ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 141 and 142

[WH–FRL–6570–5]

RIN 2040–AD18

National Primary Drinking Water Regulations: Long Term 1 Enhanced Surface Water Treatment and Filter Backwash Rule

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: In this document, EPA is proposing the Long Term 1 Enhanced Surface Water Treatment and Filter Backwash Rule (LT1FBR). The purposes of the LT1FBR are to: Improve control of microbial pathogens in drinking water, including *Cryptosporidium*, for public water systems (PWSs) serving fewer than 10,000 people; prevent increases in microbial risk while PWSs serving fewer than 10,000 people control for disinfection byproducts, and; require certain PWSs to institute changes to the return of recycle flows within the treatment process to reduce the effects of recycle on compromising microbial control. Today's proposal addresses two statutory requirements of the 1996 Safe Drinking Water Act (SDWA) Amendments. First, it addresses the statutory requirement to establish a Long Term Final Enhanced Surface Water Treatment Rule (LTESWTR) for PWSs that serve under 10,000 people. Second, it addresses the statutory requirement to promulgate a regulation which ''governs'' the recycle of filter backwash within the treatment process of public utilities.

Today's proposed LT1FBR contains 5 key provisions for surface water and ground water under the direct influence of surface water (GWUDI) systems serving fewer than 10,000 people: A treatment technique requiring a 2-log (99 percent) *Cryptosporidium* removal requirement; strengthened combined filter effluent turbidity performance standards and new individual filter turbidity provisions; disinfection benchmark provisions to assure continued microbial protection is provided while facilities take the necessary steps to comply with new disinfection byproduct standards; inclusion of *Cryptosporidium* in the definition of GWUDI and in the watershed control requirements for unfiltered public water systems; and requirements for covers on new finished water reservoirs.

Today's proposed LT1FBR contains three key provisions for all conventional and direct filtration systems which recycle and use surface water or GWUDI: A provision requiring recycle flows to be introduced prior to the point of primary coagulant addition; a requirement for systems meeting criteria to perform a one-time self assessment of their recycle practice and consult with their primacy agency to address and correct high risk recycle operations; and a requirement for direct filtration systems to provide information to the State on their current recycle practice.

The Agency believes implementing the provisions contained in today's proposal will improve public health protection in two fundamental ways. First, the provisions will reduce the level of *Cryptosporidium* in filtered finished drinking water supplies through improvements in filtration and recycle practice resulting in a reduced likelihood of outbreaks of cryptosporidiosis. Second, the filtration provisions are expected to increase the level of protection from exposure to other pathogens (*i.e. Giardia* or other waterborne bacterial or viral pathogens). It is also important to note that while today's proposed rule contains new provisions which in some cases strengthen or modify requirements of the 1989 Surface Water Treatment Rule, each public water system must continue to comply with the current rules while new microbial and disinfectants/disinfection byproducts rules are being developed. In conjunction with the Maximum Contaminant Level Goal (MCLG) established in the Interim Enhanced Surface Water Treatment Rule, the Agency developed a treatment technique in lieu of a Maximum Contaminant Level (MCL) for *Cryptosporidium* because it is not economically and technologically feasible to accurately ascertain the level of *Cryptosporidium* using current analytical methods.

DATES: The Agency requests comments on today's proposal. Comments must be received or post-marked by midnight June 9, 2000. Comments received after this date may not be considered in decision making on the proposed rule.

ADDRESSES: Send written comments on today's proposed rule to the LT1FBR Comment Clerk: Water Docket MC 410, W–99–10, Environmental Protection Agency 401 M Street, S.W., Washington, DC 20460. Please submit an original and three copies of comments and enclosures (including references).

Those who comment and want EPA to acknowledge receipt of their comments must enclose a self-addressed stamped envelope. No facsimiles (faxes) will be accepted. Comments may also be submitted electronically to ow-docket@epamail.epa.gov. For additional information on submitting electronic comments see Supplementary Information Section.

Public comments on today's proposal, other major supporting documents, and a copy of the index to the public docket for this rulemaking are available for review at EPA's Office of Water Docket: 401 M Street, SW., Rm. EB57, Washington, DC 20460 from 9:00 a.m. to 4:00 p.m., Eastern Time, Monday through Friday, excluding legal holidays. For access to docket materials or to schedule an appointment please call (202) 260–3027.

FOR FURTHER INFORMATION CONTACT: Technical inquiries on the rule should be directed to Jeffery Robichaud at 401 M Street, SW., MC4607, Washington, DC 20460 or (202) 260–2568. For general information contact the Safe Drinking Water Hotline, Telephone (800) 426–4791. The Safe Drinking Water Hotline is open Monday through Friday, excluding federal holidays, from 9:00 a.m. to 5:30 p.m. Eastern Time.

SUPPLEMENTARY INFORMATION: Entities potentially regulated by the LT1FBR are public water systems (PWSs) that use surface water or ground water under the direct influence of surface water (GWUDI). The recycle control provisions are applicable to all PWSs using surface water or GWUDI, regardless of the population served. All other provisions of the LT1FBR are only applicable to PWSs serving under 10,000 people. Regulated categories and entities include:

Category	Examples of regulated entities
Industry	Public Water Systems that use surface water or ground water under the direct influence of surface water.
State, Local, Tribal or Federal Governments.	Public Water Systems that use surface water or ground water under the direct influence of surface water.

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by the LT1FBR. This table lists the types of entities that EPA is now aware could potentially be regulated by this rule. Other types of entities not listed in this table could also be regulated. To determine whether your facility is regulated by this action, you should carefully examine the definition of public water system in § 141.3 of the Code of Federal Regulations and applicability criteria in §§ 141.76 and 141.501 of today's proposal. If you have questions regarding the applicability of the LT1FBR to a particular entity, consult the person listed in the preceding section entitled **FOR FURTHER INFORMATION CONTACT**.

Submitting Comments

Send an original and three copies of your comments and enclosures (including references) to W–99–10 Comment Clerk, Water Docket (MC4101), USEPA, 401 M Street, SW., Washington, D.C. 20460. Comments must be received or post-marked by midnight June 9, 2000. Note that the Agency is not soliciting comment on, nor will it respond to, comments on previously published regulatory language that is included in this document to ease the reader's understanding of the proposed language.

To ensure that EPA can read, understand and therefore properly respond to comments, the Agency would prefer that commenters cite, where possible, the paragraph(s) or sections in the proposed rule or supporting documents to which each comment refers. Commenters should use a separate paragraph for each issue discussed.

Electronic Comments

Comments may also be submitted electronically to ow-docket@epamail.epa.gov. Electronic comments must be submitted as an ASCII, WP5.1, WP6.1 or WP8 file avoiding the use of special characters and form of encryption. Electronic comments must be identified by the docket number W–99–10. Comments and data will also be accepted on disks in WP 5.1, 6.1, 8 or ASCII file format. Electronic comments on this document may be filed online at many Federal Depository Libraries.

The record for this rulemaking has been established under docket number W–99–10, and includes supporting documentation as well as printed, paper versions of electronic comments. The record is available for inspection from 9 a.m. to 4 p.m., Monday through Friday, excluding legal holidays at the Water Docket, EB 57, USEPA Headquarters, 401 M Street, SW., Washington, D.C. For access to docket materials, please call (202) 260–3027 to schedule an appointment.

List of Abbreviations Used in This Document

ASCE American Society of Civil Engineers
ASDWA Association of State Drinking Water Administrators
ASTM American Society for Testing Materials
AWWA American Water Works Association
AWWARF American Water Works Association Research Foundation
°C Degrees Centigrade
CCP Composite Correction Program
CDC Centers for Disease Control
CFE Combined Filter Effluent
CFR Code of Federal Regulations
COI Cost of Illness
CPE Comprehensive Performance Evaluation
CT The Residual Concentration of Disinfectant (mg/L) Multiplied by the Contact Time (in minutes)
CTA Comprehensive Technical Assistance
CWSS Community Water System Survey
DBPs Disinfection Byproducts
DBPR Disinfectants/Disinfection Byproducts Rule
ESWTR Enhanced Surface Water Treatment Rule
FACA Federal Advisory Committee Act
GAC Granular Activated Carbon
GAO Government Accounting Office
GWUDI Ground Water Under the Direct Influence of Surface Water
HAA5 Haloacetic acids (Monochloroacetic, Dichloroacetic, Trichloroacetic, Monobromoacetic and Dibromoacetic Acids)
HPC Heterotropic Plate Count
hrs Hours
ICR Information Collection Rule
IESWTR Interim Enhanced Surface Water Treatment Rule
IFA Immunofluorescence Assay
Log Inactivation Logarithm of (N_o/N_T)
Log Logarithm (common, base 10)
LTESWTR Long Term Enhanced Surface Water Treatment Rule
LT1FBR Long Term 1 Enhanced Surface Water Treatment and Filter Backwash Rule
MCL Maximum Contaminant Level
MCLG Maximum Contaminant Level Goal
MGD Million Gallons per Day
M-DBP Microbial and Disinfectants/Disinfection Byproducts
MPA Microscopic Particulate Analysis
NODA Notice of Data Availability
NPDWR National Primary Drinking Water Regulation
N_T The Concentration of Surviving Microorganisms at Time T
NTTAA National Technology Transfer and Advancement Act
NTU Nephelometric Turbidity Unit
PE Performance Evaluation
PWS Public Water System
Reg. Neg. Regulatory Negotiation
RIA Regulatory Impact Analysis
RFA Regulatory Flexibility Act
RSD Relative Standard Deviation
SAB Science Advisory Board
SDWA Safe Drinking Water Act
SWTR Surface Water Treatment Rule
TC Total Coliforms
TCR Total Coliform Rule
TTHM Total Trihalomethanes
TWG Technical Work Group
TWS Transient Non-Community Water System
UMRA Unfunded Mandates Reform Act
URCIS Unregulated Contaminant Information System
x log removal Reduction to $1/10^x$ of original concentration

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I. Introduction and Background

A. Statutory Requirements and Legal Authority

The Safe Drinking Water Act (SDWA or the Act), as amended in 1986, requires U.S. Environmental Protection Agency (EPA) to publish a maximum contaminant level goal (MCLG) for each contaminant which, in the judgement of the EPA Administrator, ''may have any adverse effect on the health of persons and which is known or anticipated to occur in public water systems' (Section 1412(b)(3)(A)). MCLGs are to be set at a level at which ''no known or anticipated adverse effect on the health of persons occur and which allows an adequate margin of safety'' (Section 1412(b)(4)).

The Act was again amended in August 1996, resulting in the renumbering and augmentation of certain sections with additional statutory language. New sections were added establishing new drinking water requirements. These modifications are outlined below.

The Act requires EPA to publish a National Primary Drinking Water Regulation (NPDWR) that specifies either a maximum contaminant level (MCL) or treatment technique (Sections 1401(1) and 1412(a)(3)) at the same time it publishes an MCLG, which is a non-enforceable health goal. EPA is authorized to promulgate a NPDWR ''that requires the use of a treatment technique in lieu of establishing an MCL,'' if the Agency finds that ''it is not economically or technologically feasible to ascertain the level of the contaminant.'' EPA's general authority to set MCLGs and NPDWRs applies to contaminants that may ''have an adverse effect on the health of persons,'' that are ''known to occur or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern,'' and for which ''in the sole judgement of the Administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction for persons served by public water systems'' (SDWA Section 1412(b)(1)(A)).

The 1996 amendments, also require EPA, when proposing a NPDWR that includes an MCL or treatment technique, to publish and seek public comment on an analysis of health risk reduction and cost impacts. EPA is required to take into consideration the effects of contaminants upon sensitive subpopulations (i.e., infants, children, pregnant women, the elderly, and individuals with a history of serious illness), and other relevant factors (Section 1412(b)(3)(C)).

The amendments established a number of regulatory deadlines, including schedules for a Stage 1 Disinfection Byproduct Rule (DBPR), an Interim Enhanced Surface Water Treatment Rule (IESWTR), a Long Term Final Enhanced Surface Water Treatment Rule (LTESWTR), and a Stage 2 DBPR (Section 1412(b)(2)(C)). To provide additional time for systems serving fewer than 10,000 people to comply with the IESWTR provisions and also ensure these systems implement Stage 1 DBPR and the IESWTR provisions simultaneously, the Agency split the IESWTR into two rules: the IESWR and the LT1ESWTR. The Act as amended also requires EPA to promulgate regulations to ''govern'' the recycle of filter backwash within the treatment process of public utilities (Section 1412(b)(14)).

Under 1412(b)(4)(E)(ii), EPA must develop a Small System Technology List for the LT1FBR. The filtration technologies listed in the Small System Compliance Technology List for the Surface Water Treatment Rule and Total Coliform Rule (EPA–815–R–98–001, September 1998) are also the technologies which would achieve compliance with the provisions of the LT1FBR. EPA will develop a separate list for the LT1FBR as new technologies become available.

Although the Act permits small system variances for compliance with a requirement of a national primary drinking water regulation which specifies a maximum contaminant level or treatment technique, Section 1415(e)(6)(B) of SDWA, excludes variances for any national primary drinking water regulation for a microbial contaminant or an indicator or treatment technique for a microbial contaminant. LT1FBR requires treatment techniques to control *Cryptosporidium* (a microbial contaminant), and as such systems governed by the LT1FBR are ineligible for variances.

Finally, as part of the 1996 SDWA Amendments, recordkeeping requirements were modified to apply to every person who is subject to a requirement of this title or who is a grantee (Section 1445(a)(1)(A)). Such persons are required to establish and maintain such records, make such reports, conduct such monitoring, and provide such information as the Administrator may reasonably require by regulation.

B. Existing Regulations and Stakeholder Involvement

1. 1979 Total Trihalomethane Rule

In November 1979 (44 FR 68624) (EPA, 1979) EPA set an interim MCL for total trihalomethanes (TTHM—the sum of chloroform, bromoform, bromodichloromethane, dibromochloromethane) of 0.10 mg/l as an annual average. Compliance is defined on the basis of a running annual average of quarterly averages for four samples taken in the distribution system. The value for each sample is the sum of the measured concentrations of chloroform, bromodichloromethane, dibromochloromethane and bromoform.

The interim TTHM standard applies to community water systems using surface water and/or ground water serving at least 10,000 people that add a disinfectant to the drinking water during any part of the treatment process. At their discretion, States may extend coverage to smaller PWSs; however, most States have not exercised this option. The Stage 1 DBPR (as discussed later) contains updated TTHM requirements.

2. Total Coliform Rule

The Total Coliform Rule (TCR) (54 FR 27544, June 29, 1989) (EPA, 1989a) applies to all public water systems. The TCR sets compliance with the Maximum Contaminant Level (MCL) for total coliforms (TC) as follows. For systems that collect 40 or more samples per month, no more than 5 percent of the samples may be TC-positive; for those that collect fewer than 40 samples, no more than one sample may be TC-positive. If a system has a TC-positive sample, it must test that sample for the presence of fecal coliforms or *E. coli*. The system must also collect a set of repeat samples, and analyze for TC (and fecal coliform or *E. coli* within 24 hours of the first TC-positive sample).

In addition, any fecal coliform-positive repeat sample, *E-coli.*-positive repeat sample, or any total-coliform-positive repeat sample following a fecal coliform-positive or *E-coli*-positive routine sample constitutes an acute violation of the MCL for total coliforms. If a system exceeds the MCL, it must notify the public using mandatory language developed by the EPA. The required monitoring frequency for a system depends on the number of people served and ranges from 480 samples per month for the largest systems to once annually for the smallest systems. All systems must have a written plan identifying where samples are to be collected.

The TCR also requires an on-site inspection (referred to as a sanitary survey) every 5 years for each system that collects fewer than five samples per month. This requirement is extended to every 10 years for non-community systems using only protected and disinfected ground water.

3. Surface Water Treatment Rule

Under the Surface Water Treatment Rule (SWTR) (54 FR 27486, June 29, 1989) (EPA, 1989b), EPA set maximum contaminant level goals of zero for *Giardia lamblia*, viruses, and *Legionella* and promulgated regulatory requirements for all PWSs using surface water sources or ground water sources under the direct influence of surface water. The SWTR includes treatment technique requirements for filtered and unfiltered systems that are intended to protect against the adverse health effects of exposure to *Giardia* lamblia, viruses, and *Legionella,* as well as many other pathogenic organisms. Briefly, those requirements include (1) Requirements for maintenance of a disinfectant residual in the distribution system; (2) removal and/or inactivation of 3 log (99.9 percent) for *Giardia* and 4 log (99.99 percent) for viruses; (3) combined filter effluent turbidity performance standard of 5 nephelometric turbidity units (NTU) as a maximum and 0.5 NTU at the 95th percentile monthly, based on 4-hour monitoring for treatment plants using conventional treatment or direct filtration (with separate standards for other filtration technologies); and (4) watershed protection and other requirements for unfiltered systems. Systems seeking to avoid filtration were required to meet avoidance criteria and obtain avoidance determination by December 30, 1991, otherwise filtration must have been provided by June 29, 1993. For systems properly avoiding filtration, later failures to meet avoidance criteria triggered a requirement that filtration be provided within 18 months.

4. Information Collection Rule

The Information Collection Rule (ICR), which was promulgated on May 14, 1996 (61 FR 24354) (EPA, 1996) applied to large public water systems serving populations of 100,000 or more. A more limited set of ICR requirements pertain to ground water systems serving between 50,000 and 100,000 people. About 300 PWSs operating 500 treatment plants were involved with the extensive ICR data collection. Under the ICR, these PWSs monitored for water quality factors affecting disinfection byproduct (DBP) formation and DBPs within the treatment plant and in the distribution system on a monthly basis for 18 months. In addition, PWSs were required to provide treatment train schematics, operating data and source water occurrence data for bacteria, viruses, and protozoa. Finally, a subset of PWSs performed treatment studies, using either granular activated carbon (GAC) or membrane processes, to evaluate DBP precursor removal and control of DBPs. Monitoring for treatment study applicability began in September 1996. The remaining occurrence monitoring began in July 1997 and concluded in December 1998.

The purpose of the ICR was to collect occurrence and treatment information to help evaluate the need for possible changes to the current microbial requirements and existing microbial treatment practices, and to help evaluate the need for future regulation of disinfectants and disinfection byproducts (DBPs). The ICR will provide EPA with additional information on the national occurrence in drinking water of (1) chemical byproducts that form when disinfectants used for microbial control react with naturally occurring compounds already present in source water; and (2) disease-causing microorganisms, including *Cryptosporidium*, *Giardia*, and viruses. Analysis of ICR data is not expected to be completed in the time frame necessary for inclusion in the LT1FBR, however if the data is available and has been quality controlled and peer reviewed during the necessary time frame, EPA will consider the datat as it refines its analysis for the final rule.

The ICR also required PWSs to provide engineering data on how they currently control for such contaminants. The ICR monthly sampling data will also provide information on the quality of the recycle waters via monthly monitoring (for 18 months) of pH, alkalinity, turbidity, temperature, calcium and total hardness, TOC, UV_{254}, bromide, ammonia, and disinfectant residual (if disinfectant is used). This data will provide some indication of the treatability of the water, the extent to which contaminant concentration effects may occur, and the potential for contribution to DBP formation. However, sampling to determine the occurrence of pathogens in recycle waters was not performed.

5. Interim Enhanced Surface Water Treatment Rule

Public water systems serving 10,000 or more people that use surface water or ground water under the direct influence of surface water (GWUDI) are required to comply with the IESWTR (63 FR 69477, December 16, 1998) (EPA, 1998a) by December of 2001. The purposes of the IESWTR are to improve control of microbial pathogens, specifically the protozoan *Cryptosporidium*, and address risk trade-offs between pathogens and disinfection byproducts. Key provisions established by the rule include: a Maximum Contaminant Level Goal (MCLG) of zero for *Cryptosporidium*; 2-log (99 percent) *Cryptosporidium* removal requirements for systems that filter; strengthened combined filter effluent turbidity performance standards of 1.0 NTU as a maximum and 0.3 NTU at the 95th percentile monthly, based on 4-hour monitoring for treatment plants using conventional treatment or direct filtration; requirements for individual filter turbidity monitoring; disinfection benchmark provisions to assess the level of microbial protection provided as facilities take the necessary steps to comply with new disinfection byproduct standards; inclusion of *Cryptosporidium* in the definition of GWUDI and in the watershed control requirements for unfiltered public water systems; requirements for covers on new finished water reservoirs; and sanitary surveys for all surface water systems regardless of size.

6. Stage 1 Disinfectants and Disinfection Byproduct Rule

The Stage 1 DBPR applies to all PWSs that are community water systems (CWSs) or nontransient noncommunity water systems (NTNCWs) that treat their water with a chemical disinfectant for either primary or residual treatment. In addition, certain requirements for chlorine dioxide apply to transient noncommunity water systems (TNCWSs). The Stage 1 DBPR (EPA, 1998c) was published at the same time as the IESWTR (63 FR 69477, December 16, 1998) (EPA, 1998a). Surface water and GWUDI systems serving at least 10,000 persons are required to comply with the Stage 1 Disinfectants and Disinfection Byproducts Rule by December 2001. Ground water systems and surface water and GWUDI systems serving fewer than 10,000 must comply with the Stage 1 Disinfectants and Disinfection Byproducts Rule by December 2003.

The Stage 1 DBPR finalizes maximum residual disinfectant level goals (MRDLGs) for chlorine, chloramines, and chlorine dioxide; MCLGs for four trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, and bromoform), two haloacetic acids (dichloroacetic acid and trichloroacetic acid), bromate, and chlorite; and NPDWRs for three disinfectants (chlorine, chloramines, and chlorine dioxide), two groups of organic disinfection byproducts TTHMs and HAA5 and two inorganic disinfection byproducts, chlorite and bromate. The NPDWRs consist of maximum residual disinfectant levels (MRDLs) or maximum contaminant levels (MCLs) or treatment techniques for these disinfectants and their byproducts. The NPDWRs also include monitoring, reporting, and public notification requirements for these compounds. The Stage 1 DBPR includes the best available technologies (BATs) upon which the MRDLs and MCLs are based. EPA believes the implementation of the Stage 1 DBPR will reduce the levels of disinfectants and disinfection byproducts in drinking water supplies. The Agency believes the rule will provide public health protection for an additional 20 million households that were not previously covered by drinking water rules for disinfection byproducts.

7. Stakeholder Involvement

EPA conducted two stakeholder meetings to solicit feedback and information from the regulated community and other concerned stakeholders on issues relating to today's proposed rule. The first meeting was held July 22 and 23, 1998 in Lakewood, Colorado. EPA presented potential regulatory components for the LT1FBR. Breakout sessions with stakeholders were held to generate feedback on the regulatory provisions being considered and to solicit feedback on next steps for rule development and stakeholder involvement. Additionally, information was presented summarizing ongoing research and data gathering activities regarding the recycle of filter backwash. The presentations generated useful discussion and provided substantial feedback to EPA regarding technical issues, stakeholder concerns, and possible regulatory options (EPA 1999k). The second stakeholder meeting was held in Dallas, Texas on March 3 and 4, 1999. EPA presented new analyses, summaries of current research, and revised regulatory options and data collected since the July stakeholder meeting. Regional perspectives on turbidity and disinfection benchmarking components were also discussed with presentations from EPA Region VI and the Texas Natural Resources Conservation Commission. Four break-out sessions were extremely useful and generated a wide range of information, issues, and technical input from a diverse group of stakeholders (EPA 1999j).

The Agency utilized the feedback received during these two stakeholder meetings in developing today's proposed rule. EPA also mailed a draft version of the preamble for today's proposed rule to the attendees of these meetings. Several of the options which are presented today represent modifications suggested by stakeholders.

II. Public Health Risk

The purpose of this section is to discuss the health risk associated with pathogens, particularly *Cryptosporidium*, in surface waters and GWUDI. More detailed information about such pathogens and other contaminants of concern may be found in an EPA criteria document for *Giardia* (EPA 1998d), three EPA criteria documents for viruses (EPA, 1985; 1999a; 1999b), the *Cryptosporidium* and *Giardia* Occurrence Assessment for the Interim Enhanced Surface Water Treatment Rule (EPA, 1998b) and the LT1FBR Occurrence and Assessment Document (EPA 1999c). EPA requests comment on today's proposed rule, the information supporting the proposal, and the potential impact of proposed regulatory provisions on public health risk.

A. Introduction

In 1990, EPA's Science Advisory Board (SAB), an independent panel of experts established by Congress, cited drinking water contamination as one of the most important environmental risks and indicated that disease-causing microbial contaminants (i.e., bacteria, protozoa and viruses) are probably the greatest remaining health risk management challenge for drinking water suppliers (EPA/SAB, 1990). Information on the number of waterborne disease outbreaks from the U.S. Centers for Disease Control and Prevention (CDC) underscores this concern. CDC indicates that, between 1980 and 1996, 401 waterborne disease outbreaks were reported, with over 750,000 associated cases of disease. During this period, a number of agents were implicated as the cause, including protozoa, viruses and bacteria.

Waterborne disease caused by *Cryptosporidium* is of particular concern, as it is difficult to inactivate *Cryptosporidium* oocysts with standard disinfection practices (unlike pathogens such as viruses and bacteria), and there is currently no therapeutic treatment for cryptosporidiosis (unlike giardiasis). Because *Cryptosporidium* is not generally inactivated in systems using standard disinfection practices, the control of *Cryptosporidium* is dependent on physical removal processes (e.g., filtration).

The filter effluent turbidity limits specified under the SWTR were created to remove large parasite cysts such as *Giardia* and did not specifically control for smaller *Cryptosporidium* oocysts. In addition, filter backwash water recycling practices such as adding recycled water to the treatment train after primary coagulant addition may overwhelm the plant and harm efforts to control *Giardia lamblia, Cryptosporidium*, and emerging pathogens. Despite filtration and disinfection, *Cryptosporidium* oocysts have been found in filtered drinking water (LeChevallier, et al., 1991a; EPA, 1999c), and many of the individuals affected by waterborne disease outbreaks caused by *Cryptosporidium* were served by filtered surface water supplies (Solo-Gabriele and Neumeister, 1996). Surface water systems that filter and disinfect may still be vulnerable to *Cryptosporidium*, depending on the source water quality and treatment effectiveness. EPA believes that today's proposal, however, will ensure that drinking water treatment is operating efficiently to control *Cryptosporidium* (see Sections IV.A and IV.D) and other microbiological contaminants of concern (*e.g., Giardia*).

In order to assess the public health risk associated with consumption of surface water or GWUDI from PWSs, EPA has evaluated information and conducted analysis in four important areas discussed in the following paragraphs. These areas are: (1) The health effects of cryptosporidiosis; (2) cryptosporidiosis waterborne disease outbreak data; (3) *Cryptosporidium* occurrence data from raw surface water, raw GWUDI, finished water, and recycle stream studies; and (4) an assessment of the current baseline surface water treatment required by existing regulations.

B. Health Effects of Cryptosporidiosis and Sources and Transmission of Cryptosporidium

Waterborne diseases are usually acute (*i.e.,* sudden onset and typically lasting a short time in healthy people), and most waterborne pathogens cause gastrointestinal illness, with diarrhea, abdominal discomfort, nausea, vomiting, and/or other symptoms. Some waterborne pathogens cause or are associated with more serious disorders such as hepatitis, gastric cancer, peptic ulcers, myocarditis, swollen lymph glands, meningitis, encephalitis, and many other diseases. Cryptosporidiosis is a protozoal infection that usually causes 7–14 days of diarrhea with possibly a low-grade fever, nausea, and abdominal cramps in healthy individuals (Juranek, 1995). Unlike giardiasis for which effective antibiotic therapy is available, an antibiotic treatment for cryptosporidiosis does not exist (Framm and Soave, 1997).

There are several species of *Cryptosporidium* which have been identified, including *C. baileyi* and *C. meleagridis* (bird host); *C. muris* (mouse host); *C. nasorum* (fish host), *C. parvum* (mammalian host), and *C. serpentis* (snake host). *Cryptosporidium* parvum was first recognized as a human pathogen in 1976 (Juranek, 1995). Recently, both the human and cattle types of *C. parvum* have been found in healthy individuals, and these types, *C. felis*, and a dog type have been found in immunocompromised individuals (Pieniazek et al., 1999). Transmission of cryptosporidiosis often occurs through the ingestion of infective *Cryptosporidium* oocysts from feces-contaminated food or water, but may also result from direct or indirect contact with infected persons or mammals (Casemore, 1990; Cordell and Addiss, 1994). Dupont, et. al., 1995, found through a human feeding study that a low dose of *C. parvum* is sufficient to cause infection in healthy adults (Dupont et. al., 1995). Animal agriculture as a nonpoint source of *C. parvum* has been implicated as the source of contamination for the 1993 outbreak in Milwaukee, Wisconsin, the largest outbreak of waterborne disease in the history of the United States (Walker et al., 1998). Other sources of *C. parvum* include discharges from municipal wastewater treatment facilities and drainage from slaughterhouses. In addition, rainfall appears to increase the concentration of *Cryptosporidium* in surface water, documented in a study by Atherholt, et al. (1998).

There is evidence that an immune response to *Cryptosporidium* exists, but the degree and duration of this immunity is not well characterized (Fayer and Ungar, 1986). Recent work conducted by Chappell, *et al.* (1999) indicates that individuals with evidence of prior exposure to *Cryptosporidium parvum* have demonstrated immunity to low doses of oocysts (approximately 500 oocysts). The investigators found the 50 percent infectious dose for previously exposed individuals (possessing a pre-existing blood serum antibody) to be 1,880 oocysts compared to 132 oocysts for individuals without prior exposure, and individuals with prior exposure who became infected shed fewer oocysts. Because of this type of immune response, symptomatic infection in communities exposed to chronic low levels of oocysts will primarily be observed in newcomers (*e.g.,* visitors, young children) (Frost *et al.*, 1997; Okhuysen *et al.*, 1998).

Sensitive populations are more likely to become infected and ill, and gastrointestinal illness among this population may be chronic. These sensitive populations include children, especially the very young; the elderly; pregnant women; and the immunocompromised (Gerba *et al.*, 1996; Fayer and Ungar, 1986; EPA 1998e). This sensitive segment represents almost 20 percent of the population in the U.S. (Gerba *et al.*, 1996). EPA is particularly concerned about the exposure of severely immunocompromised persons to *Cryptosporidium* in drinking water, because the severity and duration of illness is often greater in immunocompromised persons than in healthy individuals, and it may be fatal among this population. For instance, a follow-up study of the 1993 Milwaukee, Wisconsin, waterborne disease outbreak reported that at least 50 *Cryptosporidium*-associated deaths occurred among the severely immunocompromised (Hoxie *et al.*, 1997).

Cases of illness from cryptosporidiosis were rarely reported until 1982, when the disease became prevalent due to the AIDS epidemic (Current, 1983). As laboratory diagnostic techniques improved during subsequent years, outbreaks among immunocompetent persons were recognized as well. Over the last several years there have been a number of documented waterborne cryptosporidiosis outbreaks in the U.S., United Kingdom, Canada and other countries (Rose, 1997, Craun *et al.*, 1998).

C. Waterborne Disease Outbreaks in the United States

The occurrence of outbreaks of waterborne gastrointestinal infections, including cryptosporidiosis, may be much greater than suggested by reported surveillance data (Craun and Calderon 1996). The CDC–EPA, and the Council of State and Territorial Epidemiologists have maintained a collaborative surveillance program for collection and periodic reporting of data on waterborne disease outbreaks since 1971. The CDC database and biennial CDC-EPA surveillance summaries include data reported voluntarily by the States on the incidence and prevalence of waterborne illnesses. However, the following information demonstrates why the reported surveillance data may under-report actual outbreaks.

The U.S. National Research Council strongly suggests that the number of identified and reported outbreaks in the CDC database (both for surface and ground waters) represents a small percentage of actual waterborne disease outbreaks National Research Council, 1997; Bennett *et al.*, 1987). In practice, most waterborne outbreaks in community water systems are not recognized until a sizable proportion of the population is ill (Perz *et al.*)

Healthy adults with cryptosporidiosis may not suffer severe symptoms from the disease; therefore, infected individuals may not seek medical assistance, and their cases are subsequently not reported. Even if infected individuals consult a physician, *Cryptosporidium* may not be identified by routine diagnostic tests for gastroenteritis and, therefore, tends to be under-reported in the general population (Juranek 1995). Such obstacles to outbreak reporting indicate that the incidence of disease and outbreaks of cryptosporidiosis may be much higher than officially reported by the CDC.

The CDC database is based upon responses to a voluntary and confidential survey that is completed by State and local public health officials. CDC defines a waterborne disease outbreak as occurring when at least two persons experience a similar illness after ingesting water (Kramer *et al.*, 1996). Cryptosporidiosis water system outbreak data from the CDC database appear in Table II.1 and Table II.2.

Table II.1 illustrates the reported number of waterborne disease outbreaks in U.S. community, noncommunity, and individual drinking water systems between 1971 and 1996. According to the CDC–EPA database, a total of 652 outbreaks and 572,829 cases of illnesses were reported between 1971 and 1996 (see Table II–1). The total number of outbreaks reported includes outbreaks resulting from protozoan contamination, virus contamination, bacterial contamination, chemical contamination, and unknown factors.

TABLE II.1.—COMPARISON OF OUTBREAKS AND OUTBREAK-RELATED ILLNESSES FROM GROUND WATER AND SURFACE WATER FOR THE PERIOD 1971–1996 [1]

Water source	Total outbreaks [2]	Cases of [2] illnesses	Outbreaks in CWSs	Outbreaks in NCWSs
Ground	371 (57%)	90,815 (16%).	113	258
Surface	223 (34%)	471,375 (82%).	148	43
Other	58 (9%)	10,639 (2%).	30	19

TABLE II.1.—COMPARISON OF OUTBREAKS AND OUTBREAK-RELATED ILLNESSES FROM GROUND WATER AND SURFACE WATER FOR THE PERIOD 1971–1996 [1]—Continued

Water source	Total outbreaks [2]	Cases of [2] illnesses	Outbreaks in CWSs	Outbreaks in NCWSs
All Systems [3]	652 (100%).	572,829 (100%).	291	320

[1] Craun and Calderon, 1994, CDC, 1998.
[2] Includes outbreaks in CWSs + NCWSs + Private wells.

Epidemiological investigations of outbreaks in populations served by filtered systems have shown that treatment deficiencies have resulted in the plants' failure to remove contamination from the water. Sometimes operational deficiencies have been discovered only during post-outbreak investigations. Rose (1997) identified the following types of environmental and operating conditions commonly present in filtered surface water systems at the time cryptosporidiosis outbreaks have occurred:

- Improperly-installed, -operated, -maintained, or -interpreted monitoring
- Equipment (*e.g.*, turbidimeters);
- Inoperable flocculators, chemical injectors, or filters;
- Inadequate personnel response to failures of primary monitoring equipment;
- Filter backwash recycle;
- High concentrations of oocysts in source water with no mitigative barrier;
- Flushing of oocysts (by heavy rain or snow melt) from land surfaces upstream of the plant intakes; and
- Altered or suboptimal filtration during periods of high turbidity, with turbidity spikes detected in finished water.

From 1984 to 1994, there have been 19 reported outbreaks of cryptosporidiosis in the U.S. (Craun *et al.,* 1998). As mentioned previously, C. parvum was not identified as a human pathogen until 1976. Furthermore, cryptosporidiosis outbreaks were not reported in the U.S. prior to 1984. Ten of these cryptosporidiosis outbreaks have been documented in CWSs, NCWSs, and a private water system (Moore *et al.*, 1993; Kramer *et al.,* 1996; Levy *et al.*, 1998; ; Craun *et al.*, 1998). The remaining nine outbreaks were associated with recreational activities (Craun *et al.*, 1998). The cryptosporidiosis outbreaks in U.S. drinking water systems are presented in Table II.2.

TABLE II.2.—CRYPTOSPORIDIOSIS OUTBREAKS IN U.S. DRINKING WATER SYSTEMS

Year	Location and CWS, NCWS, or private	Cases of illness (estimated)	Source water	Treatment	Suspected cause
1984	Braun Station, TX, CWS.	117 (2,000)	Well	Chlorination	Sewage-contaminated well.
1987	Carrollton, GA, CWS	(13,000)	River	Conventional filtration/chlorination; inadequate backwashing of some filters.	Treatment deficiencies.
1991	Berks County, PA, NCWS.	(551)	Well	Chlorination	Ground water under the influence of surface water.
1992	Medford (Jackson County), OR, CWS.	(3,000; combined total for Jackson County and Talent, below).	Spring/River	Chlorination/package filtration plant.	Source not identified.
1992	Talent, OR, CWS	see Medford, OR	Spring/River	Chlorination/package filtration plant.	Treatment deficiencies.
1993	Milwaukee, WI, CWS	(403,000)	Lake	Conventional filtration	High source water contamination and treatment deficiencies.
1993	Yakima, WA, private	7	Well	N/A	Ground water under the influence of surface water.
1993	Cook County, MN, NCWS.	27	Lake	Filtered, chlorinated	Possible sewage backflow from toilet/septic tank.
1994	Clark County, NV, CWS.	103; many confirmed for cryptosporidiosis were HIV positive.	River/Lake	Prechlorination, filtration and post-filtration chlorination.	Source not identified.
1994	Walla Walla, WA, CWS.	134	Well	None reported	Sewage contamination.

Craun, *et al.,* 1998.

Six of the ten cryptosporidiosis outbreaks reported in Table II.2 originated from surface water or possibly GWUDI supplied by public drinking water systems serving fewer than 10,000 persons. The first outbreak (117 known cases, 2,000 estimated cases of illness), in Braun Station, Texas in 1984, was caused by sewage leaking into a ground water well suspected to be under the influence of surface water. A second outbreak in Pennsylvania in 1991 (551 estimated cases of illness), occurred at a well also under the influence of surface water. The third and fourth (multi-episodic) outbreaks took place in Jackson County, Oregon in 1992 (3,000 estimated cases of illness) and were linked to treatment deficiencies in the Talent, OR surface water system. A fifth outbreak (27 cases of illness) in Minnesota, in 1993, occurred at a resort supplied by lake water. Finally, a sixth outbreak (134 cases of illness) in Washington in 1994, occurred due to sewage-contaminated wells at a CWS.

Three of the ten outbreaks (Carollton, GA (1987); Talent, OR (1992); Milwaukee, WI (1993)) were caused by water supplied by water treatment plants where the recycle of filter backwash was implicated as a possible cause of the outbreak. In total, the nine outbreaks which have taken place in PWSs have caused an estimated 419,939 cases of illness. These outbreaks illustrate that when treatment in place is not operating optimally or when source water is highly contaminated, *Cryptosporidium* may enter the finished drinking water and infect drinking water consumers, ultimately resulting in waterborne disease outbreaks.

D. Source Water Occurrence Studies

Cryptosporidium is common in the environment (Rose, 1988; LeChevallier et al., 1991b). Runoff from unprotected watersheds allows the transport of these microorganisms from sources of oocysts (*e.g.,* untreated wastewater, agricultural runoff) to water bodies used as intake sites for drinking water treatment plants. If treatment operates inefficiently, oocysts may enter the finished water at levels of public health concern. A particular public health challenge is that simply increasing existing disinfection levels above those most commonly practiced for standard disinfectants (i.e., chlorine or chloramines) in the U.S. today does not appear to be an effective strategy for controlling *Cryptosporidium*.

