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Drinking Water Crises in the United States Phase 2: Predictive Modeling

Executive Summary

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Overview

The Water Quality Research Foundation (WQRF) Drinking Water Crisis in the United States Phase 2 Predictive Modeling Study follows the Phase 1 effort to identify drinking water crises which occurred in the United States between 2009-2019. The resulting Phase 1 data set includes nearly 250,000 qualified cases, defined by the following:

- The contamination event occurred between 2009-2019 in a public or private water supply
- The contaminant is known, or suspected, to cause adverse health effects (acute or chronic) in humans
- The contaminant could be federally regulated or unregulated
- The population served by the contaminated water supply was at least 100 people

The Phase 2 Predictive Modeling Study aims to meet the following objectives:

1. Collect and assess all available and relevant data to identify historical and current drinking water contamination events
2. Develop a qualitative model to describe likely future drinking water contamination events
3. Assess how point-of-use (POU) and point-of-entry (POE) devices can be utilized to protect public health in the event of likely future drinking water contamination events

The Predictive Modeling Study outcomes identified over twenty individual or groups of contaminants likely to be of the greatest concern for drinking water in the next five to ten years. Among the contaminants that are of the highest priority based on potential health risks and exposure from drinking water include the following:

- Microbial contaminants (i.e., total coliform, *E.coli*, *Legionella pneumophila*)
- Lead & copper
- Arsenic
- Disinfection byproducts (DBPs)
- Per- and polyfluoroalkyl substances (PFAS)
- Nitrate

The full list of contaminants identified by the model along with their ranking in terms of priority as a drinking water contaminant, reason for identification, and available POU/POE treatment options is provided in Table 1.

Methodology

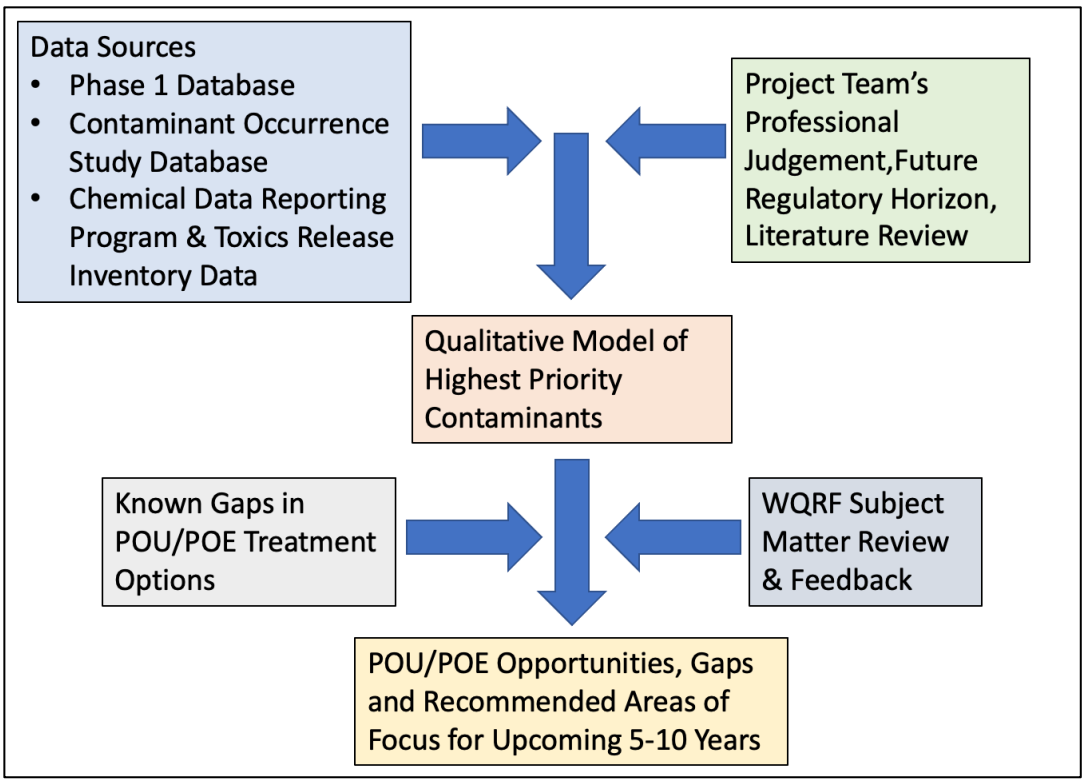
The Predictive Modeling Study utilizes available and relevant data to assess drinking water contaminants of concern that will most likely be the cause of drinking water contamination at levels known or suspected to cause adverse health effects in the next five to ten years. The qualitative model includes the following steps:

