limits are met, *Legionella* will be controlled.
	Heterotrophic Plate Count (HPC)	TT	None. Used to measure variety of bacteria common in water.	Filtration avoidance is allowed under certain circumstances (see Regulation). Lower bacteria concentration indicates better maintained water system.
	Interim Enhanced Surface Water Treatment Rule (IESWTR)			Applies to all public water systems using surface water or ground water under the direct influence of surface water. Must continue to comply with SWTR. Treatment effectiveness is demonstrated by combined effluent turbidity ≤ 0.3 NTU in 95% of measurements taken each month. Conventional and direct filtration systems must measure combined filter effluent turbidity at least every four hours and continuously monitor turbidity of each individual filter. The maximum turbidity limit is 1 NTU. If the PWS meets filtered water turbidity criteria, it is assumed to achieve the required 2-log *Cryptosporidium* removal. Performance triggers for individual filter turbidities lead to additional reporting and assessments if exceeded. IESWTR applies to systems ≥ 10,000; LT1ESWTR applies to systems < 10,000 people.
	Turbidity	TT	None. Interferes with disinfection.	
	Cryptosporidium	TT / 0	Gastrointestinal illness; Cryptosporidiosis	
	Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)			
	Turbidity	TT	None. Interferes with disinfection.	
	Cryptosporidium	TT / 0	Gastrointestinal illness; Cryptosporidiosis	
	Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)			Applies to all public water systems using surface water or ground water under the direct influence of surface water. Monthly monitoring for *Cryptosporidium* for 2 years is required to characterize the source water. Small systems monitor for *E.coli* in lieu of *Cryptosporidium*, unless *E.coli* is high — then monitor for *Cryptosporidium*. Calculated *Cryptosporidium* concentration defines required level of additional treatment. Treatment bins differ for filtered and unfiltered systems. Additional treatment options selected from the Microbial Toolbox.
	Cryptosporidium	TT / 0	Gastrointestinal illness; Cryptosporidiosis	
	Filter Backwash Rule			No monitoring is required, but systems must collect and retain information on recycle flows for review by the primacy agency. Applies to all systems using conventional or direct filtration treatment that recycle spent filter backwash water (excluding membrane plants), thickener supernatant, or liquids from dewatering processes. TT Requirement: All recycle flows must be returned at the head of the plant so that complete treatment of the recycle stream is provided. Treatment of recycle streams prior to recycle is not required.
	Cryptosporidium	TT / 0	Gastrointestinal illness; Cryptosporidiosis	
	Ground Water Rule (GWR)			Applies to all ground water systems. Sanitary surveys required every 3 years for CWS and every 5 years for NCWS. Source water monitoring is required for systems that do not treat to 4-log viral inactivation and is triggered by a total coliform (TC)-positive sample in the distribution system. Samples must be taken within 24 hours of TC-positive at all sources on line at the time the TC sample was taken. There are special notification requirements for wholesalers and consecutive systems for TC-positive. If primacy agency identifies significant deficiencies in sanitary survey, corrective action is required and can consist of: correcting deficiencies, providing alternative source of water, eliminating source of contamination, or providing treatment for 4-log inactivation of viruses.
	Viruses	TT	Gastrointestinal illness	
Additional Rules	**Consumer Confidence Report (CCR) Rule**	None (data reporting only)		PWS to prepare and make available electronically (or mail paper copies if requested) annual CCR to their customers every July.

SECONDARY STANDARDS

GUIDELINES	CONTAMINANT	SECONDARY MCL (mg/L unless noted)	NOTICEABLE EFFECTS ABOVE SECONDARY MCL
National Secondary Drinking Water Standards are non-enforceable guidelines regulating contaminants that may cause cosmetic effects or aesthetic effects in drinking water. The EPA recommends secondary standards but does not require systems to comply with secondary MCLs. States may establish or enforce standards that differ from these recommendations.	Aluminum	0.05 to 0.2	Colored water
	Chloride	250	Salty taste
	Color	15 color units	Visible tint
	Copper	1	Metallic taste; blue-green staining
	Corrosivity	Noncorrosive	Metallic taste; corroded pipes/fixtures; staining
	Fluoride•	2.0	Tooth discoloration
	Foaming Agents	0.5	Frothy; cloudy; bitter taste; odor
	Iron	0.3	Rusty color; sediment; metallic taste; reddish or orange staining
	Manganese	0.05	Black to brown color; black staining; bitter metallic taste
	Odor	3 TON (threshold odor number)	"Rotten-egg," musty, dusty, or chemical smell
	pH	6.5 - 8.5 su (standard unit)	Low pH: bitter metallic taste; corrosion. High pH: slippery feel; soda taste; deposits
	Silver	0.10	Skin discoloration; graying of the white part of the eye
	Sulfate	250	Salty taste
• *U.S. Department of Health and Human Services has revised the recommended fluoride level in drinking water to 0.7 mg/L.*	Total Dissolved Solids (TDS)	500	Hardness; deposits; colored water; staining; salty taste
	Zinc	5	Metallic taste