Cryptosporidium oocysts have been detected in wastewater, pristine surface water, surface water receiving agricultural runoff or contaminated by sewage, ground water under the direct influence of surface water (GWUDI), water for recreational use, and drinking water (Rose 1997, Soave 1995). Over 25 environmental surveys have reported *Cryptosporidium* source water occurrence data from surface water or GWUDI (presented in Tables II.3 and II.4), which typically involved the collection of a few water samples from a number of sampling locations having different characteristics (e.g., polluted vs. pristine; lakes or reservoirs vs. rivers). Results are presented as oocysts per 100 liters, unless otherwise marked.

Each of the studies cited in Tables II.3 and II.4 presents *Cryptosporidium* source water occurrence information, including (where possible): (1) The number of samples collected; (2) the number of samples positive; and (3) both the means and ranges for the concentrations of *Cryptosporidium* detected (where available). However, the immunofluorescence assay (IFA) method and other *Cryptosporidium* detection methods are inaccurate and lack adequate precision. Current methods do not indicate the species of *Cryptosporidium* identified or whether the oocysts detected are viable or infectious (Frey et al., 1997). The methods for detecting *Cryptosporidium* were modeled from *Giardia* methods, therefore recovery of *Cryptosporidium* is deficient primarily because *Cryptosporidium* oocysts are more difficult to capture due to their size (*Cryptosporidium* oocysts are 4–6μθ≧m; *Giardia* cysts are 8–12μθ≧m). In addition, it is a challenge to recover *Cryptosporidium* oocysts from the filters when they are concentrated, due to the adhesive character of the organisms. Other potential limitations to the protozoan detection methods include: (1) Filters used to concentrate the water samples are easily clogged by debris from the water sample; (2) interference occurs between debris or particulates that fluoresce due to cross reactivity of antibodies, which results in false positive identifications; (3) it is difficult to view the structure of oocysts on the membrane filter or slide, resulting in false negative determinations; and (4) most methods require an advanced level of skill to be performed accurately.

Despite these limitations, the occurrence information generated from these studies demonstrates that *Cryptosporidium* occurs in source waters. The source waters for which EPA has compiled information include rivers, reservoirs, lakes, streams, raw water intakes, springs, wells under the influence of surface water and infiltration galleries. The most comprehensive study in scope and national representation (LeChevallier and Norton, 1995) will be described in further detail following Tables II.3 and II.4.

TABLE II.3.—SUMMARY OF SURFACE WATER SURVEY AND MONITORING DATA FOR CRYPTOSPORIDIUM OOCYSTS

Sample source	Number of samples (n)	Samples positive for *Cryptosporidium* (percent)[a]	Range of oocyst conc. (oocysts/100L)	Mean (oocysts/100L)	Reference
Rivers	25	100	200–11,200	2510	Ongerth and Stibbs 1987.
River	6	100	200–580,000	192,000(a)	Madore et al. 1987.
Reservoirs/rivers (polluted)	6	100	19–300	99(a)	Rose 1988.
Reservoir (pristine)	6	83	1–13	2(a)	Rose 1988.
Impacted river	11	100	200–11,200[b]	2,500(g)	Rose et al. 1988a[b].
Lake	20	71	0–2200	58(g)	Rose et al. 1988b[b].
Stream	19	74	0–24,000	109(g)	Rose et al. 1988b[b]
Raw water	85	87	7–48,400	270(g) detectable.	LeChevallier et al. 1991c.
River (pristine)	59	32	NR	29(g)	Rose et al. 1991.
River (polluted)	38	74	<0.1–4,400[b]	66(g)	Rose et al. 1991.
Lake/reservoir (pristine)	34	53	NR	9.3(g)	Rose et al. 1991.
Lake/reservoir (polluted)	24	58	<0.1–380[b]	103(g)	Rose et al. 1991.

TABLE II.3.—SUMMARY OF SURFACE WATER SURVEY AND MONITORING DATA FOR CRYPTOSPORIDIUM OOCYSTS—Continued

Sample source	Number of samples (n)	Samples positive for *Cryptosporidium* (percent)[a]	Range of oocyst conc. (oocysts/100L)	Mean (oocysts/100L)	Reference
River (all samples)	36	97	15–45 (pristine) 1000–6,350 (agricultural).	20 (pristine) 1,830 (agricultural).	Hansen and Ongerth 1991.
Protected drinking water supply (subset of all).	6	81	15–42	24(g)	Hansen and Ongerth 1991.
Pristine river, forestry area (subset of all).	6	100	46–697	162(g)	Hansen and Ongerth 1991.
River below rural community in forested area (subset of all).	6	100	54–360	107(g)	Hansen and Ongerth 1991.
River below dairy farming agricultural activities (subset of all).	6	100	330–6,350	1,072(g)	Hansen and Ongerth 1991.
Reservoirs	56	45	NR	NR	Consonery et al. 1992.
Streams	33	48	NR	NR	Consonery et al. 1992.
Rivers	37	51	NR	NR	Consonery et al. 1992.
Site 1—River source (high turbidity)	10	100	82–7,190	480	LeChevallier and Norton 1992.
Site 2—River source (moderate turbidity).	10	70	42–510	250	LeChevallier and Norton 1992.
Site 3—Reservoir source (low turbidity).	10	70	77–870	250	LeChevallier and Norton 1992.
Lakes	179	6	0–2,240	3.3 (median)	Archer et al. 1995.
Streams	210	6	0–2,000	7 (median)	Archer et al. 1995.
Finished water	262	13	0.29–57	33 (detectable)	LeChevallier and Norton 1995.
River/lake	262	52	6.5–6,510	240 (detectable)	LeChevallier and Norton 1995.
River/lake	147	20	30–980	200	LeChevallier et al. 1995.
River 1	15	73	0–2,230	188 (a) all samples 43 (g) detected.	States et al. 1995.
River 2	15	80	0–1,470	147 (a) all samples 61 (g) detected.	States et al. 1995.
Dairy farm stream	13	77	0–1,110	126 (a) all samples 55 (g) detected.	States et al. 1995.
Reservoir inlets	60	5	0.7–24	1.9(g) 1.6 (median).	LeChevallier et al. 1997b.
Reservoir outlets	60	12	1.2–107	6.1(g) 60 (median).	LeChevallier et al. 1997b.
River (polluted)	72	40	20–280	24(g)	LeChevallier et al. 1997a.
Source water	NR	24	1–5,390[c]	740(a)[c] 71(g)[c]	Swertfeger et al. 1997.
First flush (storm event)	20	35	0–41,700	NR	Stewart et al. 1997.
Grab (non-storm event)	21	19	0–650	NR	Stewart et al. 1997.
River 1	24	63	0–1,470	58(g)	States et al. 1997.
Stream by dairy farm	22	82	0–2,300	42(g)	States et al. 1997.
River 2 (at plant intake)	24	63	0–2,200	31(g)	States et al. 1997.
Reservoirs (unfiltered system)	NR	37–52[d]	15–43 (maxima)[d].	0.8–1.4[d]	Okun et al. 1997.
Raw water intakes	148	25	0.04–18	0.3	Consonery et al. 1997.
Raw water intakes (rural)	NR	NR	40–400	NR	Swiger et al. 1999.
Raw Water	100 plants	77	0.5–117	3(g)	McTigue, et al. 1998.
DE River, Winter	18	NR	NR	70 per 500L(g)	Atherholt, et al. 1998.
DE River, Spring	18	NR	NR	100 per 500L(g)	Atherholt, et al. 1998.
DE River, Summer	18	NR	NR	30 per 500L(g)	Atherholt, et al. 1998.
DE River, Fall	18	NR	NR	20 per 500L(g)	Atherholt, et al. 1998.

[a] Rounded to nearest percent.
[b] As cited in Lisle and Rose 1995.
[c] Based on presumptive oocyst count
[d] Combined monitoring results for multiple sites in large urban water supply.
[e] As cited in States et al. 1997.
(a) = arithmetic average.
(g) = geometric average.
NR = not reported, NA = not applicable.

TABLE II.4.—SUMMARY OF U.S. GWUDI MONITORING DATA FOR CRYPTOSPORIDIUM OOCYSTS

Sample source	Number of samples (n)	Samples positive for *Cryptosporidium* oocysts (percent)	Range of positive values (oocysts/100L)	Mean (oocysts/100L) [a]	Reference
Well	17 (6 wells)	(1 sample)	.085L	NA	Archer et al. 1995.
Ground water sources (all categories)	199 sites[b]	11[b]	0.002–0.45d	NR	Hancock et al. 1998.
Vertical wells (subcategory of above ground water sources).	149 sites[b]	5[b]	NR	NR	Hancock et al. 1998.
Springs (subcategory of above ground water sources).	35 sites[b]	20[b]	NR	NR	Hancock et al. 1998.
Infiltration galleries (subcategory of above ground water sources).	4 sites[b]	50[b]	NR	NR	Hancock et al. 1998.
Horizontal wells (subcategory of above ground water sources).	11 sites[b]	45[b]	NR	NR	Hancock et al. 1998.
Ground water	17	41.2	NR	NR	Rosen et al., 1996.
Ground water	18	5.6	.13	.13	Rose et al. 1991.
Springs	7 (4 springs)	57[b]	0.25–10	4	Rose et al. 1991.
Wells	5 sites	100	0.26–3	0.9	SAIC, 1997 [c]
Vertical well Lemont Well #4 (Center Co., PA, Aug. 1992).	6	66.7	NR	NR	Lee, 1993.

[a] Geometric mean reported unless otherwise indicated.
[b] Data are presented as the percentage of positive sites.
[c] Data included are confirmed positive samples not reported in Hancock, 1998.
NA = not applicable.
NR = not reported.

The LeChevallier and Norton (1995) study collected the most samples and repeat samples from the largest number of surface water plants nationally. LeChevallier and Norton conducted the study to determine the level of *Cryptosporidium* in surface water supplies and plant effluent water. In total, surface water sources for 72 treatment plants in 15 States and 2 Canadian provinces were sampled. Sixty-seven surface water locations were examined. The generated data set covered a two-year monitoring period (March, 1991 to January, 1993) which was combined with a previous set of data (October, 1988 to June, 1990) collected from most of the same set of systems to create a database containing five samples (IFA) per site or more for 94 percent of the 67 systems sampled. *Cryptosporidium* oocysts were detected in 135 (51.5 percent) of the 262 raw water samples collected between March 1991 and January 1993, while 87 percent of the 85 samples were positive during the survey period from October, 1988 to June, 1990. The geometric mean of detectable *Cryptosporidium* was 240 oocysts/100L, with a range from 6.5 to 6510 oocysts/100L. When the 1991–1993 results (n=262) were combined with the previous results (n=85), *Cryptosporidium* was detected in 60.2 percent of the samples. The authors hypothesize the origin of the decrease in detections in the second round of sampling to be most probably linked to fluctuating or declining source water concentrations of *Cryptosporidium* oocysts from the first reporting period to the second.

LeChevallier and Norton (1995) also detected *Cryptosporidium* oocysts in 35 of 262 plant effluent samples (13.4 percent) analyzed between 1991 and 1993. When detected, the oocyst levels averaged 3.3 oocysts/100 L (range = 0.29 to 57 oocysts/100 L). A summary of occurrence data for all samples in filtered effluents for the years 1988 to 1993 showed that 32 of the water treatment plants (45 percent) were consistently negative for *Cryptosporidium*; 24 plants (34 percent) were positive once; and 15 plants (21 percent) were positive for *Cryptosporidium* two or more times between 1988 to 1993. Forty-four of the plants (62 percent) were positive for *Giardia*, *Cryptosporidium*, or both at one time or another (LeChevallier and Norton 1995).

The oocyst recoveries and densities reported by LeChevallier and Norton (1995) are comparable to the results of another survey of treated, untreated, protected (pristine) and feces-contaminated (polluted) water supplies (Rose et al. 1991). Six of thirty-six samples (17 percent) taken from potable drinking water were positive for *Cryptosporidium*, and concentrations in these waters ranged from .5 to 1.7 oocysts/100L. In addition, a total of 188 surface water samples were analyzed from rivers, lakes, or springs in 17 States. The majority of surface water samples were obtained from Arizona, California, and Utah (126 samples in all), with others from eastern States (28 samples), northwestern States (14 samples), southern States (13 samples), midwestern States (6 samples), and Hawaii (1 sample). Arithmetic average oocyst concentrations ranged from less than 1 to 4,400 oocysts/100 L, depending on the type of water analyzed. *Cryptosporidium* oocysts were found in 55 percent of the surface water samples at an average concentration of 43 oocysts/100 L.

The LeChevallier and Norton (1995) study collected the most samples and repeat samples from the most surface water plants on a national level. Therefore, the data from this study were analyzed by EPA (EPA, 1998n) to generate a distribution of source water occurrence, presented in Table II.5.

TABLE II.5.—BASELINE EXPECTED NATIONAL SOURCE WATER CRYPTOSPORIDIUM DISTRIBUTIONS

Percentile	Source water concentration (oocysts/100L)
25	103
50	231
75	516
90	1064
95	1641
Mean	470
Standard Deviation	841

Although limited by the small number of samples per site (one to sixteen samples; most sites were sampled five times), the mean concentration at the 69 sites from the eastern and central U.S. seems to be represented by a lognormal distribution.

In addition to the source water data, several studies have detected *Cryptosporidium* oocysts in finished water. The results of these studies have been compiled in Table II.6.

TABLE II.6.—SUMMARY OF U.S. FINISHED WATER MONITORING DATA FOR CRYPTOSPORIDIUM OOCYSTS

Sample source	Number of samples (n)	Samples positive for *Cryptosporidium* (percent)	Range of oocyst conc. (oocysts/ 100L)	Mean (oocysts/ 100L)	Reference
Filtered water	82	27	0.1–48	1.5	LeChevallier et al. 1991a.
Finished water (unfiltered)	6	33	0.1–1.7	0.2	LeChevallier et al. 1992.
Finished water	262	13	0.29–57	33 (detectable).	LeChevallier and Norton 1995.
Finished water (clearwell)	14	14	NR	NR	Consonery et al. 1992.
Finished water (filter effluents)	118	26	NR	NR	Consonery et al. 1992.
Site 1—Filter effluent	10	70	1–4	NR	LeChevallier and Norton 1992.
Site 2—Filter effluent	10	10	0.5	NA	LeChevallier and Norton 1992.
Site 3—Filter effluent	10	10	2	NA	LeChevallier and Norton 1992.
Finished water	1,237	7	NR	NR	Rosen et al. 1996.
Filtered (non-storm event)	87	10	0–420	NR	Stewart et al. 1997a.
Finished water	24	**8 ***13	0–0.6	0.5 (g)	States et al. 1997.
Finished water	155	2.5	0.02–0.8	0.2	Consonery et al. 1997.
Finished water	100	15	0.04–0.08	0.08 (g)	McTigue, et al. 1998.

*Plants
**Confirmed
***Presumed

These studies show that despite some treatment in place, *Cryptosporidium* may still pass through the treatment plant and into finished water.

In general, oocysts are detected more frequently and in higher concentrations in rivers and streams than in lakes and reservoirs (LeChevallier *et al.*, 1991b; Rose *et al.*, 1988a,b). Madore *et al.* (1987) found high concentrations of oocysts in a river affected by agricultural runoff (5800 oocysts/L). Such concentrations are especially significant if the contaminant removal process (*e.g.*, sedimentation, filtration) of the treatment plant is not operating effectively. Oocysts may pass through to the finished water, as LeChevallier and Norton (1995) and several other researchers also found, and infect drinking water consumers.

E. Filter Backwash and Other Process Streams: Occurrence and Impact Studies

Pathogenic microorganisms are removed during the sedimentation and/or filtration processes in a water treatment plant. Recycle streams generated during treatment, such as spent filter backwash water, sedimentation basin sludge, or thickener supernatant are often returned to the treatment train. These recycle streams, therefore, may contain high concentrations of pathogens, including chlorine-resistant *Cryptosporidium* oocysts. Recycle can degrade the treatment process, especially when entering the treatment train after the rapid mix stage, by causing a chemical imbalance, hydraulic surge and potentially overwhelming the plant's filtration capacity with a large concentration of pathogens. High oocyst concentrations found in recycle waters can increase the risk of pathogens passing through the treatment plant into finished water.

AWWA has compiled issue papers on each of the following recycle streams: Spent filter backwash water, sedimentation basin solids, combined thickener supernatant, ion-exchange regenerate, membrane concentrate, lagoon decant, mechanical dewatering device concentrate, monofill leachate, sludge drying bed leachate, and small-volume streams (*e.g.*, floor, roof, lab drains) (Environmental Engineering & Technology, 1999). In addition, EPA compiled existing occurrence data on *Cryptosporidium* in recycle streams. Through these efforts, *Cryptosporidium* occurrence data has been found for three types of recycle streams: Spent filter backwash water, sedimentation basin solids, and thickener supernatant.

Nine studies have reported the occurrence of *Cryptosporidium* for these process streams. Each study's scope and results are presented in Table II.7, and brief narratives on each major study follow the table. Note that the results of the studies, if not presented in the published report as oocysts/100L, have been converted into oocysts/100L.

TABLE II.7.—CRYPTOSPORIDIUM OCCURRENCE IN FILTER BACKWASH AND OTHER RECYCLE STREAMS

Name/location of study	Number of samples (n)	Type of sample	Cyst/oocyst concentration	Number of treatment plants sampled	Reference
Drinking water treatment facilities.	2	backflush waters from rapid sand filters.	sample 1: 26,000 oocysts/gal (calc. as 686,900 oocysts/ 100L). sample 2: 92,000 oocysts/gal (calc as 2,430,600 oocysts/ 100L)	2	Rose et al. 1986.

TABLE II.7.—CRYPTOSPORIDIUM OCCURRENCE IN FILTER BACKWASH AND OTHER RECYCLE STREAMS—Continued

Name/location of study	Number of samples (n)	Type of sample	Cyst/oocyst concentration	Number of treatment plants sampled	Reference
Thames, U.K.,	not reported	backwash water from rapid sand filter.	Over 1,000,000 oocysts/100L in backwash water on 2/19/89. 100,000 oocysts/100L in supernatant from settlement tanks during the next few days	1	Colbourne 1989.
Potable water supplies in 17 States.	not reported	filter backwash from rapid sand filters (10 to 40 L sample vol.).	217 oocysts/ 100 L (geometric mean).	not reported	Rose et al. 1991.
Name/location not reported.	not reported	raw water initial backwash water	7 to 108 oocysts/100L detected at levels 57 to 61 times higher than in the raw water.	not reported not reported	LeChevallier et al. 1991c.
Bangor Water Treatment Plant (PA).	*Round 1:* 1 (8-hour composite).	raw water filter backwash supernatant recycle 6 oocysts/100L.	902 oocysts/100L.	141 oocysts/ 100L. 1	Cornwell and Lee 1993.
Round 2: 1 (8-hour composite).	raw water filter backwash supernatant recycle	140 oocysts/100L	850 oocysts/100L.	750 oocysts/ 100L. 1	Cornwell and Lee 1993.
Moshannon Valley Water Treatment Plant.	Round 1: 1 (8-hour composite).	raw water spent backwash supernatant recycle sludge 13 oocysts/ 100L.	16,613 oocysts/100L.	82 oocysts/ 100L.	2,642 oocysts/100L. 1 Cornwell and Lee 1993.
	Round 2: 1 (8-hour composite).	raw water supernatant recycle	20 oocysts/100L	420 oocysts/ 100L. 1	Cornwell and Lee 1993.
Plant ''C''	11 samples using continuous flow centrifugation;.	39 samples using cartridge filters.	backwash water from rapid sand filters; samples collected from sedimentation basins during sedimentation phase of backwash water at depths of 1, 2, 3, and 3.3 m.	continuous flow: range 1 to 69 oocysts/100 L; 8 of 11 samples positive.	cartridge filters: ranges 0.8 to 252/100 L; 33 of 39 samples positive 1 Karanis et al. 1996.
Pittsburgh Drinking Water Treatment Plant.	24 (two years of monthly samples).	filter backwash	328 oocysts/ 100 L (geometric mean); (38 percent occurrence rate).	non-detect-13,158 oocysts/ 100L. 1	States et al. 1997.
''Plant Number 3''	not reported	raw water spent backwash	140 oocysts/100L	850 oocysts/ 100L.	not reported Cornwell 1997.
''Plant C'' (see Karanis, et al., 1996).	12 50	raw water backwash water from rapid sand filters.	avg. 23.2 oocysts/100L (max. 109 oocysts/100L) in 8 of 12 samples.	avg. 22.1 oocysts/100L (max. 257 oocysts/ 100L) in 41 of 50 samples	1 Karanis et al 1998.
''Plant A''	1	rapid sand filter (sample taken 10 min. after start of backwashing).	150 oocysts/100L.		

The occurrence data available and reported are primarily for raw and recycle stream water. If filter backwash enters the treatment train as a slug load and disrupts the treatment process, it is possible its effects would not be readily seen in the finished water until several minutes or hours after returning the filter to service. In addition, the poor recovery efficiencies of the IFA *Cryptosporidium* detection method complicate measurements in dilute finished effluent waters.

As shown in Table II.7, the concentrations of oocysts in backwash water and other recycle streams are greater than the concentrations generally found in raw water. For example, four studies (Cornwell and Lee, 1993; States *et al.,* 1997; Rose *et al.,* 1986; and Colbourne, 1989) have reported *Cryptosporidium* oocyst concentrations in filter backwash water exceeding 10,000 oocysts/100L. Such concentrations illustrate that the treatment plant has been removing oocysts from the influent water during the sedimentation and/or filtration processes. As expected, the oocysts have concentrated on the filters and/or in the sedimentation basin sludge. Therefore, the recycling of such process streams (*e.g.,* filter backwash, thickener supernatant, sedimentation basin sludge) re-introduces high concentrations of oocysts to the drinking water treatment train.

Recycle can potentially return a significant number of oocysts to the treatment plant in a short amount of time, particularly if the recycle is returned to the treatment process without prior treatment, equalization, or some other type of hydraulic detention. In addition, Di Giovanni, *et al.* (1999) presented data indicating that viable oocysts have been detected in filter backwash samples using a cell culture/polymerase chain reaction (PCR) method. Cell culture is a test of the viability/infectivity of the oocysts, while PCR identified the cells infected by *C. parvum*. Although recovery by IFA was poor (6 to 8 percent for backwash samples), 9 filter backwash recycle samples were found to contain viable and infectious oocysts, and the infectious agent was determined to be more than 98 percent similar in structure to *C. parvum*. Should filter backwash recycle disrupt normal treatment operations or should treatment not function efficiently due to other deficiencies, high concentrations of potentially viable, infectious oocysts may pass through the plant into finished drinking water. The recycle stream occurrence studies presented in Table II.7 are described in further detail in the following sections.

Thames, U.K. Water Utilities Experience with Cryptosporidium, Colbourne (1989)

In response to a cryptosporidiosis outbreak reported in February of 1989, Thames Water undertook an investigation of pathogen concentrations within the Farmoor conventional treatment plant's treatment train, finished and raw waters. The investigation occurred over a two month period, from February to April 1989 and included sampling of settled filter backwash, the supernatant from spent filter backwash, raw water, and water sampled at the end of various Thames distribution points.

On February 19, 1989 at the start of the outbreak investigation, a concentration of approximately 1,000,000 oocysts/100L was detected in the filter backwash water. During the first few days of the following investigation, the supernatant of the settled backwash water contained approximately 100,000 oocysts/100L. At the peak of the outbreak, thirty percent of Thames' distribution system samples were positive for oocysts, and ranged in concentration from 0.2 to 7700 oocysts/100L. Raw reservoir water contained oocyst concentrations ranging from .2 to 1400 oocysts/100L. After washing the filters twice in 24 hours, no oocysts were found in the settled backwash waters. Thames, U.K. Water Utilities determined that a storm causing intense precipitation and runoff resulted in elevated levels of oocysts in the source water which led to the high concentrations of oocysts entering the plant and subsequently deposited on the filters and recycled as filter backwash.

Survey of Potable Water Supplies for Cryptosporidium and Giardia, Rose, et al., 1991

In this survey, Rose, *et al.,* collected 257 samples from 17 States from 1985 to 1988. The samples were collected on cartridge filters and analyzed using variations of the IFA method. The reported percent recovery for the method was 29 to 58 percent. Filter backwash samples were a subset of the 257, 10 to 40 L samples were collected from rapid sand filters.

Rose, *et al.* reported the geometric mean of the backwash samples at 217 *Cryptosporidium* oocysts/100L. This was the highest reported average *Cryptosporidium* concentration of any of the water types tested, which included polluted and pristine surface and ground water sources, drinking water sources in addition to filter backwash recycle water.

Giardia and Cryptosporidium in Water Supplies, LeChevallier, et al. (1991c)

LeChevallier *et al.* conducted a study to determine ''whether compliance with the SWTR would ensure control of *Giardia* in potable water supplies.'' Raw water and plant effluent samples were collected from 66 surface water treatment plants in 14 States and one Canadian province, although only selected sites were tested for *Cryptosporidium* oocysts in filter backwash and settled backwash water.

In the analysis of pathogen concentrations in the raw water and filter backwash water of the water treatment process, LeChevallier *et al.* (1991c) found very high oocyst levels in backwash water of utilities that had low raw water parasite concentrations. The pathogens were detected using a combined IFA method that the authors developed. *Cryptosporidium* levels in the initial backwash water were 57 to 61 times higher than in the raw water supplies. Raw water samples were found to contain from 7 to 108 oocysts/100L. LeChevallier *et al.* (1991c) also noted that when *Cryptosporidium* were detected in plant effluent samples (12 of 13 times), the organisms were also observed in the backwash samples. The study concluded that the consistency of these results shows that accumulation of parasites in the treatment filters (and subsequent release in the filter backwash recycle water) could be related to subsequent passage through treatment barriers.

Recycle Stream Effects on Water Treatment, Cornwell and Lee (1993, 1994)

The results described in Cornwell and Lee's 1993 American Water Works Association Research Foundation Report and 1994 Journal of the American Water Works Association article on the Bangor and Moshannon Valley, PA water treatment plants are consistent with the results of States *et al.* (1997). In total, Cornwell and Lee investigated eight water treatment plants, examining treatment efficiencies including several recycle streams and their impacts, and reporting a range of pathogen and other water quality data. All of the pathogen testing was conducted using the EPA IFA method refined by LeChevallier, *et al.* (1991c).

Cornwell and Lee (1993) conducted two rounds of sampling at both the Bangor and Moshannon plants, sampling the different recycle and treatment streams as eight-hour composites. They detected *Cryptosporidium* concentrations of over 16,500 *Cryptosporidium* oocysts/100L in the backwash water at an adsorption clarifier plant (Moshannon Valley) and over 850 *Cryptosporidium* oocysts/100L in backwash water from a direct filtration plant (Bangor). The parasite levels in the backwash samples were significantly higher than concentrations found in the raw source water, which contained *Cryptosporidium* oocyst concentrations of 13–20 oocysts/100L at the Moshannon Valley plant and 6–140 oocysts/100L at the Bangor plant.

In addition, Cornwell and Lee determined oocyst concentrations for two other recycle streams, combined thickener supernatant and sedimentation basin solids. The supernatant pathogen concentrations were reported at 141 *Cryptosporidium* oocysts/100L at the Bangor plant, and levels were reported at 82 to 420 oocysts/100L for the Moshannon plant in Rounds 1 and 2 of sampling, respectively. The sedimentation basin sludge was reported at 2,642 *Cryptosporidium* oocysts/100L in the clarifier sludge from the Moshannon Valley plant.

Giardia and Cryptosporidium in Backwash Water from Rapid Sand Filters Used for Drinking Water, Karanis et al. (1996) and Distribution and Removal of Giardia and Cryptosporidium in Water Supplies in Germany Karanis, et al. (1998)

Karanis *et al.* (1996 and 1998) conducted a four-year research study (samples collected from July, 1993–December, 1995) on the efficiency of *Cryptosporidium* removal by six different surface water treatment plants from Germany, all of which treat by conventional filtration. The method used was an IFA method dubbed the ''EPA method'', developed by Jakubowski and Ericksen, 1979.

Karanis et al. (1996) detected *Cryptosporidium* in 82 percent of the samples of backwash water from rapid sand filters of a water treatment plant (''Plant C'') supplied by small rivers. Eight out of 12 raw water samples tested were positive for *Cryptosporidium* (range of 0.8 to 109 oocysts/100L). Backwash water samples collected by continuous flow centrifugation were positive for *Cryptosporidium* in 8 of 11 samples (range of 1 to 69/100L). Of 39 samples collected using cartridge filters, 33 were positive for *Cryptosporidium* (range of 0.8 to 252/100L). The authors called attention to the high detection rate of *Cryptosporidium* in the backwash waters (82 percent) of Plant C and to the fact that the supernatant following sedimentation was not free from cysts and oocysts (Karanis et al. 1996).

In the 1998 publication, Karanis et al. compiled the data from the 1996 study with more backwash occurrence data collected from another treatment plant (''Plant A''). The filter backwash of Plant A was sampled 10 minutes after the start of backwashing, and the backwash water was found to contain 150 *Cryptosporidium* oocysts/100L.

Protozoa in River Water: Sources, Occurrence, and Treatment, States, et al. (1997)

Over a two year period (July, 1994-June, 1996), States et al. sampled monthly for *Cryptosporidium* in the raw, settled, filtered and filter backwash water at the Pittsburgh Drinking Water Treatment Plant, in order to gauge the efficiency of pathogen removal at the plant. States et al. identified several sources contributing oocysts to the influent water, including sewage plant effluent, combined sewer overflows, dairy farm streams, and recycling of backwash water. All pathogen sampling was conducted with the IFA method.

Cryptosporidium occurred in the raw Allegheny river water supplying the plant with a geometric mean of 31 oocysts/100L in 63 percent of samples collected, and ranged from non-detect to 2,333 oocysts/100L (see Table II.3 for source water information). Of the filter backwash samples, a geometric mean of 328 oocysts/100L was found at an occurrence rate of 38 percent of samples, with a range from non-detect to 13,158 oocysts/100L. The fact that the mean concentration of *Cryptosporidium* oocysts in backwash water can be substantially higher than the oocyst concentration in untreated river water suggests that recycling untreated filter backwash water can be a significant source of this parasite to water within the treatment process.

F. Summary and Conclusions

Cryptosporidiosis is a disease without a therapeutic cure, and its causative agent, *Cryptosporidium*, is resistant to chlorine disinfection. *Cryptosporidium* has been known to cause severe illness, especially in immunocompromised individuals, and can be fatal. Several waterborne cryptosporidiosis outbreaks have been reported, and it is likely that others have occurred but have gone unreported. *Cryptosporidium* has been detected in a wide range of source waters, documented in over 30 studies from the literature, and it has been found at levels of concern in filter backwash water and other recycle streams.

One of the key regulations EPA has developed and implemented to counter pathogens in drinking water is the SWTR (54 FR 27486, June 19, 1989). The SWTR requires that surface water systems have sufficient treatment to reduce the source water concentration of *Giardia* and viruses by at least 99.9 percent (3 log) and 99.99 percent (4 log), respectively. A shortcoming of the SWTR, however, is that the rule does not specifically control for *Cryptosporidium*. The first report of a recognized waterborne outbreak caused by *Cryptosporidium* was published during the development of the SWTR (D'Antonio et al. 1985).

In 1998, the Agency finalized the IESWTR that enhances the microbial pathogen protection provided by the SWTR for systems serving 10,000 or more persons. The IESWTR includes an MCLG of zero for *Cryptosporidium* and requires a minimum 2-log (99 percent) removal of *Cryptosporidium*, linked to enhanced combined filter effluent and individual filter turbidity control provisions.

Several provisions of today's proposed rule, the LT1FBR, are designed to address the concerns covered by the IESWTR, improving control of *Cryptosporidium* and other microbial contaminants, for the portion of the public served by small PWSs (i.e., serving less than 10,000 persons). The LT1FBR also addresses the concern that for all PWSs that practice recycling, *Cryptosporidium* (and other emerging pathogens resistant to standard disinfection practice) are reintroduced to the treatment process of PWSs by the recycle of spent filter backwash water, solids treatment residuals, and other process streams.

Insufficient treatment practices have been cited as the cause of several reported waterborne disease outbreaks (Rose, 1997). Rose (1997) also found that a reduction in turbidity is indicative of a more efficient filtration process. Therefore, the turbidity and filter monitoring requirements of today's proposed LT1FBR will ensure that the removal process necessary to protect the public from cryptosporidiosis is operating properly, and the recycle stream provisions will ensure that the treatment process is not disrupted or operating inefficiently. The LT1FBR requirements that address the potential for *Cryptosporidium* to enter the finished drinking water supply will be described in more detail in the following sections.

III. Baseline Information-Systems Potentially Affected By Today's Proposed Rule

EPA utilized the 1997 state-verified version of the Safe Drinking Water Information System (SDWIS) to develop the total universe of systems which utilize surface water or groundwater under the direct influence (GWUDI) as sources. This universe consists of 11,593 systems serving fewer than 10,000 persons, and 2,096 systems serving 10,000 or more persons. Given this initial baseline, the Agency developed estimates of the number of systems which would be affected by components of today's proposed rule by utilizing three primary sources: Safe Drinking Water Information Systems; Community Water Supply Survey; and Water: Stats. A brief overview of each of the data sources is described in the following paragraphs.

Safe Drinking Water Information System (SDWIS)

SDWIS contains information about PWSs including violations of EPA's regulations for safe drinking water. Pertinent information in this database includes system name and ID, population served, geographic location, type of source water, and type of treatment (if provided).

Community Water System Survey (CWSS)

EPA conducted the 1995 CWSS to obtain data to support its development and evaluation of drinking water regulations. The survey consisted of a stratified random sample of 3,700 water systems nationwide (surface water and groundwater). The survey asked 24 operational and 13 financial questions.

Water:/Stats (WaterStats)

WaterStats is an in-depth database of water utility information compiled by the American Water Works Association. The database consists of 898 utilities of all sizes and provides a variety of data including treatment information.

Information regarding estimates of the number of systems which may potentially be affected by specific components of today's proposed rule can be found in the discussion of each proposed rule component in Section IV.

IV. Discussion of Proposed LT1FBR Requirements

A. Enhanced Filtration Requirements

As discussed earlier in this preamble, one of the key objectives of today's proposed rule is ensuring that an adequate level of public health protection is maintained in order to minimize the risk associated with *Cryptosporidium*. While the current SWTR provides protection from viruses and *Giardia*, it does not specifically address *Cryptosporidium*, which has been linked to outbreaks resulting in over 420,000 cases of gastrointestinal illness in the 1990s (403,000 associated with the Milwaukee outbreak). Because of *Cryptosporidium*'s resistance to disinfection practices currently in place at small systems throughout the country, the Agency believes enhanced filtration requirements are necessary to improve control of this microbial pathogen.

In the IESWTR, the Agency utilized an approach consisting of three major components to address *Cryptosporidium* at plants serving populations of 10,000 or more. The first component required systems to achieve a 2 log removal of *Cryptosporidium*. The second component consisted of strengthened turbidity requirements for combined filter effluent. The third component required individual filter turbidity monitoring.

In today's proposed rule addressing systems serving fewer than 10,000 persons, the Agency is utilizing the same framework. Where appropriate, EPA has evaluated additional options in an effort to alleviate burden on small systems while still maintaining a comparable level of public health protection.

The following sections describe the overview and purpose of each of the rule components, relevant data utilized during development, the requirements of today's proposed rule (including consideration of additional options where appropriate), and a request for comment regarding each component.

1. Two Log *Cryptosporidium* Removal Requirement

a. Two Log Removal

i. Overview and Purpose

The 1998 IESWTR (63 FR 69477, December 16, 1998) establishes an MCLG of zero for *Cryptosporidium* in order to adequately protect public health. In conjunction with the MCLG, the IESWTR also established a treatment technique requiring 2 log *Cryptosporidium* removal for all surface water and GWUDI systems which filter and serve populations of 10,000 or more people, because it was not economically and technologically feasible to accurately ascertain the level of *Cryptosporidium* using current analytical methods. The Agency believes it is appropriate and necessary to extend this treatment technique of 2 log *Cryptosporidium* removal requirement to systems serving fewer than 10,000 people.

ii. Data

As detailed later in this section, EPA believes that the data and principles supporting requirements established for systems serving populations of 10,000 or more are also applicable to systems serving populations fewer than 10,000. The following section provides information and data regarding: (1) the estimated number of small systems subject to the proposed 2 log *Cryptosporidium* removal requirement; and (2) *Cryptosporidium* removal using various filtration technologies.

Estimate of the Number of Systems Subject to 2 log Cryptosporidium Removal Requirement

Using the baseline described in Section III of today's proposed rule, the Agency applied percentages of surface water and GWUDI systems which filter (taken from the 1995 CWSS) in order to develop an estimate of the number of systems which filter and serve fewer than 10,000 persons. This resulted in an estimated 9,133 surface water and GWUDI systems that filter which may be subject to the proposed removal requirement. Table IV.1 provides this estimate broken down by system size and type.

TABLE IV.1.—ESTIMATE OF SYSTEMS SUBJECT TO 2 LOG CRYPTOSPORIDIUM REMOVAL REQUIREMENT [a]

System type	Population served					
	<100	101–500	501–1K [b]	1K–3.3K [b]	3.3K–10K [b]	Total #Sys.
Community	888	1453	950	2022	1591	6903
Non Community	1099	374	78	64	35	1649
NTNC	214	204	82	64	17	581
Total	2201	2031	1110	2150	1643	[b] 9134b

[a] Numbers may not add due to rounding

[b] K = thousands

Cryptosporidium Removal Using Conventional and Direct Filtration

During development of the LT1FBR, the Agency reviewed the results of several studies that demonstrated the ability of conventional and direct filtration systems to achieve 2 log removal of *Cryptosporidium* at well operated plants achieving low turbidity levels. Table IV.2 provides key information from these studies. A brief description of each study follows the table.

TABLE IV.2.—CONVENTIONAL AND DIRECT FILTRATION REMOVAL STUDIES

Type of treatment	Log removal	Experimental design	Researcher
Conventional	*Cryptosporidium* 4.2–5.2	Pilot plants	Patania *et al.* 1995
	Giardia 4.1–5.1	Pilot plants	Patania *et al.* 1995
	Cryptosporidium 1.9–4.0	Pilot-scale plants	Nieminski/Ongerth 1995
	Giardia 2.2–3.9	Pilot-scale plants	Nieminski/Ongerth 1995
	Cryptosporidium 1.9–2.8	Full-scale plants	Nieminski/Ongerth 1995
	Giardia 2.8–3.7	Full-scale plants	Nieminski/Ongerth 1995
	Cryptosporidium 2.3–2.5	Full-scale plants	LeChevallier and Norton 1992
	Giardia 2.2–2.8	Full-scale plants	
	Cryptosporidium 2–3	Pilot plants	LeChevallier and Norton 1992
	Giardia and Crypto 1.5–2	Full-scale plant (operation considered not optimized).	Foundation for Water Research, Britain 1994
	Cryptosporidium 4.1–5.2	Pilot Plant (optimal treatment)	Kelley *et al.* 1995
	Cryptosporidium .2–1.7	Pilot Plant (suboptimal treatment)	Dugan *et al.* 1999
			Dugan *et al.* 1999
Direct filtration	*Cryptosporidium* 2.7–3.1	Pilot plants	Ongerth/Pecaroro 1995
	Giardia 3.1–3.5	Pilot plants	Ongerth/Pecaroro 1995
	Cryptosporidium 2.7–5.9	Pilot plants	Patania *et al.* 1995
	Giardia 3.4–5.0	Pilot plants	Patania *et al.* 1995
	Cryptosporidium 1.3–3.8	Pilot plants	Nieminski/Ongerth 1995
	Giardia 2.9–4.0	Pilot plants	Nieminski/Ongerth 1995
	Cryptosporidium 2–3	Pilot plants	West *et al.* 1994
Rapid Granular Filtration (alone).	*Cryptosporidium* 2.3–4.9	Pilot plant	Swertfeger *et al.*, 1998
	Giardia 2.7–5.4		

Patania, Nancy L, et al. 1995

This study consisted of four pilot studies which evaluated treatment variables for their impact on *Cryptosporidium* and *Giardia* removal efficiencies. Raw water turbidities in the study ranged between 0.2 and 13 NTU. When treatment conditions were optimized for turbidity and particle removal at four different sites, *Cryptosporidium* removal ranged from 2.7 to 5.9 log and *Giardia* removal ranged from 3.4 to 5.1 log during stable filter operation. The median turbidity removal was 1.4 log, whereas the median particle removal was 2 log. Median oocyst and cyst removal was 4.2 log. A filter effluent turbidity of 0.1 NTU or less resulted in the most effective cyst removal, up to 1 log greater than when filter effluent turbidities were greater than 0.1 NTU (within the 0.1 to 0.3 NTU range). *Cryptosporidium* removal rates of less than 2.0 log occurred at the end of the filtration cycle.