1. Assess US Environmental Protection Agency (EPA) Safe Drinking Water Information System (SDWIS) violation data for public water systems (PWSs) to evaluate contaminants leading to the highest number of health-based violations.

2. Assess EPA's Unregulated Contaminant Monitoring Rule (UCMR) data sets to assess unregulated contaminants with the highest number of detections in drinking water served by PWSs.
3. Assess national drinking water occurrence data for PWSs to evaluate contaminants based on the number of PWSs with occurrence at levels above the contaminant's maximum contaminant level (MCL).
4. Review EPA's Contaminant Candidate Lists (CCLs) for contaminants that are not currently regulated but on EPA's radar and could potentially be regulated in the future.
5. Research federal and state processes to revise current regulations or set future regulations and the motivation for the potential future regulatory changes.
6. Research relevant drinking water publications, conference presentations, and news articles to assess and rank contaminants based on academic, industry, and public interest and concern.
7. Review EPA's Toxic Substances Control Act (TSCA) Chemical Data Reporting (CDR) and Toxics Release Inventory (TRI) data sets for chemical production, use, and release quantities and trends.
8. Draw upon expert knowledge and experience to evaluate all contaminants identified in steps 1-8 and develop a list of top priority contaminants of concern for the next five to ten years.
9. Research available POU and POE treatment options for the top priority contaminants and the NSF/ANSI certified products based on removal claims for contaminants of interest.
10. Synthesize information gathered in steps 1-9 to develop predictions for the top priorities of concern in the next five to ten years and identify potential opportunities for the POU/POE industry to protect public health.

Figure 1 provides a flow chart of the predictive model's qualitative methodology.

Figure 1 Predictive model qualitative methodology flow chart



Results

A summary of the results from each step of the qualitative model are described below.

The assessment of health-based violations to the EPA's National Primary Drinking Water Regulations (NPDWRs) for PWSs between 2009 and 2019 identified twelve contaminants as the greatest concern based on the highest number of violations. Those contaminants, in order by the number of health-based violations, included total coliform, total trihalomethane (TTHM), arsenic, five haloacetic acids (HAA5), copper, lead, nitrate, combined radium (-226 & -228), gross alpha, uranium, fluoride, and total nitrate and nitrite.

The assessment of EPA's UCMR2, UCMR3, and UCMR4 data sets identified thirteen contaminants with the highest number of detections in drinking water served by PWSs. The UCMR contaminants with the highest number of detections, order by the number of detections, include strontium, chromium-6, HAA5, six brominated haloacetic acids (HAA6Br), nine haloacetic acids (HAA9), vanadium, chlorate, chromium, molybdenum, manganese, 1,4-dioxane, germanium, and n-nitroso-dimethylamine (NDMA).

Contaminants with federal and state regulations were assessed to determine those resulting in the highest number of PWSs with occurrence above the MCL or Action Level. The top contaminants in order by the number of PWSs with occurrence above federal standards include lead, TTHM, copper, HAA5, arsenic, nitrate, total nitrate and nitrite, radium, fluoride, and uranium. The federally regulated contaminants identified in this assessment are consistent with those contaminants that resulted in the highest number of health-based violations. The top contaminants in order by the number of PWSs with occurrence above state-specific standards include iron (North Carolina), manganese (North Carolina), iron (New York), chloride (New York), manganese (New York), arsenic (New Jersey), chloride (Connecticut), fluoride (New York), zinc (New York), and tetrachloroethylene (PCE) (New Jersey). The results for the state-specific standards are dependent on whether states have their own standards that go beyond those set by the EPA and the availability of occurrence data for the given state.

