

567—43.11(455B) Enhanced treatment for *Cryptosporidium*.

43.11(1) Applicability. The requirements of this rule are national primary drinking water regulations and establish or extend TT requirements in lieu of MCLs for *Cryptosporidium*. These requirements are in addition to the filtration and disinfection requirements of rules 567—43.5(455B), 567—43.9(455B) and 567—43.10(455B) and apply to all Iowa PWSs supplied by SW or IGW sources.

a. Wholesale systems. Wholesale systems must comply with these requirements based on the population of the largest system in the combined distribution system.

b. Filtered systems. This rule applies to those filtered systems that must provide filtration treatment pursuant to rule 567—43.5(455B), whether or not the system is currently operating a filtration system.

43.11(2) General. Systems subject to this rule must comply with the following:

a. Source water monitoring. Systems must conduct two rounds of source water monitoring for each plant that treats a SW or IGW source. This monitoring may include sampling for *Cryptosporidium*, *E. coli*, and turbidity, as described in 43.11(3), to determine what level, if any, of additional *Cryptosporidium* treatment the systems must provide.

b. Disinfection profiles and benchmarks. Systems planning to make a significant change to their disinfection practice must develop disinfection profiles and calculate disinfection benchmarks, as described in 43.11(4).

c. Treatment bin determination. Systems must determine their *Cryptosporidium* treatment bin classification and provide additional *Cryptosporidium* treatment, if required, according to the prescribed schedule.

d. Additional treatment. Systems required to provide additional *Cryptosporidium* treatment must implement microbial toolbox options as described in 43.11(8) through 43.11(13).

e. Recordkeeping and reporting. Systems must comply with the applicable recordkeeping and reporting requirements in 43.11(14) and 43.11(15).

f. Significant deficiencies. Systems must address significant deficiencies identified during sanitary surveys as described in 43.1(7).

43.11(3) Source water monitoring.

a. Schedule. Systems must conduct the source water monitoring no later than the month and year listed in Table 1. A system may avoid the source water monitoring if it provides a total of at least 5.5-log treatment for *Cryptosporidium*, equivalent to meeting the treatment requirements of Bin 4 in 43.11(6). The system must install and operate technologies to provide this level of treatment by the applicable treatment compliance date specified in 43.11(7).

Table 1: Source Water Monitoring Schedule

System	First round of monitoring	Second round of monitoring
Serves at least 100,000 people	October 2006	April 2015
Serves 50,000-99,999 people	April 2007	October 2015
Serves 10,000-49,999 people	April 2008	October 2016
Serves fewer than 10,000 people and only monitors <i>E. coli</i>	October 2008	October 2017
Serves fewer than 10,000 people and monitors <i>Cryptosporidium</i>	April 2010	April 2019

b. Monitoring requirements. The minimum monitoring requirements are listed below. Systems may sample more frequently, provided the sampling frequency is evenly spaced throughout the monitoring period.

(1) Serving at least 10,000 people. Systems serving at least 10,000 people must sample their source water for *Cryptosporidium*, *E. coli*, and turbidity at least monthly for 24 months.

(2) Serving fewer than 10,000 people. Systems serving fewer than 10,000 people are allowed to first conduct *E. coli* monitoring to determine if further *Cryptosporidium* monitoring is required.

1. Systems must sample their source water for *E. coli* at least once every two weeks for 12 months. If the annual mean *E. coli* concentration is at or below 100 *E. coli* per 100 mL, the system can avoid further *Cryptosporidium* monitoring in that sampling round.

2. A system may avoid *E. coli* monitoring if it notifies the department no later than three months prior to the *E. coli* monitoring start date that the system will conduct *Cryptosporidium* monitoring.

3. Systems that fail to conduct the required *E. coli* monitoring or that cannot meet the *E. coli* annual mean limit must conduct *Cryptosporidium* monitoring. The system must sample its source water for *Cryptosporidium* either at least twice per month for 12 months or at least monthly for 24 months.

4. A system that begins monitoring for *E. coli* and determines during the sampling period that the system mathematically cannot meet the applicable *E. coli* annual mean limit may discontinue the *E. coli* monitoring. The system is then required to start *Cryptosporidium* monitoring according to the schedule in Table 1.

(3) Plants operating only part of the year. Systems with SW or IGW treatment plants that operate for only part of the year must conduct source water monitoring in accordance with this rule, but with the following modifications.

1. Systems must sample their source water only during the months that the plant operates unless the department specifies another monitoring period based on plant operating practices.

2. Systems with plants that operate less than six months per year must collect at least six samples per year for two years. The samples must be evenly spaced throughout the period the plant operates.

(4) New sources. A system that begins using a new SW or IGW source after the dates in Table 1 must monitor according to a department-approved schedule and comply with this subrule. The system must also meet the requirements of the bin classification and *Cryptosporidium* treatment for the new source on a department-approved schedule. The system must conduct the second round of source water monitoring no later than six years following the initial bin classification or determination of the mean *Cryptosporidium* level, as applicable.

(5) Monitoring violation determination. Failure to collect any source water sample required under this subrule in accordance with the sampling plan, location, analytical method, approved laboratory, or reporting requirements of 43.11(3) "c" through "e" is a monitoring violation.

c. *Sampling plan.* Systems must submit a sampling plan that specifies the sampling locations in relation to the sources and treatment processes and the calendar dates of sample collection. The specific treatment process locations that must be included in the plan are pretreatment, points of chemical treatment, and filter backwash recycle.

(1) The sampling plan must be submitted in a form acceptable to the department no later than three months prior to the applicable monitoring date in Table 1. If the department does not respond to a system regarding the submitted sampling plan prior to the start of the monitoring period, the system must sample according to the submitted plan.

(2) The system must monitor within two days of the date specified in the plan, unless one of the following conditions occurs.

1. If an extreme condition or situation exists that may pose danger to the sample collector, or that cannot be avoided, and causes the system to be unable to sample in the scheduled five-day period, the system must sample as close to the scheduled date as is feasible unless the department approves an alternative sampling date. The system must submit an explanation for the delayed sampling date to the department within one week of the missed sampling period. A replacement sample must be collected.

2. If a system is unable to report a valid analytical result for a scheduled sampling date due to equipment failure, loss of or damage to the sample, failure to comply with the analytical method or quality control requirements, or failure of the laboratory to analyze the sample, the system must notify the department of the cause of the delay and collect a replacement sample.

3. A replacement sample must be collected within 21 days of the scheduled sampling period or on the department-approved resampling date.

(3) Missed sampling dates. Systems that fail to collect source water samples on the dates specified in their sampling plan must revise their sampling plan to add collection dates all missed samples. The revised plan must be submitted to the department for approval prior to the collection of the missed samples.

d. *Sampling locations.* Systems must collect samples for each treatment plant that treats a SW or IGW source. If multiple plants draw water from the same influent (same pipe or intake), the department may approve one set of monitoring results to be used to satisfy the requirements for those plants.

(1) Chemical treatment location. Systems must collect source water samples prior to chemical treatment. If the system cannot feasibly collect a sample prior to chemical treatment, the department may grant approval in writing for sample collection after chemical treatment. This approval would only be granted if the department determines that sample collection prior to chemical treatment is not feasible for the system and that the chemical treatment is unlikely to have a significant adverse effect on the sample analysis.

(2) Filter backwash recycle return location. Systems that recycle filter backwash water must collect source water samples prior to the point of filter backwash water addition.

(3) Bank filtration credit sampling location.

1. Systems that receive *Cryptosporidium* treatment credit for bank filtration under 43.9(3) “b” or 43.10(4) “c” must collect source water samples in the SW source prior to bank filtration.