Nieminski, Eva C. and Ongerth, Jerry E. 1995

This 2-year study evaluated *Giardia* and *Cryptosporidium* cyst removal through direct and conventional filtration. The source water of the full scale plant had turbidities typically between 2.5 and 11 NTU with a maximum of 28 NTU. The source water of the pilot plant typically had turbidities of 4 NTU with a maximum of 23 NTU. For the pilot plant achieving filtered water turbidities between 0.1–0.2 NTU, *Cryptosporidium* removals averaged 3.0 log for conventional treatment and 3.0 log for direct filtration, while the respective *Giardia* removals averaged 3.4 log and 3.3 log. For the full scale plant achieving similar filtered water turbidities, *Cryptosporidium* removal averaged 2.25 log for conventional treatment and 2.8 log for direct filtration, while the respective *Giardia* removals averaged 3.3 log for conventional treatment and 3.9 log for direct filtration. Differences in performance between direct filtration and conventional treatment by the full scale plant were attributed to differences in source water quality during the filter runs.

Ongerth, Jerry E. and Pecaroro, J.P. 1995

A 1 gallon per minute (gpm) pilot scale water filtration plant was used to measure removal efficiencies of *Cryptosporidium* and *Giardia* using very low turbidity source waters (0.35 to 0.58 NTU). With optimal coagulation, 3 log removal for both pathogens were obtained. In one test run, where coagulation was intentionally sub-optimal, the removals were only 1.5 log for *Cryptosporidium* and 1.3 log for *Giardia*. This demonstrates the importance of proper coagulation for cyst removal even though the effluent turbidity was less than 0.5 NTU.

LeChevallier, Mark W. and Norton, William D. 1992

The purpose of this study was to evaluate the relationships among *Giardia*, *Cryptosporidium*, turbidity, and particle counts in raw water and filtered water effluent samples at three different systems. Source water turbidities ranged from less than 1 to 120 NTU. Removals of *Giardia* and *Cryptosporidium* (2.2 to 2.8 log) were slightly less than those reported by other researchers, possibly because full scale plants were studied under less ideal conditions than the pilot plants. The participating treatment plants operated within varying stages of treatment optimization. The median removal achieved was 2.5 log for *Cryptosporidium* and *Giardia.*

LeChevallier, Mark W.; Norton, William D.; and Lee, Raymond G. 1991b

This study evaluated removal efficiencies for *Giardia* and *Cryptosporidium* in 66 surface water treatment plants in 14 States and 1 Canadian province. Most of the utilities achieved between 2 and 2.5 log removals for both *Giardia* and *Cryptosporidium*. When no oocysts were detected in the finished water, occurrence levels were assumed at the detection limit for calculating removal efficiencies.

Foundation for Water Research 1994

This study evaluated *Cryptosporidium* removal efficiencies for several treatment processes (including conventional filtration) using a pilot plant and bench-scale testing. Raw water turbidity ranged from 1 to 30 NTU. *Cryptosporidium* oocyst removal was between 2 and 3 log using conventional filtration. Investigators concluded that any measure which reduced filter effluent turbidity should reduce risk from *Cryptosporidium*, and also showed the importance of selecting proper coagulants, dosages, and treatment pH. In addition to turbidity, increased color and dissolved metal ion coagulant concentration in the effluent are indicators of reduced efficiency of coagulation/flocculation and possible reduced oocysts removal efficiency.

Kelley, M.B. et al. 1995

This study evaluated two U.S. Army installation drinking water treatment systems for the removal of *Giardia* and *Cryptosporidium*. Protozoa removal was between 1.5 and 2 log. The authors speculated that this low *Cryptosporidium* removal efficiency occurred because the coagulation process was not optimized, although the finished water turbidity was less than 0.5 NTU.

West, Thomas; et al. 1994

This study evaluated the removal efficiency of *Cryptosporidium* through direct filtration using anthracite mono-media at filtration rates of 6 and 14 gpm/sq.ft. Raw water turbidity ranged from 0.3 to 0.7 NTU. Removal efficiencies for *Cryptosporidium* at both filtration rates were 2 log during filter ripening (despite turbidity exceeding 0.2 NTU), and 2 to 3 log for the stable filter run. Log removal declined significantly during particle breakthrough. When effluent turbidity was less than 0.1 NTU, removal typically exceeded 2 log. Log removals of *Cryptosporidium* generally exceeded that for particle removal.

Swertfeger et al., 1998

The Cincinnati Water Works conducted a 13 month pilot study to determine the optimum filtration media and depth of the media to replace media at its surface water treatment plant. The study investigated cyst and oocyst removal through filtration alone (excluding chemical addition, mixing, or sedimentation) and examined sand media, dual media, and deep dual media. Cyst and oocyst removal by each of the media designs was > 2.5 log by filtration alone.

Dugan et al., 1999

EPA conducted pilot scale experiments to assess the ability of conventional treatment to control *Cryptosporidium* oocysts under steady state conditions. The work was performed with a pilot plant designed to minimize flow rates and the number of oocysts required for spiking. With proper coagulation control, the conventional treatment process achieved at least 2 log removal of *Cryptosporidium*. In all cases where 2 log removal was not achieved, the plant also did not comply with the IESWTR filter effluent turbidity requirements.

All of the studies described above indicate that rapid granular filtration, when operated under appropriate coagulation conditions and optimized to achieve a filtered water turbidity level of less than 0.3 NTU, should achieve at least 2 log of *Cryptosporidium* removal. Removal rates vary widely, up to almost 6 log, depending upon water matrix conditions, filtered water turbidity effluent levels, and where and when removal efficiencies are measured within the filtration cycle. The highest log pathogen removal rates occurred in those pilot plants and systems which achieved very low finished water turbidities (less than 0.1 NTU). Other key points related to the studies include:

• As turbidity performance improves for treatment of a particular water, there tends to be greater removal of *Cryptosporidium*.

• Pilot plant study data in particular indicate high likelihood of achieving at least 2 log removal when plant operation is optimized to achieve low turbidity levels. Moreover, pilot studies represented in Table IV.2.a tend to be for low-turbidity waters, which are considered to be the most difficult to treat regarding particulate removal and associated protozoan removal.

• Because high removal rates were demonstrated in pilot studies using lower-turbidity source waters, it is likely that similar or higher removal rates can be achieved for higher-turbidity source waters.

• Determining *Cryptosporidium* removal in full-scale plants can be difficult due to the fact that data includes many non-detects in the finished water. In these cases, finished water concentration levels are assigned at the detection limit and are likely to result in over-estimation of oocysts in the finished water. This tends to under-estimate removal levels.

• Another factor that contributes to differences among the data is that some of the full-scale plant data comes from plants that are not optimized, but meet existing SWTR requirements. In such cases, oocyst removal may be less than 2 log. In those studies that indicate that full-scale plants are achieving greater than 2 log removal (LeChevallier studies in particular), the following characteristics pertain:

—Substantial numbers of filtered water measurements resulted in oocyst detections;

—Source water turbidity tended to be relatively high compared to some of the other studies; and

—A significant percentage of these systems were also achieving low filtered water turbidities, substantially less than 0.5 NTU.

•Removal of *Cryptosporidium* can vary significantly in the course of the filtration cycle (i.e., at the start-up and end of filter operations versus the stable period of operation).

Cryptosporidium Removal Using Slow Sand and Diatomaceous Earth Filtration

During development of the IESWTR, the Agency also evaluated several studies which demonstrated that slow sand and diatomaceous earth filtration were capable of achieving at least 2 log removal of *Cryptosporidium*. Table IV.3 provides key information from these studies. A brief description of each study follows the table.

TABLE IV.3.—SLOW SAND AND DIATOMACEOUS EARTH FILTRATION REMOVAL STUDIES

Type of treatment	Log removal	Experimental design	Researcher
Slow-sand filtration	Giardia & Cryptosporidium > 3	Pilot plant at 4.5 to 16.5°C.	Shuler and Ghosh 1991.
	Cryptosporidium 4.5	Full-scale plant	imms et. al. 1995.
Diatomaceous earth filtration.	Giardia & Cryptosporidium > 3	Pilot plant,	Shuler et. al. 1990.
	Cryptosporidium 3.3–6.68	Bench scale	Ongerth & Hutton, 1997.

Shuler and Ghosh 1991

This pilot study was conducted to evaluate the ability of slow sand filters to remove *Giardia*, *Cryptosporidium*, coliforms, and turbidity. The pilot study was conducted at Pennsylvania State University using a raw water source with a turbidity ranging from 0.2–0.4 NTU. Influent concentration of

Cryptosporidium oocysts during the pilot study ranged from 1,300 to 13,000 oocysts/gallon. Oocyst removal was shown to be greater than 4 log.

Timms et al 1995

This pilot study was conducted to evaluate the efficiency of slow sand filters at removing *Cryptosporidium*. A pilot plant was constructed of 1.13 m^2 in area and 0.5 m in depth with a filtration rate of 0.3m/h. The filter was run for 4–5 weeks before the experiment to ensure proper operation. *Cryptosporidium* oocysts were spiked to a concentration of 4,000/L. Results of the study indicated a 4.5 log removal of *Cryptosporidium* oocysts.

Shuler et al 1990

In this study, diatomaceous earth (DE) filtration was evaluated for removal of *Giardia*, *Cryptosporidium*, turbidity and coliform bacteria. The study used a 0.1m^2 pilot scale DE filter with three grades of diatomaceous earth (A, B, and C). The raw water turbidity varied between 0.1 and 1 NTU. Filter runs ranged from 2 days to 34 days. A greater than 3 log removal of *Cryptosporidium* was demonstrated in the 9 filter runs which made up the study.

Ongerth and Hutton, 1997

Bench scale studies were used to define basic characteristics of DE filtration as a function of DE grade and filtration rate. Three grades of DE were used in the tests. *Cryptosporidium* removal was measured by applying river water seeded with *Cryptosporidium* to Walton test filters. Tests were run for filtration rates of 1 and 2 gpm/sq ft. Each run was replicated 3 times. Approximately 6 logs reduction in the concentration of *Cryptosporidium* oocysts was expected under normal operating conditions.

Cryptosporidium Removal Using Alternative Filtration Technologies

EPA recognizes that systems serving fewer than 10,000 individuals employ a variety of filtration technologies other than those previously discussed. EPA collected information regarding several other popular treatment techniques in an effort to verify that these treatments were also technically capable of achieving a 2 log removal of *Cryptosporidium*. A brief discussion of these alternative technologies follows along with studies demonstrating effective *Cryptosporidium* removals.

Membrane Filtration

Membrane filtration (Reverse Osmosis, Nanofiltration, Ultrafiltration, and Microfiltration) relies upon pore size in order to remove particles from water. Membranes possess a pore size smaller than that of a *Cryptosporidium* oocyst, enabling them to achieve effective log removals. The smaller the pore size, the more effective the rate of removal. Typical pore sizes for each of the four types of membrane filtration are shown below:

- Microfiltration—1–0.1 microns (μm)
- Ultrafiltration—0.1–.01 (μm)
- Nanofiltration—.01–.001 (μm)
- Reverse Osmosis—<.001 (μm)

Bag Filtration

Bag filters are non-rigid, disposable, fabric filters where water flows from inside of the bag to the outside of the bag. One or more filter bags are contained within a pressure vessel designed to facilitate rapid change of the filter bags when the filtration capacity has been used up. Bag filters do not generally employ any chemical coagulation. The pore sizes in the filter bags designed for protozoa removal generally are small enough to remove protozoan cysts and oocysts but large enough that bacteria, viruses and fine colloidal clays would pass through. Bag filter studies have shown a significant range of results in the removal of *Cryptosporidium* oocysts (0.33–3.2 log). (Goodrich, 1995)

Cartridge Filtration

Cartridge filtration also relies on physical screening to remove particles from water. Typical cartridge filters are pressure filters with glass, fiber or ceramic membranes, or strings wrapped around a filter element housed in a pressure vessel (USEPA, 1997a).

The Agency evaluated several studies which demonstrate the ability of various alternative filtration technologies to achieve 2 log removal of *Cryptosporidium* (in several studies 2 log removal of 4–5 (μm) microspheres were used as a surrogate for *Cryptosporidium*). These studies demonstrate that 2 log removal was consistently achievable in all but bag filters. Table IV.4 provides key information from these studies. A brief description of each study follows:

TABLE IV.4.—ALTERNATIVE FILTRATION REMOVAL STUDIES

Type of treatment	Log removal	Experimental design	Researcher
Microfiltration	*Cryptosporidium* 4.2–4.9 log	Bench Scale	Jacangelo *et al.* 1997.
	Giardia 4.6–5.2 log		
	Cryptosporidium 6.0—7.0 log	Pilot Plant	
	Cryptosporidium 4.3—5.0 log	Pilot Plant	Drozd & Schartzbrod, 1997.
	Cryptosporidium 7.0–7.7 log	Bench Scale	Hirata & Hashimoto, 1998.
	Microspheres 3.57–3.71 log	Full Scale	Goodrich *et al.* 1995.
Ultrafiltration	*Cryptosporidium* 4.4—4.9 log	Bench Scale	Jacangelo *et al.* 1997.
	Giardia 4.7–5.2 log		
	Cryptosporidium 5.73–5.89 log	Bench Scale	Collins *et al.* 1996.
	Giardia 5.75–5.85 log		
	Cryptosporidium 7.1–7.4 log	Bench Scale	Hirata & Hashimoto, 1998.
	Cryptosporidium 3.5 log	pilot Plant	Lykins *et al.* 1994.
	Microspheres 3–4 log		
Reverse Osmosis	Cryptosporidium > 5.7 log	Pilot Scale	Adham *et al.* 1998
	Giardia > 5.7 log.		
Hybrid Membrane	Microspheres 4.18 log	Bench Scale	Goodrich et al. 1995
Bag Filtration	Microspheres .33–3.2 log	Pilot Plant	Goodrich et al. 1995
Cartridge filtration	Microspheres 3.52–3.68 log	Pilot Plant	Goodrich et al. 1995
	Particles (5–15 um) > 2 log	Bench Scale	Land, 1998.

Jacangelo et al., 1997

Bench scale and pilot plant tests were conducted with microfiltration and ultrafiltration filters (using six different membranes) in order to evaluate microorganism removal. Bench scale studies were conducted under worst case operating conditions (direct flow filtration at the maximum recommended transmembrane pressure using deionized water slightly buffered at pH 7). Log removal ranged from 4.7 to 5.2 log removal. Pilot plant results ranged from 6.0–7.0 log removal during worst-case operating conditions (*i.e.,* direct filtration immediately after backwashing at the maximum recommended operating transmembrane pressure).

Drozd and Schartzbrod, 1997

A pilot plant system was established to evaluate the removal of *Cryptosporidium* using crossflow microfiltration (.2 µm porosity). Results demonstrated *Cryptosporidium* log removals of 4.3 to greater than 5.5 with a corresponding mean filtrate turbidity of 0.25 NTU.

Collins et. al., 1996

This study consisted of bench scale testing of *Cryptosporidium* and *Giardia* log removals using an ultrafiltration system. Log removal of *Cryptosporidium* ranged from 5.73 to 5.89 log, while removal of *Giardia* ranged from 5.75 to 5.85 log.

Hirata & Hashimoto, 1998

Pilot scale testing using microfiltration (nominal pore size of .25 µm) and ultrafiltration (nominal cut-off molecular weight (MW) 13,000 daltons) was conducted to determine *Cryptosporidium* oocyst removal. Results conducted on the ultrafiltration units ranged from 7.1 to 7.5 logs of *Cryptosporidium* removal. Results of the microfiltration studies yielded log removals from 7.0 to 7.7 log.

Lykins et al., [1994]

An ultrafiltration system was evaluated for the removal of *Cryptosporidium* oocysts at the USEPA Test and Evaluation Facility in Cincinnati, Ohio. The filter run was just over 48 hours. A 3.5 log removal of *Cryptosporidium* oocysts was observed. Additionally, twenty-four experiments were performed using 4.5 µm polystyrene microspheres as a surrogate for *Cryptosporidium* because of a similar particle distribution. Log removal of microspheres ranged from 3 to 4 log.

Adham et al., 1998

This study was conducted to evaluate monitoring methods for membrane integrity. In addition to other activities, microbial challenge tests were conducted on reverse osmosis (RO) membranes to both determine log removals and evaluate system integrity. Log removal of *Cryptosporidium* and *Giardia* was >5.7 log in uncompromised conditions, and > 4.5 log in compromised conditions.

Goodrich et al., 1995

This study was conducted to evaluate removal efficiencies of three different bag filtration systems. Average filter pore size of the filters was 1 µm while surface area ranged from 35 to 47 sq ft. Bags were operated at 25, 50 and 100 percent of their maximum flow rate while spiked with 4.5 µm polystyrene microspheres (beads) as a surrogate for *Cryptosporidium*. Bead removal ranged from .33 to 3.2 log removal.

Goodrich et al 1995.

This study evaluated a cartridge filter with a 2 µm rating and 200 square feet of surface area for removal efficiency of *Cryptosporidium* sized particles. The filter was challenge tested with 4.5 µm polystyrene microspheres as a surrogate for *Cryptosporidium*. Flow was set at 25 gpm with 50 psi at the inlet. Results from two runs under the same conditions exhibited log removals of 3.52 and 3.68.

Land, 1998

An alternative technology demonstration test was conducted to evaluate the ability of a cartridge filter to achieve 2 log removal of particles in the 5 to 15 µm range. The cartridge achieved at least 2 log removal of the 5 to 25 µm particles 95 percent of the time up to a 20 psi pressure differential. The filter achieved at least 2 log removal of 5 to 15 µm particles up to 30-psi pressure differential.

While the studies above note that alternative filtration technologies have demonstrated in the lab the capability to achieve a 2 log removal of *Cryptosporidium*, the Agency believes that the proprietary nature of these technologies necessitates a more rigorous technology-specific determination be made. Given this issue, the Agency believes that its Environmental Technology Verification (ETV) Program can be utilized to verify the performance of innovative technologies. Managed by EPA's Office of Research and Development, ETV was created to substantially accelerate the entrance of new environmental technologies into the domestic and international marketplace. ETV consists of 12 pilot programs, one of which focuses on drinking water. The program contains a protocol for physical removal of microbiological and particulate contaminants, including test plans for bag and cartridge filters and membrane filters (NSF, 1999). These protocols can be utilized to determine whether a specific alternative technology can effectively achieve a 2 log removal of *Cryptosporidium*, and under what parameters that technology must be operated to ensure consistent levels of removal. Additional information on the ETV program can be found on the Agency's website at http://www.epa.gov/etv.

iii. Proposed Requirements

Today's proposed rule establishes a requirement for 2 log removal of *Cryptosporidium* for surface water and GWUDI systems serving fewer than 10,000 people that are required to filter under the SWTR. Compliance with the combined filter effluent turbidity requirements, as described later, ensures compliance with the 2 log removal requirement. The requirement for a 2 log removal of *Cryptosporidium* applies between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer.

iv. Request for Comments

EPA requests comment on the 2 log removal requirement as discussed. The Agency is also soliciting public comment and data on the ability of alternative filtration technologies to achieve 2 log *Cryptosporidium* removal.

2. Turbidity Requirements

a. Combined Filter Effluent

i. Overview and Purpose

In order to address concern with *Cryptosporidium*, EPA has analyzed log removal performance by well operated plants (as described in the previous section) as well as filter performance among small systems to develop an appropriate treatment technique requirement that assures an increased level of *Cryptosporidium* removal. In evaluating combined filter performance requirements, EPA considered the strengthened turbidity provisions within the IESWTR and evaluated whether these were appropriate for small systems as well.

ii. Data

In an effort to evaluate combined filter effluent (CFE) requirements, EPA collected data in several areas to supplement existing data, and address situations unique to smaller systems. This data includes:

- An estimate of the number of systems subject to the proposed strengthened turbidity requirements;
- Current turbidity levels at systems throughout the U.S. serving populations fewer than 10,000;
- The ability of package plants to meet strengthened turbidity standards; and
- The correlation between meeting CFE requirements and achieving 2 log removal of *Cryptosporidium*.

Estimate of the Number of Systems Subject to Strengthened CFE Turbidity Standards

Using the estimate of 9,134 systems which filter and serve fewer than 10,000 persons (as described in Section IV.A.1 of today's proposal), the Agency used the information contained within the CWSS database to estimate the number of systems which utilized specific types of filtration. The data was segregated based on the type of filtration utilized and the population size of the system. Percentages were derived for each of the following types of filtration:

- Conventional and Direct Filtration;
- Slow Sand Filtration;
- Diatomaceous Earth Filtration; and
- Alternative Filtration Technologies.

The percentages were applied to the estimate discussed in Section IV.A.1 of today's proposal for each of the respective population categories. Based on this analysis, the Agency estimates 5,896 conventional and direct filtration systems will be subject to the strengthened combined filter effluent turbidity standards. EPA estimates 1,756 systems utilize slow sand or diatomaceous earth filtration, and must continue to meet turbidity standards set forth in the SWTR. The remaining 1,482 systems are estimated to use alternative filtration technologies and will be required to meet turbidity standards as set forth by the State upon analysis of a 2 log *Cryptosporidium* demonstration conducted by the system.

Current Turbidity Levels

EPA has developed a data set which summarizes the historical turbidity performance of various filtration plants serving populations fewer than 10,000 (EPA, 1999d). The data set represents those systems that were in compliance with the turbidity requirements of the SWTR during all months being analyzed. The data set consists of 167 plants from 15 States. Table IV.5 provides information regarding the number of plants from each State. The data set includes plants representing each of the five population groups utilized in the CWSS (25–100, 101–500, 501–1,000, 1,001–3,300, and 3,301–10,000). The Agency has also received an additional data set from the State of California (EPA, 2000). This data has not been included in the assessments described below. The California data demonstrates similar results to the larger data set discussed below.

TABLE IV.5.—SUMMARY OF LT1FBR TURBIDITY DATA SET

State	Number of Plants
Alabama	1
California	1
Colorado	16
Illinois	13
Kansas	20
Louisiana	6
Minnesota	3
Montana	2
North Carolina	16
Ohio	4
Pennsylvania	27
South Carolina	16
Texas	23
Washington	17
West Virginia	2
Total	167

(EPA, 1999d)

This data was evaluated to assess the national impact of modifying existing turbidity requirements. The current performance of plants was assessed with respect to the number of months in which selected 95th percentile and maximum turbidity levels were met. The data show that approximately 88 percent of systems are also currently meeting the new requirements of a maximum turbidity limit of 1 NTU (Figure IV.1). With respect to the 95th percentile turbidity limit, roughly 46 percent of these systems are currently meeting the new requirement of 0.3 NTU (Figure IV.2) while approximately 70 percent meet this requirement 9 months out of the year. Estimates for systems needing to make changes to meet a turbidity performance limit of 0.3 NTU were based on the ability of systems currently to meet a 0.2 NTU. This assumption was intended to take into account a utility's concern with possible turbidity measurement error and to reflect the expectation that a number of utilities will attempt to achieve finished water turbidity levels below the regulatory performance level to assure compliance.

As depicted in Figure IV.1 and IV.2, the tighter turbidity performance standards for combined filter effluent in today's proposed rule reflect the actual, current performance many systems already achieve nationally. Revising the turbidity criteria effectively ensures that these systems continue to perform at their current level while also improving performance of a substantial number of systems that currently meet existing SWTR criteria, but operate at turbidity levels higher than proposed in today's rule.

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FIGURE IV.1

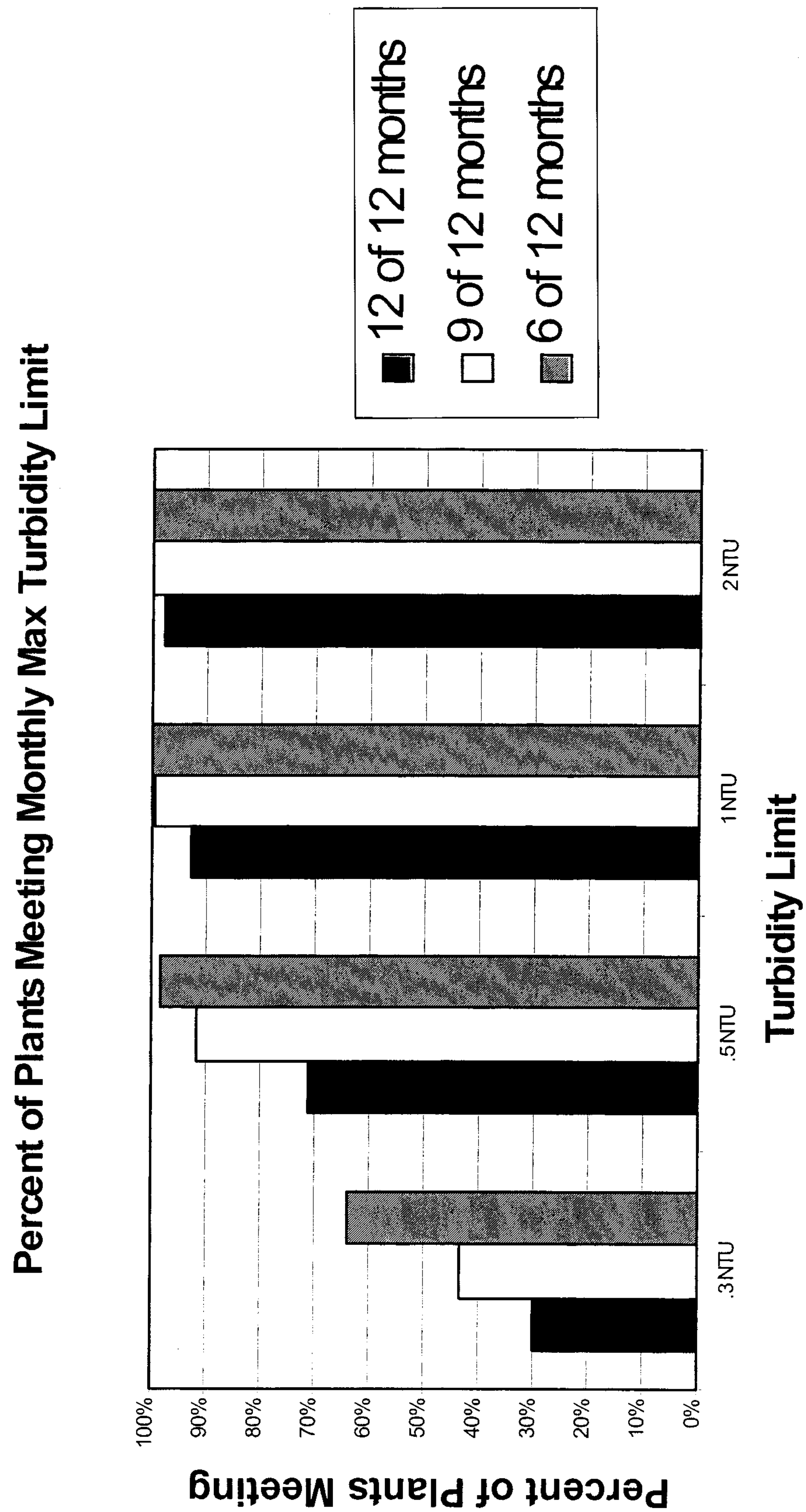
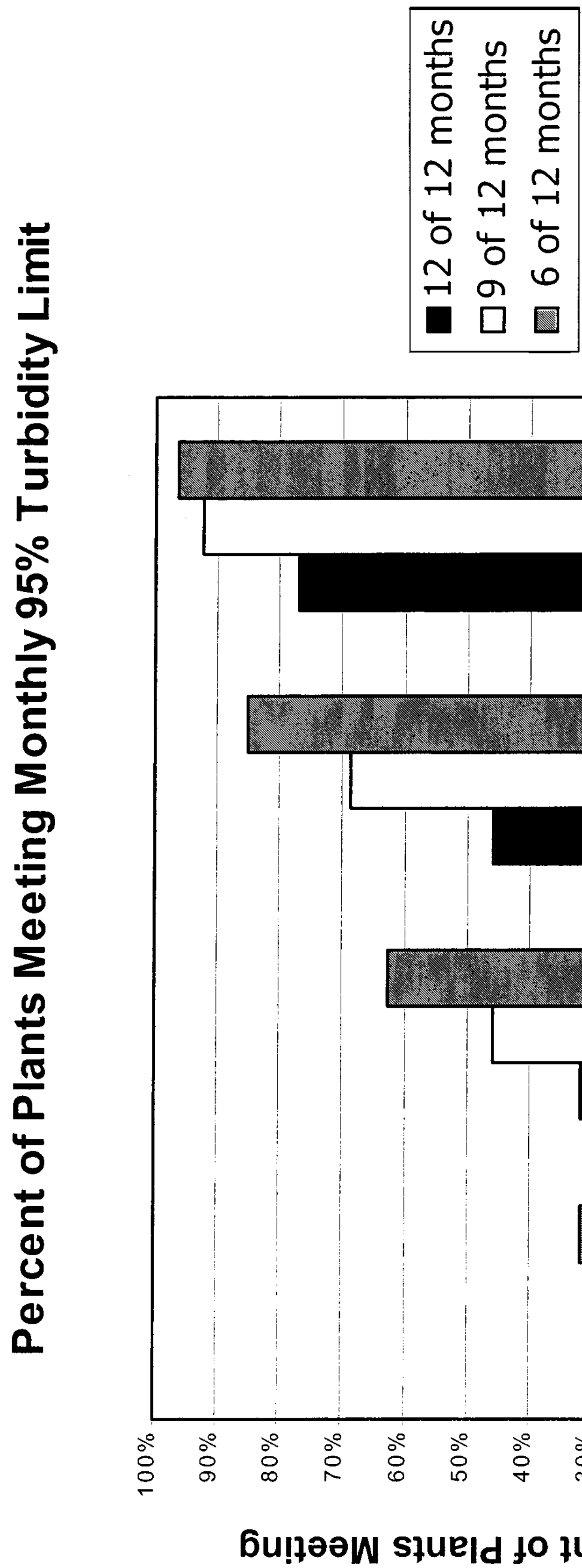

Percent of Plants Meeting Monthly Max Turbidity Limit
12 of 12 months
9 of 12 months
6 of 12 months
Percent of Plants Meeting
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
.3NTU
.5NTU
1NTU
2NTU
Turbidity Limit

FIGURE IV.2


Percent of Plants Meeting Monthly 95% Turbidity Limit
12 of 12 months
9 of 12 months
6 of 12 months
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Plants Meeting
.1 NTU
.2 NTU
.3 NTU
.4 NTU
95% Turbidity Limit (NTUs)

Package Plants

During development of today's proposed rule, some stakeholders expressed concern regarding the ability of ''package plants'' to meet the proposed requirements. EPA evaluated these systems by gathering data from around the country. The information affirms the Agency's belief that package plants can and currently do meet the turbidity limits in today's proposed rule.

Package plants combine the processes of rapid mixing, flocculation, sedimentation and filtration (rapid sand, mixed or dual media filters) into a single package system. Package Filtration Plants are preconstructed, skid mounted and transported virtually assembled to the site. The use of tube settlers, plate settlers, or adsorption clarifiers in some Package Filtration Plants results in a compact size and more treatment capacity.

Package Filtration Plants are appropriate for treating water of a fairly consistent quality with low to moderate turbidity. Effective treatment of source waters containing high levels of or extreme variability in turbidity levels requires skilled operators and close operational attention. High turbidity or excessive color in the source water could require chemical dosages above the manufacturer's recommendations for the particular plant. Excessive turbidity levels may require presedimentation or a larger capacity plant. Specific design criteria of a typical package plant and operating and maintenance requirements can vary, but an example schematic is depicted in Figure IV.3.

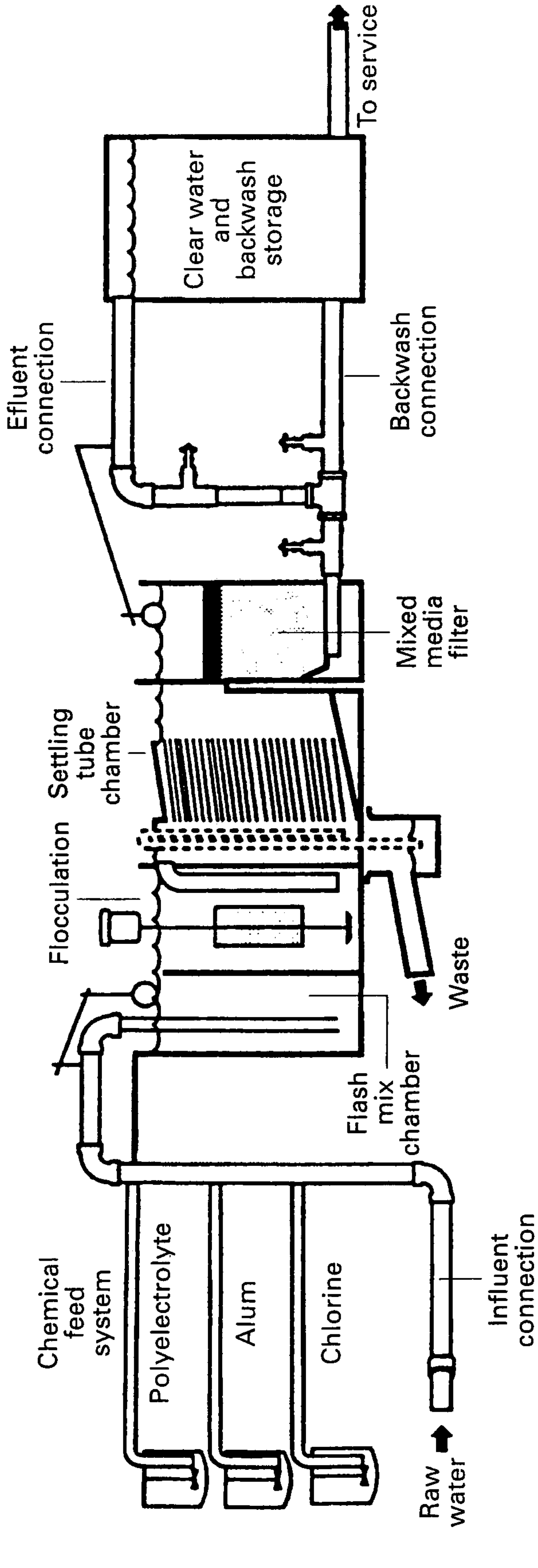


Figure IV.3 Example Package Plant Schematic

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The Agency believes that historic data show that package plants have a comparable ability to meet turbidity requirements as conventional or direct filtration systems.

A 1987 report of pilot testing using a trailer-mounted package plant system to treat raw water from Clear Lake in Lakeport, California demonstrates the ability of such systems to achieve low turbidity requirements. The raw water contained moderate to high turbidity (18 to 103 NTU). Finished water turbidities ranged from 0.07 to 0.11 NTU (EPA, 1987). Two previous studies (USEPA, 1980a,b and Cambell et al., 1995) also illustrate the ability of package systems throughout the country to meet historic turbidity performance criteria. These studies are described briefly:

Package Water Treatment Plant Performance Evaluation (USEPA, 1980a,b)

The Agency conducted a study of package water treatment systems which encompassed 36 plants in Kentucky, West Virginia, and Tennessee. Results from that study showed that the plants could provide water that met the existing turbidity limits established under the National Interim Primary Drinking Water Standards. Of the 31 plants at which turbidity measurements were made, 23 (75 percent) were found to be meeting existing standards. Of the 8 which did not meet requirements, one did not use chemical coagulants, and 6 operated less than four hours per day. (USEPA, 1980a, b)

Package Plants for Small Systems: A Field Study (Cambell et al, 1995)

This 1992 project evaluated the application of package plant technology to small communities across the U.S. The project team visited 48 facilities across the U.S. Of the 29 surface water and GWUDI systems, 21 (72 percent) had grab turbidity samples less than 0.5 NTU, the 95 percent limit which became effective in June of 1993. Twelve systems (41 percent) had values less than today's proposed 0.3 NTU 95 percent turbidity limit. (Cambell et al., 1995) It should be noted that today's rule requires compliance with turbidity limits based on 4 hour measurments.

The Agency recently evaluated Filter Plant Performance Evaluations (FPPEs) conducted by the State of Pennsylvania, in an effort to quantify the comparative abilities of package plants and conventional filtration systems to meet the required turbidity limits. The data set consisted of 100 FPPEs conducted at systems serving populations fewer than 10,000 (PADEP, 1999). Thirty-seven FPPEs were conducted at traditional conventional filtration systems while 37 were conducted at package plants or ''pre-engineered'' systems. The remaining 26 systems utilized other filtration technologies.

The FPPEs provided a rating of either acceptable or unacceptable as determined by the evaluation team. This rating was based on an assessment of the capability of individual unit processes to continuously provide an effective barrier to the passage of microorganisms. Specific performance goals were utilized to evaluate the performance of the system including the consistent ability to produce a finished water turbidity of less than 0.1 NTU, which is lower than the combined filter effluent turbidity requirement in today's proposed rule. Seventy-three percent of the traditional conventional filtration systems were rated acceptable and 89 percent of the package plants were rated acceptable.

The Agency also evaluated historic turbidity data graphs contained within each FPPE to provide a comparison of the ability of package plants and conventional systems to meet the 1 NTU max and 0.3 NTU 95 percent requirements that are contained in today's proposed rule. Sixty-seven percent of the conventional systems would meet today's proposed requirements while 74 percent of package systems in the data set would meet today's proposed requirements. The Agency believes that, when viewed alongside the aforementioned studies (USEPA, 1980a,b and Cambell et al., 1995), it is apparent that package systems have the ability to achieve more stringent turbidity limits.