Currently, EPA's draft Fifth CCL (CCL5) is the most recent update to the CCL. A review of the draft CCL5 identified the following contaminants as the most likely contaminants to be of concern for drinking water in the next five to ten years: DBPs, especially brominated haloacetic acids (HAAs), microbial contaminants, especially *Legionella pneumophila*, PFAS, 1,4-dioxane, 1,2,3-trichloropropane, and manganese.

A review of the current or upcoming federal and state drinking water regulations identified several regulatory changes of national and state-specific importance.

- **Lead & Copper**: EPA published the Lead and Copper Rule Revisions (LCRR) on January 15, 2021 (USEPA 2021b), which impact many PWSs nationwide. Among the updates to the Lead and Copper Rule, the revisions establish a 10 µg/L "trigger level" and allow for community water systems (CWSs) serving populations of 10,000 or less and all non-transient non-community water systems (NTNCWSs) to achieve compliance through the provision and maintenance of POU devices that are certified to reduce lead concentrations (USEPA 2019, WQA 2022).
- **PFAS**: In June 2022, the EPA set non-enforceable interim health advisories for perfluorooactanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) at 0.004 nanograms per liter (ng/L) and 0.02 ng/L, respectively, and final health advisories for GenX chemicals and PFBS

at 10 ng/L and 2,000 ng/L, respectively. Previously, EPA had set a health advisory level of 70 nanograms per liter (ng/L) for PFOA and PFOS in 2016. Since 2016, twelve states have set their own PFAS regulations or health advisories. PFAS regulations vary by state, based on which PFAS analytes are included, whether PFAS MCLs are set for individual PFAS analytes or the sum of a group of analytes, and the numeric level for the MCL. EPA is currently working towards setting drinking water regulations for PFAS, with anticipated draft and final regulations for PFOA and PFOS expected in 2022 and 2023, respectively. The upcoming UCMR5 will include monitoring for 29 PFA analytes to give a more thorough understanding of the national PFAS occurrence in drinking water for future regulatory development.

- **Microbial & Disinfection Byproducts**: The EPA reached a settlement agreement with the Waterkeepers Alliance, Inc. that commits EPA to propose revisions to the current primary standards for chlorite, *Cryptosporidium*, *Giardia lamblia*, haloacetic acids (HAAs), heterotrophic bacteria, Legionella, TTHM, and viruses. Based on EPA's request to the National Drinking Water Advisory Council (NDWAC) to form a Working Group to provide recommendations to EPA, the proposed regulations are due by in 2025. Primary topics of interest discussed in stakeholder meetings thus far have included DBPs, especially unregulated brominated HAAs, *Legionella pneumophila*, minimum disinfectant residual requirements, distribution system and storage tank management, and building water system quality.
- **Chromium-6**: California's Department of Drinking Water (DDW) released a new revised draft regulation for chromium-6 (also commonly known as hexavalent chromium) on March 21, 2022.

A review of recent relevant drinking water publications, conference presentations, and news articles predominantly identified contaminants that were also identified in previous steps, although some additional contaminants were identified as well.