2. Systems that use bank filtration as pretreatment to a filtration plant must collect source water samples from the well, which is after bank filtration has occurred. Use of bank filtration during monitoring must be consistent with routine operational practice. Systems collecting samples after a bank filtration process may not receive treatment credit for the bank filtration under 43.11(10) “c.”

(4) Multiple sources. Systems with plants that use multiple water sources, including multiple SW sources and blended SW and GW sources, must collect samples as follows:

1. The use of multiple sources during monitoring must be consistent with routine operational practice.

2. If a sampling tap is available where the sources are combined prior to treatment, the system must collect samples from that tap.

3. If a sampling tap where the sources are combined prior to treatment is not available, the system must collect samples at each source near the intake on the same day and must use either of the following options for sample analysis.

- Physically composite the source samples into a single sample for analysis. Systems may composite the sample from each source into one sample prior to analysis. The volume of the sample from each source must be weighted according to the proportion of the source in the total plant flow at the time of sample collection, or

- Analyze the samples from each source separately and mathematically composite the results by calculating a weighted average of the analytical results for each sampling date. Calculate the weighted average by multiplying the analytical result for each source by the fraction that source contributed to the total plant flow at the time of sample collection and summing the weighted analytical results.

e. Analytical methodology, laboratory certification, and data reporting requirements. Systems must have samples analyzed pursuant to this paragraph. The system must report, in a format acceptable to the department, the analytical results from the source water monitoring no later than ten days after the end of the first month following the month when the sample is collected.

(1) *Cryptosporidium* samples must be analyzed by a laboratory that is approved under EPA’s Laboratory Quality Assurance Evaluation Program for Analysis of *Cryptosporidium* in Water.

1. Approved analytical methods for *Cryptosporidium*:

- “Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration/IMS/FA,” 2005, EPA-815-R-05-002, www.nemi.gov;

- “Method 1622: *Cryptosporidium* in Water by Filtration/IMS/FA,” 2005, EPA-815-R-05-001, www.nemi.gov; and

- “Method 1623.1: *Cryptosporidium* and *Giardia* in Water by Filtration/Immunomagnetic Separation/Immunofluorescence Assay Microscopy,” 2012, EPA-816-R-12-001, nepis.epa.gov.

2. Using one of the approved methods, the laboratory must analyze at least a 10 L sample or a packed pellet volume of at least 2 mL. Systems unable to process a 10 L sample must analyze as much sample volume as can be filtered by two filters specified in the method, up to a packed pellet volume of at least 2 mL.

3. A matrix spike (MS) sample must be spiked and filtered by the laboratory according to the approved method. If the volume of the MS sample is greater than 10 L, the system may filter all but 10 L of the MS sample in the field and ship the filtered sample and the remaining 10 L of source water to the

laboratory. In this case, the laboratory must spike the remaining 10 L of water and filter it through the filter used to collect the balance of the sample in the field.

4. Flow cytometer-counted spiking suspensions must be used for the MS samples and the ongoing precision and recovery samples.

5. The following data must be reported for each *Cryptosporidium* analysis:

- PWS ID.
- Facility ID.
- Sample collection date.
- Sample type (i.e., field or MS).
- Sample volume filtered (L), to the nearest 0.25 L.
- Whether 100 percent of the filtered volume was examined by the laboratory.
- Number of oocysts counted.
- For MS samples: sample volume spiked and estimated number of oocysts spiked.
- For samples in which less than 10 L is filtered or less than 100 percent of the sample volume is examined: the number of filters used and the packed pellet volume.
- For samples in which less than 100 percent of sample volume is examined: the volume of resuspended concentrate and the volume of this resuspension processed through immunomagnetic separation.

(2) *E. coli* samples must be analyzed by a laboratory certified by EPA, the National Environmental Laboratory Accreditation Conference, or the department for total coliform or fecal coliform analysis in drinking water samples using the same approved *E. coli* method for the source water analysis.

1. Approved analytical methods for the enumeration of *E. coli* in source water are shown in Table 2.

Table 2: *E. coli* Analytical Methods

Method	EPA	SM	Other
Most probable number (MPN) with multiple tube or multiple well ^{1, 2}		9223 B ¹¹	991.15 ⁴ , Colilert ^{3, 5} Colilert-18 ^{3, 5, 6}
Membrane filtration, single step ^{1, 7, 8}	1603 ⁹		m-ColiBlue24 ¹⁰
Membrane filtration, two step		9222D/9222G ¹²	

¹Tests must be conducted to provide organism enumeration (i.e., density). Select the appropriate configuration of tubes/filtrations and dilutions/volumes to account for the quality, consistency, and anticipated organism density in the water sample.

²Enumerate samples using the multiple-tube or multiple-well procedure. Using multiple-tube procedures, employ an appropriate tube and dilution configuration of the sample as needed and report the MPN. Samples tested with Colilert® may be enumerated with the multiple-well procedures, Quanti-Tray®, Quanti-Tray® 2000, and the MPN calculated from the table provided by the manufacturer.

³These tests are collectively known as defined enzyme substrate tests, where, for example, a substrate is used to detect the enzyme beta-glucuronidase produced by *E. coli*.

⁴Association of Official Analytical Chemists, International. "Official Methods of Analysis of AOAC International, 16th Ed., Volume 1, Chapter 17, 1995. AOAC, 481 N. Frederick Ave., Suite 500, Gaithersburg, MD 20877-2417.

⁵Descriptions of the Colilert®, Colilert-18®, Quanti-Tray®, and Quanti-Tray® 2000 may be obtained from IDEXX Laboratories, Inc., 1 IDEXX Drive, Westbrook, ME 04092.

⁶Colilert-18® is an optimized formulation of the Colilert® for the determination of total coliforms and *E. coli* that provides results within 18 hours of incubation at 35 degrees Celsius rather than the 24 hours required for the Colilert® test.

⁷The filter must be a 0.45 micron membrane filter or a membrane filter with another pore size certified by the manufacturer to fully retain cultivated organisms and to be free of extractables that could interfere with organism growth.

⁸When the membrane filter method has been used previously to test waters with high turbidity or large numbers of noncoliform bacteria, a parallel test should be conducted with a multiple-tube technique to demonstrate applicability and comparability of results.

⁹Method 1603: *Escherichia coli* (*E. coli*) in Water by Membrane Filtration Using Modified Membrane-Thermotolerant *Escherichia coli* Agar (modified mTEC), July 2006, EPA 821-R-06-011, nepis.epa.gov.

¹⁰A description of the m-ColiBlue24® test, Total Coliforms and *E. coli*, Hach Company, 100 Dayton Ave., Ames, IA 50010.

¹¹SM 18th (1992), 19th (1995), and 20th (1998) editions.

¹²SM, 20th edition (1998).

2. The holding time (the time period from sample collection to initiation of analysis) shall not exceed 30 hours. The department may approve a 48-hour holding time on a case-by-case basis, if the 30-hour

holding time is not feasible. If an extension is allowed, the laboratory must use the Colilert® reagent version of the SM 9223B to conduct the analysis.

3. The samples must be maintained between 0 and 10 degrees Celsius during storage and transit to the laboratory.

4. The following data must be reported for each *E. coli* analysis:

- PWS ID.
- Facility ID.
- Sample collection date.
- Analytical method number.
- Method type.
- Source type (flowing stream or river; lake or reservoir; or IGW).
- Number of *E. coli* per 100 mL.
- Turbidity in NTU.

(3) Turbidity. The approved analytical methods for turbidity are in 43.5(4)“a”(1). Turbidity measurements must be made by a party approved by the department, and reported on the laboratory data sheet with the corresponding *E. coli* sample.

43.11(4) Disinfection profiling and benchmarking.

a. *General requirements.* Following completion of the first round of source water monitoring, a system that plans to make a significant change to its disinfection practice must develop disinfection profiles and calculate disinfection benchmarks for *Giardia lamblia* and viruses.