POTENTIAL FUTURE REGULATIONS

CONTAMINANT OR RULE	DESCRIPTION
Per- and Polyfluoroalkyl Substances (PFAS)	On March 14, 2023, the EPA announced the proposed National Primary Drinking Water Regulation (NPDWR) for six PFAS. Draft Maximum Contaminant Levels (MCLs) were established for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) at 4 nanograms per liter (ng/L) each. The draft rule also proposes a joint limit on four other chemicals, including: • perfluorononanoic acid (PFNA), • hexafluoropropylene oxide dimer acid (HFPO-DA, commonly known as GenX Chemicals), • perfluorohexane sulfonic acid (PFHxS), and • perfluorobutane sulfonic acid (PFBS). The joint limit would be expressed as a Hazard Index (HI) of 1.0. The HI is a unitless value calculated by comparing measured concentrations for each of the four PFAS to health-based water concentrations proposed in the rule. According to the EPA, this approach is intended to protect communities from the additive effects of multiple PFAS when they occur together. PFOA and PFOS are not included in the HI because their MCLGs are zero. **PFAS** — Health-Based Water Concentration (ng/L) aka MCLG GenX — 10 ng/L PFBS — 2,000 ng/L PFNA — 10 ng/L PFHxS — 9 ng/L **HAZARD INDEX** = measured concentration/health-based water concentration HI = ([GenX]/10 ng/L) + ([PFBS]/2000 ng/L) + ([PFNA]/10 ng/L) + ([PFHxS]/9 ng/L)
Lead and Copper Rule	The Lead and Copper Rule (LCR) was promulgated in 1991 and has had multiple small modifications since then. EPA published **Lead and Copper Rule Revisions**, or LCRR, with an effective date of Dec. 16, 2021, giving utilities three years to comply. October 16, 2024, is one of the first compliance deadlines that will require utilities to submit information for an initial lead service line inventory. EPA concluded that there were significant opportunities to improve the 2021 LCRR. On November 30, 2023, EPA announced the proposed **Lead and Copper Rule Improvements** (LCRI) to address additional key issues and opportunities to reduce risk associated with lead and copper in drinking water with the intent to promulgate the LCRI prior to October 2024. LCRI focus areas include: 1. Achieve 100% lead pipe replacement within 10 years. 2. Keep tabs on legacy lead pipelines with updates on inventories and publicly available lead service line replacement plans. 3. Improve tap sampling with first liter and fifth liter samples. 4. Lower the lead action level from 15 micrograms per liter (mcg/L) to 10 mcg/L. 5. Strengthen protections to reduce exposure with additional outreach and certified water filters to customers in service areas where multiple lead action level exceedances have occurred.

▸ Expected dates are subject to change due to uncertainties with EPA's schedule.

KEY

AL	Action Level	**MFL**	Million Fibers per Liter	**NTNCWS**	Non-Transient Non-Community Water System
CWS	Community Water System	**mg/L**	Milligrams per Liter	**NTU**	Nephelometric Turbidity Unit
EPA	United States Environmental Protection Agency	**MGD**	Million Gallons per Day	**pCi/L**	Picocuries per Liter
GPM	Gallons per Minute	**MRDL**	Maximum Residual Disinfectant Level	**PWS**	Public Water System
HPC	Heterotrophic Plate Count	**MRDLG**	Maximum Residual Disinfectant Level Goal	**SDWA**	Safe Drinking Water Act
MCL	Maximum Contaminant Level	**mrem**	Millirem	**TC**	Total Coliform
MCLG	Maximum Contaminant Level Goal	**NCWS**	Non-Community Water System	**TT**	Treatment Technique

LIGHTING THE PATH TO UTILITY RESILIENCY

Utilities are facing new and intensifying challenges from extreme weather events, resource scarcity, aging infrastructure and changing demographics. To proactively manage these risks before they become system disruptions or service failures, we propose a *Path to Utility Resiliency*. Our *Path to Utility Resiliency* involves four major stages: Assess, Plan, Implement, and Maintain. There are common steps outlined in each of these stages; however, if you're looking to concentrate your efforts, we've also listed specific steps per stage for six different focus areas. Scan the QR code at right to learn more about our experience and approach to utility resiliency.