Correlation Between CFE Requirements and 2-log Cryptosporidium Removal

Recent pilot scale experiments performed by the Agency assessed the ability of conventional treatment to control *Cryptosporidium* under steady state conditions. The work was performed with a pilot plant that was designed to minimize flow rates and as a result the number of oocyst required for continuous spiking. (Dugan et al. 1999)

Viable oocysts were fed into the plant influent at a concentration of 10^6/L for 36 to 60 hours. The removals of oocysts and the surrogate parameters turbidity, total particle counts and aerobic endospores were measured through sedimentation and filtration. There was a positive correlation between the log removals of oocysts and all surrogate parameters through the coagulation and settling process. With proper coagulation control, the conventional treatment process achieved the 2 log total *Cryptosporidium* removal required by the IESWTR. In all cases where 2 log total removal was not achieved, the plant also did not comply with the IESWTR's CFE turbidity requirements. Table IV.6 provides information on *Cryptosporidium* removals from this study.

TABLE IV.6.—LOG REMOVAL OF OOCYSTS (DUGAN ET AL. 1999)

Run	Log removal crypto	Exceeds CFE requirements
1	4.5	No.
2	5.2	No.
3	1.6	Yes, average CFE 2.1 NTU.
4	1.7	Yes, only 88% CFE under 0.3 NTU.
5	4.1	No.
6	5.1	No.
7	0.2	Yes, average CFE 0.5 NTU.
8	0.5	Yes, only 83% CFE under 0.3 NTU.
9	5.1	No.
10	4.8	No.

iii. Proposed Requirements

Today's proposed rule establishes combined filter effluent turbidity requirements which apply to all surface water and GWUDI systems which filter and serve populations fewer than 10,000. For conventional and direct filtration systems, the turbidity level of representative samples of a system's combined filter effluent water must be less than or equal to 0.3 NTU in at least 95 percent of the measurements taken each month. The turbidity level of representative samples of a system's filtered water must not exceed 1 NTU at any time.

For membrane filtration, (microfiltration, ultrafiltration, nanofiltration, and reverse osmosis) the Agency is proposing to require that the turbidity level of representative samples of a system's combined filter effluent water must be less than or equal to 0.3 NTU in at least 95 percent of the measurements taken each month. The turbidity level of representative samples of a system's filtered water must not exceed 1 NTU at any time. EPA included turbidity limits for membrane systems to allow such systems the ability to opt out of a possible costly demonstration of the ability to remove *Cryptosporidium*. The studies displayed previously in Table IV.4, demonstrate the ability of these technologies to achieve log-removals in excess of 2 log. In lieu of these turbidity limits, a public water system which utilizes membrane filtration may demonstrate to the State for purposes of membrane approval (using pilot plant studies or other means) that membrane filtration in combination with disinfection treatment consistently achieves 3 log removal and/or inactivation of *Giardia* lamblia cysts, 4 log removal and/or inactivation of viruses, and 2 log removal of *Cryptosporidium* oocysts. For each approval, the State will set turbidity performance requirements that the system must meet at least 95 percent of the time and that the system may not exceed at any time at a level that consistently achieves 3 log removal and/or inactivation of *Giardia* lamblia cysts, 4 log removal and/or inactivation of viruses, and 2 log removal of *Cryptosporidium* oocysts.

Systems utilizing slow sand or diatomaceous earth filtration must continue to meet the combined filter effluent limits established for these technologies under the SWTR (found in § 141.73 (b) and (c)). Namely, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month and the turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU.

For all other alternative filtration technologies (those other than conventional, direct, slow sand, diatomaceous earth, or membrane), public water systems must demonstrate to the State for purposes of approval (using pilot plant studies or other means), that the alternative filtration technology in combination with disinfection treatment, consistently achieves 3 log removal and/or inactivation of *Giardia* lamblia cysts, 4 log removal and/or inactivation of viruses, and 2 log removal of *Cryptosporidium* oocysts. For each approval, the State will set turbidity performance requirements that the system must meet at least 95 percent of the time and that the system may not exceed at any time at a level that consistently achieves 3 log removal and/or inactivation of *Giardia* lamblia cysts, 4 log removal and/or inactivation of viruses, and 2 log removal of *Cryptosporidium* oocysts.

iv. Request for Comments

EPA solicits comment on the proposal to require systems to meet the proposed combined filter effluent turbidity requirements. Additionally, EPA solicits comment on the following:

- The ability of package plants and/or other unique conventional and/or direct systems to meet the combined filter effluent requirements;
- Microbial attachment to particulate material or inert substances in water systems may have the effect of providing "shelter" to microbes by reducing their exposure to disinfectants (USEPA, 1999e). While inactivation of *Cryptosporidium* is not a consideration of this rule, should maximum combined filter effluent limits for slow sand and diatomaceous earth filtration systems be lowered to 1 or 2 NTU and/or 95th percentile requirements lowered to 0.3 NTU to minimize the ability of turbidity particles to "shelter" *Cryptosporidium* oocysts?
- Systems which practice enhanced coagulation may produce higher turbidity effluent because of the process. Should such systems be allowed to apply to the State for alternative exceedance levels similar to the provisions contained in the rule for systems which practice lime softening?
- Issues specific to small systems regarding the proposed combined filter effluent requirements;
- Establishment of turbidity limits for alternative filtration technologies;
- Allowance of a demonstration to establish site specific limits in lieu of generic turbidity limits, including components of such demonstration; and
- The number of small membrane systems employed throughout the country.

The Agency also requests comment on establishment of turbidity limits for membrane systems. While integrity of membranes provides the clearest understanding of the effectiveness of membranes, turbidity has been utilized as an indicator of performance (and corresponding *Cryptosporidium* log removal) for all filtration technologies. EPA solicits comment on modifying the requirements for membrane filters to meet integrity testing, as approved by the State and with a frequency approved by the State.

b. Individual Filter Turbidity

i. Overview and Purpose

During development of the IESWTR, it was recognized that performance of individual filters within a plant were of paramount importance to producing low-turbidity water. Two important concepts regarding individual filters were discussed. First, it was recognized that poor performance (and potential pathogen breakthrough) of one filter could be masked by optimal performance in other filters, with no discernable rise in combined filter effluent turbidity. Second, it was noted that individual filters are susceptible to turbidity spikes (of short duration) which would not be captured by four-hour combined filter effluent measurements. To address the shortcomings associated with individual filters, EPA established individual filter monitoring requirements in the IESWTR. For the reasons discussed below, the Agency believes it appropriate and necessary to extend individual filter monitoring requirements to systems serving populations fewer than 10,000 in the LT1FBR.

ii. Data

EPA believes that the support and underlying principles regarding the IESWTR individual filter monitoring requirements are also applicable for the LT1FBR. The Agency has estimated that 5,897 conventional and direct filtration systems will be subject to today's proposed individual filter turbidity requirements. Information regarding this estimate is found in Section IV.A.2.a of today's proposal. The Agency has analyzed information regarding turbidity spikes and filter masking which are presented next.

Turbidity Spikes

During a turbidity spike, significant amounts of particulate matter (including *Cryptosporidium* oocysts, if present) may pass through the filter. Various factors affect the duration and amplitude of filter spikes, including sudden changes to the flow rate through the filter, treatment of the filter backwash water, filter-to-waste capability, and site-specific water quality conditions. Recent experiments have suggest that surging has a significant effect on rapid sand filtration performance (Glasgow and Wheatley, 1998). An example filter profile depicting turbidity spikes is shown in Figure IV.4.

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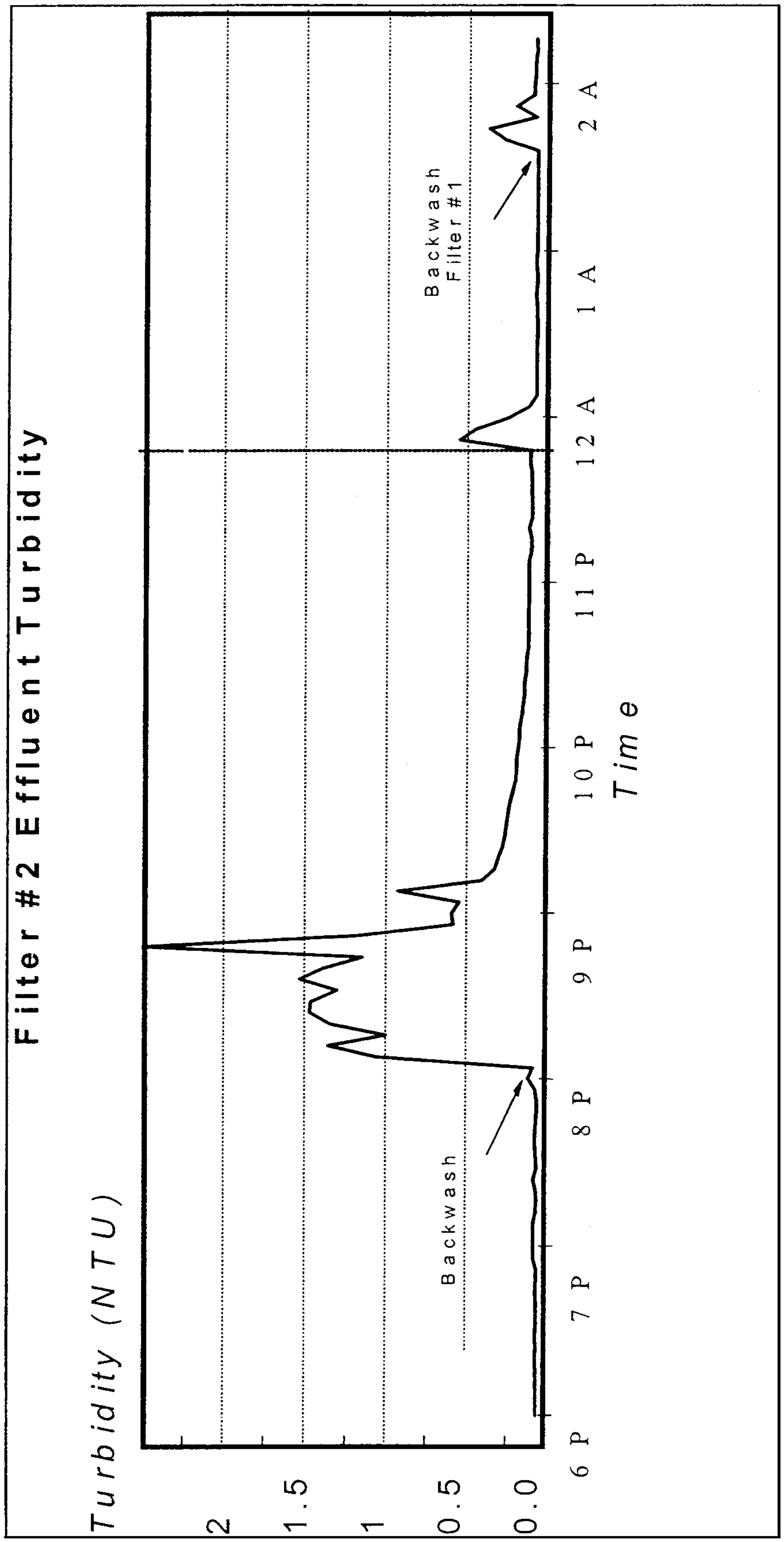
Figure IV.4. Example Filter Profile Depicting Turbidity Spikes



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Studies considered by both EPA and the M–DBP Advisory Committee noted that the greatest potential for a peak in turbidity (and thus, pathogen breakthrough) is near the beginning of the filter run after filter backwash or start up of operation (Amirtharajah, 1988; Bucklin, et al. 1988; Cleasby, 1990; and Hall and Croll, 1996). This phenomenon is depicted in Figure IV.4. Turbidity spikes also may occur for a variety of other reasons. These include:

• Outages or maintenance activities at processes within the treatment train;

• Coagulant feed pump or equipment failure;

• Filters being run at significantly higher loading rates than approved;

• Disruption in filter media;

• Excessive or insufficient coagulant dosage; and

• Hydraulic surges due to pump changes or other filters being brought on/off-line.

A recent study was completed which evaluated particle removal by filtration throughout the country. While the emphasis of this study was particle counting and removal, fifty-two of the 100 plants surveyed were also surveyed for turbidity with on-line turbidimeters. While all of the plants were able to meet 0.5 NTU 95 percent of the time, it was noted that there was a significant occurrence of spikes during the filter runs. These were determined to be a major source of raising the 95th percentile value for most of the filter runs. (McTigue *et al.* 1998)

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Figure IV.5a Results of Filter Turbidity Spike Analysis - Ripening Spikes by Change in Turbidity (McTigue 1998, Photorevised EPA 2000)

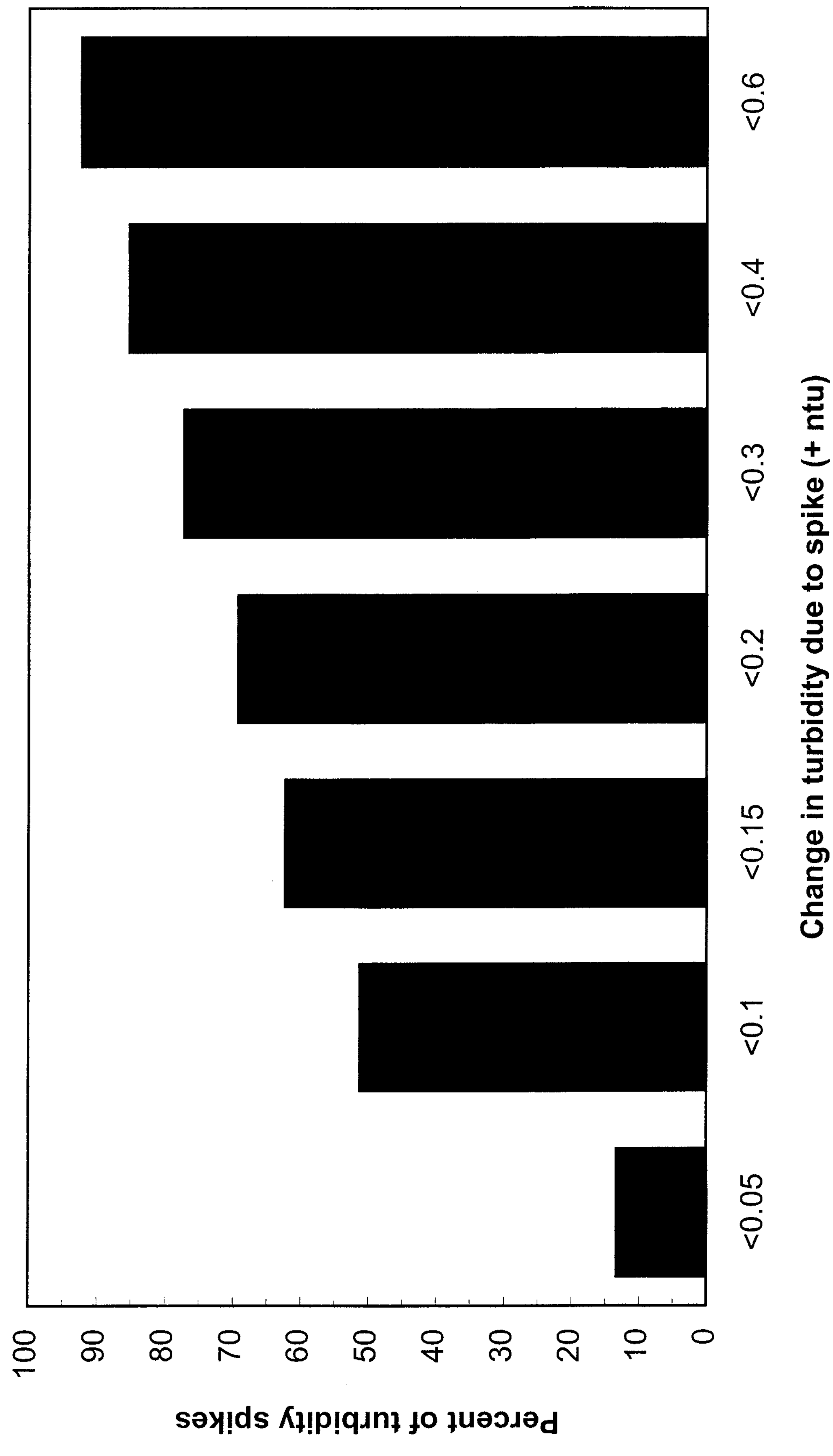


Figure IV.5b Results of Filter Turbidity Spike Analysis - Ripening Spikes by Duration (McTigue 1998, Photorevised EPA 2000)

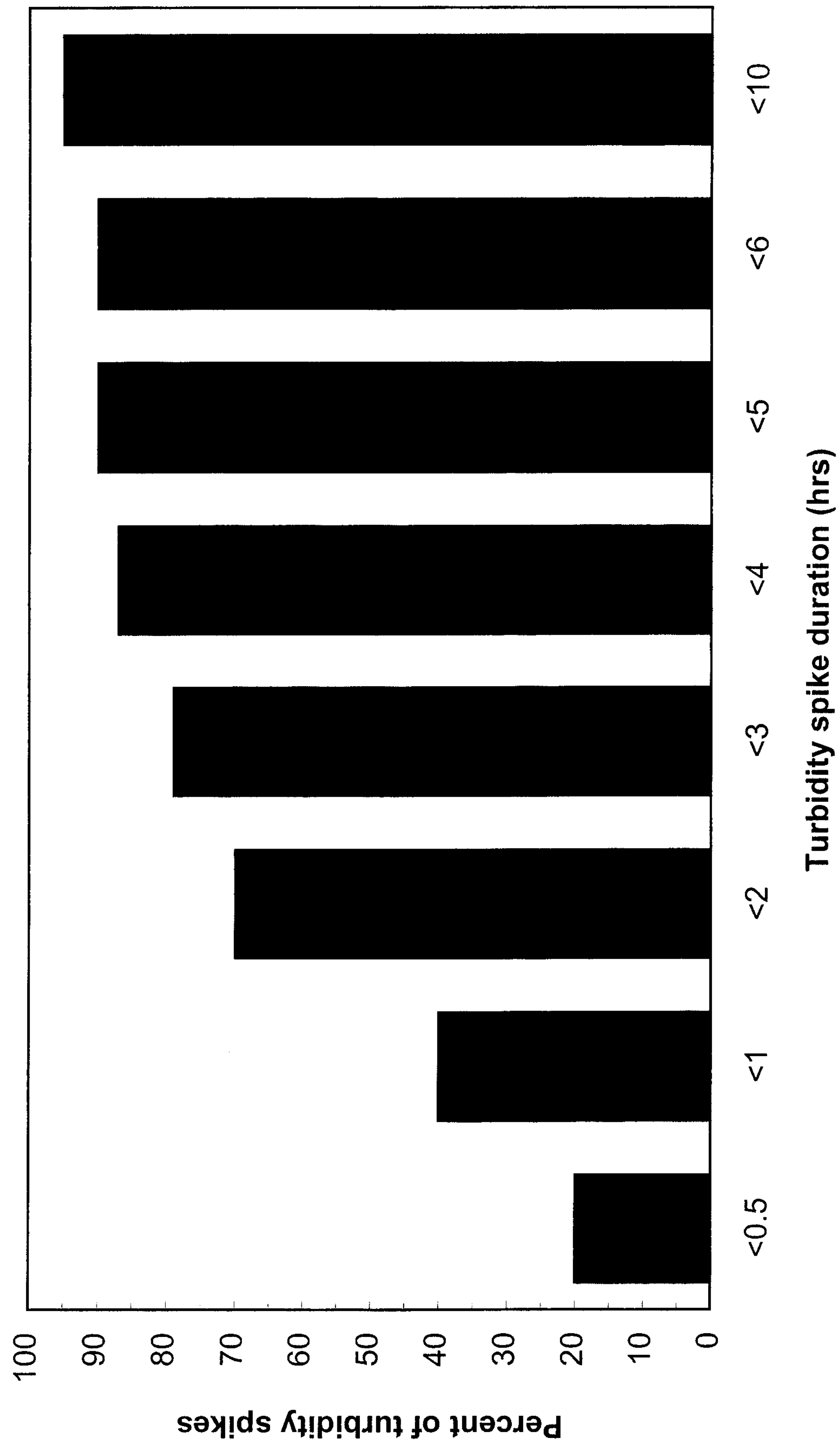


Figure IV.5c Results of Filter Turbidity Spike Analysis - Middle of Run Spikes by Change in Turbidity (McTigue 1998, Photorevised EPA 2000)

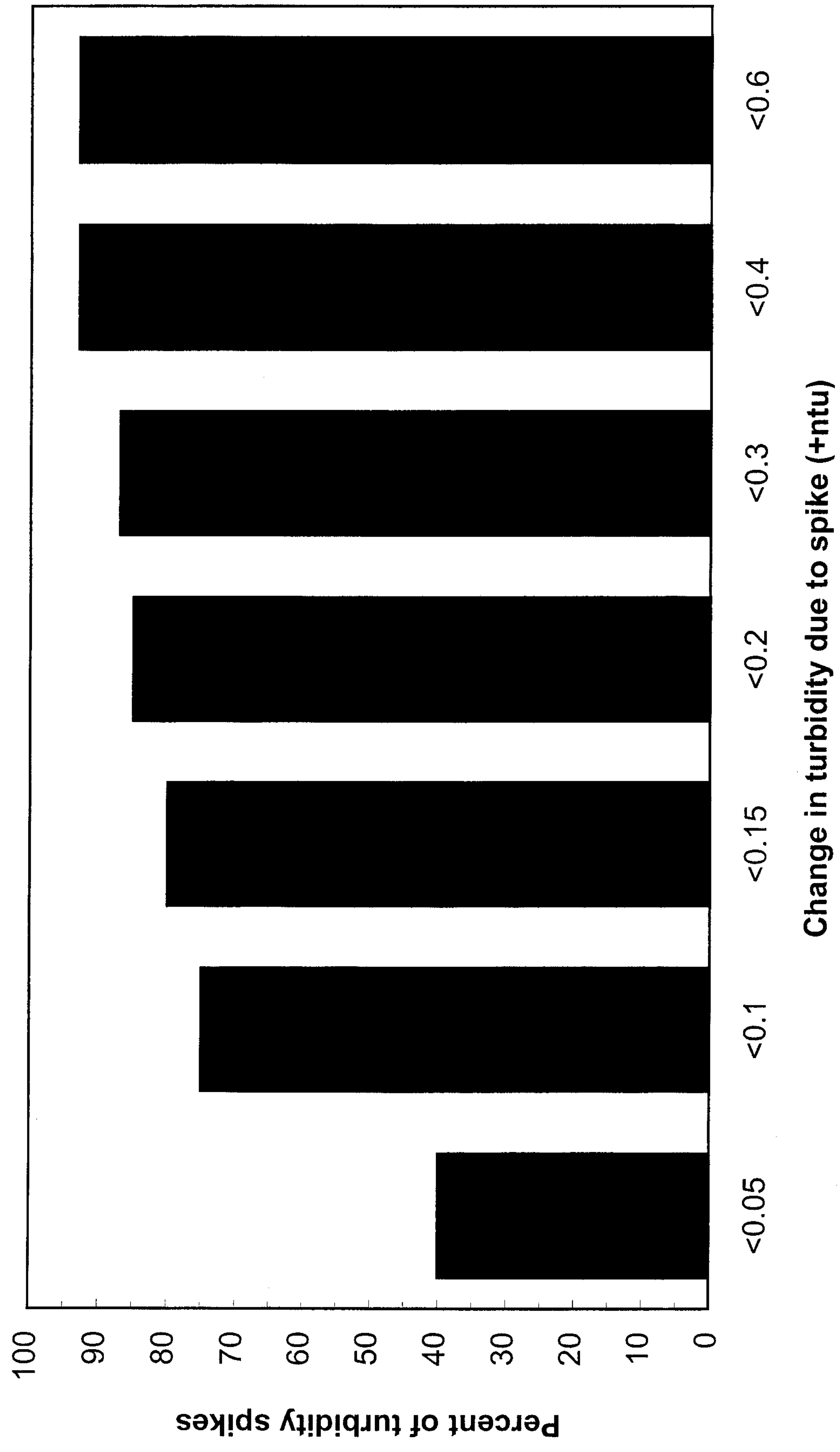


Figure IV.5d Results of Filter Turbidity Spike Analysis - Middle of Run Spikes by Change in Turbidity (McTigue 1998, Photorevised EPA 2000)

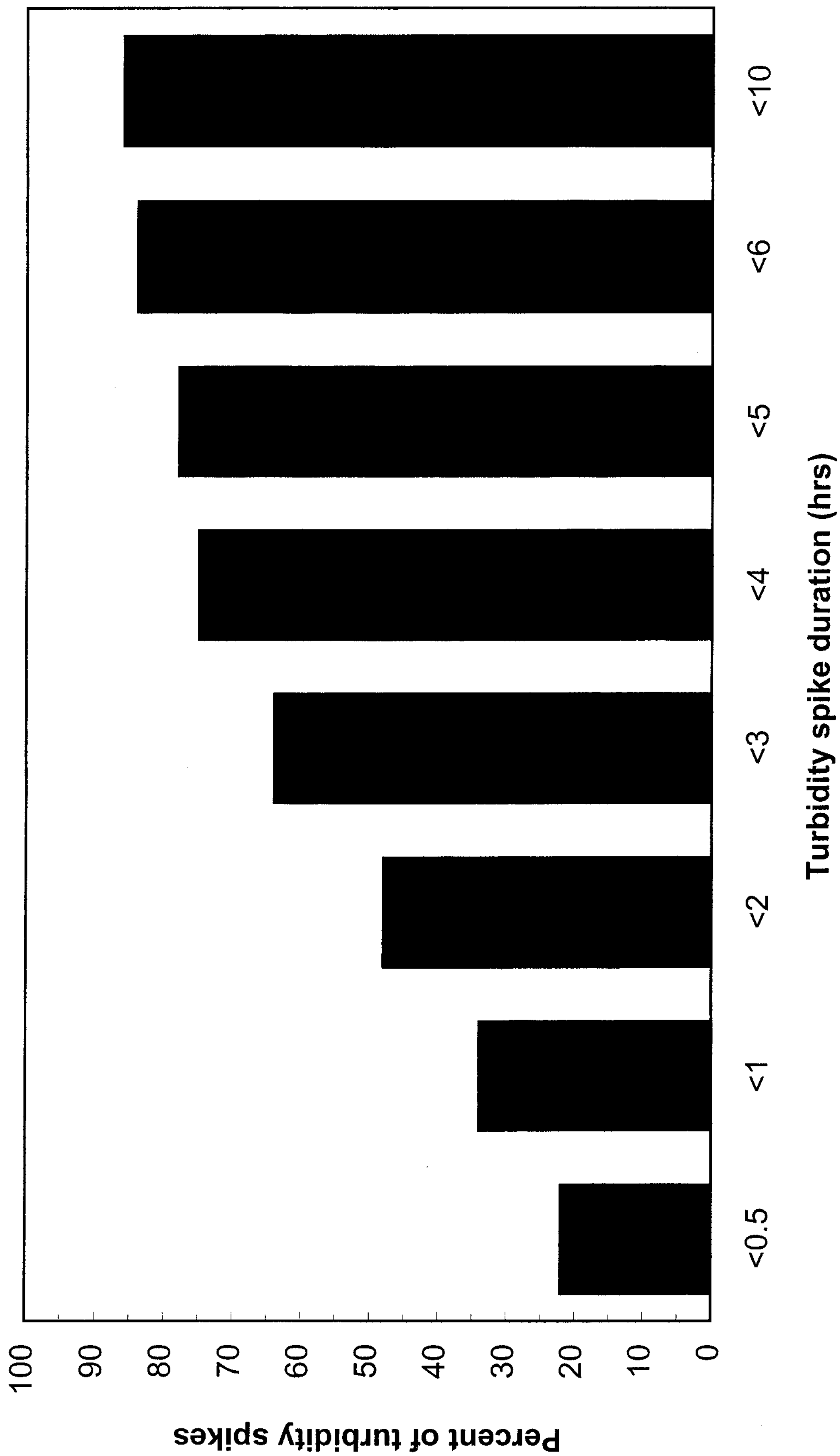


Figure IV.5e Results of Filter Turbidity Spike Analysis - End of Run Spikes by Change in Turbidity (McTigue 1998, Photorevised EPA 2000)

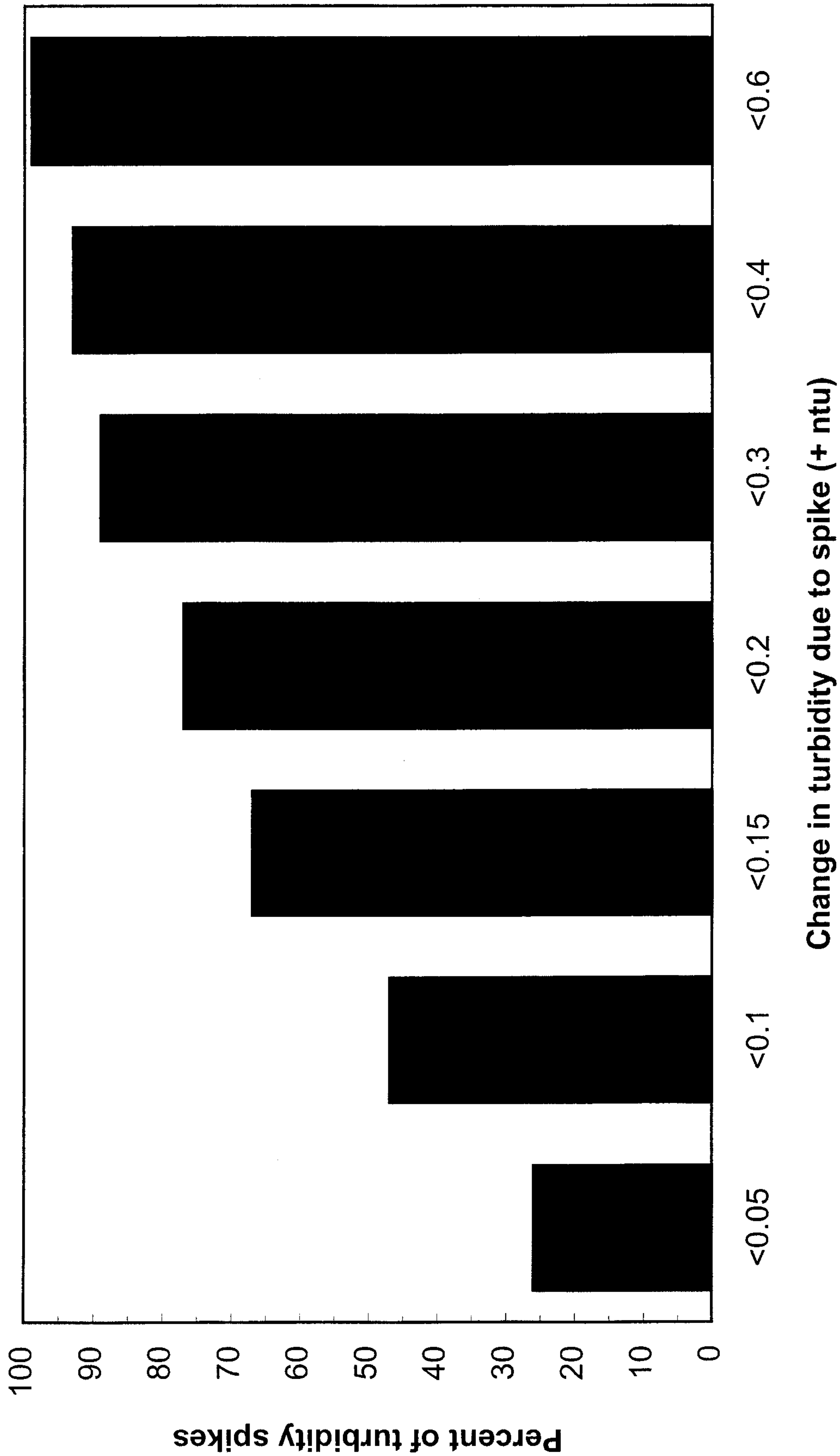
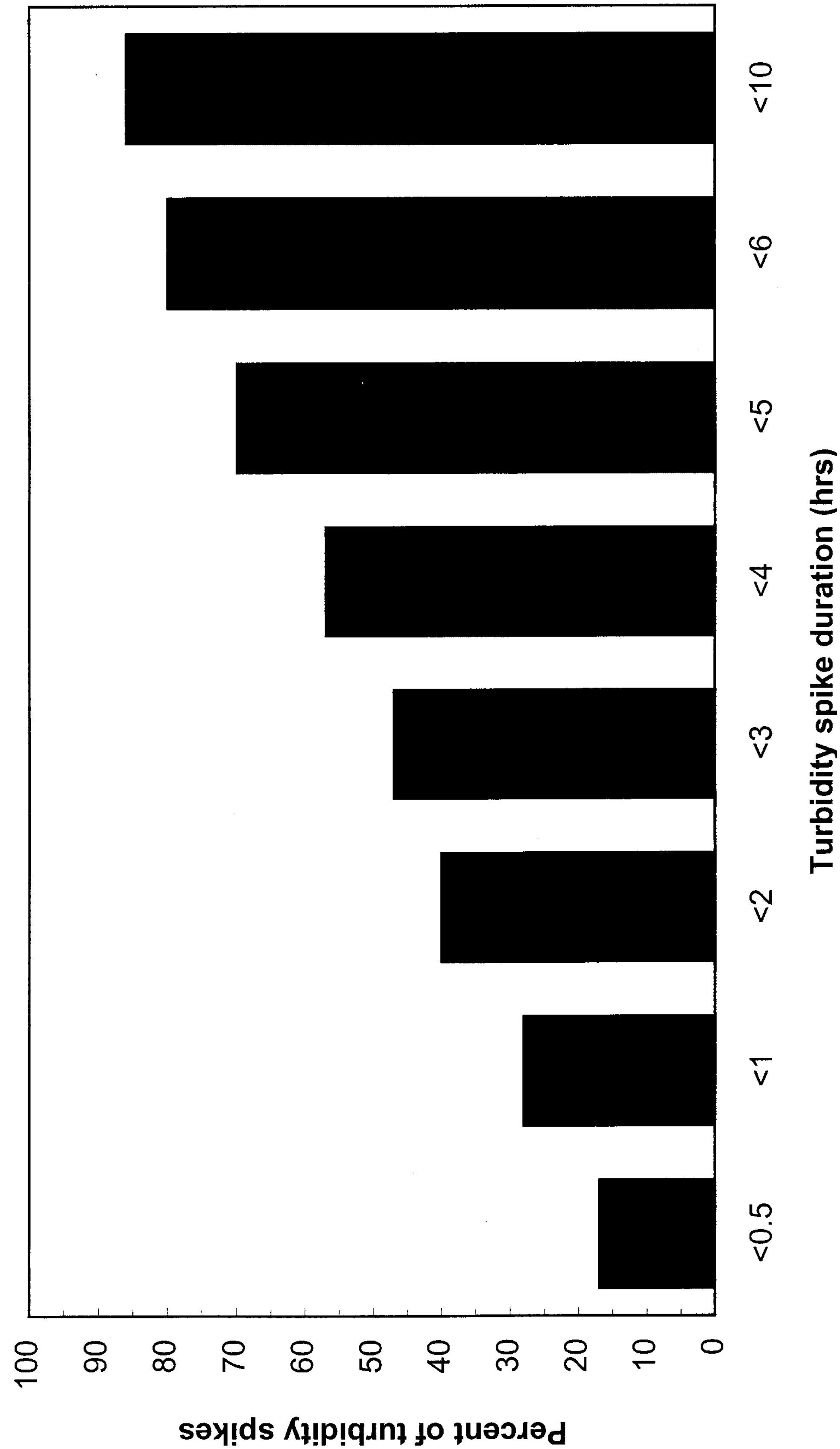


Figure IV.5f Results of Filter Turbidity Spike Analysis - End of Run Spikes by Duration (McTigue 1998, Photorevised EPA 2000)



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Masking of Filter Performance

Combined Filter Effluent monitoring can mask poor performance of individual filters which may allow passage of particulates (including *Cryptosporidium* oocysts). One poorly performing filter, can be effectively ''masked'' by other well operated filters because water from each of the filters is combined before an effluent turbidity measurement is taken. The following example illustrates this phenomenon.

The fictitious City of ''Smithville'' (depicted in Figure IV.6) operates a conventional filtration plant with four rapid granular filters as shown below. Filter number 1 has significant problems because the depth and placement of the media are contributing to elevated turbidities. Filters 2, 3, and 4 do not have these problems and are operating properly.

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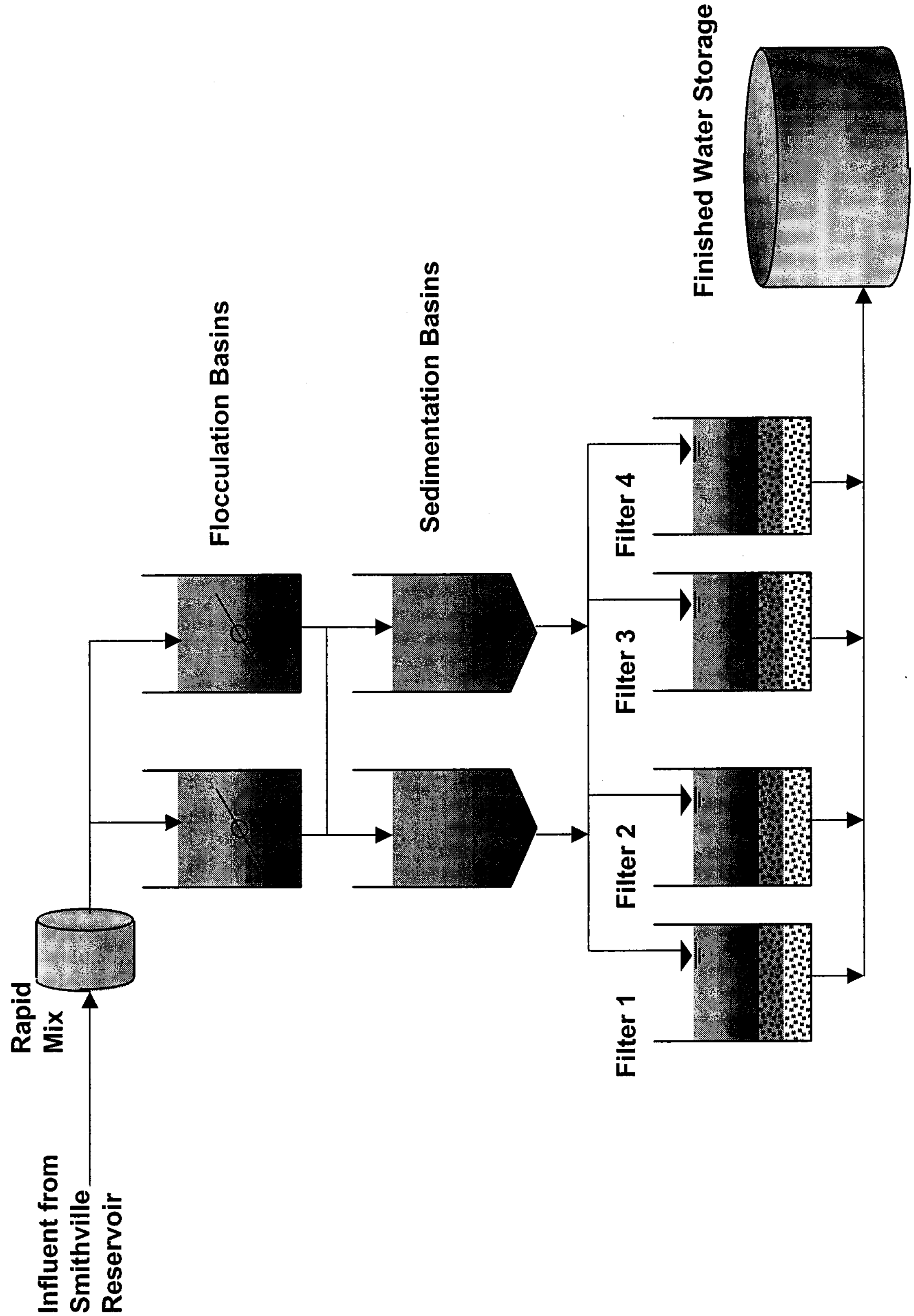
Figure IV.6 Schematic of Conventional Treatment Plant



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Turbidity measurements taken at the clearwell indicate 0.3 NTU. Filter 4 produces water with a turbidity of 0.08 NTU, Filter 3 a turbidity of 0.2 NTU, Filter 2 a turbidity of 0.1 NTU, and Filter 1 a turbidity of 0.9 NTU. Each filter contributes an equal proportion of water, but each is operating at different turbidity levels which contributes to the combined filter effluent of 0.32 NTU. ([0.08+0.2+0.1+0.9]÷4 = 0.32 NTU)

As discussed previously in Section IV.2.a, the Agency believes that a system must meet 0.3 NTU 95 percent of the time an appropriate treatment technique requirement that assures an increased level of *Cryptosporidium* removal. While the fictitious system described above would barely meet the required CFE turbidity, it is entirely possible that they would not be achieving an overall 2 log removal of *Cryptosporidium* with one filter achieving considerably less than 2-log removal. This issue highlights the importance of understanding the performance of individual filters relative to overall plant performance.

iii. Proposed Requirements

Today's proposed rule establishes an individual filter turbidity requirement which applies to all surface water and GWUDI systems using filtration and which serve populations fewer than 10,000 and utilize direct or conventional filtration. In developing this requirement, the Agency evaluated several alternatives (A, B and C) in an attempt to reduce the burden faced by small systems while still providing: (1) A comparable level of public health protection as that afforded to systems serving 10,000 or more people and (2) an early-warning tool systems can use to detect and correct problems with filters.