(1) A system must notify the department prior to changing its disinfection practice and must include in the notice the completed disinfection profile and disinfection benchmark for *Giardia lamblia* and viruses, a description of the proposed change in disinfection practice, and an analysis of how the proposed change will affect the current level of disinfection.

(2) A significant change to the disinfection practice is defined as:

1. Any change to the point of disinfection;
2. Any change to the disinfectant(s) used in the treatment plant;
3. Any change to the disinfection process; or
4. Any other modification identified by the department as a significant change to disinfection practice.

b. *Developing a disinfection profile.* To develop a disinfection profile, a system must monitor at least weekly for a period of 12 consecutive months to determine the total log inactivation for *Giardia lamblia* and viruses. If a system monitors more frequently, the frequency must be evenly spaced. A system that operates for fewer than 12 months per year must monitor weekly during the operation period. Systems must determine log inactivation for *Giardia lamblia* through the entire plant, based on CT_{99.9} values in Appendix A, Tables 1 through 6, as applicable. Systems must determine log inactivation for viruses through the entire treatment plant based on a department-approved protocol.

(1) Monitoring requirements. Systems with a single point of disinfectant application prior to the entrance to the distribution system must conduct the monitoring in this subparagraph. Systems with multiple points of disinfectant application must conduct the same monitoring for each disinfection segment. Systems must monitor the parameters necessary to determine the total inactivation ratio. The analytical methods for the parameters are in 43.5(4)“a.” All measurements must be taken during peak hourly flow.

1. For systems using a disinfectant other than UV, the temperature of the disinfected water must be measured in degrees Celsius at each RDC sampling point or at an alternative department-approved location.

2. For systems using chlorine, the pH of the disinfected water must be measured at each chlorine RDC sampling point or at an alternative department-approved location.

3. The disinfectant contact time must be determined in minutes.

4. The RDCs of the water must be determined in mg/L before or at the first customer and prior to each additional point of disinfectant application.

5. A system may use existing data to meet the monitoring requirements if: the data are substantially equivalent to the required data, it has not made any significant change to its treatment practice, and it has

the same source water as it had when the data were collected. Systems may develop disinfection profiles using up to three years of existing data.

6. A system may use disinfection profiles developed under 43.9(2) or 43.10(2) if it has not made a significant change to its treatment practice and has the same source water as it had when the profile was developed. The virus profile must be developed using the same data on which the *Giardia lamblia* profile is based.

(2) Total inactivation ratio calculation for *Giardia lamblia*.

1. Systems using only one point of disinfectant application may determine the total inactivation ratio ($CT_{\text{calc}}/CT_{99,9}$) for the disinfection segment using either of the following methods.

- Determine one inactivation ratio before or at the first customer during peak hourly flow; or
- Determine successive sequential inactivation ratios between the point of disinfectant application and a point before or at the first customer during peak hourly flow. Calculate the total inactivation ratio by determining the inactivation ratio for each sequence ($CT_{\text{calc}}/CT_{99,9}$) and adding the values together.

2. Systems using more than one point of disinfectant application before the first customer must determine the CT value of each disinfection segment immediately prior to the next point of disinfectant application, or for the final segment, before or at the first customer, during peak hourly flow. Calculate the ($CT_{\text{calc}}/CT_{99,9}$) value of each segment and add the values together to determine the total inactivation ratio.

3. Systems must then determine the total logs of inactivation by multiplying the total inactivation ratio by 3.0.

(3) Total inactivation ratio calculation for viruses. The system must calculate the log of inactivation for viruses using a department-approved protocol.

c. *Disinfection benchmark calculation.*

(1) For each year of profiling data collected and calculated under this subrule, systems must determine the lowest mean monthly level of both *Giardia lamblia* and virus inactivation. Systems must determine the mean *Giardia lamblia* and virus inactivation for each calendar month for each year of profiling data by dividing the sum of daily or weekly *Giardia lamblia* and virus log inactivation by the number of values calculated for that month.

(2) For a system with one year of profiling data, the disinfection benchmark is the lowest monthly mean value. For a system with more than one year of profiling data, the disinfection benchmark is the mean of the lowest monthly mean values of *Giardia lamblia* and virus log inactivation in each year of profiling data.

43.11(5) Bin classification. Upon completion of the first round of source water monitoring, systems must calculate an initial *Cryptosporidium* bin concentration for each plant for which monitoring was required. Calculation of the bin concentration must use the *Cryptosporidium* results reported under 43.11(3) "a."

a. *Calculation of mean Cryptosporidium or bin concentration value.*

(1) For systems that collect a total of at least 48 samples, the bin concentration is equal to the arithmetic mean of all sample concentrations.

(2) For systems that collect at least 24 samples but not more than 47 samples, the bin concentration is equal to the highest arithmetic mean of all sample concentrations in any 12 consecutive months during which *Cryptosporidium* samples were collected.

(3) For systems that serve fewer than 10,000 people and monitor *Cryptosporidium* for only one year (i.e., 24 samples in 12 months), the bin concentration is equal to the arithmetic mean of all sample concentrations.

(4) For systems with plants operating only part of the year that monitor fewer than 12 months per year, the bin concentration is equal to the highest arithmetic mean of all sample concentrations during any year of *Cryptosporidium* monitoring.

(5) If the monthly *Cryptosporidium* sampling frequency varies, systems must first calculate a monthly average for each month of monitoring. Systems must then use these monthly average concentrations, rather than individual sample concentrations, in the applicable calculation for bin classification.

b. *Determination of bin classification.*

(1) First monitoring round. A system must determine the bin classification from Table 3, using its calculated bin concentration from 43.11(5)“a.”

Table 3: Bin Classification Table

System Type	<i>Cryptosporidium</i> Concentration, in oocysts/L	Bin Classification
Systems required to monitor for <i>Cryptosporidium</i> under 43.11(3)“b”(1) or 43.11(3)“b”(2)“3”	Fewer than 0.075 oocysts/L	Bin 1
	Between 0.075 and fewer than 1.0 oocysts/L	Bin 2
	Between 1.0 and fewer than 3.0 oocysts/L	Bin 3
	3.0 oocysts/L or greater	Bin 4
Systems serving fewer than 10,000 and not required to monitor for <i>Cryptosporidium</i> , pursuant to 43.11(3)“b”(2)“1”	Not applicable	Bin 1

(2) Second monitoring round. Following completion of the second round of source water monitoring, a system must recalculate its bin concentration and determine its new bin classification, using the protocols in 43.11(5)“a” and “b.”

c. Reporting bin classification to the department. Within six months of the end of the sampling period, the system must report its bin classification to the department for approval. The report must include a summary of the source water monitoring data and the calculation procedure used to determine the bin classification.

d. TT violation. Failure to comply with 43.11(5)“b” and “c” is a violation of the TT requirement.

43.11(6) Additional *Cryptosporidium* treatment requirements. A system must provide the level of additional *Cryptosporidium* treatment specified in Table 4 based on its bin classification determined in 43.11(5) and according to the schedule in 43.11(7).

a. Determination of additional requirements. Using Table 4, a system must determine any additional *Cryptosporidium* treatment requirements based upon its bin classification. The Bin 1 classification does not require any additional treatment. Bins 2 through 4 require additional treatment.