- **Top contaminants in news articles**: PFAS, lead, arsenic, DBPs, nitrate, total coliform/*E.coli* (boil water notifications), taste and odor issues, nanomaterials, radium, and fluoride
- **Top contaminants in publications/articles/presentations**: PFAS, lead, pesticides/insecticides/herbicides, plastics/microplastics, DBPs (i.e., nitrosamines), *Legionella*/*Legionella pneumophila*, nitrate, arsenic, fluoride, vanadium, perchlorate, 1,2,3-trichloropropane, 1,4-dioxane, pharmaceuticals, antimicrobial resistant bacteria, harmful algal blooms, mycobacteria

A review of EPA's TSCA and TRI identified the following contaminants as the most produced and most released chemicals based on reported information by mass:

- **Top released chemicals**: lead compounds, zinc compounds, manganese compounds, barium compounds, arsenic compounds, nitrate compounds, copper compounds, chromium compounds, methanol, sulfuric acid
- **Top produced chemicals**: leach solutions, sulfite/cooking liquors, fuels, diesel no. 2, ethanol, calcium oxide silicate, fly ash, sulfuric acid, calcium hydroxide, butane, ethane

The results of steps 1-7 were reviewed and aggregated to produce a list of the top contaminants of concern based on each analysis. The contaminants identified as the top contaminants of concern for the next five to ten years are included below in Table 1. The POU and POE treatment options for these contaminants were research and summarized in Table 1

Predictions and Recommendations

Over the next 5-10 years, it is anticipated that many drinking water systems will be working on meeting compliance with the lead and copper rule (LCR) through replacing lead service lines and implementing optimal corrosion control treatment. Some drinking water utilities may implement the use of POU treatment as a compliance strategy. Beyond drinking water utilities, consumers that may have concerns about lead levels in their own drinking water may also look toward POU or POE treatment to reduce their exposure. Lead exposure at any level is understood to present a health risk, and therefore, even consumers served by a drinking water system that is in compliance with the LCR may look for additional treatment for lead. Lead and copper are anticipated to remain primary contaminants of concern in the next 5-10 years, and the POU/POE industry is expected to play an important role in meaningful health risk reduction through the removal of lead and copper in drinking water.

Total coliform and *E.coli* are expected to remain major contaminants of concern for the next 5-10 years. It is possible that EPA could propose revisions to the microbial, disinfectant, and disinfection byproduct (M/DBP) by 2025 that may strengthen disinfection requirements and subsequently reduce the occurrence of total coliform and *E.coli*, but the time frame for such revisions to be implemented and affect meaningful change would be beyond the five year horizon.

Legionella, especially *Legionella pneumophila*, was found to be the unregulated microbial contaminant of the greatest concern. Controlling *Legionella* presents challenges for drinking water utilities because these efforts also rely on the management of building water systems and premise plumbing, which are not under the control of drinking water utilities. Due to the nature of *Legionella* and the reliance on building water system management, the POU/POE industry has an opportunity to provide options for building water managers and consumers to treat drinking water for *Legionella* at problematic locations.

DBPs are expected to remain a primary contaminant of concern, and the POU/POE industry has the opportunity to further protect the public against potential health risks from DBP exposure due to the nature of DBP formation in distribution systems. Depending on the application of the POU/POE treatment, e.g., for compliance or for removal of unregulated DBPs, further testing and validation may be necessary. For example, the treatment technologies available are generally far more effective at removing TTHM as opposed to HAAs, and while there are POU/POE treatment options with NSF/ANSI certification based on haloacetonitriles removal claims, the available treatment options are ineffective at removing nitrosamines, i.e., NDMA. The analysis conducted as part of this study suggests that DBPs will continue to be major contaminants of concern for the next 5-10 years, and POU/POE treatment options provide the public with a means to reduce their DBP exposure.

PFAS have been a major topic in drinking water communities, conferences, publications, and the news over the last 5 years. The first proposed federal regulation anticipated in 2022, and several states have set their own regulations or health advisories. PFAS currently represents an important opportunity for the POU/POE industry to support consumers and potentially drinking water utilities, depending on the state and state approvals for compliance by POU/POE treatment, in effectively removing PFAS to protect public health. POU/POE treatment options are available, although further testing and validation will be important based on the application and the specific PFAS contaminants.