Alternative A

The first alternative considered by the Agency was requiring direct and conventional filtration systems serving populations fewer than 10,000 to meet the same requirements as established for systems serving 10,000 or more people. This alternative would require that all conventional and direct filtration systems must conduct continuous monitoring of turbidity (one turbidity measurement every 15 minutes) for each individual filter. Systems must provide an exceptions report to the State as part of the existing combined filter effluent reporting process for any of the following circumstances:

(1) Any individual filter with a turbidity level greater than 1.0 NTU based on two consecutive measurements fifteen minutes apart;

(2) Any individual filter with a turbidity greater than 0.5 NTU at the end of the first four hours of filter operation based on two consecutive measurements fifteen minutes apart;

(3) Any individual filter with turbidity levels greater than 1.0 NTU based on two consecutive measurements fifteen minutes apart at any time in each of three consecutive months (the system must, in addition to filing an exceptions report, conduct a self-assessment of the filter); and

(4) Any individual filter with turbidity levels greater than 2.0 NTU based on two consecutive measurements fifteen minutes apart at any time in each of two consecutive months (the system must file an exceptions report and must arrange for a comprehensive performance evaluation (CPE) to be conducted by the State or a third party approved by the State).

Under the first two circumstances identified, a system must produce a filter profile if no obvious reason for the abnormal filter performance can be identified.

Alternative B

The second alternative considered by the Agency represents a slight modification from the individual filter monitoring requirements of large systems. The 0.5 NTU exceptions report trigger would be omitted in an effort to reduce the burden associated with daily data evaluation. Additionally, the filter profile requirement would be removed. Requirement language was slightly modified in an effort to simplify the requirement for small system operators. This alternative would still require that all conventional and direct filtration systems conduct *continuous* monitoring (one turbidity measurement every 15 minutes) for each individual filter, but includes the following three requirements:

(1) A system must provide an exceptions report to the State as part of the existing combined effluent reporting process if any individual filter turbidity measurement exceeds 1.0 NTU (unless the system can show that the next reading is less than 1.0 NTU);

(2) If a system is required to submit an exceptions report for the same filter in three consecutive months, the system must conduct a self-assessment of the filter.

(3) If a system is required to submit an exceptions report for the same filter in two consecutive months which contains an exceedance of 2.0 NTU by the same filter, the system must arrange for a CPE to be conducted by the State or a third party approved by the State.

Alternative C

The third alternative considered by the Agency would include new triggers for reporting and follow-up action in an effort to reduce the daily burden associated with data review. This alternative would still require that all conventional and direct filtration systems must conduct *continuous* monitoring (one turbidity measurement every 15 minutes) for each individual filter, but would include the following three requirements:

(1) A system must provide an exceptions report to the State as part of the existing combined effluent reporting process if filter samples exceed 0.5 NTU in at least 5 percent of the measurements taken each month and/or any individual filter measurement exceeds 2.0 NTU (unless the system can show that the following reading was < 2.0 NTU).

(2) If a system is required to submit an exceptions report for the same filter in three consecutive months the system must conduct a self-assessment of the filter.

(3) If a system is required to submit an exceptions report for the same filter in two consecutive months which contains an exceedance of 2.0 NTU by the same filter, the system must arrange for a CPE to be conducted by the State or a third party approved by the State.

For all three alternatives the requirements regarding self assessments and CPEs are the same. If a CPE is required, the system must arrange for the State or a third party approved by the State to conduct the CPE no later than 30 days following the exceedance. The CPE must be completed and submitted to the State no later than 90 days following the exceedance which triggered the CPE. If a self-assessment is required it must take place within 14 days of the exceedance and the system must report to the State that the self-assessment was conducted. The self assessment must consist of at least the following components:

- assessment of filter performance;
- development of a filter profile;
- identification and prioritization of factors limiting filter performance;
- assessment of the applicability of corrections; and
- preparation of a filter self assessment report.

In considering each of the above alternatives, the Agency attempted to reduce the burden faced by small systems. Each of the three alternatives was judged to provide levels of public health protection comparable to those in the IESWTR for large systems. Alternative A, because it contains the same requirements as IESWTR, was expected to afford the same level of public health protection. Alternative B, (which removes the four-hour 0.5 NTU trigger and the filter profile requirement) was expected to afford comparable health protection because the core components which provide the overwhelming majority of the public health protection (monitoring frequency, trigger which requires follow-up action, and the follow-up actions) are the same as the IESWTR. Alternative C was expected to provide comparable health protection because follow-up action is the same as under the IESWTR and a 0.5 NTU 95percent percentile trigger was expected to identify the same systems which the triggers established under the IESWTR would identify. All three were also considered useful diagnostic tools for small systems to evaluate the performance of filters and correct problems before follow-up action was necessary. The first alternative was viewed as significantly more challenging to implement and burdensome for smaller systems due to the amount of required daily data review. This evaluation was also echoed by small entity representatives during the Agency's SBREFA process as well as stakeholders at each of the public meetings held to discuss issues related to today's proposed rule. While Alternative C reduced burden associated with daily data review, it would institute a very different trigger for small systems than established by the IESWTR for large systems. This was viewed as problematic by several stakeholders who stressed the importance of maintaining similar requirements in order to limit transactional costs and additional State burden. Therefore, the Agency is proposing Alternative B as described above, which allows operators to expend less time to evaluate their turbidity data. Alternative B maintains a comparable level of public health protection as those afforded large systems, reduces much of the burden associated with daily data collection and review (removing the requirement to conduct a filter profile allows systems to review data once a week instead of daily if they so choose), yet still serves as a self-diagnostic tool for operators and provides the mechanism for State follow-up when significant performance problems exist.

iv. Request for Comments

The individual filter monitoring provisions represent a challenging opportunity to provide systems with a useful tool for assessing filters and correcting problems before State intervention is necessary or combined filter turbidity is affected and treatment technique violations occur. The Agency is actively seeking comment on this provision. Because of the complexity of this provision, specific requests for comment have been broken down into five distinct areas.

Comments on the Alternatives

EPA requests comment on today's proposed individual filter requirement and each of the alternatives as well as additional alternatives for this provision such as establishing a different frequency for individual filter monitoring (*e.g.,* 60 minute or 30 minute increments). The Agency also seeks comment or information on:

• Tools and or guidance which would be useful and necessary in order to educate operators on how to comply with individual filter provisions and perform any necessary calculations;

• Data correlating individual filter performance relative to combined filter effluent;

• Contributing factors to turbidity spikes associated with reduced filter performance;

• Practices which contribute to poor individual filter performance and filter spikes; and

• Any additional concerns with individual filter performance.

Modifications to the Alternatives

The Agency also seeks comment on a variety of proposed modifications to the individual filter monitoring alternatives discussed which could be incorporated in order to better address the concerns and realities of small surface water systems. These modifications include:

• Modification of the alternatives to include a provision which would require systems which do not staff the plant during all hours of operation, to utilize an alarm/phone system to alert off-site operators of significantly elevated turbidity levels and poor individual filter performance;

• A modification to allow conventional and direct filtration systems with either 2–3 or less filters to sample combined filter effluent continuously (every 15 minutes) in lieu of monitoring individual filter turbidity. This modification would reduce the data collection/analysis burden for the smallest systems while not compromising the level of public health protection;

• A modification to lengthen the period of time (120 days or a period of time established by the State but not to exceed 120 days) for completion of the CPE and/or a modification to lengthen the requirement that a CPE must be conducted no later than 60 or 90 days following the exceedance; and

• A modification to require systems to notify the State within 24 hours of triggering the CPE or IFA. This would inform States sooner so they can begin to work with systems to address performance of filters and conduct CPEs and IFAs as necessary.

Establishment of Subcategories

The Agency is also evaluating the need to establish subcategories in the final rule for individual filter monitoring/reporting. EPA is currently considering these three categories:

1. Systems serving populations of 3,300 or more persons;

2. Systems with more than 2 filters, but less than 3,300 persons; and

3. Systems with 2 or fewer filters serving populations fewer than 3,300 persons.

Individual filter monitoring requirements would also be based on these subcategories. Systems serving 3,300 or greater would be required to meet the same individual turbidity requirements as the IESWTR (Alternative A as described above). Systems serving fewer than 3,300 but using more than 2 filters would be required to meet a modified version of the IESWTR individual filter requirements (Alternative B as described above). Systems serving fewer than 3,300 and using 2 or fewer filters would continue to monitor and report only combined filter effluent turbidity at an increased frequency (once every 15 minutes, 30 minutes, or one hour).

Input and or comment on cut-offs for subcategories and how to apply subcategories to Alternatives is requested. The Agency would also like to take comment on additional strategies to tailor individual filter monitoring for the smallest systems while continuing to maintain an adequate level of public health protection. Such possible strategies include:

• Since small systems are often understaffed one approach would require those systems utilizing only two or fewer filters to utilize, maintain, and continually operate an alarm/phone system during all hours of operation, which alert off-site operators of significantly elevated turbidity levels and poor individual filter performance and/or automatically shuts the system down if turbidity levels exceed a specified performance level. This modification would be in addition to the proposed requirements.

• Establishing a more general modification which would require systems which do not staff the plant during all hours of operation to utilize an alarm/phone system to alert off-site operators of significantly elevated turbidity levels and poor individual filter performance, and/or to automatically shut the system down if turbidity levels exceed a specified performance level.

- If systems with 2 or fewer filters is allowed to sample combined filter effluent in lieu of individual filter effluent with a frequency of a reading every hour and combined filter effluent turbidity exceeds 0.5 NTU, should the system be required to take grab samples of individual filter turbidity for all filters every 15 minutes until the results of those samples are lower than 0.5 NTU?

Reliability

Maintaining reliable performance at systems using filtration requires that the filters be examined at intervals to determine if problems are developing. This can mean that a filter must go off-line for replacement or upgrades of media, underdrains, backwash lines etc. In order to provide adequate public health protection at small systems, the lack of duplicate units can be a problem. EPA is considering requiring any system with only one filter to install an additional filter. The schedule would be set by the primacy agency, but the filter would have to be installed no later than 6 years after promulgation. EPA is requesting comment on this potential requirement.

Data Gathering Recordkeeping and Reporting

The Agency is evaluating data gathering/reporting requirements for systems. A system collecting data at a frequency of once every 15 minutes, (and operating) 24 hours a day, would record approximately 2800 data points for *each* filter throughout the course of the month. Although the smallest systems in operation today routinely operate on the average of 4 to 12 hours a day (resulting in 480 to 1400 data points per filter), these systems do not typically use sophisticated data recording systems such as SCADAs. The lack of modern equipment at small systems may result in difficulty with retrieving and analyzing data for reporting purposes. While the Agency intends to issue guidance targeted at aiding these systems with the data gathering requirements, EPA is also seeking feedback on a modification to the frequency of data gathering required under each of the aforementioned options. Specifically, the Agency would like to request comment on modifying the frequency for systems serving fewer than 3,300 to continuous monitoring on a 30 or 60 minute basis. EPA also requests comment on the availability and practicality of data systems that would allow small systems, State inspectors, and technical assistance providers to use individual filter turbidity data to improve performance, perform filter analysis, conduct individual filter self assessments, etc. The Agency is interested in *specific* practical combinations of data recorders, charts, hand written recordings from turbidimeters, that would accomplish this.

Failure of Continuous Turbidity Monitoring

Under today's proposed rule, the Agency requires that if there is a failure in the continuous turbidity monitoring equipment, the system must conduct grab sampling every four hours in lieu of continuous monitoring until the turbidimeter is back on-line. A system has five working days to resume continuous monitoring before a violation is incurred. EPA would like to solicit comment on modifying this component to require systems to take grab samples at an increased frequency, specifically every 30 minutes, 1 hour, or 2 hours.

B. Disinfection Benchmarking Requirements

Small systems will be required to comply with the Stage 1 Disinfection Byproduct Rule (Stage 1 DBPR) in the first calendar quarter of 2004. The Stage 1 DBPR set Maximum Contaminant Levels (MCLs) for Total Trihalomethanes (chloroform, bromodichloromethane, chlorodibromomethane, and bromoform), and five Haloacetic Acids (i.e., the sum of the concentrations of mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids.) The LT1FBR follows the principles set forth in earlier FACA negotiations, i.e., that existing microbial protection must not be significantly reduced or undercut as a result of systems taking the necessary steps to comply with the MCL's for TTHM and HAA5 set forth in Stage 1 DBPR. The disinfection benchmarking requirements are designed to ensure that risk from one contaminant is not increased while risk from another contaminant is decreased.

The Stage 1 DBPR was promulgated because disinfectants such as chlorine can react with natural organic and inorganic matter in source water and distribution systems to form disinfection byproducts (DBPs). Results from toxicology studies have shown several DBPs (e.g., bromodichloromethane, bromoform, chloroform, dichloroacetic acid, and bromate) to potentially cause cancer in laboratory animals. Other DBPs (e.g., certain haloacetic acids) have been shown to cause adverse reproductive or developmental effects in laboratory animals. Concern about these health effects may cause public water utilities to consider altering their disinfection practices to minimize health risks to consumers.

A fundamental principle, therefore, of the 1992–1993 regulatory negotiation reflected in the 1994 proposal for the IESWTR was that new standards for control of DBPs must not result in significant increases in microbial risk. This principle was also one of the underlying premises of the 1997 M–DBP Advisory Committee's deliberations, i.e., that existing microbial protection must not be significantly reduced or undercut as a result of systems taking the necessary steps to comply with the MCL's for TTHM and HAA5 set forth in Stage 1 DBPR. The Advisory Committee reached agreement on the use of microbial profiling and benchmarking as a process by which a PWS and the State, working together, could assure that there would be no significant reduction in microbial protection as the result of modifying disinfection practices in order to comply with Stage 1 DBPR.

The process established under the IESWTR has three components: (1) Applicability Monitoring; (2) Disinfection Profiling; and (3) Disinfection Benchmarking. These components have the following three goals respectively: (1) determine which systems have annual average TTHM and HAA5 levels close enough to the MCL (e.g., 80 percent of the MCL) that they may need to consider altering their disinfection practices to comply with Stage 1 DBPR; (2) those systems that have TTHM and HAA5 levels of at least 80 percent of the MCLs must develop a baseline of current microbial inactivation over the period of 1 year; and (3) determine the benchmark, or the month with the lowest average level of microbial inactivation, which becomes the critical period for that year.

The aforementioned components were applied to systems serving 10,000 or more people in the IESWTR and were carried out sequentially. In response to concerns about early implementation (any requirement which would require action prior to 2 years after the promulgation date of the rule), the Agency is considering modifying the IESWTR approach for small systems, as described in the following section. Additionally, the specific provisions have been modified to take into account specific needs of small systems. EPA's goal in developing these requirements is to recognize the specific needs of small system and States, while providing small systems with a useful means of ensuring that existing microbial protection must not be significantly reduced or undercut as a result of systems taking the necessary steps to comply with the MCL's for TTHM and HAA5 set forth in Stage 1 DBPR.

The description of the disinfection benchmarking components of today's proposed rule will be broken into the three segments: (1) Applicability Monitoring; (2) Disinfection Profiling; and (3) Disinfection Benchmarking. Each section will provide an overview and purpose, data, a description of the proposed requirements, and request for comment.

1. Applicability Monitoring

a. Overview and Purpose

The purpose of the TTHM and HAA5 applicability monitoring is to serve as an indicator for systems that are likely to consider making changes to their disinfection practices in order to comply with the Stage 1 DBPR. TTHM samples which equal or exceed 0.064 mg/L and/or HAA5 samples equal or exceed 0.048 mg/L (80 percent of their respective MCLs) represent DBP levels of concern. Systems with TTHM or HAA5 levels exceeding 80 percent of the respective MCLs may consider changing their disinfection practice in order to comply with the Stage 1 DBPR.

b. Data

In 1987, EPA established monitoring requirements for 51 unregulated synthetic organic chemicals. Subsequently, an additional 113 unregulated contaminants were added to the monitoring requirements. Information on TTHMs has become available from the first round of monitoring conducted by systems serving fewer than 10,000 people.

Preliminary analysis of the data from the Unregulated Contaminant Information System (URCIS, Data) suggest that roughly 12 percent of systems serving fewer than 10,000 would exceed 64 μ/L or 80 percent of the MCL for TTHM (Table IV.7). This number is presented only as an indicator, as it represents samples taken at the entrance to distribution systems. In general, TTHMs and HAA5s tend to increase with time as water travels through the distribution system. The Stage 1 Disinfection Byproducts Rule estimated 20 percent of systems serving fewer than 10,000 would exceed 80 percent of the MCLs for either TTHMs or HAA5s or both. EPA is working to improve the knowledge of TTHM and HAA5 formation kinetics in the distribution systems for systems serving fewer than 10,000 people. EPA is currently developing a model to predict the formation of TTHM and HAA5 in the distribution system based on operational measurements. This model is not yet available. In order to develop a better estimate of the percent of small systems that would be triggered into the profiling requirements (i.e., develop a profile of microbial inactivation over a period of 1 year) EPA is considering the following method:

- Use URCIS data to show how many systems serving 10,000 or more people have TTHM levels at or above 0.064 mg/L;
- Compare those values to the data received from the Information Collection Rule for TTHM average values taken at representative points in the distribution system;
- Determine the mathematical factor by which the two values differ; and
- Apply that factor to the URCIS data for systems serving fewer than 10,000 people to estimate the percent of those systems that would have TTHM values at or above 0.064mg/L as an average of values taken at representative points in the distribution system.

TABLE IV.7.—TTHM LEVELS AT SMALL SURFACE SYSTEMS

[Data from Unregulated Contaminant Database, 1987–92 [1]]

System size (population served)	Total number of systems	Number of systems w/ ave. TTHM ≥ 64 μg/L (80 % of MCL)	Maximum level of ave. TTHM (μg/L)
<500	74	0 (0%)	56
501–1,000	44	6 (13.6%)	222
1,001–3,300	114	12 (10.5%)	172
3,301–10,000	116	25 (21.6%)	279
Total	348	43 (12.4%)	279

[1] In Unregulated Contaminant Database (1987–1992), there are ten States (*i.e.*, CA, DE, IN, MD, MI, MO, NC, NY, PR, WV). However, only eight of them can be identified with the data of both population and TTHM for systems serving fewer than 10,000 people (See next page).

The Agency requests comment on this approach to estimating TTHM levels in the distribution system based on TTHM levels at the entry point to the distribution system. The Agency also requests comment on the relationship of HAA5 formation relative to TTHM formation in the distribution system. Specifically, is there data to support the hypothesis that HAA5s do not peak at the same point in the distribution system as TTHMs?

The Agency also received two full years of TTHM data for seventy-four systems in the State of Missouri (Missouri, 1998). This data consisted of quarterly TTHM data, which was converted into an annual average. The data (presented in Table IV.8) demonstrates a very different picture than that displayed by the URCIS data described above. In 1996, 88 percent of the systems exceeded 64 μg/L, while in 1997, 85 percent exceeded 64 μg/L. Figure IV.7 graphically displays this data set.

TABLE IV.8.—TTHM LEVELS AT SMALL SURFACE SYSTEMS IN THE STATE OF MISSOURI

[State of Missouri, 1996, 1997]

Year	Total number of systems	Number of systems w/ ave. TTHM ≥ 64 μg/L (80 percent of MCL)	Maximum Level of Ave. TTHM (μg/L)
1996	74	65 (88%)	276
1997	75	64 (85%)	251
All years	149	129 (87%)	276

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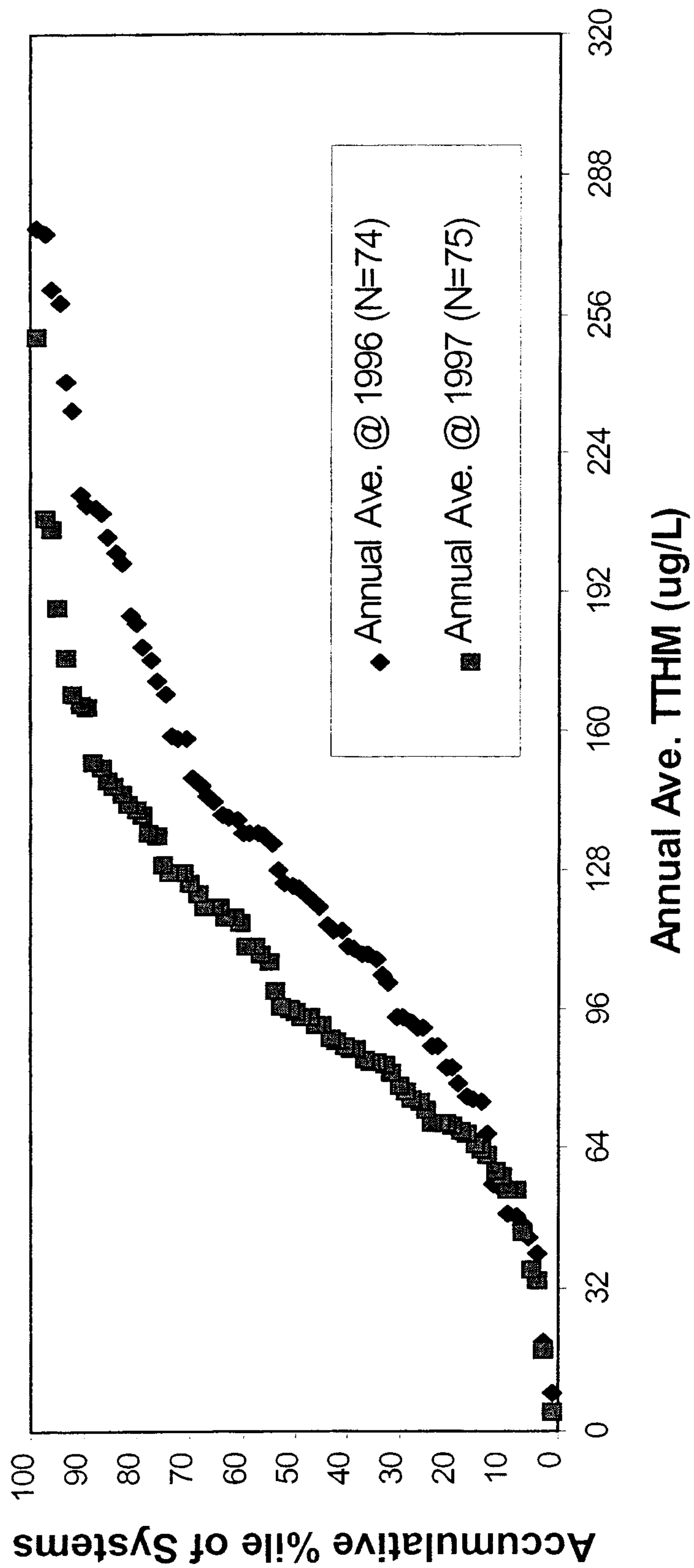
Figure IV.7 Distribution of Annual Ave. TTHM for Small SW Systems (<10,000) in Missouri



There are several potential reasons for the differences between the data shown in Tables IV.7 and IV.8. Data in Table IV.7 contains zero values which may be indicative of no sample being taken rather than a sample with a value of zero. Additionally, data shown in IV.8 was collected within the distribution system, while data in Table IV.7 was taken at the entry point to the distribution system. The data collection method used in collecting the data shown in Table IV.8 is similar to the methodology required under the Stage 1 DBPR.

c. Proposed Requirements

EPA considered four alternatives for systems to use TTHM and HAA5 data to determine which systems whether they would be required to develop a disinfection profile. In today's proposed rule, EPA is proposing Alternative 4.

Alternative 1

The IESWTR required that systems monitor for TTHMs at four points in the distribution system each quarter. At least one of those samples must be taken at a point which represents the maximum residence time of the water in the system. The remaining three must be taken at representative locations in the distribution system, taking into account number of persons served, different sources of water and different treatment methods employed. The results of all analyses per quarter are averaged and reported to the State.

EPA considered applying this alternative to systems serving fewer than 10,000 people and requested input from small system operators and other interested parties, including the public. Based on the feedback EPA received, two other alternatives were developed for consideration (listed as Alternatives 2 and 3).

Alternative 2

EPA considered requiring systems serving fewer than 10,000 people to monitor for TTHM and HAA5 at the point of maximum residence time according to the following schedule:

- No less than once per quarter per treatment plant operated for systems serving populations between 500 and 10,000 persons; and no less than once per year per treatment plant during the month of warmest water temperature for systems serving populations less than 500. If systems wish to take additional samples, however, they would be permitted to do so.
- Systems may consult with States and elect not to perform TTHM and HAA5 monitoring and proceed directly with the development of a disinfection profile.

This alternative provides an applicability monitoring frequency identical to the DBP monitoring frequency under the Stage 1 DBPR that systems will have to comply with in 2004. In addition, it allows systems the flexibility to skip TTHM and HAA5 monitoring completely, pending State approval, and begin profiling immediately.

Alternative 3

EPA considered requiring all systems serving fewer than 10,000 people to monitor once per year per system during the month of warmest water temperature of 2002 and at the point of maximum residence time.

During the SBREFA process and during stakeholder meetings, EPA received some positive comments regarding Alternative 3 as the least burdensome approach. Other stakeholders, however, pointed out that Alternative 3 does not allow systems to measure seasonal variation as is done in Alternative 2 for systems serving populations between 500 and 10,000. Several stakeholders agreed that despite the costs, the information obtained from applicability monitoring will be useful. EPA agrees that it is valuable to systems to monitor and understand the seasonal variation in TTHM and HAA5 values, however, EPA has determined that requiring a full year of monitoring may place an excessive burden on both States and systems. In order to complete a full year of monitoring and another full year of disinfection data gathering, systems would have to start TTHM and HAA5 monitoring January of 2002.

Under SDWA, States have two years to develop their own regulations as part of their primacy requirements, EPA recognized that requiring Applicability Monitoring during this period would pose a burden on States. In response to these concerns, the Agency developed a new alternative, described in the following paragraph.

Alternative 4

Applicability Monitoring is optional and not a requirement under today's proposed rule. If a system has TTHM and HAA5 data taken during the month of warmest water temperature (from 1998–2002) and taken at the point of maximum residence time, they may submit this data to the State prior to [DATE 2 YEARS AFTER PUBLICATION OF FINAL RULE]. If the data shows TTHM and HAA5 levels less than 80 percent of the MCLs, the system does not have to develop a disinfection profile. If the data shows TTHM and HAA5 levels at or above 80 percent of the MCLs, the system would be required to develop a disinfection profile in 2003 as described later in section IV.B.2. If the system does not have, or does not gather TTHM and HAA5 data during the month of warmest water temperature and at the point of maximum residence time in the distribution system as described, then the system would automatically be required to develop a disinfection profile starting January 1 of 2003. This option still provides systems with the necessary tools for assessing potential changes to their disinfection practice, (i.e. the generation of the profile), while not forcing States to pass their primacy regulations, contact all small systems within their jurisdiction, and set up TTHM and HAA5 monitoring all within the first year after promulgation of this rule. Systems will still be able to ensure public health protection by having the disinfection profile when monitoring under Stage 1 DBPR takes effect. It should be noted that EPA estimates the cost for applicability monitoring (as described in Alternative 4) and disinfection profiling (as described in Alternative 3 in Section IV.B.2.c of this preamble) are roughly equivalent. EPA anticipates that systems with known low levels of TOC may opt to conduct the applicability monitoring while the remaining systems will develop a disinfection profile.

d. Request for Comment

EPA requests comment on the proposed requirement, other alternatives listed, or other alternatives that have not yet been raised for consideration. The Agency also requests comment on approaches for determining the percent of systems that would be affected by this requirement. Specifically:

- With respect to Alternative 4, the Agency requests comment on approaches for determining the percent of systems that might demonstrate TTHM and HAA5 levels less than 80 percent of their respective MCLs and would therefore not develop a disinfection profile.
- The Agency requests additional information (similar to the State of Missouri data discussed previously) on the current levels of TTHM and HAA5s in the distribution systems of systems serving fewer than 10,000 people.
- The Agency requests comment on developing a TTHM and HAA5 monitoring scheme during the winter months as opposed to the current monitoring scheme based on the highest TTHM/HAA5 formation potential during the month of warmest water temperature. If a relationship can be established, and shown to be consistent through geographical variations, EPA would consider modifying an alternative so that applicability monitoring would occur during the 1st quarter of 2003.
- The Agency requests comment on modifying Alternative 3, to require systems to begin monitor for TTHMs and HAA5s during the warmest water temperature month of 2003. The results of this monitoring would be used to

determine whether a system would need to develop a disinfection profile during 2004. This option is closer in structure and timing to the IESWTR and has been included for comment. It should be noted, however, that postponing the disinfection profile until 2004 would prevent systems from having inactivation data prior to their compliance date with the Stage 1 DBPR, possibly compromising simultaneous compliance.

2. Disinfection Profiling

a. Overview and Purpose

The disinfection profile is a graphical representation showing how disinfection varies at a given plant over time. The profile gives the plant operator an idea of how seasonal changes in water quality and water demand can have a direct effect on the level of disinfection the plant is achieving.

The strategy of disinfection profiling and benchmarking stemmed from data provided to the EPA and M–DBP Advisory Committee by PWSs and reviewed by stakeholders. The microbial inactivation data (expressed as logs of *Giardia lamblia* inactivation) used by the M–DBP Advisory Committee demonstrated high variability. Inactivation varied by several log on a day-to-day basis at any particular treatment plant and by as much as tens of logs over a year due to changes in water temperature, flow rate (and, consequently, contact time), seasonal changes in residual disinfectant, pH, and disinfectant demand and, consequently, disinfectant residual. There were also differences between years at individual plants. To address these variations, M–DBP stakeholders developed the procedure of profiling inactivation levels at an individual plant over a period of at least one year, and then establishing a benchmark of minimum inactivation as a way to characterize disinfection practice. This approach makes it possible for a plant that may need to change its disinfection practice in order to meet DBP MCLs to determine the impact the change would have on its current level of disinfection or inactivation and, thereby, to assure that there is no significant increase in microbial risk. In order to develop the profile, a system must measure four parameters (EPA is assuming most small systems use chlorine as their disinfection agent, and these requirements are based on this assumption):

(1) Disinfectant residual concentration (C, in mg/L) before or at the first customer and just prior to each additional point of disinfectant addition;

(2) Contact time (T, in minutes) during peak flow conditions;

(3) Water temperature (°C); and

(4) pH.

Systems convert this operational data to a number representing log inactivation values for *Giardia* by using tables provided by EPA. Systems graph this information over time to develop a profile of their microbial inactivation. EPA will prepare guidance specifically developed for small systems to assist in the development of the disinfection profile. Several spreadsheets and simple programs are currently available to aid in calculating microbial inactivation and the Agency intends to make such spreadsheets available in guidance.

b. Data

Figure IV.8a depicts a hypothetical disinfection profile showing seasonal variation in microbial inactivation.

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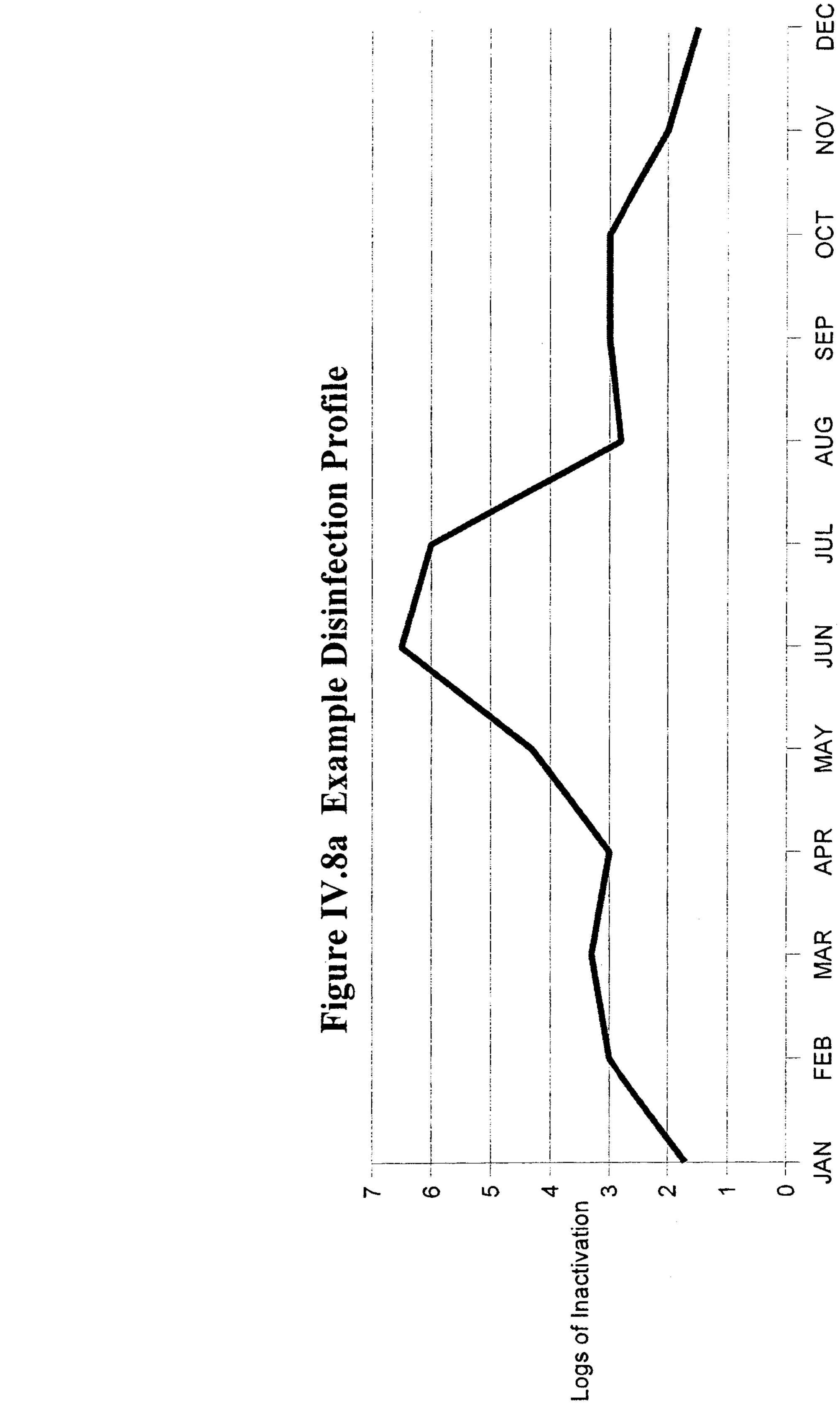

Figure IV.8a Example Disinfection Profile

c. Proposed Requirements

EPA considered four alternatives for requiring systems to develop the disinfection profile.

Alternative 1

The IESWTR requires systems serving 10,000 or more persons to measure the four parameters described above and develop a profile of microbial inactivation on a daily basis. EPA considered extending this requirement to systems serving fewer than 10,000 persons and requested input from small system operators and other interested stakeholders including the public. EPA received feedback that this requirement would place too heavy of a burden on the small system operator for at least two reasons:

- Small system operators are not present at the plant every day; and
- Small systems often have only one operator at a plant who is responsible for all aspects of maintenance, monitoring and operation.

Alternative 2

EPA also considered not requiring the disinfection profile at all. After consideration of the feedback of small system operators and other interested stakeholders, however, EPA believes that there is a strong benefit in the plant operator knowing the level of microbial inactivation, and that the principles developed during the regulation negotiation and Federal Advisory Committee prior to promulgation of the IESWTR could be applied to small systems for the purpose of public health protection. Recognizing the potential burdens the profiling procedures placed on small systems, EPA considered two additional alternatives.

Alternative 3

EPA considered requiring *all* systems serving fewer than 10,000 persons, to develop a disinfection profile based on *weekly* measurements for one year during or prior to 2003. A system with TTHM and HAA5 levels less than 80 percent of the MCLs (based on either required or optional monitoring as described in section IV.B.1) would not be required to conduct disinfection profiling. EPA believes this alternative would save the operator time (in comparison to Alternative 1), and still provide information on seasonal variation over the period of one year.

Alternative 4

Finally, EPA considered a monitoring requirement only during a one month critical monitoring period to be determined by the State. In general, colder temperatures reduce disinfection efficiency. For systems in warmer climates, or climates that do not change very much during the course of the year, the State would identify other critical periods or conditions. This alternative reduces the number of times the operator has to calculate the microbial inactivation.

EPA considered all of the above alternatives, and in today's proposed rule, EPA is proposing Alternative 3. First, this alternative does not require systems to begin monitoring before States have two years to develop their regulations as part of primacy requirements. Given early implementation concerns, the timing of this alternative appears to be the most appropriate in balancing early implementation issues with the need for systems to prepare for implementation of the Stage 1 DBPR and ensuring adequate and effective microbial protection. Second, it allows systems and States which have been proactive in conducting applicability monitoring to reduce costs for those systems which can demonstrate low TTHM and HAA5 levels. Third, this alternative allows systems and States the opportunity to understand seasonal variability in microbial disinfection. Finally, this alternative takes into account the flexibility needed by the smallest systems while maintaining comparable levels of public health protection with the larger systems.

Request for Comments

EPA requests comment on this proposed requirement as well as Alternatives 1,2, and 4. The Agency also requests comment on a possible modification to Alternatives 1, 3 and 4. Under this modification, systems serving populations fewer than 500 would have the opportunity to apply to the State to perform the weekly inactivation calculation (although data weekly data collection would still be required). If the system decided to make a change in disinfection practice, then the State would assist the system with the development of the disinfection profile.