Table 4: Additional *Cryptosporidium* Treatment Requirements

Bin Classification	Treatment Used by the System for Compliance with 43.5, 43.9, and 43.10			
	Conventional filtration (including softening)	Direct filtration	Slow sand or diatomaceous earth filtration	Alternative filtration technologies
Bin 1	No additional treatment	No additional treatment	No additional treatment	No additional treatment
Bin 2	1-log treatment	1.5-log treatment	1-log treatment	At least 4.0-log ¹
Bin 3	2-log treatment	2.5-log treatment	2-log treatment	At least 5.0-log ¹
Bin 4	2.5-log treatment	3-log treatment	2.5-log treatment	At least 5.5-log ¹

¹The total *Cryptosporidium* removal and inactivation must be at least this value, as determined by the department.

b. Treatment requirements for Bins 2 through 4. A system that is classified as Bin 2, 3, or 4 must use one or more of the treatment and management options in 43.11(8) to comply with the additional *Cryptosporidium* treatment requirements. Systems classified as Bins 3 and 4 must achieve at least 1-log of additional *Cryptosporidium* treatment by using either one or a combination of the following: bag filters, bank filtration, cartridge filters, chlorine dioxide, membranes, ozone, or UV, as listed in 43.11(9) through 43.11(13).

c. TT violation. Failure by a system in any month to achieve treatment credit by meeting criteria in 43.11(9) through 43.11(13) that is at least equal to the level of treatment required in 43.11(6)“a” is a violation of the TT requirement.

d. Significant changes to the watershed. If, after the system’s completion of source water monitoring (either round), the department determines during a sanitary survey or an equivalent source water assessment that significant changes occurred in the system’s watershed that could lead to increased contamination of the source water by *Cryptosporidium*, the system must take department-specified actions to address the contamination. These actions may include additional source water monitoring or implementation of the microbial toolbox options in 43.11(8).

43.11(7) Schedule for compliance with *Cryptosporidium* treatment. Following the initial bin classification under 43.11(5), systems must provide the level of *Cryptosporidium* treatment required in 43.11(6), according to the schedule in Table 5. If a system's bin classification changes following the second round of source water monitoring, the system must provide the level of *Cryptosporidium* treatment required in 43.11(6), on a department-approved schedule.

Table 5: *Cryptosporidium* Treatment Compliance Dates

Schedule	Population Served by System	Compliance Date for <i>Cryptosporidium</i> treatment requirements ¹
1	At least 100,000 people	April 1, 2012
2	From 50,000 to 99,999 people	October 1, 2012
3	From 10,000 to 49,999 people	October 1, 2013
4	Fewer than 10,000 people	October 1, 2014

¹The department may allow up to an additional two years for compliance with the treatment requirement if the system must make capital improvements.

43.11(8) Microbial toolbox options for meeting *Cryptosporidium* treatment requirements. Systems receive the treatment credits listed in Table 6 by meeting the conditions for microbial toolbox options described in 43.11(9) through 43.11(13). Systems apply these treatment credits to meet the treatment requirements in 43.11(6). Table 6 summarizes options in the microbial toolbox.

Table 6: Microbial Toolbox Summary Table: Options, Treatment Credits, and Criteria

Toolbox Option	Specific Criteria Rule	<i>Cryptosporidium</i> treatment credit with design and implementation criteria
Source Protection and Management Toolbox Options		
Watershed control program (WCP)	43.11(9)	0.5-log credit for department-approved program comprising required elements, annual program status report to department, and regular watershed survey.
Alternative source/intake management	43.11(9) "b"	No prescribed credit. Systems may conduct simultaneous monitoring for treatment bin classification at alternative intake locations or under alternative intake management strategies.
Prefiltration Toolbox Options		
Presedimentation basin with coagulation	43.11(10) "a"	0.5-log credit during any month that presedimentation basins achieve a monthly mean reduction of 0.5-log or greater in turbidity or alternative department-approved performance criteria. To be eligible, basins must be operated continuously with coagulant addition and all plant flow must pass through the basins.
Two-stage lime softening	43.11(10) "b"	0.5-log credit for two-stage softening where chemical addition and hardness precipitation occur in both stages. All plant flow must pass through both stages. Single-stage softening is credited as equivalent to conventional treatment.
Bank filtration	43.11(10) "c"	0.5-log credit for 25-foot setback; 1.0-log credit for 50-foot setback; aquifer must be unconsolidated sand containing at least 10 percent fines; average turbidity in wells must be less than 1 NTU. A system using a well followed by filtration when conducting source water monitoring must sample the well to determine bin classification and is not eligible for additional credit.
Treatment Performance Toolbox Options		
Combined filter performance	43.11(11) "a"	0.5-log credit for CFE turbidity less than or equal to 0.15 NTU in at least 95 percent of measurements each month.
Individual filter performance	43.11(11) "b"	0.5-log credit (in addition to the 0.5-log combined filter performance credit) if IFE turbidity is less than or equal to 0.15 NTU in at least 95 percent of samples

Toolbox Option	Specific Criteria Rule	<i>Cryptosporidium</i> treatment credit with design and implementation criteria
		each month in each filter and is never greater than 0.3 NTU in two consecutive measurements in any filter.
Demonstration of performance	43.11(11)“c”	Credit awarded to unit process or treatment train based on a demonstration to the department with a department-approved protocol.
Additional Filtration Toolbox Options		
Bag or cartridge filters (individual filters)	43.11(12)“a”	Up to 2-log credit based on the removal efficiency demonstrated during challenge testing with a 1.0-log factor of safety.
Bag or cartridge filters (in series)	43.11(12)“a”	Up to 2.5-log credit based on the removal efficiency demonstrated during challenge testing with a 0.5-log factor of safety.
Membrane filtration	43.11(12)“b”	Log credit equivalent to removal efficiency demonstrated in challenge test for device if supported by direct integrity testing.
Second-stage filtration	43.11(12)“c”	0.5-log credit for second separate granular media filtration stage if treatment train includes coagulation prior to first filter.
Slow sand filtration	43.11(12)“d”	2.5-log credit as a secondary filtration step; 3.0-log credit as a primary filtration process. No prior chlorination for either option.
Inactivation Toolbox Options		
Chlorine dioxide	43.11(13)	Log credit based on measured CT in relation to CT table.
Ozone	43.11(13)	Log credit based on measured CT in relation to CT table.
UV	43.11(13)	Log credit based on validated UV dose in relation to UV dose table; reactor validation testing required to establish UV dose and associated operating conditions.

43.11(9) Source toolbox components.

a. *Watershed control program (WCP)*. Systems receive 0.5-log *Cryptosporidium* treatment credit for implementing a WCP that meets the requirements of this paragraph.

(1) Notification. Systems that intend to apply for the WCP credit must notify the department of this intent no later than two years prior to the applicable treatment compliance date in 43.11(7).

(2) Proposed watershed control plan. Systems must submit a proposed watershed control plan to the department no later than one year before the applicable treatment compliance date in 43.11(7). The department must approve the plan for the system to receive WCP treatment credit. The plan must include the following:

1. Identification of an “area of influence” outside of which the likelihood of *Cryptosporidium* or fecal contamination affecting the treatment plant intake is not significant. This is the area to be evaluated in future watershed surveys under 43.11(9)“a”(5)“2.”

2. Identification of both potential and actual sources of *Cryptosporidium* contamination and an assessment of the relative impact of these sources on the system’s source water quality.

3. An analysis of the effectiveness and feasibility of control measures that could reduce *Cryptosporidium* loading from sources of contamination to the system’s source water.

4. A statement of goals and specific actions the system will undertake to reduce source water *Cryptosporidium* levels. The plan must explain how the actions are expected to contribute to specific goals, identify watershed partners and their roles, identify resource requirements and commitments, and include a schedule for plan implementation with deadlines for completing specific actions.

(3) Existing WCPs. Systems with WCPs that were in place on January 5, 2006, are eligible to seek this credit. The systems’ watershed control plans must meet the criteria in 43.11(9)“a”(2) and must specify ongoing and future actions that will reduce source water *Cryptosporidium* levels.