The current arsenic MCL was set by the Arsenic Rule in 2001, which public drinking water systems were required to meet by 2006. Sixteen years later, the Arsenic Rule is still responsible for significant number

of health based MCL violations, particularly for smaller drinking water systems. There is a meaningful opportunity for the POU/POE industry to help protect consumers against exposure to arsenic in the next 5-10 years, and in some states, there may be opportunities to work with drinking water utilities and state regulators to employ or enable POU/POE options for compliance purposes.

Like arsenic, nitrate has been regulated for many years and has an acute MCL. It is not an emerging contaminant or a new concern, but it is one of the top priority contaminants in terms of the number of health based MCL violations and occurrence over the MCL. Nitrate is expected to remain a top concern over the next 5-10 years based on the analysis conducted in this study. As with arsenic, there is an opportunity for the POU/POE industry to help protect consumers against exposure to nitrate above the MCL. Additionally, in some states, there could be an opportunity to work with drinking water utilities and state regulators to employ or enable POU/POE options for compliance purposes.

Two radionuclides, radium and uranium, were identified by this model. These fall into a similar category as arsenic and uranium such that the Radionuclide Rule has been in place for years, no upcoming changes to the rule are anticipated, but the contaminants remain a concern for many public drinking water utilities. These contaminants are expected to still be a concern in the next 5-10 years, and they present an opportunity for the POU/POE industry through helping consumers protect themselves and potentially, for some states, could provide an opportunity to work with drinking water utilities and state regulators for compliance purposes.

Chromium-6 is noteworthy at the time of this report because the California Department of Drinking Water released a new draft MCL for chromium-6 in 2022. The reinstatement of a chromium-6 MCL could have implications for hundreds of drinking water systems in California. The new regulation could result in more consumers looking for additional home treatment options, such as POU or POE devices, or it is possible that systems could investigate POU/POE treatment options for compliance.

Contaminants such as manganese, 1,4-dioxane, and 1,2,3-trichloropropane are currently on EPA's CCL5, and while they are not currently federally regulated, there is the potential that they could be in the future. Perchlorate is another contaminant that has been considered for federal regulation by the EPA. In a decision published in 2020, the EPA chose not to regulate perchlorate, stating that it did not meet the requirements as a drinking water contaminant under the SDWA. EPA did release a plan to address perchlorate contamination on March 31, 2022 (USEPA 2022). In the case of manganese, 1,4-dioxane, 1,2,3-trichloropropane, and perchlorate, there are understood health risks from exposure, and the reduction or removal of their occurrence could be beneficial to consumer health. Therefore, the POU/POE industry has an opportunity to provide consumers with a treatment option for these contaminants. There are established POU/POE treatment options for manganese and for perchlorate, while POU/POE treatment options for 1,2,3-trichloropropane need further validation and testing. POU/POE treatment options for 1,4-dioxane are not well established.

Harmful algal blooms (HABs) and cyanotoxins are a health risk in natural water bodies, including source waters for drinking water, and cyanotoxins are a concern for public drinking water. Conventional drinking water treatment processes can generally remove cyanobacteria and low levels of cyanotoxins, there is an opportunity for the POU/POE industry particularly for communities where source waters have been experiencing seasonal blooms and high levels of cyanotoxins. In these communities, consumers may have interest in further protection against these toxins. POU/POE treatment options are available, although depending on the application of the treatment, further testing and validation

may be needed. While there are POU/POE treatment options with NSF/ANSI certification for microcystin removal claims, there are no certified options for the removal of other cyanotoxins.

Microplastics have been become a contaminant of concern over the last several years, and they have been at the center of drinking water related news articles, publications, and conference talks. Due to consumer concerns, the POU/POE industry has an opportunity to provide treatment options for microplastics. Microplastics remain an emerging contaminant with far more research required to fully understand the impact on drinking water quality and human health, and similarly, further research is recommended to provide the best POU/POE treatment options.