The Agency also requests comment on a modification to Alternative 3 which would require systems to develop a disinfection profile in 2004 only if Applicability Monitoring conducted in 2003 indicated TTHM and HAA5 levels of 80 percent or greater of the MCL. This modification would be coupled with the applicability monitoring modification discussed in the previous section.

3. Disinfection Benchmarking

a. Overview and Purpose

The DBPR requires systems to meet lower MCLs for a number of disinfection byproducts. In order to meet these requirements, many systems will require changes to their current disinfection practices. In order to ensure that current microbial inactivation does not fall below those levels required for adequate *Giardia* and virus inactivation as required by the SWTR, a disinfection benchmark is necessary. A disinfection benchmark represents the lowest average monthly *Giardia* inactivation level achieved by a system. Using this benchmark States and systems can begin to understand the current inactivation achieved at the system, and estimate how changes to disinfection practices will affect inactivation.

b. Data

Based on the hypothetical disinfection profile depicted in Figure IV.8a, the benchmark, or critical period, is the lowest level of inactivation achieved by the system over the course of the year. Figure IV.8b shows that this benchmark (denoted by the dotted line) takes place in December for the hypothetical system.

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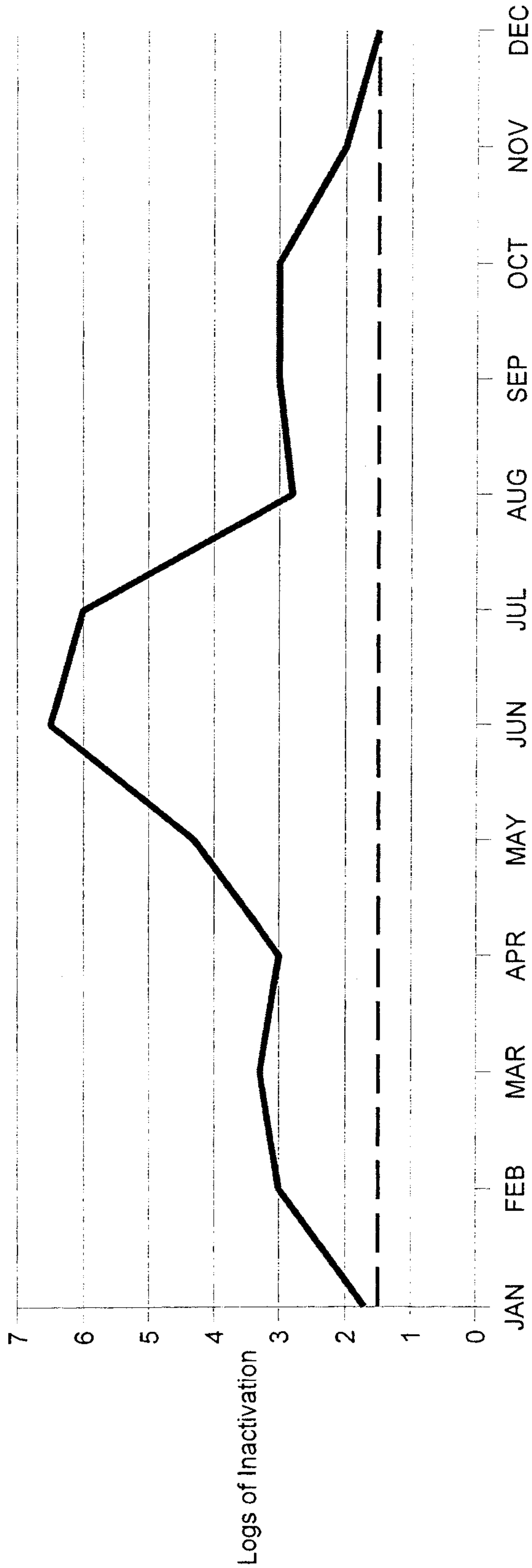

Figure IV.8b Example Disinfection Profile with Benchmark

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c. Proposed Requirements

If a system that is required to produce a disinfection profile decides to make a significant change in disinfection practice after the profile is developed, it must consult with the State and receive approval before implementing such a change. Significant changes in disinfection practice are defined as: (1) moving the point of disinfection (other than routine seasonal changes already approved by the State); (2) changing the type of disinfectant; (3) changing the disinfection process; or (4) making other modifications designated as significant by the State. Supporting materials for such consultation with the State must include a description of the proposed change, the disinfection profile developed under today's proposed rule for *Giardia lamblia* (and, if necessary, viruses for systems using ozone or chloramines), and an analysis of how the proposed change might affect the current level of *Giardia* inactivation. In addition, the State is required to review disinfection profiles as part of its periodic sanitary survey.

A log inactivation benchmark is calculated as follows:

(1) Calculate the average log inactivation for either each calendar month, or critical monitoring period (depending on final rule requirement for the profiling provisions).

(2) Determine the calendar month with the lowest average log inactivation; or lowest inactivation level within the critical monitoring period.

(3) The lowest average month, or lowest level during the critical monitoring period becomes the critical measurement for that year.

(4) If acceptable data from multiple years are available, the average of critical periods for each year becomes the benchmark.

(5) If only one year of data is available, the critical period (lowest monthly average inactivation level) for that year is the benchmark.

d. Request for Comments

EPA has included a requirement that State approval be obtained prior to making a significant change to disinfection practice. EPA requests comment on whether the rule should require State approval or whether only state consultation is necessary.

EPA also requests comment on providing systems serving fewer than 500 the option to provide raw data to the State, and allowing the State to determine the benchmark.

C. Additional Requirements

1. Inclusion of *Cryptosporidium* in definition of GWUDI

a. Overview and Purpose

Groundwater sources are found to be under the direct influence of surface water (GWUDI) if they exhibit specific traits. The SWTR defined ground waters containing *Giardia lamblia* as GWUDI. One such trait is the presence of protozoa such as *Giardia* which migrate from surface water to groundwater. The IESWTR expanded the SWTR's definition of GWUDI to include the presence of *Cryptosporidium*. The Agency believes it appropriate and necessary to extend this modification of the definition of GWUDI to systems serving fewer than 10,000 persons.

b. Data

The Agency issued guidance on the Microscopic Particulate Analysis (MPA) in October 1992 as the Consensus Method for Determining Groundwater Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (EPA, 1992). Additional guidance for making GWUDI determinations is also available (USEPA, 1994a,b). Since 1990, States have acquired substantial experience in making GWUDI determinations and have documented their approaches (Massachusetts Department of Environmental Protection, 1993; Maryland, 1993; Sonoma County Water Agency, 1991). Guidance on existing practices undertaken by States in response to the SWTR may also be found in the State Sanitary Survey Resource Directory, jointly published in December 1995 by EPA and the Association of State Drinking Water Administrators (EPA/ASDWA). AWWARF has also published guidance (Wilson et al., 1996).

Most recently, Hancock et al. (1997) used the MPA test to study the occurrence of *Giardia* and *Cryptosporidium* in the subsurface. They found that, in a study of 383 ground water samples, the presence of *Giardia* correlated with the presence of *Cryptosporidium*. The presence of both pathogens correlated with the amount of sample examined, but not with the month of sampling. There was a correlation between source depth and occurrence of *Giardia* but not *Cryptosporidium*. The investigators also found no correlation between the distance of the ground water source from adjacent surface water and the occurrence of either *Giardia* or *Cryptosporidium*. However, they did find a correlation between distance from a surface water source and generalized MPA risk ratings of high (high represents an MPA score of 20 or greater), medium or low, but no correlation was found with the specific numerical values that are calculated by the MPA scoring system. An additional two reports (SAIC 1997a and 1997b) provide data on wells with *Giardia* cyst and *Cryptosporidium* oocyst recovery and concurrent MPA analysis.

c. Proposed Requirements

In today's proposed rule, EPA is modifying the definition of GWUDI to include *Cryptosporidium* for systems serving fewer than 10,000 persons.

Under the SWTR, States were required to determine whether systems using ground water were using ground water under the direct influence of surface water (GWUDI). State determinations were required to be completed by June 29, 1994 for CWSs and by June 29, 1999 for NCWSs. EPA does not believe that it is necessary to make a new determination of GWUDI for this rule based on the addition of *Cryptosporidium* to the definition of "ground water under the direct influence of surface water". While a new determination is not required, States may elect to conduct a new analysis based on such factors as a new land use pattern (conversion to dairy farming, addition of septic tanks).

EPA does not believe that a new determination is necessary because the current screening methods appear to adequately address the possibility of *Cryptosporidium* in the ground water.

d. Request for Comments

The Agency requests comment on the proposal to modify the definition of GWUDI to include *Cryptosporidium* for systems serving fewer than 10,000 persons.

2. Inclusion of *Cryptosporidium* Watershed Requirements for Unfiltered Systems

a. Overview and Purpose

Existing SWTR requirements for unfiltered surface water and GWUDI systems require these systems to minimize the potential for source water contamination by *Giardia lamblia* and viruses. Because *Cryptosporidium* has proven resistant to levels of disinfection currently practiced at systems throughout the country, the Agency felt it imperative to include *Cryptosporidium* in the watershed control provisions wherever *Giardia lamblia* is mentioned. The IESWTR therefore, modified existing watershed regulatory requirements for unfiltered systems to include the control of

Cryptosporidium. The Agency believes it appropriate and necessary to extend this requirement to systems serving fewer than 10,000 persons.

It should be noted that today's proposed requirements do not replace requirements established for unfiltered systems under the SWTR. Systems must continue to maintain compliance with the requirements of the SWTR for avoidance of filtration. If an unfiltered system fails any of the avoidance criteria, that system must install filtration within 18 months, regardless of future compliance with avoidance criteria.

EPA anticipates that in the planned Long Term 2 Enhanced Surface Water Treatment rule, the Agency will reevaluate treatment requirements necessary to manage risks posed by *Cryptosporidium* and other microbial pathogens in both filtered and unfiltered surface water systems. In conducting this reevaluation, EPA will utilize the results of several large surveys, including the Information Collection Rule (ICR) and ICR Supplemental Surveys, to more fully characterize the occurrence of waterborne pathogens, as well as watershed and water quality parameters which might serve as indicators of pathogen risk level. The LT2ESWTR will also incorporate the results of ongoing research on removal and inactivation efficiencies of treatment processes, as well as studies of pathogen health effects and disease transmission. Promulgation of the LT2ESWTR is currently scheduled for May, 2002.

b. Data

Watershed control requirements were initially established in 1989 (54 FR 27496, June 29, 1989) (EPA, 1989b), as one of a number of preconditions that a public water system using surface water must meet to avoid filtration. The SWTR specifies the conditions under which a system can avoid filtration (40 CFR 141.71). These conditions include good source water quality, as measured by concentrations of coliforms and turbidity; disinfection requirements; watershed control; periodic on-site inspections; the absence of waterborne disease outbreaks; and compliance with the Total Coliform Rule and the MCL for TTHMs. The watershed control program under the SWTR must include a characterization of the watershed hydrology characteristics, land ownership, and activities which may have an adverse effect on source water quality, and must minimize the potential for source water contamination by *Giardia lamblia* and viruses.

The SWTR Guidance Manual (EPA, 1991a) identifies both natural and human-caused sources of contamination to be controlled. These sources include wild animal populations, wastewater treatment plants, grazing animals, feedlots, and recreational activities. The SWTR Guidance Manual recommends that grazing and sewage discharges not be permitted within the watershed of unfiltered systems, but indicates that these activities may be permissible on a case-by-case basis where there is a long detention time and a high degree of dilution between the point of activity and the water intake. Although there are no specific monitoring requirements in the watershed protection program, the non-filtering utility is required to develop State-approved techniques to eliminate or minimize the impact of identified point and non-point sources of pathogenic contamination. The guidance already suggests identifying sources of microbial contamination, other than *Giardia*, transmitted by animals, and points out specifically that *Cryptosporidium* may be present if there is grazing in the watershed.

c. Proposed Requirements

In today's proposed rule, EPA is extending the existing watershed control regulatory requirements for unfiltered systems serving fewer than 10,000 people to include the control of *Cryptosporidium*. *Cryptosporidium* will be included in the watershed control provisions for these systems wherever *Giardia lamblia* is mentioned.

Specifically, the public water system must maintain a watershed control program which minimizes the potential for contamination by *Giardia lamblia,* and *Cryptosporidium* oocysts and viruses in the water. The State must determine whether the watershed control program is adequate to meet this goal. The adequacy of a program to limit potential contamination by *Giardia lamblia* cysts, *Cryptosporidium* oocysts and viruses must be based on: The comprehensiveness of the watershed review; the effectiveness of the system's program to monitor and control detrimental activities occurring in the watershed; and the extent to which the water system has maximized land ownership and/or controlled land use within the watershed.

It should be noted that unfiltered systems must continue to maintain compliance with the requirements of the SWTR for avoidance of filtration. If an unfiltered system fails any of the avoidance criteria, that system must install filtration within 18 months, regardless of future compliance with avoidance criteria.

d. Request for Comments

EPA requests comment on the inclusion of these requirements for unfiltered systems serving fewer than 10,000 people.

3. Requirements for Covering New Reservoirs

a. Overview and Purpose

Open finished water reservoirs, holding tanks, and storage tanks are utilized by public water systems throughout the country. Because these reservoirs are open to the environment and outside influences, they can be subject to the reintroduction of contaminants which the treatment plant was designed to remove. The IESWTR contains a requirement that all newly constructed finished water reservoirs, holding tanks, and storage tanks be covered. The Agency believes it appropriate and necessary to extend this requirement to systems serving fewer than 10,000 people.

b. Data

Existing EPA guidelines recommend that all finished water reservoirs and storage tanks be covered (EPA, 1991b). The American Water Works Association (AWWA) also has issued a policy statement strongly supporting the covering of reservoirs that store potable water (AWWA, 1993). In addition, a survey of nine States was conducted in the summer of 1996 (Montgomery Watson, 1996). The States which were surveyed included several in the West (Oregon, Washington, California, Idaho, Arizona, and Utah), two States in the East known to have water systems with open reservoirs (New York and New Jersey), and one midwestern State (Wisconsin). Seven of the nine States which were surveyed require by direct rule that all new finished water reservoirs and tanks be covered.

Under the IESWTR, systems serving populations of 10,000 or greater were prohibited from constructing uncovered finished water reservoirs after February 16, 1999. The Agency developed an Uncovered Finished Water Reservoirs Guidance Manual (USEPA, 1999f) which provides a basic understanding of the potential sources of external contamination in uncovered finished water reservoirs. It also provides guidance to water treatment operators for evaluating and maintaining water quality in reservoirs. The document discusses:

- Existing regulations and policies pertaining to uncovered reservoirs;
- Development of a reservoir management plan;

• Potential sources of water quality degradation and contamination;
• Operation and maintenance of reservoirs to maintain water quality; and
• Mitigating potential water quality degradation.

As discussed in the 1997 IESWTR NODA (EPA, 1997b), when a finished water reservoir is open to the atmosphere it may be subject to some of the environmental factors that surface water is subject to, depending upon site-specific characteristics and the extent of protection provided. Potential sources of contamination to uncovered reservoirs and tanks include airborne chemicals, surface water runoff, animal carcasses, animal or bird droppings and growth of algae and other aquatic organisms due to sunlight that results in biomass (Bailey and Lippy, 1978). In addition, uncovered reservoirs may be subject to contamination by persons tossing items into the reservoir or illegal swimming (Pluntze 1974; Erb, 1989). Increases in algal cells, heterotrophic plate count (HPC) bacteria, turbidity, color, particle counts, biomass and decreases in chlorine residuals have been reported (Pluntze, 1974, AWWA Committee Report, 1983, Silverman et al., 1983, LeChevallier et al. 1997a).

Small mammals, birds, fish, and the growth of algae may contribute to the microbial degradation of an open finished water reservoir (Graczyk et al., 1996a; Geldreich, 1990; Fayer and Ungar, 1986;). In one study, sea gulls contaminated a 10 million gallon reservoir and increased bacteriological growth, and in another study waterfowl were found to elevate coliform levels in small recreational lakes by twenty times their normal levels (Morra, 1979). Algal growth increases the biomass in the reservoir, which reduces dissolved oxygen and thereby increases the release of iron, manganese, and nutrients from the sediments. This, in turn, supports more growth (Cooke and Carlson, 1989). In addition, algae can cause drinking water taste and odor problems as well as impact water treatment processes. A 1997 study conducted by the City of Seattle (Seattle Public Utilities, 1997) evaluated nutrient loadings by three groups of birds at Seattle's open reservoirs. Table IV.9 indicated the amount of soluble nutrient loadings estimated over the course of the year. It shows that bird feces may contribute nutrient loadings that can enhance algal growth in the reservoir.

TABLE IV.9.—1997 NUTRIENT LOADINGS BY BIRD GROUPS IN SEATTLE'S OPEN RESERVOIRS

Reservoir	Geese		Gulls		Ducks		Overall	
	Nitr. kg/yr	Phos. kg/yr	Nitr. kg/yr	Phos. kg/yr	Nitr. kg/yr	Phos. kg/yr	Total kg/yr	Conc. (mg/L)
Beacon Hill*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bitter Lake	0.82	0.24	0.01	0.00	0.06	0.02	1.15	14.09
Green Lake	1.78	0.52	0.03	0.01	0.53	0.16	3.04	16.05
Lake Forest	2.23	0.65	0.36	0.11	0.07	0.02	3.43	15.09
Lincoln	0.00	0.00	0.24	0.07	0.01	0.00	0.31	3.96
Maple Leaf	2.16	0.63	0.13	0.04	0.35	0.10	3.42	15.43
Myrtle	0.00	0.00	0.08	0.02	0.01	0.00	0.12	4.35
Volunteer	0.00	0.00	0.01	0.00	0.01	0.00	0.03	0.42
West Seattle	0.40	0.12	0.38	0.11	0.02	0.01	1.03	4

c. Proposed Requirements

In today's proposed rule EPA is requiring surface water and GWUDI systems that serve fewer than 10,000 people to cover all new reservoirs, holding tanks or other storage facilities for finished water for which construction begins 60 days after the publication of the final rule in the **Federal Register**. Today's proposed rule does not apply these requirements to existing uncovered finished water reservoirs.

d. Request for Comments

EPA solicits comments regarding the requirement to require that all new reservoirs, holding tanks and storage facilities for finished water be covered.

D. Recycle Provisions for Public Water Systems Employing Rapid Granular Filtration Using Surface Water and GWUDI as a Source

Section 1412(b)(14) of the 1996 SDWA Amendments requires EPA to promulgate a regulation to govern the recycle of filter backwash within the treatment process of public water systems. The Agency is concerned that the recycle of spent filter backwash and other recycle streams may introduce additional *Cryptosporidium* oocysts to the treatment process. Adding oocysts to the treatment process may increase the risk oocysts will occur in finished water supplies and threaten public health. The Agency is further concerned because *Cryptosporidium* is not inactivated by standard disinfection practice, an important treatment barrier employed to control microbial pathogens. Oocysts returned to the plant by recycle flow therefore remain a threat to pass through filters into the finished water.

The Agency engaged in three primary information gathering activities to investigate the potential risk posed by returning recycle flows that may contain *Cryptosporidium* to the treatment process. First, the Agency performed a broad literature search to gather research papers and information on the occurrence of *Cryptosporidium* and organic and inorganic materials in recycle flows. The literature search also sought information regarding the potential impact recycle may have on plant treatment efficiency. Second, the Agency worked with AWWA, AWWSCo., and Cincinnati Water Works to develop twelve issue papers on commonly generated recycle flows (Environmental Engineering and Technology, Inc.,1999). These papers are summarized in the next section. Information from EPA's literature search was incorporated into the issue papers. Third, the Agency presented preliminary data and potential regulatory components to stakeholders, and solicited feedback, at public meetings in Denver, Colorado, and Dallas, Texas. EPA also received valuable input from representatives of small water systems through the SBREFA process.

Through the above activities, the Agency has identified four primary concerns regarding the recycle of spent filter backwash and other recycle streams within the treatment process of PWSs. The first concern is that some recycle flows contain *Cryptosporidium* oocysts, frequently at higher concentrations than plant source waters. Recycling these flows may increase the number of oocysts entering the plant and the number of oocysts reaching the filters. Loading more oocysts to the filters could increase finished water oocyst concentrations. The second concern regards the location in the treatment process recycle flow is returned. The return of recycle at the point of primary coagulant addition or downstream of it may disrupt treatment chemistry by introducing residual coagulant or other treatment chemicals to the process stream and thereby lower plant treatment efficiency. Also, recycle flow returned to the clarification process may not achieve sufficient residence time for oocysts in the recycle flow to be removed, or it may create hydraulic currents that lower the unit's overall oocyst removal efficiency. The third concern regards direct filtration plants. Direct filtration plants do not employ clarification in their primary treatment process to remove suspended solids and oocysts; all oocyst removal is achieved by the filters. If the recycle flow is not treated before being returned to the plant, all of the oocysts captured by a filter during a filter run will be returned to the plant and again loaded to the filters. This may lead to ever increasing levels of oocysts being applied to the filters and could increase the concentration of oocysts in finished water. Therefore, it is important for direct filtration plants to provide adequate recycle flow treatment to remove oocysts and protect the integrity of the filters and finished water quality. Finally, the fourth concern is that the direct recycle of spent filter backwash without first providing treatment, equalization, or some form of hydraulic detention for the recycle flow, may cause plants to exceed State-approved operating capacity during recycle events. This can cause clarification and filter loading rates to be exceeded, which may lower overall oocyst removal provided by the plant and increase finished water oocyst concentrations.

EPA has particular concerns regarding the direct recycle of spent filter backwash water as it is produced (i.e., recycle flow is not retained in an equalization basin, treatment unit, or other hydraulic detention unit prior to reintroduction to the main treatment process) for the following reasons:

(1) Direct recycle may cause operating rates for clarification and filtration to be exceeded, which may lower overall *Cryptosporidium* removal;

(2) Direct recycle may hydraulically upset some plants, lowering overall plant treatment performance, and;

(3) Clarification and filtration operating rates may be exceeded at precisely the time recycle flow may be returning large numbers of oocysts to the treatment process.

The impact of direct recycle practice to smaller plants with few filters is of greatest concern because return of recycle flow can double or triple plant influent flow, which may hydraulically overload the plant and reduce oocyst removal.

Since standard disinfection practice does not inactivate *Cryptosporidium*, its control is entirely dependent on physical removal processes. The Agency is concerned that direct recycle may cause some plants to exceed operating capacity and thus lower their physical removal capabilities. This can increase the risk of oocysts entering the finished water and lead to an increased risk to public health.

The limited data (Cornwell and Lee, 1993) EPA has identified regarding plants with existing equalization and/or treatment indicates they may be at no greater risk of hydraulic upset or degradation of oocyst removal performance than non-recycle plants. Given current data limitations, it is reasonable to assume the presence and utilization of adequate recycle flow equalization and/or treatment processes will alleviate the potential for hydraulic disruptions and the impairment of treatment performance. Data suggesting otherwise is currently unavailable.

The potential for recycle to return significant numbers of oocysts to the treatment train does provide a general basis for concern regarding the impact of recycle practice to finished water quality. However, the Agency does not currently believe data warrants a national regulation requiring all recycle plants to provide recycle flow equalization or treatment for the following reasons:

(1) Data correlating oocyst occurrence in recycle streams to increased oocyst occurrence in finished water is unavailable;

(2) Data regarding the response of full-scale plants to recycle events is limited;

(3) Data is not available to determine the level of recycle flow equalization or treatment full-scale systems may need, if any, to control the risk of oocysts entering finished water, and;

(4) Whether and the extent to which oocyst occurrence in source water influences the necessary level of recycle treatment and equalization is unknown.

The Agency believes requiring plants that may be at greater risk due to recycle, such as direct recycle plants and direct filtration plants, to characterize their recycle practice and provide data to the State for its review provides a cost effective opportunity to increase public health protection and supply a measure of safety to finished drinking water supplies. EPA believes that today's proposal will address potentially higher risk recycle situations that may threaten the performance of some systems, and will do so by allowing State drinking water programs to consider site-specific treatment conditions and needs. The Agency believes these recycle provisions are needed to protect plant performance, the quality of finished water supplies, and to provide an additional measure of public health protection.

1. Treatment Processes That Commonly Recycle and Recycle Flow Occurrence Data

a. Treatment Processes That Commonly Recycle

The purpose of this section is to provide general background on common treatment plant processes, fundamental plant operations, and the origin of plant recycle streams. Detailed information on the specific recycle flows these processes generate are presented after this background discussion. Four general types of water treatment processes, conventional filtration, direct filtration, softening, and contact clarification, are discussed. Although there are numerous variations of these four treatment processes, only the most basic configurations are discussed here. The operation of package plants and options to returning recycle to the treatment process are also summarized.

i. Conventional Treatment Plants

Conventional water filtration plants are defined by the use of four essential unit processes: Rapid mix, coagulation/flocculation, sedimentation, and filtration. Sedimentation employs gravity settling to remove floc and particles. Particles not removed by sedimentation may be removed by the filters. Periodically, accumulated solids must be removed from the sedimentation unit. These solids, termed "residuals," are currently disposed to sanitary sewer, treated with gravity thickening, or some other process prior to returning them to plant headworks or other locations in the treatment train. Clarification processes other than sedimentation may also be used, and they also produce process residuals.

Clarification sludge may be processed on-site if the plant is equipped with solids treatment facilities. Commonly employed treatment processes include thickeners, dewatering equipment (*e.g.*, plate and frame presses, belt filter presses, or centrifuges), and lagoons. Each of these processes produces residual water streams that are currently returned to the treatment process at the headworks or other locations prior to filtration. The volume of residuals produced by clarification depends upon the amount of solids present in the raw water, the dose and type of coagulant applied, and the concentration of solids in the treated water stream.

The one residual stream associated with filtration, spent filter backwash water, is produced during periodic backwashing events performed to remove accumulated solids from the filter. Spent filter backwash is frequently returned to the treatment process at the head of the plant, other locations prior to the filters, or disposed of to sanitary sewer or surface water. Some plants have the capability to send the filtrate produced during the filter ripening period to plant headworks, a raw water reservoir, or to a sanitary sewer or surface water rather than to the clear well as finished water. This practice, referred to as ''filter-to-waste'' is used to prevent solids, which pass through the filter more easily during the ripening period, from entering the finished water.

Filter backwash operations can differ significantly from plant to plant. The main variables are the time between backwashes (length of filter run), the rate of backwash flow, the duration of the backwash cycle, and the backwashing method. The time between filter backwashes is generally a function of either run time, headloss, or solids breakthrough. Both headloss and solids breakthrough can be dependent upon the quality of the sedimentation effluent. Regardless of the variable driving backwash frequency, the interval between backwashes typically vary from 24 to 72 hours. Recommended backwash frequency is every 24–48 hours (ASCE/AWWA, 1998).

There are a number of different methods that can be used to backwash a filter. These include: Upflow water only, upflow water with surface wash, and air/water backwash. Air/water backwash systems typically use 30–50 percent less water than the other two methods. The filter backwash flow rate can vary, depending on media type, water temperature, and backwash method, but generally has a maximum of 15–23 gpm/ft^2 (air/water backwash may have a lower maximum rate of 6–7 gpm/ft^2). A number of different backwash sequences are employed, but a typical backwash consists of a low rate wash (6–7 gpm/ft^2 for several minutes), followed by a high rate wash (15–23 gpm/ft^2 for 5–15 minutes), which is then followed by a final low rate wash (6–7 gpm/ft^2 for several additional minutes). Some treatment plants only use a high rate wash for 15 to 30 minutes. Backwash rates are significantly higher than filtration rates, which vary from 1 to 8 gpm/ft^2.

ii. Direct Filtration Plants

The direct filtration process is similar to conventional treatment, except the clarification process is not present. Direct filtration plants produce the same filter residual as conventional filtration plants, namely filter backwash, and may also generate a filter-to-waste flow. Direct filtration plants do not produce clarification residuals because clarification is not employed. Filter backwash may be either recycled to the head of the plant or discharged to surface waters or a sanitary sewer. Although direct filtration plants generally treat source waters that have low concentrations of suspended material, the solids loading to the filters may be higher than at conventional plants because solids are not removed in a clarification process prior to filtration. If spent filter backwash is not treated to remove solids prior to recycle, solids loading onto the filters will continue to increase over time, as an exit from the treatment process is unavailable. Filter run length may be shorter in some direct filtration plants relative to conventional plants because the solids loading to the filters may be higher due to the lack of a clarification process. The concentration of solids in the source water is a key variable in filter run length.

iii. Softening Plants

Softening plants utilize the same basic treatment processes as conventional treatment plants. Softening plants remove hardness (calcium and magnesium ions) through precipitation, followed by solids removal. Many softening plants employ a two-stage process, which consists of a rapid mix-flocculation-sedimentation sequence, in series, followed by filtration. Others use a single stage process, resembling conventional treatment plants. Precipitation of the calcium and magnesium ions is accomplished through the addition of lime (calcium hydroxide), with or without soda ash (sodium carbonate), which reacts with the calcium and magnesium ions in the raw water to form calcium carbonate and magnesium hydroxide. The precipitation of the calcium carbonate can be improved by recirculating some of the calcium carbonate sludge into the rapid mix unit because the additional solids provide nucleation points for the precipitation of calcium and magnesium. Without this recirculation, additional hydraulic detention time in the flocculation and sedimentation basins may be required to prevent excessive scale deposits in the plant clearwell or in the distribution system.

A softening plant generally has the same residual streams as a conventional plant: Filter backwash, sedimentation solids, and thickener supernatant and dewatering liquids. A filter-to-waste flow may also be generated. These residual streams are either disposed or recycled within the plant. A portion of the sedimentation basin solids are commonly recycled as the sedimentation basin solids contain significant quantities of precipitated calcium carbonate, recycle of these solids reduces the required chemical dose. Solids are generally recycled into the rapid mix chamber to maximize their effectiveness.

iv. Contact Clarification Plants

In the contact clarification process, the flocculation and clarification (and often the rapid mix) processes are combined in one unit, an upflow solids contactor or contact clarifier. Contact clarifiers are employed in both softening and non-softening processes. Raw water flows into the contact clarifier at the top of the central compartment, where chemical addition and rapid mix occurs. The water then flows underneath a skirt and into the outer sedimentation zone where solid separation occurs. A large portion of previously settled solids from the sedimentation zone is circulated to the mixing zone to enhance flocculation. The remainder of the solids are disposed to prevent their accumulation. Circulation and disposal of accumulated solids allows clarifier loading rates to be 10 to 20 times greater than loading rates for conventional sedimentation basins. Solids recirculation rates are generally different for softening and turbidity removal applications, with rates of up to 12 times the raw water flow for softening processes and up to 8 times the raw water flow for non-softening processes (ASCE/AWWA, 1998). Following clarification, treated water from the contactor is then filtered.

The residual streams from contact clarification plants are similar to those for conventional filtration plants. They include filter backwash, clarification solids, thickener supernatant, and dewatering liquids. The key operational consideration for these types of systems is the maintenance of a high concentration of solids within the skirt to allow high loading rates while maintaining adequate solids removal. Solids recirculation (*e.g.*, recycle) helps contact clarification processes maintain the necessary solids concentration.

Softening plants may also generate filter to waste flow.

v. Package Plants

Package plants are typically used to produce between a few thousand to 1 million gallons of water per day. Package plants can employ a conventional treatment train, as well as proprietary unit processes. Package plants typically include the same processes found in large plants, including coagulation, flocculation, clarification and filtration. The potential recycle streams are also comparable. The recycle of filter backwash may occur, however, the typical package plant may not be designed to convey process streams back into the plant as recycle.

vi. Summary of Recycle Disposal Options

Two recycle disposal options available to some plants are direct discharge to sanitary sewers or discharge to surface waters. Discharge of recycle waters to the municipal sewer system may occur when the treatment plant and Publicly Owned Treatment Works (POTW) are under the same authority or when the plant has access to a sanitary sewer and a POTW agrees to accept its discharge.

There may be a fee associated with discharge to a sanitary sewer system, and the total fee may vary with the volume of backwash effluent discharged as well as the amount of solids in the effluent (Cornwell and Lee, 1994). In addition to the fee requirement, discharging into the sewer system may require the plant to equalize the effluent prior to discharging to the POTW. The equalization process requires holding the effluent in tanks and gradually releasing it into the sanitary sewer system. The fee associated with sanitary sewer discharge may influence whether a plant recycles to the treatment process or discharges to a sanitary sewer.

Another option to recycle within the treatment process is the direct discharge of recycle flow to surface waters, such as creeks, streams, rivers, and reservoirs. Direct discharge is a relatively common method of disposal for water treatment plant flows. A National Pollutant Discharge Elimination System (NPDES) permit requires that certain water quality conditions be met prior to the discharge of effluent into surface waters. Treatment of the effluent prior to discharge may be required. The cost of effluent treatment may influence whether plants recycle within the treatment process or discharge to surface water.

b. Recycle Flow Occurrence Data

EPA has not regulated recycle flows in previous rulemakings. The 1996 SDWA Amendments have lead the Agency to perform an examination of recycle flow occurrence data for the first time. EPA discovered through its literature search and its work with AWWA, AWWSCo., and Cincinnati Water Works to develop the issue papers, that the amount of recycle stream occurrence data available is very limited, particularly for *Cryptosporidium*, the primary focus of this regulation. This may be because *Cryptosporidium* was identified as a contaminant of concern relatively recently and because currently available oocyst detection methods have limitations.

Twelve issue papers were developed to compile information on several commonly produced recycle streams. Each individual paper summarizes how the recycle stream is generated, the typical volume generated, characterizes the occurrence of various recycle stream constituents to the extent data allows, (*i.e.*, occurrence of *Cryptosporidium* and inorganic and organic material), and briefly discusses potential impacts of recycling the stream. The discussion of potential impacts is usually brief, due to overall data limitations and particularly due to a lack of data on *Cryptosporidium* occurrence. The 12 recycle streams examined include:

- untreated spent filter backwash water
- gravity settled spent filter backwash water
- combined gravity thickener supernatant (spent filter backwash and clarification process solids)
- gravity thickener supernatant from sedimentation basin solids
- mechanical dewatering device concentrate
- untreated basin solids
- lagoon decant
- sludge drying bed leachate
- monofill leachate membrane concentrate
- ion exchange regenerate
- minor streams

A total of 112 references were used to complete the issue papers, and AWWSCo. and Cincinnati Water Works performed sampling of non-microbial recycle stream constituents to supplement occurrence information.

Cryptosporidium occurrence data was only identified for five recycle streams, namely: untreated spent filter backwash water, gravity settled spent filter backwash water, untreated sedimentation basin solids, combined thickener supernatant, and sludge drying bed leachate. Oocysts may occur in the other recycle streams as well, but published occurrence data was not identified. The issue papers and supporting literature indicate data does not exist to correlate oocyst occurrence in recycle streams to the occurrence of oocysts in finished water. However, the issue papers did identify data showing that oocysts occur in recycle streams, often at concentrations higher than that of the source water.

Cryptosporidium is not the only constituent of recycle waters. Other common constituents are manganese, iron, aluminum, disinfection byproducts, organic carbon, *Giardia* lamblia and particles. EPA does not currently have data to indicate these constituents occur in recycle streams at levels which threaten treatment plant performance, finished water quality, or public health. Additionally, current regulations may largely control any minor risk these constituents may present. For example, organic matter in recycle flow may form disinfection byproducts in the presence of oxidants. The Stage 1 DBPR, which requires monitoring for disinfection byproducts, will identify systems experiencing disinfection byproduct occurrence above or near applicable MCLs through distribution system monitoring. Additionally, Secondary Maximum Contaminant Levels (SMCLs) have been promulgated to control occurrence of aluminum, iron, and manganese at levels of .05–.2 mg/l, .3 mg/l, and .05 mg/l, respectively. Particle levels are controlled by effluent turbidity standards and *Giardia* lamblia is controlled through a combination of disinfection and filtration requirements. EPA believes existing regulations control these recycle stream constituents. Therefore, their control is not a primary goal of today's proposal. Additionally, detailed discussion of these constituents is not provided in the below summary of the issue papers because: (1) control of *Cryptosporidium* is the focus of the recycle provisions, and; (2) concentrations of inorganic and organic materials reported in the issue papers are for recycle streams, not finished water occurrence. The recycle stream concentrations will be significantly diluted by mixing with source water.

The occurrence of recycle flow constituents other than *Cryptosporidium* is not discussed in today's preamble for the above reasons. The following discussion of recycle stream occurrence data covers only untreated spent filter backwash water, gravity settled spent filter backwash water, combined gravity thickener supernatant (a combination of spent filter backwash and clarification process solids), gravity thickener supernatant from clarification process solids, and mechanical dewatering device liquids. These five recycle streams are discussed in detail because they are most likely to present a threat to treatment plant performance or finished water quality when recycled. For example, treated and untreated spent filter backwash water and thickener supernatant are the only two recycle streams of sufficient volume to cause plants to exceed their operating capacity during recycle events. The five recycle streams discussed below are also most likely to contain *Cryptosporidium*.

Copies of all the issue papers are available for public review in the Office of Water docket for this rulemaking. Portions of the following recycle stream descriptions use excerpts from the issue papers.

i. Untreated Spent Filter Backwash Water

Water treatment plants that employ rapid granular filtration (e.g., conventional, softening, direct filtration, contact clarification) generate spent filter backwash water. The backwash water is generated when water is forced through the filter, counter-current to the flow direction during treatment operations, to dislodge and remove accumulated particles and pathogens residing in the filter media. Backwash rates are typically five to eight times the process rate, and are used to clean the filter at the end of a filter run, which is generally 24 to 72 hours in length. Backwash operations usually last from 10 to 25 minutes. The flow rate and duration of backwashing are the primary factors that determine the volume of backwash water produced. Once the backwashing process is complete, the backwash water and entrained solids are either disposed of to a sanitary sewer, discharged to a surface water, or returned to the treatment process. Plants currently return spent filter backwash to the treatment process at a variety of locations, usually between plant headworks and clarification. Data regarding common recycle return locations is discussed in the next section of this preamble.

Spent filter backwash can be returned to the treatment process directly as it is produced, be detained in an equalization basin, or passed through a treatment process, such as clarification, prior to being returned to the plant. On a daily basis, spent filter backwash can range from 2 to 10 percent of plant production. Spent filter backwash is usually produced on an intermittent basis, but large plants with numerous filters may produce it continuously. At small and mid-size plants, large volume, short duration flows of spent filter backwash are usually produced. This may cause some plants, particularly smaller plants that recycle directly without flow equalization or treatment, to exceed their operating capacity or to experience hydraulic disruptions, both of which may negatively impact treatment efficiency and oocyst removal.

The concentrations of *Cryptosporidium* reported in the untreated spent filter backwash issue paper ranges from non-detect to a concentration of 18,421 oocysts per 100 L. This range is not amenable to formal statistical analysis, but rather provides a summary of minimum and maximum oocyst concentrations reported in available literature. Although a few studies report isolated data points of greater than 10,000 oocysts/100L for filter backwash water (Rose *et al.*, 1989; Cornwell and Lee, 1993; Colbourne, 1989), occurrence studies that collected the largest number of samples reported mean filter backwash oocyst occurrence concentrations of a few hundred oocysts per 100L (States *et al.*, 1997; Karanis *et al.*, 1996). The high concentration of oocysts found in some spent filter backwash samples is cause for concern, because oocysts are not inactivated by standard disinfection practice. They remain a threat to pass through the plant into the finished water if they are returned to the treatment process. However, current oocyst detection methods do not allow the occurrence of oocysts in spent filter backwash water to be correlated to finished water oocyst concentrations for a range of plant types, source water qualities, and recycle practices. Today's proposal does not require the installation of recycle equalization or treatment for spent filter backwash water on a national basis due to these data limitations.