(4) Department response to plan. If the department does not respond to a system regarding approval of a watershed control plan submitted under this subrule and the system meets the other requirements of this subrule, the WCP will be considered approved and 0.5-log *Cryptosporidium* treatment credit will be awarded unless and until the department subsequently withdraws such approval.

(5) System requirements to maintain 0.5-log credit. Systems must complete the following actions to maintain the 0.5-log credit.

1. Submit an annual WCP status report to the department. The WCP status report must describe the system's implementation of the approved plan and assess the adequacy of the plan to meet its goals. The report must explain how the system is addressing any shortcomings in plan implementation, including those previously identified by the department or as a result of the watershed survey conducted under 43.11(9)"a"(5)"2." It must also describe any significant watershed changes that have occurred since the last watershed sanitary survey. If a system determines during implementation that significant changes to its approved WCP are necessary, it must notify the department prior to making the changes. If a program change is likely to reduce the level of source water protection, the system must list in its notification the actions the system will take to mitigate this effect.

2. Undergo a watershed sanitary survey every three years for CWSs and every five years for NTNCs or TNCs and submit the survey report to the department. Surveys must be conducted according to department guidelines and by persons acceptable to the department.

- A watershed sanitary survey must encompass the region identified in the department-approved watershed control plan as the area of influence; assess the implementation of actions to reduce source water *Cryptosporidium* levels; and identify any significant new sources of *Cryptosporidium*.

- If the department determines that significant changes may have occurred in the watershed since the previous watershed sanitary survey, systems must undergo another watershed sanitary survey by the department-specified date, which may be earlier than the regular three- or five-year frequency.

3. Systems must make the watershed control plan, annual status reports, and watershed sanitary survey reports available to the public upon request. These documents must be in plain language and include criteria to evaluate the success of the WCP in achieving plan goals. The department may approve systems to withhold portions of the plan or the reports from the public, based on security considerations.

(6) Withdrawal of WCP treatment credit. If the department determines that a system is not carrying out the approved watershed control plan, it may withdraw the WCP treatment credit.

b. Alternative source. Systems may conduct source water monitoring that reflects a different intake location (either in the same source or for an alternate source) or a different procedure for the timing or level of withdrawal from the source (alternative source monitoring). If the department approves, a system may determine its bin classification under 43.11(5) based on alternative source monitoring results.

- (1) Systems conducting alternative source monitoring must also monitor their current plan intake concurrently, as described in 43.11(3).

- (2) Alternative source monitoring must meet the requirements for source monitoring to determine bin classification, as described in 43.11(3). Systems must report the alternative source monitoring results to the department and provide supporting information documenting the operating conditions during sample collection.

- (3) If a system determines its bin classification under 43.11(5) using alternative source monitoring results that reflect a different intake location or a different procedure for managing the timing or level of withdrawal from the source, it must relocate the intake or permanently adopt the withdrawal procedure, as applicable, no later than the applicable treatment compliance date in 43.11(7).

43.11(10) Prefiltration treatment toolbox components.

a. Presedimentation. Systems receive 0.5-log *Cryptosporidium* treatment credit for a presedimentation basin during any month the process meets the criteria in this paragraph.

- (1) The presedimentation basin must be in continuous operation and must treat the entire plant flow taken from a SW or IGW source.

- (2) The system must continuously add a coagulant to the presedimentation basin.

- (3) The presedimentation basin must achieve either of the following performance criteria:

1. Demonstrates at least 0.5-log mean reduction of influent turbidity, determined by using daily turbidity measurements in the presedimentation process influent and effluent, and calculated as follows: $\text{LOG}_{10}(\text{monthly mean of daily influent turbidity}) - \text{LOG}_{10}(\text{monthly mean of daily effluent turbidity})$; or

2. Complies with department-approved performance criteria that demonstrate at least 0.5-log mean removal of micron-sized particulate material through the presedimentation process.

b. *Two-stage lime softening.* Systems receive an additional 0.5-log *Cryptosporidium* treatment credit for a two-stage lime softening plant if chemical addition and hardness precipitation occur in two separate and sequential softening stages prior to filtration. Both softening stages must treat the entire plant flow taken from a SW or IGW source.

c. *Bank filtration.* Systems receive *Cryptosporidium* treatment credit for bank filtration that serves as pretreatment to a filtration plant by meeting the criteria in this paragraph. Systems using bank filtration when beginning source water monitoring under 43.11(3) "a" must collect samples as described in 43.11(3) "d"(3) and are not eligible for this credit.

(1) Treatment credit. Wells with a GW flow path of at least 25 feet receive 0.5-log treatment credit; wells with a GW flow path of at least 50 feet receive 1.0-log treatment credit. The GW flow path must be determined as specified in 43.11(10) "c"(4).

(2) Credit eligibility. Only horizontal and vertical wells in granular aquifers are eligible for treatment credit. Granular aquifers are those comprised of sand, clay, silt, rock fragments, pebbles or larger particles, and minor cement. A system must characterize the aquifer at the well site to determine aquifer properties. Systems must extract a core from the aquifer and demonstrate that in at least 90 percent of the core length, grains less than 1.0 mm in diameter constitute at least 10 percent of the core material.

(3) GW flow path measurement. For vertical wells, the GW flow path is the measured distance from the edge of the surface water body under high flow conditions (determined by the 100-year floodplain elevation boundary or by the floodway, as defined in Federal Emergency Management Agency flood hazard maps) to the well screen. For horizontal wells, the GW flow path is the measured distance from the bed of the river under normal flow conditions to the closest horizontal well lateral screen.

(4) Turbidity monitoring at the wellhead. Systems must monitor each wellhead for turbidity at least once every four hours while the bank filtration process is in operation. If monthly average turbidity levels, based on daily maximum values in the well, exceed 1 NTU, the system must report this result to the department and conduct an assessment within 30 days to determine the cause of the high turbidity levels in the well. If the department determines that microbial removal has been compromised, it may revoke treatment credit until the system implements department-approved corrective actions to remediate the problem.

(5) Springs and infiltration galleries. This treatment credit is not eligible for springs and infiltration galleries. Springs and infiltration galleries are eligible for credit through demonstration of performance study under 43.11(11) "c."

(6) Bank filtration demonstration of performance. The department may approve *Cryptosporidium* treatment credit for bank filtration based on a demonstration of performance study that meets the criteria in this subparagraph. This treatment credit may be greater than 1.0-log and may be awarded to bank filtration that does not meet the criteria in 43.11(10) "c"(1) through "c"(5). The study must:

1. Follow a department-approved protocol;
2. Involve the collection of data on the removal of *Cryptosporidium* or a surrogate for *Cryptosporidium* and related hydrogeologic and WQPs during the full range of operating conditions; and
3. Include sampling both from the production well(s) and from monitoring wells that are screened and located along the shortest flow path between the SW source and the production well(s).

43.11(11) Treatment performance toolbox components. This option pertains to physical treatment processes.

a. *Combined filter performance.* Systems using conventional filtration treatment or direct filtration treatment receive an additional 0.5-log *Cryptosporidium* treatment credit during any month the system meets the criteria in this paragraph. CFE turbidity must be less than or equal to 0.15 NTU in at least 95 percent of the measurements. Turbidity must be measured as described in 43.5(4) and, if applicable, 43.10(4).

b. Individual filter performance. Systems using conventional filtration treatment or direct filtration treatment receive 0.5-log *Cryptosporidium* treatment credit during any month the system meets the criteria in this paragraph, which can be in addition to the CFE 0.5-log credit from 43.11(11)“a.” Compliance with these criteria must be based on individual filter turbidity monitoring as described in 43.9(4) or 43.10(5), as appropriate.

(1) The filtered water turbidity for each individual filter must be less than or equal to 0.15 NTU in at least 95 percent of the measurements recorded each month.

