Requirements for *Cryptosporidium* compliance, based on the risks related to raw water quality and to the performance of different treatment processes

A Discussion Paper

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Information ex USEPA (LT2ESWTR, August 2003)	Comments
EPA is proposing risk-targeted treatment requirements for *Cryptosporidium* control in filtered water supplies that are based on a microbial approach. Systems that use any water other than secure groundwater will conduct raw water monitoring to determine an average *Cryptosporidium* concentration. Based on monitoring results, filtered water supplies will be classified in one of four possible risk categories (bins). The bin classification determines the extent of any additional *Cryptosporidium* treatment requirements beyond the requirements of current regulations.	
EPA expects the majority of filtered systems to be classified as Bin 1, which carries no additional treatment requirements. Bin 2–4 systems will be required to provide 1.0 to 2.5 log of treatment (ie, 90 to 99.7% reduction) for *Cryptosporidium* in addition to conventional treatment. Conventional treatment is defined as a series of processes including coagulation, flocculation, sedimentation, and filtration, and is considered to be capable of achieving 3 log removal of *Cryptosporidium*). The sedimentation stage is considered to earn 0.5 of these 3 log credits. Filtered systems will meet additional *Cryptosporidium* treatment requirements by using one or more treatment or control steps from a 'microbial toolbox' of options. Rather than monitoring for *Cryptosporidium*, filtered systems may elect to comply with the treatment requirements of Bin 4 directly.	If EPA thinks most US supplies will fall into Bin 1, then most likely ours will too. To avoid filtration in the US, raw water must have a higher quality (SWTR). We don't have that 'rule'. Often our treatment of unfiltered supplies is based on costs, not raw water quality.
All surface water systems that are not required to filter must provide at least 2 log (ie, 99%) inactivation of *Cryptosporidium*. Unfiltered systems will monitor for *Cryptosporidium* in their raw water and must achieve at least 3 log (ie, 99.9%) inactivation of *Cryptosporidium* if the mean level exceeds 0.01 oocysts/L. Unfiltered systems may elect to provide 3 log inactivation directly, instead of monitoring for *Cryptosporidium*. The proposal requires that unfiltered systems achieve their overall inactivation requirements using a minimum of two disinfectants.	We don't have much data on numbers of *Cryptosporidium* in our raw waters.
Bin classification (Table IV-2) is determined by averaging the *Cryptosporidium* concentrations measured for individual samples. EPA Method 1622 was used for enumeration.	Note that an appropriate treatment process may be in place, but it still needs to be monitored for compliance.

Table IV–2. - Bin classification table for filtered systems

If average Cryptosporidium concentration is:	% found in ICRESS Study 1999-2000	Then the classification is:	Removals needed
<0.075 oocysts per litre	59%	Bin 1	3 log = 99.9%
0.075 – 0.99	36%	Bin 2	4 log = 99.99
1.0 – 2.9	5%	Bin 3	5 log = 99.999
>3	0%	Bin 4	5.5 log = 99.9997

Bins 1 and 2 can use a single treatment process. Bins 3 and 4 must use >1.

SWTR specified (inter alia) 3 log removal *Giardia*, 4 log viruses. Filter effluent 0.5 NTU (95%-ile), none >5.

IESWTR reduced filter effluent to 0.3 and 1.0 NTU respectively, and added 2 log removal for Crypto.

Systems serving at least 10,000 people are required to monitor *Cryptosporidium* in their raw water for 24 months, and their bin classification must be based on the following: (1) Highest 12 month running annual average for monthly sampling, or (2) two year mean if system conducts twice-per-month or more frequent sampling for 24 months (i.e., at least 48 samples). Systems serving <10,000 people are required to collect 24 *Cryptosporidium* samples over 12 months if they exceed the E. coli trigger level (see next paragraph), and their bin classification must be based on the mean of the 24 samples.	That makes 24 samples for all water supplies serving >10,000, plus all those with <10,000 but with 'too many' E. coli – a lot of testing! <u>So we could consider an alternative indicator or approach</u>: (i) we could assume that all water supplies are equivalent to Bin 2 (ii) or, all are Bin 2 unless they prove otherwise by monitoring their raw water (iii) or, all supplies do E. coli testing on raw waters instead of *Cryptosporidium* to find their Bin number. (iv) to avoid the cost of E. coli testing, some small supplies could be classified Bin 2 based on land-use.
## Alternative indicator monitoring for filtered systems In recognition of the relatively high cost of analysing samples for *Cryptosporidium*, EPA explored the use of indicator criteria to identify raw waters that may have high levels of *Cryptosporidium* occurrence. The goal was to find one or more parameters that could be analyzed at low cost and identify those systems likely to exceed the Bin 1 boundary of 0.075 oocysts/L. Data were evaluated for possible indicator parameters, including fecal coliforms, total coliforms, E. coli, viruses, and turbidity. Based on available data, E. coli was found to provide the best performance as a *Cryptosporidium* indicator, and the inclusion of other parameters like turbidity was not found to improve accuracy.	We could adopt the same E. coli alternative.