The Agency is concerned that certain recycle practices, such as returning spent filter backwash to locations other than prior to the point of primary coagulant addition, or hydraulically overloading the plant with recycle flow so it exceeds its State approved operating capacity, may present risk to finished water quality and public health. Exceeding plant operating capacity during recycle events may cause greater risk to finished water quality, because plant performance is potentially being lowered at precisely the time oocysts are returned to the plant in the recycle flow. To address this concern, today's proposal requires that certain direct recycle plants that recycle spent filter backwash water and/or thickener supernatant to perform a self assessment of their recycle practice and report the results to the State. The self assessment requirements are discussed in detail later in this preamble.

ii. Gravity Settled Spent Filter Backwash Water

Gravity settled spent filter backwash water is generated by the same filter backwash process and is produced in the same volume as untreated spent filter backwash water. The difference between the two streams is that the former is treated by gravity settling prior to its return to the primary treatment process. Sedimentation treatment is usually accomplished by retaining the spent filter backwash water in a treatment unit for a period of time to allow suspended solids (including oocysts) to settle to the bottom of the basin. Polymer may be used to improve process efficiency. The water that leaves the basin is gravity settled spent filter backwash water. Removing solids from the spent filter backwash causes only a minor reduction in volume as the solids content of the untreated stream is low, usually below 1 percent.

Providing gravity settling for spent filter backwash is advantageous for two reasons. First, the sedimentation process detains the spent filter backwash in treatment basins for a period of hours, which lowers the possibility a large recycle volume will be returned to the plant in a short amount of time and cause the plant operating capacity to be exceeded. Second, treating the spent filter backwash flow can remove *Cryptosporidium* oocysts from the flow, which will reduce the number of oocysts returned to the plant.

Limited data show that sedimentation can effectively remove oocysts. Cornwell and Lee (1993) conducted limited sampling of spent filter backwash water at two plants prior to and after sedimentation treatment. The first facility practiced direct filtration and was sampled twice. The *Cryptosporidium* concentrations into and out of the sedimentation basin treating spent filter backwash were 900/100L and 140/100L, respectively, for the first sampling and 850/100L in the influent and 750/100L in the effluent for the second sampling. At the second plant a sludge settling pond received both sedimentation basin sludge and spent filter backwash, and the spent filter backwash oocyst concentration was 16,500/100L, and the treated recycle water concentration was 420/100L. In a study by Karanis (1996), *Cryptosporidium* was regularly detected in settled backwash waters. Of the 50 samples collected, 82 percent tested positive for *Cryptosporidium.* The mean value for *Cryptosporidium* was 22 oocysts/100L.

Sedimentation treatment can remove oocysts from spent filter backwash, but data indicate oocysts remain in gravity settled spent filter backwash water even after treatment. The Agency believes that sedimentation treatment for spent filter backwash waters is capable of removing oocysts and improving the quality of the water prior to recycle. However, given current data limitations, the Agency does not believe it is possible to specify, in a national regulation, the conditions (*e.g.*, source water oocyst concentrations, primary treatment train performance, concentration of oocysts in spent filter backwash, ability of sedimentation to remove oocysts under a range of conditions) under which sedimentation treatment of spent filter backwash water may be appropriate. This decision is best made by State programs to allow consideration of site-specific conditions and treatment needs.

iii. Combined Gravity Thickener Supernatant

Combined gravity thickener supernatant is derived from the treatment of filter backwash water and sedimentation basin solids in gravity thickener units. These two flows may not reside in the thickener at the same time or in equal volumes, depending on plant operations. The volume of thickener supernatant generated at a water treatment plant is a function of the type of flows it treats, the solids content of the influent stream, and the method of thickener operation. Regardless of whether a continuous or a batch process is used, a number of factors, including residuals production (a function of plant production, raw water suspended solids, and coagulant dose), volume of spent filter backwash water produced, and the level of treatment provided to thickener influent streams, directly affect the quantity of thickener supernatant produced.

The flow entering the thickener is primarily spent filter backwash water. Sedimentation basin solids is the second largest flow. Flow from dewatering devices, which is generated by the dewatering of residuals, may comprise a minor volume entering the thickener. Combined thickeners will have an influent that may be eighty-percent spent filter backwash or more by volume. About eighty-percent of the solids entering the thickener will be from the sedimentation basin sludge, as spent filter backwash water has a comparatively low solids concentration.

A recent FAX survey (AWWA, 1998) identified more than 300 water treatment plants in the United States with production capacities ranging from less than 2 mgd to greater than 50 mgd that recycle spent filter backwash water. Many of the survey respondents indicated that they recycle more than just spent filter backwash water. Based on the survey and published literature, thickener supernatant is probably the second largest and second most frequently recycled stream at water treatment facilities after spent filter backwash.

Data summarized in the issue paper showed that thickener supernatant quality varies widely, due in large part because the type and quality of recycle streams entering thickeners varies over time and from plant to plant. The turbidity, total suspended solids, and particle counts of thickener effluent are directly impacted by the quality of water loaded onto the thickener, thickener design, and thickener operation (e.g., residence time, use of polymer).

Data on the occurrence of *Cryptosporidium* was limited to two samples, with oocyst occurrence ranging from 82 to 420 oocysts per 100 L. Data is too limited, and practice varies too widely, to draw conclusions on the impact recycle of this flow may have on plant performance. However, given that the contents of the thickener have been treated and the amount of flow produced by gravity thickeners is relatively modest, it may be feasible to recycle the flow in a manner that minimizes adverse impact. Additionally, treatment plant personnel have a vested interest in optimizing thickener operation to minimize sludge dewatering and handling costs; optimization of thickener operation is likely to assist oocyst removal. However, additional data is needed to characterize the occurrence of *Cryptosporidium* and the potential impact recycle of combined thickener supernatant may have on finished water quality.

iv. Gravity Thickener Supernatant from Sedimentation Solids

Gravity settled sedimentation basin solids are sedimentation basin solids that have undergone settling to allow solid sludge components to settle to the bottom of a gravity thickener. The supernatant from the thickener is a potential recycle flow. The tank bottom is sloped to enhance solids thickening and collection and removal of settled solids is accomplished with a bottom scraper mechanism. If the supernatant is recycled, it can be returned to the plant continuously or intermittently, depending on whether the thickener is operated in batch mode. Thickeners may receive and treat both spent filter backwash water and sedimentation basin solids. For purposes of this discussion, and the data presented in the issue paper, the gravity thickener is only receiving sedimentation basin solids.

The volume of treated sedimentation basin solids supernatant generated is dependent on the amount of sludge produced in the sedimentation basin, the solids content of the sludge, and method of thickener operation. Sludge production is a function of plant production, raw water suspended solids, coagulant type, and coagulant dose. The quantity of sedimentation basin sludge supernatant is approximately 75 to 90 percent of the original volume of sedimentation basin sludge produced.

There is a very limited amount of data on the quality of thickener supernatant produced by gravity settling of only sedimentation basin solids (i.e., spent filter backwash and other flows are not added to the thickener), and no data was identified regarding the concentration of *Cryptosporidium* that occur in the supernatant. As is the case with combined gravity thickener supernatant, it is difficult to determine what impact, if any, the return of the supernatant may have on plant operations and finished water quality due to limited data. Additional data is necessary to determine the concentration of oocysts in this recycle stream, and to characterize the impact its recycle may have to plant performance.

v. Mechanical Dewatering Device Liquids

Water treatment plant residuals (usually thickened sludge) are usually dewatered prior to disposal to remove water and reduce volume. Two common mechanical dewatering devices used to separate solids from water are the belt filter press, which compresses the residuals between two continuous porous belts stretched over a series of rollers, and the centrifuge, which applies a strong centrifugal force to separate solids from water. The plate and frame press is another dewatering device that contains a series of filter plates, supported and contained in a structured frame, which separate sludge solids from water using a positive pressure differential as the driving force. Water removed from the solids with a belt filter press is called filtrate, from a filter press it is called pressate, and the water separated from the residuals with a centrifuge is referred to as centrate.

These streams will be collectively referred to as ''dewatering liquid'' for the following discussion.

The volume of dewatering liquid produced depends primarily on the volume and solids content of the thickened residuals fed to the mechanical dewatering device. Plants that produce small sludge volumes, and hence a low volume of thickener residuals, will process fewer residuals in the mechanical dewatering device and hence produce a smaller volume of dewatering liquid than a plant producing a large volume of solids, all else being equal. Since residuals are often thickened (typically to about 2 percent solids) prior to dewatering, the volume of the dewatering device feed stream is significantly lower than the volume of sedimentation basin residuals generated. If the sedimentation basin sludge flow is assumed to be 0.6 percent of plant production, then dewatering device flow may be approximately 0.1 to 0.2 percent of plant flow. Generally these streams are mixed in with other recycle streams prior to being returned to the plant. Mechanical dewatering devices may be operated intermittently, after a suitable volume of residuals have been produced for dewatering. The production of dewatering liquid and its recycle may not be a continuous process.

Data on the constituents in dewatering liquid were found in three references, one on belt filter press liquids, one on plate and frame pressate, and one on centrifuge centrate. Data on the occurrence of *Cryptosporidium* was not identified. Given the small, intermittent flow produced by mechanical dewatering devices, recycle flows from them are unlikely to cause plants to exceed operating capacity. However, it is possible that dewatering device liquid contains *Cryptosporidium* because it derived from solids likely to hold a large numbers of oocysts. Additional data is necessary to determine the concentration of oocysts in this recycle stream, and to characterize any impact its recycle may have to plant performance.

2. National Recycle Practices

a. Information Collection Rule

Public water systems affected by the ICR were required to report whether recycle is practiced and sample washwater (i.e., recycle flow) between the washwater treatment plant (if one existed) and the point at which recycle is added to the process train. Sampling of plant recycle flow was required prior to blending with the process train. Monthly samples were required for pH, alkalinity, turbidity, temperature, calcium and total hardness, TOC, UV_{254}, bromide, ammonia, and disinfectant residual if disinfectant was used. Systems were also required to measure recycle flow at the time of sampling, the twenty four hour average flow prior to sampling, and report whether treatment of the recycle was provided and, if so, the type of treatment. Reportable treatment types were plain sedimentation, coagulation and sedimentation, filtration, disinfection, or a description of an alternative treatment type. Plants were also required to submit a plant schematic to identify sampling locations. EPA used the sampling schematics and other reported information to compile a database of national recycle practice.

i. Recycle Practice

The Agency developed a database from the ICR sampling schematics and other reported information. Table IV.10 summarizes the plants in the database. Of the 502 plants in the database at the time the analysis was performed, 362 used rapid granular filtration.

TABLE IV.10.—RECYCLE PRACTICE AT ICR PLANTS

Plant classification	Number
All ICR plants	502
Filtration plants [a]	362
Filtration plants recycling [b]	226
Filtration plants treating recycle	148
Recycle plants serving ≥100,000	168
Recycle plants serving <100,000	58

[a] Defined as conventional, lime softening, other softening, and direct filtration plants.
[b] Plants report existence of a recycle stream, not its origin.

These plants are classified as conventional, lime softening, other softening, and direct filtration. The remaining 140 plants in the database do not employ rapid granular filtration capability and generally provide disinfection for ground water. Of the 362 filtration plants in the database, 226 (62.4 percent) reported recycling to the treatment process. Seventy-four percent of the plants that recycle serve populations greater than 100,000 and 26 percent serve populations below 100,000. Figure IV.9 shows the distribution of plants by treatment type and Figure IV.10 shows the distribution of plants by population served. Table IV.11 shows that 88 percent of ICR recycle plants use surface water. An additional one percent use GWUDI and another one percent use a combination of ground water and surface water. Therefore, 90 percent of ICR recycle plants use a source water that could contain *Cryptosporidium*.

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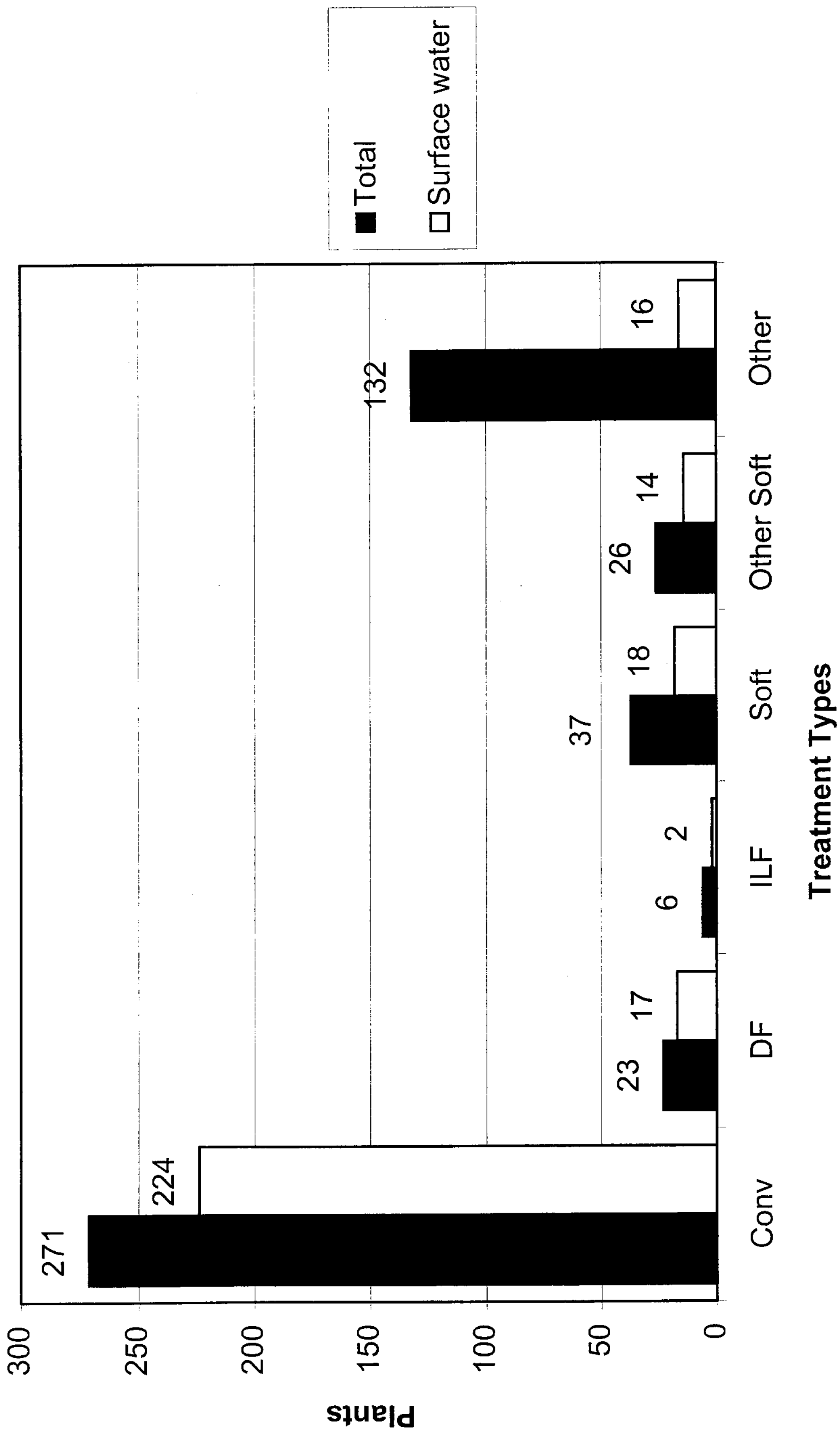

Figure IV.9 ICR Plants by Treatment Train Type

Figure IV.10 ICR Recycle Plants by Population Served

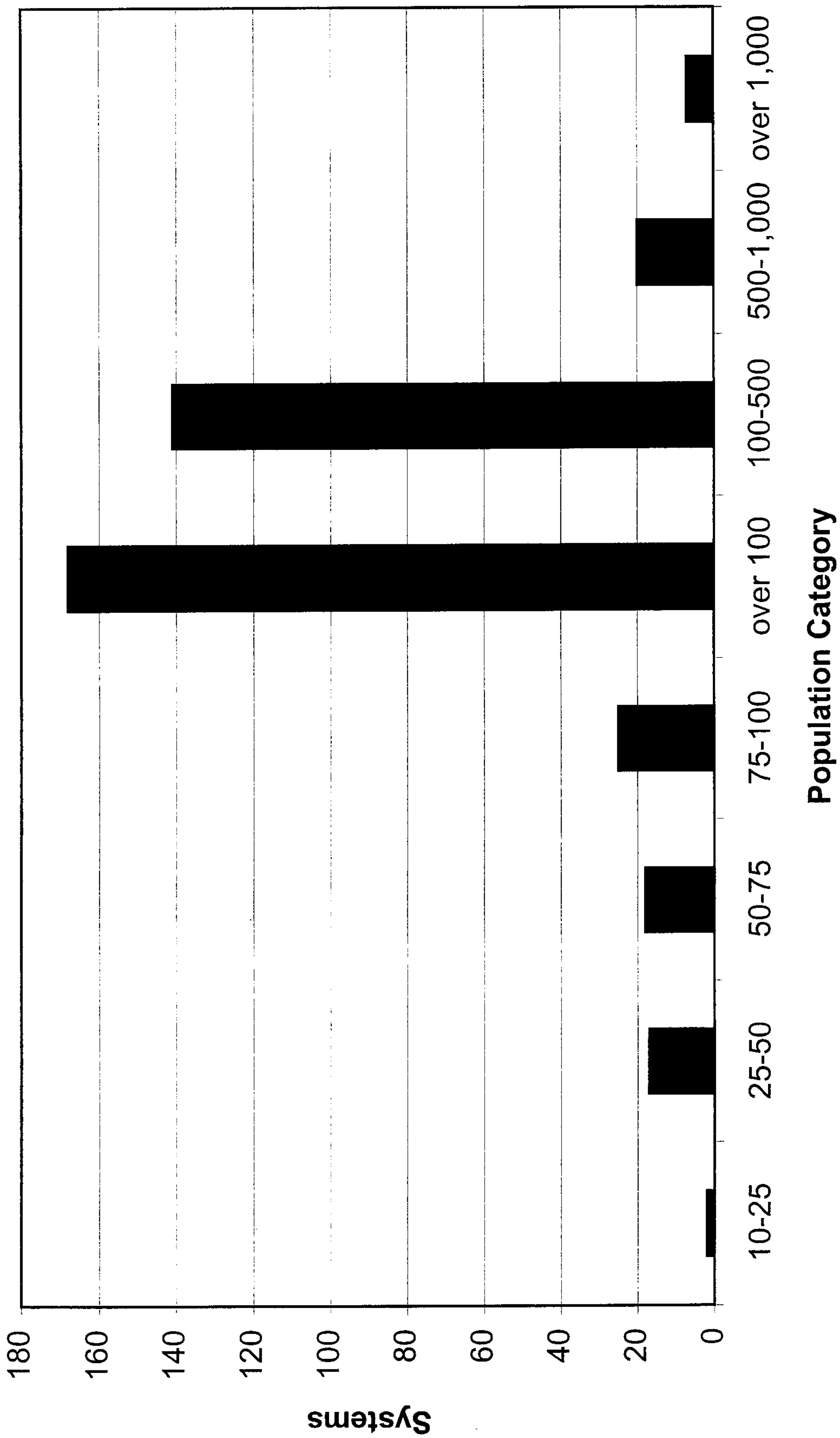

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TABLE IV.11.—SOURCE WATER USE BY ICR RECYCLE PLANTS

Source water type	Number of plants	Percent of recycle plants
Total number of recycle plants	226	100
Surface Water	199	88
Ground water under the influence	3	1
Ground water and surface water	2	1
Ground water only	22	10

Table IV.12 shows that 65 percent of ICR recycle plants report providing treatment for the recycle flow. The percentage of plants providing treatment is the same for the subsets of plants serving greater than and less than 100,000 people. Sedimentation is the most widely reported treatment method, as 77 percent of plants providing treatment employ it. The database does not provide information on the solids removal efficiency of the sedimentation units. All direct filtration plants practicing recycle reported providing treatment for the recycle flow.

TABLE IV.12.—TREATMENT OF RECYCLE AT ICR PLANTS [1]

ICR recycling plants	Number of plants	Percentage of recycle plants
Number of recycle plants	226	100
Practice recycle treatment	147	65
Use sedimentation	114	77
Use sedimentation/coagulation	14	10
Use two or more treatments	14	10
Other treatment	5	3

[1] Disinfection not counted as treatment because it does not inactivate *Cryptosporidium*.

Table IV.13 indicates that 75 percent of ICR recycle plants return recycle prior to rapid mix. Fifteen percent return it prior to sedimentation, and ten percent of plants return it prior to filtration. These percentages hold for the subsets of plants serving greater than and less than 100,000 people. The data indicate that introducing recycle prior to rapid mix may be a common practice. EPA believes that introducing recycle flow prior to the point of primary coagulant addition, is the best recycle return location because it limits the possibility residual treatment chemicals in the recycle flow will disrupt treatment chemistry.

TABLE IV.13.—RECYCLE RETURN POINT

Point of recycle return	Number of plants	percent of plants
Number of recycle plants	[1]224	100
Prior to point of primary coagulant addition	169	75
Prior to sedimentation	34	15
Prior to filtration	21	10

[1] Recycle return point could not be determined for two plants.

The data provides the following conclusions regarding the recycle practice of ICR plants: (1) The recycle of spent filter backwash and other process streams is a common practice; (2) the great majority of recycle plants in the database use filtration and surface water sources; (3) a majority of plants in the database that recycle provide treatment for recycle flow, and; (4) a large majority of plants in the database that recycle (approximately 3 out of 4) recycle prior to the point of primary coagulant addition.

b. Recycle FAX Survey

The AWWA sent a FAX survey (AWWA, 1998) to its membership in June 1998 to gather information on recycle practices. Plants were not targeted based on source water type, the type of treatment process employed, or any other factor. The survey was sent to the broad membership to increase the number of responses. Responses indicating a plant recycled spent filter backwash or other flows were compiled to create a database. The resulting database included 335 plants. The database does not contain information from respondents who reported recycle was not practiced. Data from some of the FAX survey respondents also populates the ICR database. Plants in the database are well distributed geographically and represent a broad range of plant sizes as measured by capacity. Figure IV.11 shows plant distribution by capacity and Figure IV.12 by geographic location. The following discussion of FAX survey data is divided into two sections. The first discusses national recycle practice and the second discusses options for recycle disposal in lieu of returning recycle to the treatment process.

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Figure IV.11 Distribution of Fax Survey Plants by Plant Capacity

(Environmental Engineering and Technology, Inc., 1998)

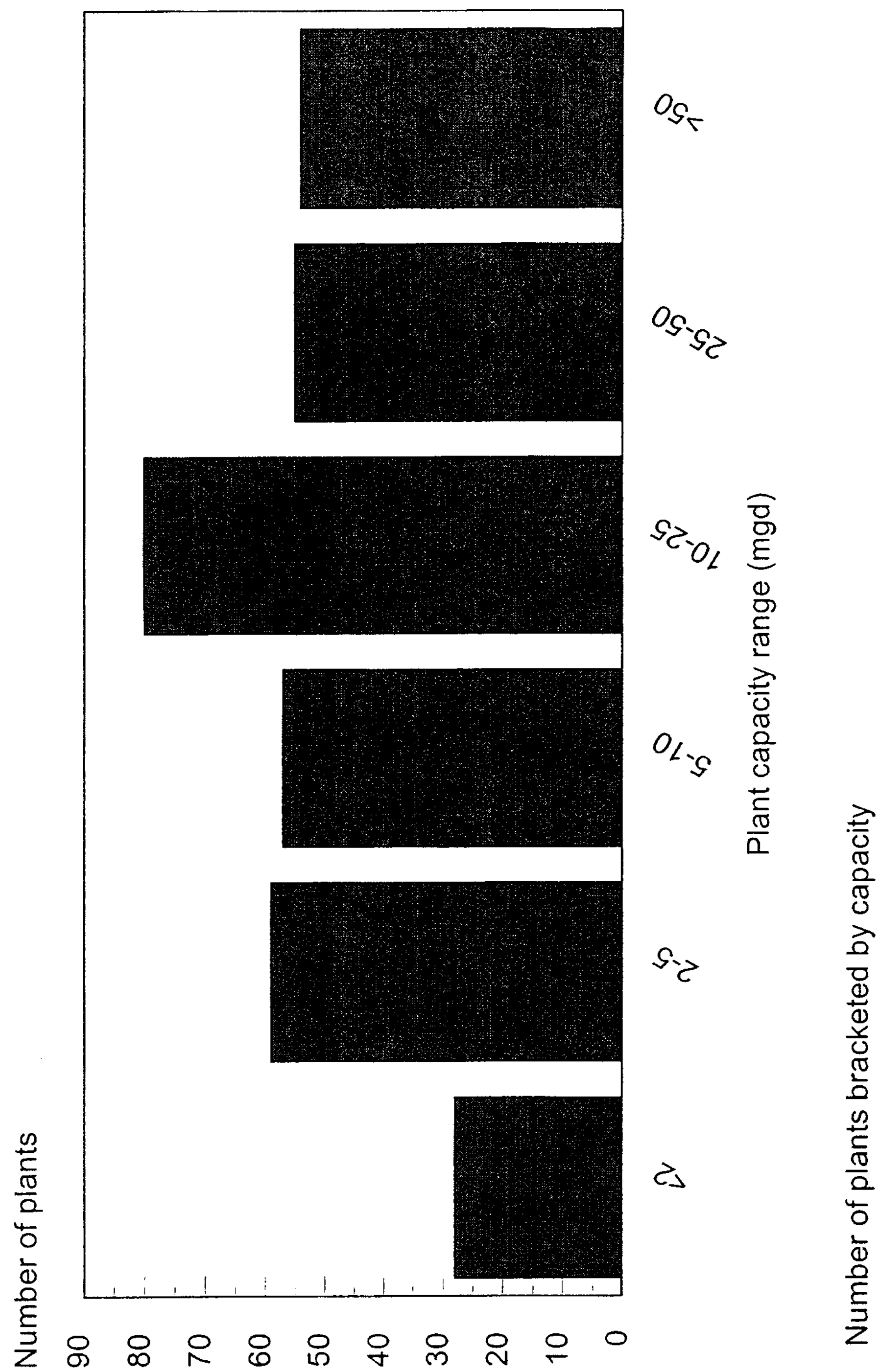
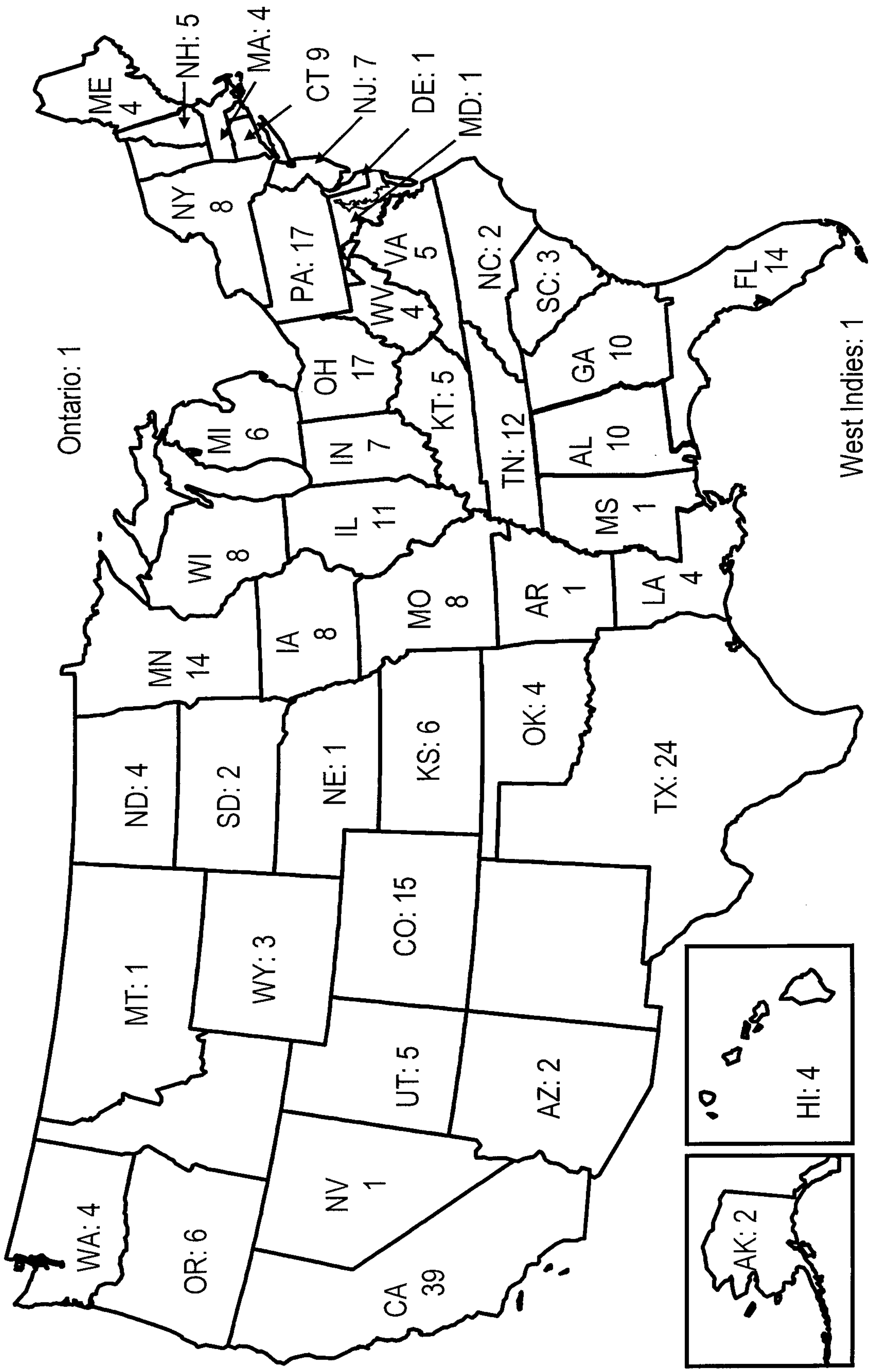


Figure IV.12 Number of Plants per State Included in AWWA Recycle Survey



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i. Recycle practice

Data summarized in Table IV.14 show that 78 percent of plants in the database rely on a surface water as their source. The percentage of plants using source water influenced by a surface water (which may contain *Cryptosporidium*) could be higher because the data do not report whether wells were pure ground water or GWUDI.

TABLE IV.14.—SOURCE WATER USED BY FAX SURVEY PLANTS

Source water type	Percent of plants
Surface Water	78
River	27
Reservoir	28
Lake	16
Other	7
Well [1]	22

[1] Wells sources not defined as either ground water or ground water under the direct influence of surface water.

Table IV.15 shows that a wide variety of treatment process types are included in the data, with conventional filtration (rapid mix, coagulation, sedimentation, filtration) representing over half of the plants submitting data. Upflow clarification is the second most common treatment process reported. Ten percent of plants in the database use direct filtration. Only four percent of plants do not use rapid granular filtration.

TABLE IV.15.—TREATMENT TRAINS OF FAX SURVEY PLANTS

Treatment process type	Percent of plants [1]
Rapid mix, coagulation, filtration	51
Upflow clarifier	21
Softening	14
Direct filtration	10
Other	4

[1] 96 percent of plant in the database provide filtration.

Table IV.16 indicates that a vast majority of plants recycle prior to the point of primary coagulant addition. Only six percent of plants returned recycle in the sedimentation basin or just prior to filtration.

TABLE IV.16.—RECYCLE RETURN POINT OF FAX SURVEY PLANTS

Return point	Percent of plants
Prior to point of primary coagulant addition	83
Pre-sedimentation (e.g., rapid mix)	11
Sedimentation basin	4
Before filtration	2

Table IV.17 shows that the majority of plants in the database provide some type of treatment for the recycle flow prior to its reintroduction to the treatment process. Approximately 70 percent of plants reported providing treatment, with sedimentation being employed by over half of these plants. Equalization, defined as a treatment technology by the survey, is practiced by 20 percent of plants in the database. Fourteen percent of plants reported using both sedimentation and equalization.

TABLE IV.17.—RECYCLE TREATMENT AT FAX SURVEY PLANTS

Treatment type	Percent of plants
No treatment	30
Treatment	70
Sedimentation	54
Equalization	20
Sedimentation and equalization	14
Lagoon	5
Others	7

Table IV.18 summarizes recycle treatment practice and frequency of direct recycle based on population served. The table illustrates that, for plants supplying data, treatment of recycle with sedimentation is provided more frequently as plant service population deceases. Plants serving populations of less than 10,000 recycle directly (27.5 percent) less frequently than plants serving populations greater than 100,000 (50 percent). The data indicate that a majority of small plants in the database may have installed equalization or sedimentation treatment to protect treatment process integrity from recycle induced hydraulic disruption. All direct filtration plants in the FAX survey provide recycle treatment or equalization.

TABLE IV.18.—RECYCLE PRACTICE BASED ON POPULATION SERVED [1]

Population served	Recycle practice			
	#Plants	Equalization	Sedimentation	Direct recycle
<10,000	43	9% (n=4)	67% (n=29)	23% (n=10)
10,000–50,000	79	10% (n=8)	57% (n=45)	33% (n=26)
50,000–100,000	35	17% (n=6)	54% (n=19)	29% (n=10)
100,000	65	35% (n=23)	23% (n=15)	42% (n=27)

[1] Based on 222 surface water plants suppling all necessary data to make determination.

FAX survey data support the following conclusions regarding the recycle practice of plants supplying data: (1) The recycle of spent filter backwash and other process streams is a common practice; (2) the majority of recycle plants use surface water as their source and are thereby at risk from *Cryptosporidium*; (3) a large majority of plants providing data recycle prior to the point of primary coagulant addition, and; (4) a majority of plants supplying data provide treatment for recycle waters prior to reintroducing them to the treatment plant. The FAX survey provides an informative snapshot of national recycle practices due to the number of recycle plants it includes, the geographic distribution of respondents, and the good representation of plants serving populations of less than 10,000 people.

ii. Options to recycle.

The FAX survey asked whether feasible alternatives to recycle are available (i.e., NPDES surface water discharge permit, pretreatment permit for discharge to POTW) and the importance of recycle to optimizing treatment performance and meeting production requirements. Responses to these questions is summarized in Table IV.19.

Table IV.19 shows that approximately 20 percent of respondents could not obtain either an NPDES surface water discharge permit or a pretreatment permit for discharge to a POTW. Approximately 90 percent of respondents stated that recycle flow is not important to meet typical demand.

Twenty-four percent of all respondents stated that returning recycle to the treatment process is important for optimal operation. ''Optimal operation'' was not defined by the survey and respondents may have considered not changing current plant operation (e.g., not changing current recycle practice) an aspect of optimal treatment, rather than addressing whether recycle practice is important for the plant to produce the highest quality finished water.

TABLE IV.19.—OPTIONS TO RECYCLE AS REPORTED BY FAX SURVEY PLANTS [1]

Question	Percent Yes	Percent No	Percent Unknown
Able to obtain NPDES surface discharge permit?	41% (n=131)	37% (n=120)	22% (n=70)
Able to obtain pretreatment permit for POTW discharge?	43% (n=137)	42% (n=136)	15% (n=48)
Can obtain either an NPDES or a POTW discharge permit?	60% (n=192)	19.5% (n=63)	20.5% (n=66)
Is recycle important to meet peak demand?	14% (n=44)	80% (n=257)	6% (n=20)
Is recycle important to meet typical demand?	9% (n=28)	85% (n=272)	6% (n=21)
Is recycle important to optimal operation? (All plants in survey)	24% (n=75)	70% (n=225)	6% (n=21)
Is recycle important to optimal operation? [2] (softening plants only)	13% (n=3)	83% (n=19)	4% (n=1)

[1] Number of plants varies from question to question due to different response rates.
[2] Optimal operation not defined by survey. May include overall plant operation rather than importance of recycle to producing highest possible quality finished water.

iii. Conclusions

The ICR and FAX survey data are complimentary, as the ICR data supplies a wealth of data regarding recycle practices at large capacity plants, while the FAX Survey provides data on recycle practices over a range of plant capacities. Taken together, the two data sets provide a good picture of current recycle practice. The data indicate that recycle is a common practice for plants sampled. Approximately half of the respondents providing data return recycle flow to the treatment process and 70 percent provide some type of recycle treatment. Sedimentation and equalization are the two most commonly employed treatment technologies for plants supplying data. Approximately 80 percent of plants sampled return recycle prior to the point of primary coagulant addition. Examining the recycle practices of plants in the ICR and FAX survey data show that small plants (*i.e.*, fewer than 10,000 people served) are more than twice as likely as large plants (*i.e.*, greater than 100,000 people served) to provide sedimentation for recycle treatment (58 versus 26 percent).

The FAX survey responses show that approximately half of plants providing data have an option to recycle return, whether it be an NPDES surface water discharge permit or discharge to a POTW. Eighty-five percent of respondents stated that recycle flow is not important to meet peak demand. Less than a quarter of respondents have monitored pathogen concentrations in backwash water and fewer than half have any monitoring data to characterize the quality of the backwash water.

3. Recycle Provisions for PWSs Employing Rapid Granular Filtration Using Surface Water or Ground Water Under the Direct Influence of Surface Water

a. Return Select Recycle Streams Prior to the Point of Primary Coagulant Addition

i. Overview and Purpose

Today's proposal requires that systems employing rapid granular filtration and using surface water or GWUDI as a source return filter backwash, thickener supernatant, and liquids from dewatering processes to the primary treatment process prior to the point of primary coagulant addition. The goal of this provision is to protect the integrity of chemical treatment and ensure these recycle streams are passed through as many physical removal processes as possible to provide maximum opportunity for removal of *Cryptosporidium* oocysts from the recycle flow. Since *Cryptosporidium* is resistant to standard disinfection practice, it is important that chemical treatment be optimized to protect treatment plant efficiency and that all available physical removal processes be employed to remove it.

Today's proposal requires these flows be returned prior to the point of primary coagulant addition because these streams are either of sufficient volume to cause hydraulic disruption within the treatment process when recycled and/or are likely to contain *Cryptosporidium* oocysts. Minor recycle streams, such as lab sample lines, pump packing water, and infrequent process overflows are not likely to threaten plants' hydraulic stability or contain appreciable numbers of oocysts.

Treatment plant types that need to return recycle to a location other than prior to the point of primary coagulant addition to maintain optimal treatment performance (optimal performance as indicated by finished water or intra-plant turbidity levels), plants that are designed to employ recycle flow as an intrinsic component of their operations, plants with very low influent turbidity levels that may need alternative recycle locations to obtain satisfactory suspended solids removal, or other types of plants constrained by unique treatment considerations, may apply to the State to recycle at an alternative location under today's proposal. Once approved by the State, plants may recycle to the specified location.

ii. Data

Data from the ICR and FAX Survey indicate that 75 and 78 percent of plants, respectively, return recycle prior to the point of primary coagulant addition. The ''point of primary coagulant addition'' was defined in both analyses as the return of recycle prior to the rapid mix unit. The FAX Survey data indicate that 77 percent of plants serving under 10,000 people recycle prior to the point of primary coagulant addition. It also showed that 78 percent percent of all plants in the database return recycle there, which suggests that plants serving smaller populations may return recycle prior to the point of primary coagulant addition as frequently as plants serving larger populations. Other common recycle return locations are the rapid mix unit, between rapid mix and clarification, or into the clarification unit itself.