(2) No individual filter may have a measured turbidity greater than 0.3 NTU in two consecutive measurements taken 15 minutes apart.

(3) Any system that has received treatment credit for individual filter performance and fails to meet the requirements of 43.11(11)“b”(2) and “b”(3) during any month shall not receive a TT violation under 43.11(6) if the department determines the following:

1. The failure was due to unusual and short-term circumstances that could not reasonably be prevented through optimizing the treatment plant design, operation, and maintenance.

2. The system has experienced no more than two such failures in any calendar year.

c. Demonstration of performance. The department may approve *Cryptosporidium* treatment credit for drinking water treatment processes based on a demonstration of performance study meeting the criteria in this paragraph. This treatment credit may be greater than or less than the prescribed treatment credits in 43.11(6) or 43.11(10) through 43.11(13) and may be awarded to treatment processes that do not meet the criteria for the prescribed credits.

(1) Systems cannot receive the prescribed treatment credit for any toolbox option in 43.11(10) through 43.11(13) if that toolbox option is included in a demonstration of performance study for which treatment credit is awarded under this paragraph.

(2) The demonstration of performance study must follow a department-approved protocol and must demonstrate the level of *Cryptosporidium* reduction the treatment process will achieve under the full range of expected operating conditions for the system.

(3) Department approval must be in writing and may include monitoring and treatment performance criteria that the system must demonstrate and report on an ongoing basis to remain eligible for the treatment credit. The department may designate such criteria where necessary to verify that the conditions under which the demonstration of performance credit was approved are maintained during routine operation.

43.11(12) Additional filtration toolbox components.

a. Bag and cartridge filters. By meeting the criteria in this paragraph, systems receive *Cryptosporidium* treatment credit of up to 2.0-log for the use of individual bag or cartridge filters and up to 2.5-log for the use of bag or cartridge filters operated in series. To be eligible for this credit, systems must report the results of challenge testing that meets the requirements of 43.11(12)“a”(2) through “a”(9) to the department. The filters must treat the entire plant flow taken from a SW or IGW source.

(1) The *Cryptosporidium* treatment credit awarded for use of bag or cartridge filters must be based on the removal efficiency demonstrated during challenge testing conducted in accordance with the criteria in 43.11(12)“a”(2) through “a”(9). A safety factor equal to 1-log for individual bag or cartridge filters and 0.5-log for bag or cartridge filters in series must be applied to challenge testing results to determine removal credit.

(2) Perform challenge testing on full-scale bag or cartridge filters and associated filter housing or pressure vessels that are identical in material and construction to the filters and housings the system will use for removal of *Cryptosporidium*. Bag or cartridge filters must be challenge tested in the same configuration that the system will use, either as individual filters or as a series configuration of filters.

(3) Conduct challenge testing using *Cryptosporidium* or a surrogate that is removed no more efficiently than *Cryptosporidium*. The microorganism or surrogate used during challenge testing is referred to as the challenge particulate. The challenge particulate concentration must be determined using a method capable of discretely quantifying the specific microorganisms or surrogate used in the test; gross measurements such as turbidity shall not be used.

(4) The maximum feed water concentration that can be used during a challenge test must be based on the detection limit of the challenge particulate in the filtrate (i.e., filtrate detection limit) and must be calculated using this equation:

$$\text{Maximum Feed Water Concentration} = 10,000 \times \text{Filtrate Detection Limit}$$

(5) Conduct challenge testing at the maximum design flow rate for the filter specified by the manufacturer.

(6) Each filter evaluated must be tested for a duration sufficient to reach 100 percent of the terminal pressure drop, which thereby establishes the maximum pressure drop under which the filter may be used to comply with this paragraph.

(7) Removal efficiency of a filter must be determined from the results of the challenge test and expressed in terms of log removal values (LRV) using the following equation:

$$\text{LRV} = \text{LOG}_{10}(C_f) - \text{LOG}_{10}(C_p)$$

Where:

LRV = log removal value demonstrated during challenge test;

C_f = feed concentration measured during challenge test; and

C_p = filtrate concentration measured during challenge test.

Equivalent units must be used for the feed and filtrate concentrations. If the challenge particulate is not detected in the filtrate, the term C_p must be set equal to the detection limit.

(8) Each filter tested must be challenged with the challenge particulate during three periods over the filtration cycle: within two hours of start-up of a new filter; when the pressure drop is between 45 and 55 percent of the terminal pressure drop; and at the end of the cycle after the pressure drop has reached 100 percent of the terminal pressure drop. An LRV must be calculated for each of these challenge periods for each filter tested. The LRV for the filter ($\text{LRV}_{\text{filter}}$) must be assigned the value of the minimum LRV observed during the three challenge periods for that filter.

(9) If fewer than 20 filters are tested, the overall removal efficiency for the filter product line must be set equal to the lowest $\text{LRV}_{\text{filter}}$ among the filters tested. If 20 or more filters are tested, the overall removal efficiency for the filter product line must be set equal to the tenth percentile of the set of $\text{LRV}_{\text{filter}}$ values for the various filters tested. The percentile is defined by $[i/(n+1)]$ where “i” is the rank of “n” individual data points ordered lowest to highest. If necessary, the tenth percentile may be calculated using linear interpolation.

(10) If a previously tested filter is modified in a manner that could change the removal efficiency of the filter product line, conduct challenge testing to demonstrate the removal efficiency of the modified filter and submit the results to the department.

b. Membrane filtration.

(1) Systems receive *Cryptosporidium* treatment credit for using membrane filtration that meets the criteria of this paragraph. Systems using membrane cartridge filters that meet the definition of membrane filtration in 567—40.2(455B) are eligible for this credit. The level of treatment credit a system receives is equal to the lower of the values determined under the following two paragraphs:

1. The removal efficiency demonstrated during challenge testing conducted under the criteria in 43.11(12)“b”(2).

2. The maximum removal efficiency that can be verified through DIT used with the membrane filtration process under the conditions in 43.11(12)“b”(3).

(2) Challenge testing. The membrane used by the system must undergo challenge testing to evaluate removal efficiency, and the system must report the challenge testing results to the department. Conduct challenge testing according to the criteria in this subparagraph.

1. Conduct challenge testing on either a full-scale membrane module, identical in material and construction to the membrane modules used in the system’s treatment facility, or a smaller-scale membrane module, identical in material and similar in construction to the full-scale module. A module is defined as the smallest component of a membrane unit in which a specific membrane surface area is housed in a device with a filtrate outlet structure.

2. Conduct challenge testing using *Cryptosporidium* oocysts or a surrogate that is removed no more efficiently than *Cryptosporidium* oocysts. The organisms or surrogate used during challenge testing is

referred to as the challenge particulate. The concentration of the challenge particulate, in both the feed and filtrate water, must be determined using a method capable of discretely quantifying the specific challenge particulate used in the test; gross measurements such as turbidity shall not be used.

3. The maximum feed water concentration that can be used during a challenge test is based on the detection limit of the challenge particulate in the filtrate and must be determined according to the following equation:

$$\text{Maximum Feed Water Concentration} = 3,160,000 \times \text{Filtrate Detection Limit}$$

4. Conduct challenge testing under representative hydraulic conditions at the maximum design flux and maximum design process recovery specified by the manufacturer for the membrane module. Flux is defined as the throughput of a pressure-driven membrane process expressed as flow per unit of membrane area. Recovery is defined as the volumetric percent of feed water that is converted to filtrate over the course of an operating cycle uninterrupted by events such as chemical cleaning or a solids removal process (i.e., backwashing).