Fluoride is often used in drinking water treatment for dental purposes, but also regulated due to health issues at higher concentrations. In the next 5-10 years, thought, it is expected that fluoride will continue to be a concern in areas with high naturally occurring levels. Based on state MCLs and available data, this study found the greatest number of PWSs with fluoride occurrence over the state MCL in New York, although further analysis would be warranted to determine areas of concern. The POU/POE industry can provide these treatment options to consumers, especially in areas with high naturally occurring fluoride.

Barium has not been a contaminant of concern based on violations and occurrence over the MCL, but barium compounds were found to be in the top 10 of chemicals released based on EPA's TRI dataset. While it is not clear whether these releases will result in any increased barium levels in source waters for drinking water systems, it is important to be aware that this is a possibility. While there's no clear indication that barium represents a significant opportunity for the POU/POE industry to protect public health, it was identified as a potential future contaminant of concern.

Iron, chloride, zinc, and sulfate are three contaminants that are regulated in some states and have a secondary standard set by the EPA based on aesthetic impacts. Concerns with iron, chloride, zinc, and sulfate are expected to be focused on aesthetic issues, as opposed to health risks. While sulfate was not directly identified by the model, sulfuric acid was found to be one of the most produced chemicals in the most recent TSCA dataset. There are established POU/POE treatment options for these contaminants.

Calcium hydroxide and calcium oxide silicate were two of the most produced chemicals based on the EPA's most recent TSCA dataset. In drinking water, calcium increases the hardness of water. While hardness is not regulated or found to be a health concern, hard water can be a concern for various reasons. There are established POU/POE treatment options for calcium in drinking water.

Table 1 POE and POU treatment options for highest priority contaminants

Contaminant	Priority for Drinking Water	Reason for Inclusion	POU/POE Treatment Category	Point of Entry (POE) Treatment Options	Point of Use (POU) Treatment Options
Arsenic	1	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Top 10 list for 2020 chemical release data ("arsenic compounds")	Established	Iron oxide/hydroxides Activated alumina Anion exchange resin in a fixed bed (requires regeneration) Manganese greensand (requires regeneration) Titanium oxy/hydroxide Iron-doped anion resin and activated alumina	Iron oxide/hydroxides Activated alumina with or without iron oxide coating Anion exchange Titanium oxy/hydroxide Reverse osmosis (RO) Carbon block filters
Copper	1	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Top 10 list for 2020 chemical release data ("copper compounds")	Established	Reverse osmosis Cation exchange resin pH neutralizing filter (if copper source is in-home corrosion)	Reverse osmosis (RO) Cation exchange resin
Lead	1	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Top 10 list for 2020 chemical release data ("lead compounds") *Recent revisions to Lead & Copper Rule *Identified in web search for recent new articles and publications	Established	Fine filtration + adsorption	Reverse osmosis Fine filtration + adsorption

Contaminant	Priority for Drinking Water	Reason for Inclusion	POU/POE Treatment Category	Point of Entry (POE) Treatment Options	Point of Use (POU) Treatment Options
Nitrate	1	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Top 10 list for 2020 chemical release data ("nitrate compounds") *Identified in web search for recent new articles and publications	Established	Reverse osmosis (RO) Anion exchange resin (subject to sulfates competitive ion exchange) Nitrate "selective" anion exchange resins	Reverse osmosis (RO) Anion exchange resin (subject to sulfates competitive ion exchange) Nitrate "selective" anion exchange resins
DBPs (TTHM)	1	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Identified in web search for recent new articles and publications *Potential future changes to M/DBP Rules in next 5-10 years	Established	Reverse osmosis (RO) Granular activated carbon (GAC)	Reverse osmosis (RO) Granular activated carbon (GAC), powdered activated carbon (PAC), and carbon block filters
Total Coliform	1	*Top 10 list based on number of health based SDWA violations	Available[1]	Ultraviolet (UV) Reverse osmosis (RO) Ozonation	Ultraviolet (UV) Reverse osmosis (RO) Ozonation P231 rated filters

