

TABLE IV-9.—STUDIES OF *Cryptosporidium* DIE-OFF DURING RAW WATER STORAGE

Researcher	Type of experiment	Log reduction
Medema <i>et al.</i> 1997 .....	River water was inoculated with <i>Cryptosporidium</i> and bacteria and incubated.	0.5 log reduction over 50 days at 5 °C; 0.5 log reduction over 20–80 days at 15 °C.
Sattar <i>et al.</i> 1999 .....	Synthetic hard water and natural water from several rivers inoculated with <i>Giardia</i> and <i>Cryptosporidium</i> .	<i>In vitro</i> conditions showed 0.7 to 2.0 log reduction over 30 days at 20 °C. Little reduction at 4 °C. <i>In situ</i> conditions showed 0.4 to 1.5 log reduction at 21 days.

Medema *et al.* (1997) conducted bench scale studies of the influence of temperature and the presence of biological activity on the die-off rate of *Cryptosporidium* oocysts. Die-off rates were determined at 5°C and 15°C, and in both natural and sterilized (autoclaved) river water. Both excystation and vital dye staining were used to determine oocyst viability. At 5°C, the die-off rate under all conditions was 0.010 log<sub>10</sub>/day, assuming first-order kinetics. This translates to 0.5 log reduction at 50 days. At 15°C, the die-off rate in natural river water approximately doubled to 0.024 log<sub>10</sub>/day (excystation) and 0.018 log<sub>10</sub>/day (dye staining). However, in autoclaved water at 15°C, the die-off rate was only 0.006 log<sub>10</sub>/day (excystation) and 0.011 log<sub>10</sub>/day (dye staining). These results suggest that oocyst die-off is more rapid at higher temperatures in natural water, and this behavior may be caused by increased biological or biochemical activity.

Sattar *et al.* (1999) evaluated factors impacting *Cryptosporidium* and *Giardia* survival. Microtubes containing untreated water from the Grand and St. Lawrence rivers (Ontario) were inoculated with purified oocysts and cysts. Samples were incubated at temperatures ranging from 4°C to 30°C, viability of oocysts and cysts was measured by excystation. At 20°C and 30°C, reductions in viable *Cryptosporidium* oocysts ranged from approximately 0.6 to 2.0 log after 30 days. However, relatively little inactivation took place when oocysts were incubated at 4°C (as low as 0.2 log at 100 days).

To evaluate oocyst survival under dynamic environmental conditions, Sattar *et al.* seeded dialysis cassettes with *Cryptosporidium* oocysts and placed them in overflow tanks receiving water from different rivers in Canada and the United States. Reductions in the concentration of viable oocysts ranged from approximately 0.4 to 1.5 log after 21 days. Survival of oocysts was enhanced by pre-filtering the water, suggesting that microbial antagonism was involved in the natural inactivation of the parasites.

Overall these studies indicate that off-stream storage of raw water has the potential to effect significant reductions in the concentration of viable *Cryptosporidium* oocysts, both through sedimentation and degradation of oocysts (*i.e.*, die-off). However, these data also illustrate the challenge in reliably estimating the amount of removal that will occur in any particular storage reservoir. Removal and die-off rates reported in these studies varied widely, and were observed to be influenced by factors like temperature, contamination, hydraulic short circuiting, and biological activity (Van Breeman *et al.* 1998, Medema *et al.* 1997, Sattar *et al.* 1999). Because of this variability and the relatively small amount of available data, it is difficult to extrapolate from these studies to develop nationally applicable criteria for awarding removal credits to raw water storage.

c. *Request for comment.* EPA requests comment on the finding that the available data are not adequate to support a presumptive *Cryptosporidium* treatment credit for off-stream raw water storage, and that systems using off-stream storage should conduct LT2ESWTR monitoring at the reservoir outlet. This monitoring approach would account for reductions in oocyst concentrations due to settling, but would not provide credit for die-off, since non-viable oocysts could still be counted during monitoring. In addition, EPA would also appreciate comment on the following specific issues:

- Is additional information available that either supports or suggests modifications to this proposal concerning off-stream raw water storage?
- How should a system address the concern that water in off-stream raw water storage reservoirs may become contaminated through processes like algal growth, run-off, roosting birds, and activities on the watershed?

#### 5. Pre-Sedimentation With Coagulant

a. *What is EPA proposing today?* Presedimentation is a preliminary treatment process used to remove particulate material from the source water before the water enters primary

sedimentation and filtration processes in a treatment plant. EPA is proposing to award a presumptive 0.5 log *Cryptosporidium* treatment credit for presedimentation that is installed after LT2ESWTR monitoring and meets the following three criteria:

(1) The presedimentation basin must be in continuous operation and must treat all of the flow reaching the treatment plant.

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

(3) The system must demonstrate on a monthly basis at least 0.5 log reduction of influent turbidity through the presedimentation process in at least 11 of the 12 previous consecutive months. This monthly demonstration of turbidity reduction must be based on the arithmetic mean of at least daily turbidity measurements in the presedimentation basin influent and effluent, and must be calculated as follows:

Monthly mean turbidity log reduction =  $\log_{10}(\text{monthly mean of daily influent turbidity}) - \log_{10}(\text{monthly mean of daily effluent turbidity})$ .

If the presedimentation process has not been in operation for 12 months, the system must verify on a monthly basis at least 0.5 log reduction of influent turbidity through the presedimentation process, calculated as specified in this paragraph, for at least all but any one of the months of operation.

Systems with presedimentation in place at the time they begin LT2ESWTR *Cryptosporidium* monitoring are not eligible for the 0.5 log presumptive credit and must sample after the basin when in use for the purpose of determining their bin assignment. The use of presedimentation during LT2ESWTR monitoring must be consistent with routine plant operation and must be recorded by the system. Guidance on monitoring is provided in Public Water System Guidance Manual for Source Water Monitoring under the LT2ESWTR (USEPA 2003g), which is available in draft in the docket for today's proposal.

b. *How was this proposal developed?* Presedimentation is used to remove gravel, sand, and other gritty material