5. Calculate removal efficiency of a membrane module using the challenge test results expressed as a log removal value (LRV), according to the following equation:

$$\text{LRV} = \text{LOG}_{10}(C_f) - \text{LOG}_{10}(C_p)$$

Where:

LRV = log removal value demonstrated during challenge test;

C_f = feed concentration measured during challenge test; and

C_p = filtrate concentration measured during challenge test.

Use equivalent units for the feed and filtrate concentrations. If the challenge particulate is not detected in the filtrate, the term C_p must be set equal to the detection limit for the purpose of calculating the LRV. An LRV must be calculated for each membrane module evaluated during the challenge test.

6. The removal efficiency of a membrane filtration process demonstrated during challenge testing must be expressed as a log removal value ($\text{LRV}_{\text{C-Test}}$). If fewer than 20 modules are tested, then $\text{LRV}_{\text{C-Test}}$ is equal to the lowest of the representative LRVs among the modules tested. If 20 or more modules are tested, then $\text{LRV}_{\text{C-Test}}$ is equal to the tenth percentile of the representative LRVs among the modules tested. The percentile is defined by $[i/(n+1)]$ where “i” is the rank of “n” individual data points ordered lowest to highest. If necessary, the tenth percentile may be calculated using linear interpolation.

7. The challenge test must establish a quality control release value (QCRV) for a nondestructive performance test that demonstrates the *Cryptosporidium* removal capability of the membrane filtration module. In order to verify *Cryptosporidium* removal capability, this performance test must be applied to each production membrane module that was not directly challenge tested but was used by the system. Production modules that do not meet the established QCRV are not eligible for the treatment credit demonstrated during the challenge test.

8. If a previously tested membrane is modified in a manner that could change the removal efficiency of the membrane or the applicability of the nondestructive performance test and associated QCRV, conduct additional challenge testing to demonstrate the removal efficiency of the modified membrane and submit the results to the department, along with determination of a new QCRV.

(3) Direct integrity testing (DIT). Systems must conduct DITs in a manner that demonstrates a removal efficiency equal to or greater than the removal credit awarded for the membrane filtration process and meets the requirements of this subparagraph. A DIT is defined as a physical test applied to a membrane unit in order to identify and isolate integrity breaches (i.e., one or more leaks that could result in contamination of the filtrate).

1. A DIT must be independently applied to each membrane unit in service. A membrane unit is defined as a group of membrane modules that share common valving that allows the unit to be isolated from the rest of the system for the purpose of integrity testing or other maintenance.

2. The DIT method must have a resolution of 3 micrometers or less, where resolution is defined as the size of the smallest integrity breach that contributes to a response from the DIT.

3. The DIT must have a sensitivity sufficient to verify the log treatment credit awarded by the department for the membrane filtration process, where sensitivity is defined as the maximum LRV that can

be reliably verified by a DIT. Sensitivity must be determined using the approach applicable to the type of DIT the system uses, as follows:

- For DITs using applied pressure or vacuum, calculate test sensitivity using the following equation:

$$LRV_{DIT} = \text{LOG}_{10} [Q_p / (VCF \times Q_{breach})]$$

Where:

LRV_{DIT} = the sensitivity of the DIT;

Q_p = total design filtrate flow from the membrane unit;

Q_{breach} = flow of water from an integrity breach associated with the smallest integrity test response that can be reliably measured; and

VCF = volumetric concentration factor, which is the ratio of the suspended solids concentration on the high-pressure side of the membrane relative to that in the feed water.

- For DITs using a particulate or molecular marker, calculate test sensitivity using the following equation:

$$LRV_{DIT} = \text{LOG}_{10} (C_f) - \text{LOG}_{10} (C_p)$$

Where:

LRV_{DIT} = the sensitivity of the DIT;

C_f = typical feed concentration of the marker used in the test; and

C_p = filtrate concentration of the marker from an integral membrane unit.

4. Establish a control limit within the sensitivity limits of the DIT that is indicative of an integral membrane unit capable of meeting the removal credit awarded by the department.

5. If the result of a DIT exceeds the control limit established under 43.11(12)“b”(3)“4,” the system must remove the membrane unit from service. Systems must conduct a DIT to verify any repairs and may return the membrane unit to service only if the DIT is within the established control limit.

6. Conduct a DIT on each membrane unit at a frequency of not less than once each day that the membrane unit is in operation. The department may approve less frequent testing, based on demonstrated process reliability, the use of multiple barriers effective for *Cryptosporidium*, or reliable process safeguards.

(4) Indirect integrity monitoring. Systems must conduct continuous indirect integrity monitoring on each membrane unit according to the following criteria. Indirect integrity monitoring is defined as monitoring some aspect of filtrate water quality that is indicative of the removal of particulate matter. A system that implements continuous DITs of membrane units in accordance with 43.11(12)“b”(3) is not subject to the continuous indirect integrity monitoring requirements. Systems must submit a monthly report to the department summarizing all continuous indirect integrity monitoring results triggering direct integrity testing and the corrective action that was taken in each case.

1. Continuous indirect integrity monitoring must:

- Include continuous filtrate turbidity monitoring, unless the department approves an alternative parameter;

- Be conducted at a frequency of no less than once every 15 minutes; and

- Be separately conducted on each membrane unit.

2. If indirect integrity monitoring includes turbidity and if the filtrate turbidity readings are above 0.15 NTU for a period greater than 15 minutes (i.e., two consecutive 15-minute readings above 0.15 NTU), DIT must immediately be performed on the associated membrane unit as specified in 43.11(12)“b”(3)“1” through “5.”

3. If indirect integrity monitoring includes a department-approved alternative parameter and if the alternative parameter exceeds a department-approved control limit for a period greater than 15 minutes, DIT must immediately be performed on the associated membrane units as specified in 43.11(12)“b”(3)“1” through “5.”

c. *Second-stage filtration.* Systems receive 0.5-log *Cryptosporidium* treatment credit for using a separate second stage of filtration that consists of sand, dual media, GAC, or other fine-grain media following granular media filtration, if the department approves. To be eligible for this credit, the first stage of filtration must be preceded by a coagulation step and both filtration stages must treat the entire plant

flow taken from a SW or IGW source. A cap, such as GAC, on a single stage of filtration is not eligible for this credit. The department must approve the treatment credit based on an assessment of the design characteristics of the filtration process.

d. Slow sand filtration (as secondary filter). Systems are eligible to receive 2.5-log *Cryptosporidium* treatment credit for using a slow sand filtration process that follows a separate stage of filtration if both filtration stages treat the entire plant flow taken from a SW or IGW source and no disinfectant residual is present in the influent water to the slow sand filtration process. The department must approve the treatment credit based on an assessment of the design characteristics of the filtration process. This does not apply to treatment credit awarded for slow sand filtration used as a primary filtration process.

43.11(13) Inactivation toolbox components.

a. Calculation of CT values.

(1) CT is the product of the disinfectant contact time (T, in minutes) and disinfectant concentration (C, in milligrams per liter). Systems with treatment credit for chlorine dioxide or ozone under 43.11(13) "b" or "c" must calculate CT at least once each day, with both C and T measured during peak hourly flow as specified in 43.5(4).

(2) Systems with several disinfection segments in sequence may calculate CT for each segment, where a disinfection segment is defined as a treatment unit process with a measurable disinfectant residual level and a liquid volume. Under this approach, systems must add the *Cryptosporidium* CT values in each segment to determine the total CT for the treatment plant.

b. CT values for chlorine dioxide and ozone. As described in 43.11(13) "a":

(1) Systems receive the *Cryptosporidium* treatment credit in Table 1 of Appendix B by meeting the corresponding chlorine dioxide CT value for the applicable water temperature.