[1] The NSF site (NSF 2022) indicates that there are NSF/ANSI certified POU and POE treatment options for ultraviolet (UV) microbiological water treatment systems with claims for Class A and Class B disinfection performance. The are no certified products utilizing the other technologies listed for microbiological treatment (i.e., reverse osmosis, ozonation, P231 filters)

Contaminant	Priority for Drinking Water	Reason for Inclusion	POU/POE Treatment Category	Point of Entry (POE) Treatment Options	Point of Use (POU) Treatment Options
Legionella	1	*Potential future regulatory changes to M/DBP Rule *Identified in web search for recent news articles and publications *Included in EPA's CCL5 list	Available [2]	Ultraviolet (UV) Reverse osmosis (RO) Ozonation	Ultraviolet (UV) Ozonation 0.2 micron biological filter P231 rated filters
DBPs (HAA5/HAA9)	1	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Identified in web search for recent new articles and publications *Regulated (HAA5) and unregulated (HAA6Br, HAA9) included in EPA's UCMR4 *Potential future changes to M/DBP Rules in next 5-10 years	Available	Reverse osmosis (RO) Granular activated carbon (GAC)	Reverse osmosis (RO) Granular activated carbon (GAC), powdered activated carbon (PAC), and carbon block filters
PFAS (PFOA + PFOS)	1	*Included in EPA's UCMR3 and upcoming UCMR5 *Top finding in web search for recent news articles and publications *Upcoming regulations planned by EPA	Established	Granular activated carbon (GAC) Anion exchange resin	Reverse osmosis (RO) Granular activated carbon (GAC), powdered activated carbon (PAC), and carbon block filters Anion exchange resin

[2] The NSF site (NSF 2022) indicates that there are NSF/ANSI certified POU and POE treatment options for ultraviolet (UV) microbiological water treatment systems with claims for Class A and Class B disinfection performance. The are no certified products utilizing the other technologies listed for microbiological treatment (i.e., reverse osmosis, ozonation, P231 filters)

Contaminant	Priority for Drinking Water	Reason for Inclusion	POU/POE Treatment Category	Point of Entry (POE) Treatment Options	Point of Use (POU) Treatment Options
PFAS (other PFAS)	High	*Included in EPA's CCL5 *Included in EPA's UCMR3 and upcoming UCMR5 *Top finding in web search for recent news articles and publications *Upcoming regulations planned by EPA	Available	Granular activated carbon (GAC) Anion exchange resin	Reverse osmosis (RO) Granular activated carbon (GAC), powdered activated carbon (PAC), and carbon block filters Anion exchange resin
DBPs (unregulated, i.e., haloacetonitriles, halonitromethanes, iodinated THMs, nitrosamines, chlorate)	High	*Identified in web search for recent new articles and publications *Unregulated DBPs included in EPA's CCL5 *Potential future changes to M/DBP Rules in next 5-10 years	Available	Reverse osmosis (RO) Granular activated carbon (GAC) *Above treatment options are not effective for removal of nitrosamines	Reverse osmosis (RO) Granular activated carbon (GAC) *Above treatment options are not effective for removal of nitrosamines
Manganese	Medium	*Top 10 list based on PWSs w/ occurrence over state MCL *Included on EPA's CCL5 list *Included in EPA's UCMR4, most detected UCMR4 contaminant after DBPs (HAAs)	Established	Ion exchange Greensand filter/ manganese dioxide	Ion exchange resin Greensand filter/ manganese dioxide Reverse osmosis
Barium	Medium	*Top 10 list for 2020 chemical release data ("barium compounds")	Established	Cation exchange resin Reverse osmosis (RO)	Cation exchange resin Reverse osmosis (RO)
Fluoride	Medium	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Identified in web search for recent news articles and publications	Established	Activated alumina (requires regeneration or tank exchange) Anion exchange (requires regeneration or tank exchange) Reverse osmosis (RO)	Activated alumina Anion exchange Reverse osmosis (RO)
Iron	Medium	*Top 10 list based on PWSs w/ occurrence over state MCL	Established	Ion exchange resin Greensand filter Oxidation / filtration	Ion exchange resin Greensand filter Reverse osmosis (RO)