E. coli is used as an indicator for systems that will exceed the Bin 1 boundary of 0.075 oocysts/L. E. coli mean concentrations of 10/100 mL and 50/100 mL are the proposed screening levels that will trigger *Cryptosporidium* monitoring in reservoir/lake and flowing stream systems, respectively.	But the trouble with using mean values – some contamination problems are caused during 'maximum events', not 'mean conditions'.

Unlike small filtered systems, small unfiltered systems cannot monitor for an indicator (eg, *E. coli*) to determine if they are required to monitor for *Cryptosporidium*. EPA has not identified indicator criteria that can effectively screen for plants with *Cryptosporidium* concentrations below 0.01 oocysts/L. Unfiltered systems are not required to conduct raw water *Cryptosporidium* monitoring if the system provides a total of at least 3 log *Cryptosporidium* inactivation, equivalent to meeting the treatment requirements for unfiltered systems with a mean *Cryptosporidium* concentration of greater than 0.01 oocysts/L (cf 0.075/L for filtered). **The microbial toolbox overview** A key feature of the microbial toolbox is that many of the components carry presumptive credits towards *Cryptosporidium* treatment requirements. Plants will receive these credits for toolbox components by demonstrating compliance with required design and implementation criteria. Treatment credit greater than the presumptive credit may be awarded for a toolbox component based on a site specific or technology-specific demonstration of performance. Table IV–7 summarizes presumptive credits and associated design and implementation criteria for microbial toolbox components.	Unfiltered systems are most commonly found in smaller communities, the ones that weigh cost against water quality. So perhaps we should not bother distinguishing between filtered and unfiltered? That is, a further cost concession, and one that the EPA could not justify. But what is our alternative?

Table IV–7: Some of EPA microbial toolbox: proposed options, log credits, and design/implementation criteria [1]

Toolbox option (non-credit earners removed)	Proposed *Cryptosporidium* log credit with design and implementation criteria[1]
Watershed control program.	0.5 log credit for State-approved program comprising EPA specified elements. Does not apply to unfiltered systems.
Pre-sedimentation basin with coagulation.	Sampling after raw water reservoir to determine bin classification. 0.5 log credit with continuous operation and coagulant addition; basins must achieve 0.5 log turbidity reduction based on the monthly mean of daily measurements in 11 of the 12 previous months; all flow must pass through basins. Systems using existing pre-sed basins must sample after basins to determine bin classification and are not eligible for presumptive credit.
Bank filtration (as pretreatment).	0.5 log credit for 25 ft. setback; 1.0 log credit for 50 ft. setback; aquifer must be unconsolidated sand containing at least 10% fines; average turbidity in wells must be < 1 NTU. Systems using existing wells followed by filtration must monitor well effluent to determine bin classification and are not eligible for presumptive credit.
Combined filter performance.	0.5 log credit for combined filter effluent turbidity ≤0.15 NTU in 95% of samples each month.
Slow sand filters.	2.5 log credit as a secondary filtration step; 3.0 log credit as a primary filtration process. No prior chlorination.
Second stage filtration.	0.5 log credit for second separate filtration stage; treatment train must include coagulation prior to first filter. No presumptive credit for roughing filters.
Membranes.	Log credit equivalent to removal efficiency demonstrated in challenge test for device if supported by direct integrity testing.
Bag filters.	1 log credit with demonstration of at least 2 log removal efficiency in challenge test.
Cartridge filters.	2 log credit with demonstration of at least 3 log removal efficiency in challenge test.
Chlorine dioxide.	Log credit based on demonstration of log inactivation using C.t table.
Ozone.	Log credit based on demonstration of log inactivation using CT table.
UV.	Log credit based on demonstration of inactivation with UV dose table; reactor testing required to establish validated operating conditions.
Individual filter performance.	1.0 log credit for demonstration of filtered water turbidity < 0.1 NTU in 95 percent of daily max values from individual filters (excluding 15 min period following backwashes) and no individual filter > 0.3 NTU in two consecutive measurements taken 15 minutes apart.
Demonstration of performance.	Credit awarded to unit process or treatment train based on demonstration to the State, through use of a State-approved protocol.

[1] Table provides summary information only