(2) Systems receive the *Cryptosporidium* treatment credit in Table 2 of Appendix B by meeting the corresponding ozone CT value for the applicable water temperature.

c. Site-specific study. The department may approve alternative chlorine dioxide or ozone CT values to those in 43.11(13) "b" on a site-specific basis. The department must base its approval on a site-specific study conducted by the system. The study must follow a department-approved protocol.

d. Ultraviolet light (UV). Systems receive *Cryptosporidium*, *Giardia lamblia*, and virus treatment credits for UV light reactors by achieving the corresponding UV dose values in Table 3 of Appendix B. Systems must use the following procedures to validate and monitor UV reactors in order to demonstrate that the reactors are achieving a particular UV dose value for treatment credit.

(1) Reactor validation testing. Systems must use UV reactors that have undergone validation testing to determine the operating conditions under which the reactor delivers the required UV dose (i.e., validated operating conditions). These operating conditions must include flow rate, UV intensity as measured by a UV sensor, and UV lamp status.

1. When determining validated operating conditions, systems must account for the following factors: UV absorbance of the water; lamp fouling and aging; measurement uncertainty of on-line sensors; UV dose distributions arising from the velocity profiles through the reactor; failure of UV lamps or other critical system components; and UV reactor inlet and outlet piping or channel configurations.

2. Validation testing must include full-scale testing of a reactor that conforms uniformly to the UV reactors used by the system and inactivation of a test microorganism whose dose response characteristics have been quantified with a low-pressure mercury vapor lamp.

3. The department may approve an alternative approach to validation testing.

(2) Reactor monitoring.

1. Systems must monitor their UV reactors to determine if the reactors are operating within validated conditions, as determined under 43.11(13) "d"(1). This monitoring must include UV sensor, flow rate, lamp status, and other parameters the department designates based on UV reactor operation. Systems must verify the calibration of UV sensors and recalibrate sensors in accordance with a department-approved protocol.

2. To receive UV light treatment credit, systems must treat at least 95 percent of the water delivered to the public during each month by UV reactors operating within validated conditions for the required UV dose. Systems must demonstrate compliance with this condition by completing the monitoring required in this subparagraph.

43.11(14) Reporting requirements. Systems must report the following to the department:

a. Source water sampling schedules and monitoring results under 43.11(3) “*c*” and “*e*,” unless the systems notify the department that they will not conduct source water monitoring due to meeting the criteria of 5.5-log treatment for *Cryptosporidium* under 43.11(3) “*a*.”

b. *Cryptosporidium* bin classification determined under 43.11(5).

c. Disinfection profiles and benchmarks as described in 43.11(4) “*a*” and “*b*” prior to making a significant change in disinfection practice.

d. In accordance with Table 7 for any microbial toolbox options used to comply with treatment requirements under 43.11(6).

Table 7: Microbial Toolbox Reporting Requirements

Toolbox Option	Systems must submit this information	Submit information in accordance with the applicable treatment compliance dates in subrule 43.11(7), as noted
1. Watershed control program (WCP)	Notice of intention to develop a new or continue an existing WCP	No later than two years before applicable date
	Watershed control plan	No later than one year before applicable date
	Annual WCP status report	Every 12 months, beginning one year after applicable date
	Watershed sanitary survey report	- For CWS, every 3 years, beginning 3 years after applicable date - For NTNC or TNC, every 5 years, beginning 5 years after applicable date
2. Alternative source/intake management	Verification that system has relocated the intake or adopted the intake withdrawal procedure reflected in monitoring results	No later than the applicable date
3. Presedimentation	Monthly verification: - Continuous basin operation; - Treatment of 100 percent of the flow; - Continuous coagulant addition; and - At least 0.5-log mean reduction of influent turbidity or compliance with alternative department-approved performance criteria	Monthly reporting within 10 days following the month monitoring was conducted, beginning on applicable date
4. Two-stage lime softening	Monthly verification: - Chemical addition and hardness precipitation occurred in two separate and sequential softening stages prior to filtration; and - Both stages treated 100 percent of plant flow	Monthly reporting within 10 days following the month monitoring was conducted, beginning on applicable date
5. Bank filtration	Initial demonstration of: - Unconsolidated, predominantly sandy aquifer; and - Setback distance of at least 25 feet for 0.5-log credit or 50 feet for 1.0-log credit	No later than applicable date
	If monthly average of daily maximum turbidity is greater than 1 NTU, report result and submit an assessment of the cause.	Report within 30 days following the month monitoring was conducted, beginning on applicable date
6. Combined filter performance	Monthly verification of CFE turbidity levels less than or equal to 0.15 NTU in at least 95 percent of the 4-hour CFE measurements taken each month	Monthly reporting within 10 days following the month monitoring was conducted, beginning on applicable date
7. Individual filter performance	Monthly verification of: - IFE turbidity levels less than or equal to 0.15 NTU in at least 95 percent of samples each month in each filter; and - No IFE turbidity levels greater than 0.3	Monthly reporting within 10 days following the month monitoring was conducted, beginning on applicable date

Toolbox Option	Systems must submit this information	Submit information in accordance with the applicable treatment compliance dates in subrule 43.11(7), as noted
	NTU in two consecutive readings 15 minutes apart	
8. Demonstration of performance	Results from testing following a department-approved protocol	No later than applicable date
	As required by the department, monthly verification of operation within conditions of department approval for demonstration of performance credit	Within 10 days following the month monitoring was conducted, beginning on applicable date
9. Bag filters and cartridge filters	Demonstration that the: - Process meets the definition of bag or cartridge filtration, and - Removal efficiency established through challenge testing is meeting criteria	No later than applicable date
	Monthly verification that 100 percent of plant flow was filtered	Within 10 days following the month monitoring was conducted, beginning on applicable date
10. Membrane filtration	Results of verification testing demonstrating: - Removal efficiency established through challenge testing meets criteria; and - Integrity test method and parameters, including resolution, sensitivity, test frequency, control limits, and associated baseline	No later than applicable date
	Monthly report summarizing: - All DITs above the control limit, and - If applicable, any turbidity or alternative department-approved indirect integrity monitoring results triggering DITs and corrective action that was taken	Within 10 days following the month monitoring was conducted, beginning on applicable date
11. Second-stage filtration	Monthly verification that 100 percent of flow was filtered through both stages and that first stage was preceded by coagulation step	Within 10 days following the month monitoring was conducted, beginning on applicable date
12. Slow sand filtration as a secondary filter	Monthly verification that both a slow sand filter and a preceding separate stage of filtration treated 100 percent of the flow from surface or IGW sources	Within 10 days following the month monitoring was conducted, beginning on applicable date
13. Chlorine dioxide	Summary of CT values for each day as described in 43.11(13)	Within 10 days following the month monitoring was conducted, beginning on applicable date
14. Ozone	Summary of CT values for each day as described in 43.11(13)	Within 10 days following the month monitoring was conducted, beginning on applicable date
15. UV	Validation test results demonstrating operating conditions that achieve required UV dose	No later than the applicable date
	Monthly report summarizing the percentage of water entering the distribution system that was not treated by UV reactors operating within validated conditions for the required dose as specified in 43.11(13) "d"	Within 10 days following the month monitoring was conducted, beginning on applicable date

43.11(15) Recordkeeping requirements.

a. Source water monitoring. Systems must keep results from the initial round of source water monitoring under 43.11(3) "a" and the second round of source water monitoring under 43.11(3) "b" until three years after bin classification under 43.11(5) for the particular round of monitoring.

b. Systems meeting 5.5-log Cryptosporidium treatment. Systems must keep, for three years, records of any notification to the department that they will meet the 5.5-log *Cryptosporidium* treatment requirements and avoid source water monitoring.

c. Microbial toolbox treatment monitoring. Systems must keep the results of treatment monitoring associated with microbial toolbox options under 43.11(8) through 43.11(13) for three years.

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