Contaminant	Priority for Drinking Water	Reason for Inclusion	POU/POE Treatment Category	Point of Entry (POE) Treatment Options	Point of Use (POU) Treatment Options
Radium	Medium	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL *Identified in web search for recent new articles and publications	Established	Cation exchange softening Reverse osmosis (RO)	Cation exchange softening Reverse osmosis
Uranium/ Gross Alpha	Medium	*Top 10 list based on number of health based SDWA violations *Top 10 list based on PWSs w/ occurrence over federal MCL	Established	Strong base anion exchange resins (chloride form) Reverse osmosis (RO)	Strong base anion exchange resins (chloride form) Reverse osmosis (RO)
Chromium Compounds/ Chromium-6, Total chromium	Medium	*Top 10 list for 2020 chemical release data ("chromium compounds") *CA's draft hexavalent chromium regulations released in March 2022	Established	Reverse osmosis (RO) Ion exchange resin	Reverse osmosis (RO) Ion exchange resin
Perchlorate	Medium	*Emerging contaminant of concern	Available	Anion exchange resin (regenerable and non-regenerable) Reverse osmosis (RO)	Anion exchange resin (regenerable and non-regenerable) Reverse osmosis
1,2,3-trichloropropane (TCP)	Medium	*Included in EPA's CCL5 *Included in EPA's UCMR3	Available	Granular activated carbon (GAC)	Granular activated carbon (GAC), powdered activated carbon (PAC), and carbon block filters
Cyanotoxins	Medium	*Included in EPA's CCL5 *Included in EPA's UCMR4 *Identified in web search for recent new articles and publications	Available [3]	Reverse osmosis (RO) Granular activated carbon (GAC)	Reverse osmosis (RO) Granular activated carbon (GAC), powdered activated carbon (PAC), and carbon block filters

[3] While there are POU/POE treatment options with NSF/ANSI certified microcystin removal claims, there are no certified removal claims for other cyanotoxins

Contaminant	Priority for Drinking Water	Reason for Inclusion	POU/POE Treatment Category	Point of Entry (POE) Treatment Options	Point of Use (POU) Treatment Options
Microplastics	Medium	*Identified in web search for recent news articles and publications *Emerging contaminant of concern	Available	Reverse osmosis (RO)	Carbon block filter Reverse osmosis (RO)
1,4-dioxane	Medium	*Included on EPA's CCL5 *Identified as emerging contaminant of concern	Not Available	Granular activated carbon (GAC) Reverse osmosis (RO)	Reverse osmosis (RO) Granular activated carbon (GAC)
Calcium hydroxide	Low	*Top 10 list for 2016 chemical production data	Established	Cation exchange water softener (treatment for calcium/hardness)	Cation exchange water softener (treatment for calcium/hardness) Reverse osmosis (RO)
Calcium oxide silicate	Low	*Top 10 list for 2016 chemical production data	Established	Cation exchange water softener (treatment for calcium/hardness)	Cation exchange water softener (treatment for calcium/hardness) Reverse osmosis (RO)
Chloride	Low	*Top 10 list based on PWSs w/ occurrence over state MCL, increasing concentrations over time in CT	Available	Reverse osmosis (RO) Ion exchange resin	Reverse osmosis (RO) Ion exchange resin
Sulfuric Acid (Sulfate considered for POU/POE treatment options)	Low	*Top 10 list for 2016 chemical production data	Available	pH neutralizing filter	Reverse osmosis (RO) Anion exchange resin Adsorptive media filtration pH neutralizing filter
Zinc	Low	*Top 10 list for 2020 chemical release data ("zinc compounds")	Established	Ion exchange resin Reverse osmosis (RO)	Ion exchange resin Reverse osmosis (RO)

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