	ASSESS	PLAN	IMPLEMENT	MAINTAIN
	Visioning Benchmarking Data Collection Evaluation Gap Analysis Schedule Definition	Goal Setting Change Readiness Prioritization Performance Metrics One Water Strategies Pilot Programs	Delivery Approaches Design, Build, Operate Performance Tracking Optimization	Data Collection Ongoing Review Performance Management
PUBLIC CONFIDENCE RESILIENCY **THE RISK** Misinformation that erodes the utility's ability to recruit employees and receive community support.	• Brand assessment • Community analytics • Customer information needs • Customer satisfaction survey • Level of service review • Stakeholder interviews	• Audience and outreach strategies • Crisis communications plan • Customer experience • Proactive storytelling • Service equity	• Civic engagement • Consensus building • Consumer Confidence Report/ regular notifications • Public education • Value of water communication	• Build and maintain trust • Public confidence in the reliability, stewardship, and communication of the utility • Public input • Transparent utility activities
FINANCIAL RESILIENCY **THE RISK** Inability to generate enough funding to sustainably maintain utility operations and an equitable level of service.	• Affordability analysis • Cost of service • Demand projections • Market survey • Policy/political limitations • Rate sufficiency	• Budget reliability • Capital funding alternatives • Equitable rate development • Equity roadmap • Impact fee feasibility • Public messaging to educate on investment and value of water • Public rate engagement • Revenue needs and strategies	• Adoption • Advocacy • Contingent strategies • Funding portfolio management • Public/private partnerships	• Consumer Price Index considerations • Cost control measures • Data-supported plan for annual rate escalation • Investment review • Periodic audits
WORKFORCE RESILIENCY **THE RISK** Increasing organizational complexity, labor shortages, and lack of institutional knowledge transfer hinders utility effectiveness and employee experience.	• Attrition trends • Culture and climate • Employee engagement • Skills/proficiency gap analysis • Staff compensation	• Automation opportunities • Essential personnel identification • Mentorship and skills training programs • Operation continuity • Succession planning • Workforce partnerships	• Leadership development pipeline • Recruitment/marketing • Standard operating procedure (SOP) development • Staff augmentation • Training/workforce development • Workflow optimization	• Employee belonging and appreciation • Implementable approaches to training • Incentive/rewards programs • Supported employee culture

INFRASTRUCTURE RESILIENCY
THE RISK
Vulnerable physical and digital systems that underperform and are subject to service failure due to lack of continuous renewal.
	• Capacity and supply reliability
	• Condition assessment
	  • Vertical assets
	  • Horizontal assets
	• Criticality assessment
	• Cyber assessment
	• Identify single points of failure
	• Network reliability
	• Physical threats
		• Asset management program
		• Capital Improvement Plan (CIP) funding
		• Cyber and SCADA planning
		• Delivery efficiency
		• Emergency response plan
		• Establish replace and rehabilitation renewal frequency
		• Facility and process modernization
			• Enhanced redundancy
			• Establish maintenance management framework
			• Controls systems upgrades
			• Critical asset hardening
			• Cyber security enhancements
			• Insurance
			• Physical security enhancements
			• Regionalization
			  • Decommission plant
				• CIP updated on predictable schedule
				• Cyber audit or monitoring/ penetration testing
				• Data-informed CIP completed
				• Emergency response exercises
				• Incident response exercises and reporting

CLIMATE RESILIENCY **THE RISK** Impairment of water supplies and systems due to ongoing and extreme weather events.	• Climate variability • Environmental relationships with assets • Extreme event risk tolerance • Supply portfolio characterization	• Disaster response planning • Emergency level of service • Green opportunities • Performance metrics: snowpack, salinity, reservoir level • Regional cooperation agreements • System hardening • Water supply diversification	• Regionalization • Seawater barrier • Supply augmentation/reuse • Watershed management	• Green targets established • Promote water supply diversification and protection

WATER QUALITY RESILIENCY
THE RISK
Safe Drinking Water Act non-compliance due to dynamic regulations, system limitations, and source degradation.
	• Acceptable finished water quality thresholds
	• Emerging contaminant sampling programs
	• Lead and Copper Rule and PFAS compliance deadlines
	• Lead service line (LSL) inventories
		• Bipartisan Infrastructure Law allocations
		• Integrated planning
		• Policy engagement
		• Stakeholder communication and partnerships
		  • Source management
		  • Disposal strategies
		• Treatability studies
			• Advanced water treatment
			• Corrosion control
			• Lead service line replacement
			• Public notification protocol
			• Regionalization
			• Residuals management
				• Meet or exceed compliance
				• Policy advocacy in place
				• Water quality performance metrics established

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