The Agency does not believe filter backwash, thickeners supernatant, or liquids from dewatering processes should be recycled at the point of primary coagulant addition or after it for three reasons:

(1) Addition of these recycle streams, which can contain residual coagulant and other treatment chemicals, after the location of primary coagulant addition, may render the chemical dose applied less effective, potentially harming the efficiency of subsequent treatment processes;

(2) Introduction of recycle into the flocculation unit or clarification unit may create hydraulic currents that exacerbate or create short circuiting, and;

(3) Recycle introduced into the clarification process may not experience sufficient residence time for adequate solids removal to occur.

The Agency is concerned that plants may not adjust chemical dosage during recycle events to account for: (1) The presence of a potentially significant amount of residual treatment chemical in recycle flow and changes in recycle flow quality, and; (2) potentially large fluctuations in plant influent flow during recycle events. EPA is concerned that changes in influent water quality and flow are not monitored on an instantaneous basis during recycle events. Since the chemistry of the recycle flow and source water may differ significantly, it is important plants mix source and recycle water to establish a uniform chemistry prior to applying treatment chemical so the dose is appropriate for the mixture. Additionally, wide fluctuation in plant influent flow during recycle events may cause chemical over-or under-dosing, which can lower overall oocyst removal efficiency. In an article concerning optimization of filtration performance, Lytle and Fox (1996) state, ''The capability to instantaneously monitor treatment processes and rapidly and effectively respond to raw and filter effluent quality changes are important factors in consistently producing low turbidity water.'' Logdson (1987) further states, ''For a plant to be operated properly, the total flow rate has to be known on an instantaneous basis or by volumetric measurement.'' EPA believes it is important plants diligently monitor the appropriateness of chemical dosing at all times, but particularly during recycle events, and strive for real-time chemical dose and influent flow management to optimize plant oocyst removal.

Pilot-scale research conducted by Patania *et al.* (1995) to examine the optimization of filtration found that chemical pretreatment was the most important variable determining oocyst removal by filtration. Edzwald and Kelley (1998) performed pilot-scale work to determine the ability of sedimentation, DAF, and filtration to remove *Cryptosporidium* and found that coagulation is critical to effective *Cryptosporidium* control by clarification and filtration. Bellamy *et al.* (1993) stated that the most important factor in plant performance is the use of optimal chemical dosages. Coagulation was recognized as the single most important step in the process of water clarification by Conley (1965). Ten pilot scale runs performed by Dugan *et al.* (1999) showed that coagulation has a large influence on the log removal of *Cryptosporidium* achieved by sedimentation. The importance of proper coagulation to filter performance was noted by Robeck *et al.* (1964) in pilot and full-scale work that showed proper coagulation is more important to the production of safe water than the filtration rate used. Results of direct filtration pilot studies, summarized by Trussell *et al.* (1980), showed that ''effective coagulant is absolutely necessary if good effluent qualities are to be consistently produced.''

Given the critical role proper chemical dosing plays in maintaining effective clarification and filtration processes, the Agency believes it is prudent and necessary to minimize the possibility recycle of spent filter backwash, thickener supernatant, and dewatering liquids will render chemical dosages applied during recycle events inaccurate, due to the presence of residual chemical or variations in influent flow, by requiring they be returned prior to the point of primary coagulant addition.

Finally, a fundamental tenet of water treatment is multiple treatment barriers should be provided to prevent microbial pathogens from entering finished water. To achieve this, conventional plants rely on coagulation, flocculation, clarification, and filtration as preventive microbial barriers. The Agency believes it is important that recycle waters be passed through each of these treatment processes to maximize the probability disinfection resistant oocysts will be removed in the plant and not enter the finished water supply.

iii. Proposed Requirements

Today's proposal requires that rapid granular filtration plants using surface water or GWUDI as a source return filter backwash, thickener supernatant, and liquids from dewatering processes prior to the point of primary coagulant addition. Plants that require an alternative recycle return location to maintain optimal finished water quality (as indicated by finished water or intra-plant turbidity levels), plants that are designed to employ recycle flow as an intrinsic component of the treatment process, or plants with unique treatment requirements or processes may apply to the State to return recycle flows to an alternative location. Plants may utilize this alternative location once granted by the State. EPA will develop detailed guidance and make it available to States and PWSs.

Softening systems may recycle process solids, but not spent filter backwash, thickener supernatant, or liquids from dewatering processes, at the point of lime addition immediately preceding the softening process to improve treatment efficiency. Literature establishes that return of process solids to point of lime addition decreases production of nuclei, increases the rate of crystallization, and increases crystal size, all of which enhance settling and process integrity (Randtke, 1999; Snoeyink and Jenkins, 1980). Contact clarification systems may recycle process solids, but not spent filter backwash, thickener supernatant, or liquids from dewatering processes, directly into the contactor to improve treatment efficiency.

iv. Request for Comments

EPA requests comment on the proposed requirements. The Agency also requests comment on the following aspects of this provision:

(1) What regulatory options are available to ensure direct recycle plants practice real-time chemical dose and influent flow management? Should flow-paced coagulant feed be required at direct recycle plants to minimize potential harmful impacts of recycle? What regulatory requirements may be applicable to ensure the integrity of the coagulation process?

(2) What treatment processes or treatment configurations may need an alternative recycle location to maintain optimal treatment?

(3) What alternative recycle locations are appropriate for such treatment configurations and what location may be inappropriate?

(4) Are there other reasons, beyond maintaining optimal treatment efficiency, to justify granting alternate recycle locations to plants? What are they?

(5) What criteria, operating practices, or other parameters should be evaluated to determine whether an alternative recycle return location should be granted?

(6) Does recycling at the point of primary coagulant addition, instead of prior to it, provide assurance that an appropriate dose of treatment chemicals will be consistently applied during recycle events? Is it necessary to mix the recycle and raw water prior to chemical addition to ensure a consistent water chemistry for chemical dosing?

(7) Are there circumstances where it would be appropriate to allow systems to recycle at the point of primary coagulant addition?

b. Recycle Requirements for Systems Practicing Direct Recycle and Meeting Specific Criteria

i. Overview and Purpose

Today's proposal requires that self assessments be performed at conventional filtration plants meeting all of the following criteria and the results of the self assessment reported to the State. The criteria are:

(1) Use of surface water or GWUDI as a source;

(2) Employ of 20 or fewer filters to meet production requirements during the highest production month in the 12 month period prior to LT1FBR's compliance date, and;

(3) Recycle spent filter backwash or thickener supernatant directly to the treatment process (*i.e.,* recycle flow is returned within the treatment process of a PWS without first passing the recycle flow through a treatment process designed to remove solids, a raw water storage reservoir, or some other structure with a volume equal to or greater than the volume of spent filter backwash water produced by one filter backwash event.)

The goal of the self assessment is to identify those direct recycle plants that exceed their State approved operating capacity, on an instantaneous basis, during recycle events. Plants are required to submit a monitoring plan to the State prior to conducting the month long self assessment monitoring. Results of self assessment monitoring must be reported to the State. The State is required to determine, by reviewing the self assessment, whether the plant's current recycle practice should be modified to protect plant performance and provide an additional measure of public health protection. The State is required to report its determination for each plant performing a self assessment to EPA and briefly summarize the reason(s) supporting each determination.

EPA selected the three aforementioned criteria to identify plants required to perform a self assessment for the following reasons. First, surface or GWUDI source waters may contain *Cryptosporidium*. Second, the hydraulic impact of recycle to plants typically employing more than 20 filters to meet production requirements should be dampened because plant influent flow is of significantly greater magnitude than the flow produced by a backwash event. Third, plants that practice direct recycle of filter backwash and/or thickener supernatant may exceed their operating capacity during recycle events due to the large volume of these streams.

ii. Data

Plants that recycle filter backwash and thickener supernatant, directly, without recycle flow equalization or treatment, may exceed their operating capacity during recycle events. Table IV.20 illustrates the magnitude by which direct recycle plants may exceed their operating capacity during recycle events. For purposes of the table, operating capacity is assumed to be either plant design flow or average flow (see example below). The values in the table are conservative, as they are likely to over predict the factor by which direct recycle plants will exceed operating capacity during recycle events. This conservatism is due to the assumed filter backwash rate of 15 gpm/ft^2 and the assumed backwash duration of 15 minutes, the minimum backwash rate and duration recommended by the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (1997). Design and average flow values assumed for plant operating capacity were developed from equations presented in EPA's baseline handbook (1999g). For purposes of this example, plant design and average flow are assumed to equal State approved operating capacity to illustrate the potential for plants to exceed operating capacity during recycle events. Relevant equations and example calculations are shown below.

Example

(1) Design to average ratios:

design flow < .25 mgd; ratio design flow : average flow = 3.2:1

design flow > .25 mgd to 1 mgd; ratio design flow : average flow = 2.8:1

design flow > 1 mgd to 10 mgd; ration design flow : average flow = 2.4:1

design flow > 10 mgd; ratio design flow : average flow = 2.0:1

(2) Maximum filter size: 700 sq./ft^2 (EPA, 1998a)

(3) Backwash volume calculation:

Filter area (ft^2) × 15 gpm/ft^2 × 15 minutes = volume of one backwash

(4) Design and average capacity exceedence factors:

(Backwash flow + design (or average) flow) ÷ design flow = exceedence factor

(5) Percent Influent that is recycle:

Backwash flow ÷ (Backwash flow + design (or average flow)) = percent of influent that is backwash

(6) Design flow = State approved operating flow

TABLE IV.20.—IMPACT OF DIRECT RECYCLE

Design flow (MGD)	Number of filters	Area of one filter (sq. ft)	Volume of one backwash (gallons)	Backwash return flow (15 minute return; gpm)	Design flow (gpm)	Average flow (gpm)	Factor design flow is exceeded by during recycle (at design flow)	Percent influent that is recycle (at design flow) (percent)	Factor design flow is exceeded by during recycle (at average flow)	Percent influent that is recycle (at average flow) (percent)
.033	2	5	1,125	75	23	7	4.3	77	3.6	91
.669	4	50	11,250	750	465	166	2.6	62	2.0	82
2.02	6	100	22,500	1,500	1,403	584	2.1	52	1.5	72
8.8	8	320	72,000	4,800	6,111	2,546	1.8	44	1.2	65
14.5	10	425	95,625	6,375	10,069	5,135	1.6	39	1.1	55
42.44	18	700	157,500	10,500	29,472	14,736	1.4	26	.86	42
56.23	24	700	157,500	10,500	39,048	19,524	1.3	21	.77	35

The purpose of Table IV.20 is to illustrate the impact direct recycle can have on plant hydraulic loading and the factor by which plant operating capacity can be exceeded during recycle events. As shown in Table IV.20, a plant with two filters would process influent at over three times its operating capacity during a recycle event. Even if the plant reduced or eliminated its raw water influent flow for the duration of the event, the remaining filter would be subject to a loading rate that exceeds its operating capacity, which could harm finished water quality.

The amount of sedimentation basin or clarification process storage available during recycle events will have an impact on the hydraulic loading to the filters and the performance of the sedimentation or clarification process. The actual increase to filter loading rates may be less than predicted in Table IV.20 due to site-specific conditions. However, the potential for direct recycle plants to exceed operating capacity is cause for concern because oocyst removal can be compromised. The Agency believes 20 filters is an appropriate number for specifying which plants are required to perform a self assessment due to the results in Table IV.20 and the above considerations.

The importance of maintaining proper plant hydraulics has been acknowledged, notably by Logdson (1987) who wrote, ''Both the quantity and quality of filtered water can be affected by plant hydraulics. Maximum hydraulic capacity is an obvious limitation. The adverse influences of rate of flow and flow patterns on water quality may not be so obvious, but they can be important.'' Fulton (1987) recognized that short circuiting can diminish the performance of settling basins, cause overloading of filters, and increase breakthrough of turbidity. Other publications (Cleasby, 1990) recognize that settled water quality deteriorates when the surface loading rate of sedimentation basins is increased. Direct recycle practice can give rise to short circuiting, cause plant operating capacity to be exceeded, and increase surface loading rates, all of which can be detrimental to *Cryptosporidium* removal.

Direct recycle practice can abruptly increase filter loading rates, which has been shown to lower filter performance. Cleasby et al. (1963) performed experimental runs with three pilot plant filters by increasing the filtration rate ten, twenty-five, and fifty-percent over various time periods and monitoring the passage of a target material during the rate increase. Conclusions drawn from the experiments were:

(1) Disturbance in filtration rate can cause filters to pass previously deposited material and the amount of material passed is dependent on the magnitude of the rate disturbance;

(2) More rapid disturbances cause more material to be flushed through the filter;

(3) The amount of material flushed through the filter is independent, or very nearly independent of disturbance's duration, and;

(4) The amount of material flushed through the filter following a disturbance is dependent on the type of material being filtered.

Pilot scale work was recently performed by Glasgow and Wheatley (1998) to investigate whether surges affect filtrate quality. Effluent turbidity and headloss within the filter media were monitored for two pilot filter columns that were surged at different magnitudes. The results were compared to control runs through the same pilot columns to determine the effect of the surge. Results indicated that surging may significantly affect full scale filter performance. Additional work is needed to confirm these results.

Recent pilot scale work by McTigue *et al.* (1998) examined the impact of doubling the filter loading instantaneously and gradually (over an 80 minute period) on pilot filters that had been in operation for a period of time or were ''dirty.'' The experiments showed that *Cryptosporidium* removal achieved by the filters was lowered by changes in filtration rate regardless of whether loading rate was increased instantaneously or gradually. In the experiment, filter loading rates of 2 gpm/ft^2 and 4 gpm/ft^2 were doubled in six separate test runs to determine whether oocysts removal was affected. Results showed that log removal of oocysts was reduced by approximately 1.5 to 2.0 logs for when filter loading rates of 2 gpm/ft^2 and 4 gpm/ft^2 were either instantaneously and gradually doubled. The report states, ''These data clearly demonstrate that any change in filter loading rate on a filter that is dirty presents a risk for breakthrough of *Giardia* and *Cryptosporidium* to the finished water, should these organisms be present in the filter.'' Effluent turbidity values remained low during increases in filter loading rates but particle count concentrations immediately increased with increases in loading rate. This may indicate that turbidity is not a good indicator of oocyst passage by dirty filters during filtration rate increases.

Results of three other pilot runs from the study showed that log removal of oocysts did not change when the influent oocyst concentration varied and all other treatment conditions were held constant. A four log removal of oocysts was obtained for all three runs despite influent oocyst concentrations of 4,610/L, 688/L, and 26/L. The report states, ''This finding indicates that the risk for passage of large numbers of cysts to the finished water is greater when a water treatment plant receives a highly concentrated slug of cysts at its intake.'' The Agency believes this is an interesting conclusion, even though it is based on a limited number of pilot runs. If further pilot and full-scale work verifies this finding, it indicates that log removal of oocysts does not increase as more oocysts are loaded to plant. Recycle of flows containing oocysts would therefore increase the number of oocysts present in finished water, relative to the number of oocysts that would occur were recycle not practiced, because plant treatment efficiency would not increase to remove the additional oocysts returned by recycle.

In summary, the Agency is concerned that direct recycle of spent filter backwash, thickener supernatant, and liquids from dewatering process may increase the risk of oocyst occurrence in finished water for the following reasons:

(1) Sampling has established that oocysts occur in finished water supplies (see Table II.6 of this preamble);

(2) Data show that oocysts occur in recycle streams;

(3) Literature indicates that hydraulically overloading the sedimentation process, as may happen during direct recycle events, can harm sedimentation performance;

(4) Literature indicates increasing or abruptly changing filtration rates can lead to more material passing through filters, and;

(5) Recent pilot scale work by McTigue *et al.* (1998) and Glasgow and Wheatley (1998) indicates that filter performance can be harmed by surges and changes to filtration rate.

The Agency encourages the States to closely examine recycle self assessments performed by direct recycle plants to determine whether direct recycle poses an unacceptable risk to finished water quality and public health and needs to be modified due to the considerations cited above.

Finally, EPA realizes that State programs may use different methodologies to set plant operating capacity. States may also apply safety factors of different magnitudes when determining operating capacity. The Agency does not believe it is appropriate to erode any safety factor or margin of safety States provide when setting operating capacity. Safety factors are provided for a reason: to provide a margin of safety to public health protection efforts. The integrity and magnitude of a safety factor should be maintained, as it is in and of itself integral to adequate public health protection. The fact a safety factor is applied when plant operating capacity is set is not a justification, *a priori,* for allowing plants to operate above said operating capacity during recycle events.

EPA also acknowledges that States may use different methodologies to set plant operating capacity. The Agency is confident that the State programs, its partners in public health protection, set plant capacity to provide necessary level of public health protection. The fact that some State programs may set plant operating capacities with different methodologies likely reflects geographical conditions and public expectations unique to certain States and sections of the country. EPA believes methodologies employed by the States results in establishment of operating capacities necessary to protect public health, meet regulatory requirements, and satisfy unique treatment needs and considerations where they exist.

iii. Proposed Requirements

Self assessments must be performed at plants meeting all of the following criteria and the results of the self assessment reported to the State:

(1) Use surface water or GWUDI as a source and employ conventional rapid granular filtration treatment;

(2) Employ of 20 or fewer filters to meet production requirements during the highest production month in the 12 month period prior to LT1FBR's compliance date, and;

(3) Recycle spent filter backwash or thickener supernatant directly to the treatment process (*i.e.,* recycle flow is returned within the treatment process of a PWS without first passing the recycle flow through a treatment process designed to remove solids, a raw water storage reservoir, or some other structure with a volume equal to or greater than the volume of spent filter backwash water produced by one filter backwash event).

Systems are required to develop and submit a recycle self assessment monitoring plan to the State no later than three months after the rule's compliance date for each plant the requirements are applicable to. At a minimum, the monitoring plan must identify the month during which monitoring will be conducted, contain a schematic identifying the location of raw and recycle flow monitoring devices, describe the type of flow monitoring devices to be used, and describe how data from the raw and recycle flow monitoring devices will be simultaneously retrieved and recorded.

The self assessment of recycle practices shall consist of the following five steps:

(1) From historical records, identify the month in the calendar year preceding LT1FBR's effective date with the highest water production.

(2) Perform the monitoring described below in the twelve month period following submission of the monitoring plan to the State.

(3) For each day of the month identified in (1), separately monitor source water influent flow and recycle flow before their confluence during one filter backwash recycle event per day, at three minute intervals during the duration of the event. Monitoring must be performed between 7:00 a.m. and 8:00 p.m. Systems that do not have a filter backwash recycle event every day between 7:00 am and 8:00 p.m. must monitor one filter backwash recycle event per day, any three days of the week, for each week during the month of monitoring, between 7:00 a.m. and 8:00 p.m. Record the time filter backwash was initiated, the influent and recycle flow at three minute intervals during the duration of the event, and the time the filter backwash recycle event ended. Record the number of filters in use when the filter backwash recycle event is monitored.

(4) Calculate the arithmetic average of all influent and recycle flow values taken at three minute intervals in (3). Sum the arithmetic average calculated for raw water influent and recycle flows. Record this value and the date the monitoring was performed. This value is referred to as event flow.

(5) After monitoring is complete, order the event flow values in increasing order, from lowest to highest, and identify the monitoring events in which plant operating capacity is exceeded.

Systems are required to submit a self assessment report to the State within one month of completing the self assessment monitoring. At a minimum, the report must provide the following information:

(1) All source and recycle flow measurements taken and the dates they were taken. For all events monitored, report the times the filter backwash recycle event was initiated, the flow measurements taken at three minute intervals, and the time the filter backwash recycle event ended. Report the number of filters in use when the backwash recycle event is monitored.

(2) All data and calculations performed to determine whether the plant exceeded its operating capacity. Report the number of event flows that exceed State approved operating capacity.

(3) A plant schematic showing the origin of all recycle flows, the hydraulic conveyance used to transport them, and their final destination in the plant.

(4) A list of all the recycle flows and the frequency at which they are returned to the plant.

(5) Average and maximum backwash flow through the filters and the average and maximum duration of backwash events in minutes, for each monitoring event, and;

(6) Typical filter run length, number of filters typically employed, and a written summary of how filter run length is determined (preset run time, headloss, turbidity level).

EPA is proposing that the State review all self assessments submitted by PWSs and report to the Agency the below information as it applies to individual plants:

(1) A finding that modifications to recycle practice are necessary, followed by a brief description of the required change and a summary of the reason(s) the change is required, or;

(2) A finding that changes to recycle practice are not necessary and a brief description of the reason(s) this determination was made.

The Agency also considered requiring all recycle plants without existing recycle flow equalization or treatment to install recycle flow equalization. As summarized in Table IV.21, several recommendations for recycle equalization and treatment have been provided. However, these recommendations are based on theoretical calculations and/or limited pilot-scale data that has not been verified by full-scale plant performance data. The Agency currently believes insufficient data is available to determine whether recycle flow equalization is necessary to protect finished water quality, and, if it is, the level of equalization required to provide protection to finished water supplies for a wide variety of source water qualities, treatment process types, and levels of treatment effectiveness. The Agency does not believe it is appropriate at this time to propose a national recycle flow equalization requirement for the following reasons:

(1) Data on the occurrence of oocysts in recycle streams, and their impact to

finished water quality upon recycle, is very limited;

(2) Data that establishes the magnitude of hydraulic disruption caused by direct recycle events for a variety of plant types, designs, and operational practices has not been identified; without this data, it is not possible to quantify how much treatment efficiency is reduced by the hydraulic disruption and the number of oocysts in the recycle flow that will enter the finished water due to the disruption. Without this information, it is not possible to specify the level of equalization necessary to control hydraulic disruption for a variety of plant configurations and operational practices with any degree of certainty and cost effectiveness, and;

(3) A uniform, national equalization standard may not be appropriate because it would not allow consideration of site-specific factors such as plant treatment efficiency, loading capacity of clarification and filtration units, source water quality, and other site-specific factors that influence the level of equalization a plant may need to control recycle event induced hydraulic disruption.

EPA believes some plants can realize substantial benefit by installing recycle flow equalization and will review data to determine the need for an equalization requirement when it becomes available. The Agency requests that commenters submit the following pilot or full-scale data to assist its effort to conduct a thorough analysis of equalization based upon the best available science:

(1) Data on the magnitude of hydraulic disruption caused by recycle events and its affect on finished water turbidity and particle count levels;

(2) Data that correlate hydraulic disruption to increased oocyst concentration in finished water, and;

(3) Any other data commenters believe that may be appropriate to analyze the need for equalization, and;

(4) Whether the regulation should require States to specify modifications to recycle practice, for all plants that exceed operating capacity during monitoring, to ensure said plants' remain below their State approved operating capacity during recycle events.

TABLE IV.21—RECOMMENDED EQUALIZATION PERCENTAGES

Source of recommendation [a]	Equalization Percentage	Is recycle treatment recommended?
Recommended Standards for Water Works. Great Lakes—Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. 1997. Albany: Health Education Services.	10%	No.
Removal of *Cryptosporidium* Oocysts by Water Treatment Process. Foundation for Water Research Limited, United Kingdom (1994).	10%	Yes. Turbidity less than 5.0 NTU or residual of 10mg/L suspended solids in treated recycle flow.
Recycle Stream Effects on Water Treatment. Cornwell, D., and R. Lee. 1993. Denver: AWWARF.	Use equalized, continuous recycle.	Use proper waste stream treatment prior to recycle.

[a] See the reference list at the end of the preamble for complete citations.

Finally, the Agency considered requiring conventional filtration plants that recycle within the treatment process to provide sedimentation or more advanced recycle treatment and concluded a national treatment requirement is inappropriate at this time due data deficiencies. The Agency believes the following data is necessary to determine whether recycle flow treatment is necessary to protect public health and the requisite level of treatment:

(1) Significant amounts of additional data on the occurrence of oocysts for a complete range of recycle streams generated by a wide variety of source water qualities, treatment plant types, plant operational and recycle practices, and plant treatment efficiencies;

(2) Data that correlates recycle stream oocyst occurrence to finished water occurrence;

(3) Additional data on the ability of full-scale sedimentation basins to remove oocysts during normal operation and during recycle events. The Agency has identified only three full-scale studies, States *et al.* (1995), Baudin and Laine (1998), and Kelly *et al.* (1995), that allow quantification of oocyst removal by sedimentation basins. Pilot scale work, such as Edzwald and Kelley (1998) and Dugan *et al.* (1999) is also available, but the number of studies is not extensive. The removal achieved by sedimentation and other clarification processes is critical for determining the number of oocysts loaded to the filters, the likely concentration of oocysts in various recycle streams, and the impact recycle may have on intra-plant oocyst concentrations. Good oocyst removal in the clarification process will remove a large percentage of oocysts from recycle and source water flows before they reach the filters. The amount of removal provided by primary clarification therefore has a large influence on the level of recycle flow treatment that may be needed to mitigate risk to finished water quality. Given that data on oocyst removal by sedimentation and other clarification processes is very limited, the Agency does not believe it is possible to assess the need for recycle treatment and specify a minimum treatment level that is meaningful for a wide variety of plant types and recycle practices;

(4) Data regarding the ability of DAF and other clarification processes to remove oocysts from recycle flow is very limited. This data is important, because the Agency anticipates plants may respond to any recycle treatment requirement by using DAF to treat recycle flow because of the advantages it provides relative to sedimentation. However, EPA has only identified four studies, Hall *et al.* (1995), Plummer *et al.* (1995), Edzwald and Kelley (1998), and Alvarez *et al.* (1999), that determined the ability of DAF to remove oocysts from source water. One study, by Grubb *et al.* (1997), addresses the ability of DAF to treat filter backwash waters has been identified, but sampling for oocyst removal was not performed, although turbidity and color removal were monitored and good results obtained. Additional data is needed to characterize the ability of DAF to remove oocysts from recycle flow before it can be used to meet any recycle treatment requirement;

(5) Full-scale data on the ability of sedimentation and other clarification processes to remove oocysts from recycle streams before they are returned to the plant is very limited. EPA has identified two studies, one by Cornwell and Lee (1993) and a study by Karanis *et al.* (1998) that provide data regarding

sedimentation's ability to remove oocysts from recycle flows. Additional information is needed to establish lower and upper bounds on the oocyst removal sedimentation can achieve; without this data, it is difficult to specify a feasible level of oocyst removal in a recycle flow treatment requirement;

(6) Microfiltration and ultrafiltration membranes appear to be very reliable at removing *Cryptosporidium* from source waters (Jacangelo *et al.,* 1995). However, the Agency has identified limited data regarding the ability of membranes to effectively treat recycle flow, and treatment of backwash with membranes may not be appropriate at all locations (Thompson *et al.,* 1995) due to incompatibility between membrane filter material and residual treatment chemical(s) in the backwash water. Additional information regarding the ability of microfiltration and ultrafiltration membranes to treat recycle flow is necessary to comprehensively evaluate their applicability, and;

(7) EPA is not aware of a surrogate, including turbidity, particle counts, or any other common and easy to measure parameter, that can serve as an indicator of the log removal of *Cryptosporidium* recycle flow treatment units achieve. The Agency does not believe it is economically or technically feasible to directly monitor oocyst removal by treatment units. Without an accurate, easy to measure surrogate for *Cryptosporidium* removal, the Agency does not believe it is possible to ascertain the level of treatment recycle flow treatment units achieve during routine operations.

Given the above limiting factors, the Agency does not believe it is prudent to establish a national recycle flow treatment requirement until additional data becomes available. EPA requests the following data be submitted:

(1) Data regarding intra-plant and recycle stream occurrence of oocysts;

(2) Information on the ability of individual treatment units of the primary treatment train to remove oocysts during normal, hydraulically challenged, and suboptimal chemical dose operations;

(3) Data on the ability of sedimentation and other clarification processes to remove oocysts from a wide range of recycle streams;

(4) Data on the compatibility of specific ultrafiltration and microfiltration membrane materials with residual chemicals that occur in recycle streams and data regarding the performance of these membrane materials at full and pilot scale, and;

(5) Information on potential surrogates that can be easily measured and can accurately establish the log removal of oocysts removed by recycle flow treatment processes.

iv. Request for Comments

EPA requests comment on the proposed requirements. The Agency also requests comment on the following:

(1) What other parameters could be monitored or what other overall monitoring schemes could be employed to assess whether a plant is exceeding its operating capacity?

(2) What data should the plant report to the State as part of its self assessment, beyond the monitoring data and other information listed above?

(3) Is monitoring during the highest flow month appropriate? Is monitoring during additional months necessary? Is daily monitoring necessary or would less frequent monitoring during the month be sufficient?

(4) Should systems be required to monitor and report turbidity measurements from a representative filter taken immediately preceding and after recycle events monitored during the self assessment to help characterize the impact of recycle on plant performance?

(5) Is limiting the self assessment to plants with 20 or less filters appropriate? Should the number of filters be less or greater than 20? What is the appropriate number of filters?

(6) Should systems be required to monitor sedimentation overflow rates or clarification loading rates while the recycle flow monitoring is performed?

(7) EPA requests comment on criteria that may identify recycle plants that could receive substantial benefit from implementing recycle equalization or treatment as a standard practice.

(8) What type and amount of data is required to determine whether recycle flow equalization would provide a benefit to finished water quality? What methodology could be used to determine an appropriate recycle flow equalization percentage, and how relevant are turbidity and particle counts, at various locations in a plant, to assessing an appropriate equalization percentage for a single plant or a plant type?

d. Requirements for Direct Filtration Plants that Recycle Using Surface Water or GWUDI

i. Overview and Purpose

Today's proposal requires direct filtration plants that recycle to report to the State whether flow equalization or treatment is provided for recycle flow prior to its return to the treatment process. The purpose of today's proposed requirement is to assess whether the existing recycle practice of direct filtration plants addresses potential risks. The Agency believes that direct filtration plants need to remove oocysts from recycle flow prior to reintroducing it to the treatment process.

ii. Data

Twenty-three direct filtration plants that used surface water responded to the FAX Survey (AWWA, 1998). In the FAX survey, plants could report whether they provide recycle flow equalization, sedimentation, or some other type of treatment. Of the respondents, 21 reported providing treatment for the recycle flow and two plants reported providing only equalization. In the ICR database, there were 23 direct filtration plants and fourteen of them recycled to the treatment process. All fourteen plants provide recycle treatment. It is not possible to determine the level of oocyst removal FAX survey and ICR plants achieve with available data.

The treatment train of a direct filtration plant does not have a clarification process to remove *Cryptosporidium* before they reach the filters; all oocyst removal is achieved by the filters. If recycle flow treatment is not provided, all of the oocysts captured in the filters will be returned to the treatment process in the recycle flow. Because a primary clarification process is not present to remove recycled oocysts, they are caught in a closed ''loop'' from which the only exit is passage through the filters into the distribution system. The Agency believes direct filtration plants should provide solids removal treatment for recycle flows to limit the number of oocysts returned to the treatment plant.

iii. Proposed Requirements

EPA is proposing that PWSs using direct filtration that recycle to the treatment process and utilize surface water or GWUDI as a source report data to the State that describes their current recycle practice. Plants should report the following information to the State:

(1) Whether recycle flow treatment or equalization is in place;

(2) The type of treatment provided for the recycle flow;

(3) If equalization, sedimentation, or some type of clarification process is used, the following information should be provided: a) physical dimensions of the unit (length, width, (or circumference) depth,) sufficient to allow calculation of volume and the

type, typical dose, and frequency with which treatment chemicals are used;

(4) The minimum and maximum hydraulic loading the treatment unit experiences, and;

(5) Maximum backwash rate, duration, typical filter run length, and the number of filters at the plant.

The State should use the above information to determine which plants need to modify recycle practice to provide additional public health protection. States are required to report to EPA whether they required individual direct filtration plants to modify recycle practice and provide a brief explanation of the reason(s) for the decision.

The Agency also considered requiring that all direct filtration plants provide a specific level of treatment for the recycle flow. However, data necessary to determine the appropriate level of treatment is unavailable. Specifically, the following data is needed:

(1) Data on the on the occurrence of oocysts in the spent filter backwash of direct filtration plants. Direct filtration plants generally use higher quality source water than conventional plants (AWWA, 1990) and it would be inaccurate to use spent filter backwash occurrence data from conventional plants to assess the level of treatment direct recycle plants may need;

(2) Data regarding the ability of sedimentation and other clarification processes to remove oocysts from recycle flows is needed to determine what may be a feasible level of treatment. This data need was treated to a detailed discussion in the previous section of the preamble;

(3) An easy to measure and accurate surrogate for oocyst removal is currently unavailable; without such a surrogate, it is not feasible to monitor the performance of recycle treatment units, and;

(4) Data on the applicability of microfiltration and ultrafiltration for treating spent filter backwash produced by direct filtration plants. This data need was discussed in detail in the previous section.

Given the lack of oocyst occurrence data for direct filtration recycle streams, and limited knowledge of the level of treatment clarification processes can achieve, the Agency does not currently believe it is possible to identify a treatment standard for direct filtration plants.

iv. Request for Comments

EPA requests comment on the proposed requirements. The Agency also requests comment on the following:

(1) Whether direct filtration plants should be required to provide treatment for recycle flows;

(2) The level of treatment direct filtration plants should achieve;

(3) Data that establishes turbidity, particle counting, or some other surrogate as an appropriate indicator of oocyst removal achieved by recycle treatment units, and;

(4) Data on the ability of clarification processes to remove oocysts and criteria that can be used to determine the applicability of specific membrane materials for treatment of spent filter backwash produced by direct filtration plants.

d. Request for Additional Comment

EPA requests comment on the following:

(1) Should the recycle of untreated clarification sludges be allowed to continue, or should the Agency ban this practice? What affect would a ban have on the operation of specific plant types, such as softening plants?

(2) Is it appropriate to apply regulatory requirements to the combined recycle flow rather than stipulating requirements for individual recycle flows? Which flows should be regulated individually and why?

V. State Implementation and Compliance Schedules

This section describes the regulations and other procedures and policies States have to adopt, or have in place, to implement today's proposed rule. States must continue to meet all other conditions of primacy in 40 CFR part 142.

Section 1413 of the SDWA establishes requirements that a State or eligible Indian tribe must meet to maintain primary enforcement responsibility (primacy) for its public water systems. These include: (1) Adopting drinking water regulations that are no less stringent than Federal NPDWRs in effect under sections 1412(a) and 1412(b) of the Act, (2) adopting and implementing adequate procedures for enforcement, (3) keeping records and making reports available on activities that EPA requires by regulation, (4) issuing variances and exemptions (if allowed by the State) under conditions no less stringent than allowed by sections 1415 and 1416, and (5) adopting and being capable of implementing an adequate plan for the provision of safe drinking water under emergency situations.

40 CFR part 142 sets out the specific program implementation requirements for States to obtain primacy for the public water supply supervision program, as authorized under section 1413 of the Act. In addition to adopting the basic primacy requirements, States may be required to adopt special primacy provisions pertaining to a specific regulation. These regulation-specific provisions may be necessary where implementation of the NPDWR involves activities beyond those in the generic rule. States are required by 40 CFR 142.12 to include these regulation-specific provisions in an application for approval of their program revisions. These State primacy requirements apply to today's proposed rule, along with the special primacy requirements discussed below.

To implement today's proposed rule, States are required to adopt revisions to § 141.2—definitions; § 141.32—public notification; § 141.70—general requirements; § 141.73—filtration; § 141.76—recycle; § 141.153—content of the reports; § 141.170—general requirements; § 142.14—records kept by States; § 142.16—special primacy requirements; and a new subpart T, consisting of § 141.500 to § 141.571.

A. Special State Primacy Requirements

In addition to adopting drinking water regulations at least as stringent as the Federal regulations listed above, EPA requires that States adopt certain additional provisions related to this regulation to have their program revision application approved by EPA. This information advises the regulated community of State requirements and helps EPA in its oversight of State programs. States which require without exception subpart H systems (all public water systems using a surface water source or a ground water source under the direct influence of surface water) to provide filtration, need not demonstrate that the State program has provisions that apply to systems which do not provide filtration treatment. However, such States must provide the text of the State statutes or regulations which specifies that public water systems using a source water must provide filtration.

EPA is currently developing, with stakeholders input, several guidance documents to aid the States and water systems in implementing today's proposed rule. This includes guidance for the following topics: Disinfection benchmarking and profiling, Turbidity, and Filter Backwash and Recycling. EPA will also work with States to develop a State implementation guidance manual.

To ensure that the State program includes all the elements necessary for a complete enforcement program, the State's application must include the following in order to obtain EPA's approval for implementing this rule:

(1) Adoption of the promulgated LT1FBR.

(2) Description of the procedures the State will use to determine the adequacy of changes in disinfection process by systems required to profile and benchmark under § 142.16(h)(2)(ii) and how the State will consult with PWSs to approve modifications to disinfection practice.

(3) Description of existing or adoption of appropriate rules or other authority under § 142.16(h)(1) to require systems to participate in a Comprehensive Technical Assistance (CTA) activity, and the performance improvement phase of the Composite Correction Program (CCP).

(4) Description of how the State will approve a method to calculate the logs of inactivation for viruses for a system that uses either chloramines or ozone for primary disinfection.

(5) For filtration technologies other than conventional filtration treatment, direct filtration, slow sand filtration or diatomaceous earth filtration, a description of how the State will determine under § 142.16(h)(2)(iii), that a public water system may use a filtration technology if the PWS demonstrates to the State, using pilot plant studies or other means, that the alternative filtration technology, in combination with the disinfection treatment that meets the requirements of Subpart T of this title, consistently achieves 99.9 percent removal and/or inactivation of *Giardia* lamblia cysts and 99.99 percent removal and/or inactivation of viruses, and 99 percent removal of *Cryptosporidium* oocysts; and a description of how, for the system that makes this demonstration, the State will set turbidity performance requirements that the system must meet 95 percent of the time and that the system may not exceed at any time a level that consistently achieves 99.9 percent removal and/or inactivation of *Giardia* lamblia cysts, 99.99 percent removal and/or inactivation of viruses, and 99 percent removal of *Cryptosporidium* oocysts.

(6) Description of the criteria the State will use under § 142.16(b)(2)(vi) to determine whether public water systems completing self assessments under § 141.76 (c) are required to modify recycle practice and the criteria that will be used to specify modifications to recycle practice.

(7) Description of the criteria the State will use under § 142.16(b)(2)(vii) to determine whether direct filtration systems reporting data under § 141.76 (d) are required to change recycle practice and the criteria that will be used to specify changes to recycle practice.

(8) The application must describe the criteria the State will use under § 142.16(b)(2)(viii) to determine whether public water systems applying for a waiver to return recycle to a location other than prior to the point of primary coagulant addition, will be granted the waiver for an alternative recycle location.

B. State Recordkeeping Requirements

Today's rule includes changes to the existing record-keeping provisions to implement the requirements in today's proposed rule. States must maintain records of the following: (1) Turbidity measurements must be kept for not less than one year;

(2) disinfectant residual measurements and other parameters necessary to document disinfection effectiveness must be kept for not less than one year; (3) decisions made on a system-by-system basis and case-by-case basis under provisions of part 141, subpart H or subpart P or subpart T; (4) records of systems consulting with the State concerning a modification of disinfection practice (including the status of the consultation);

(5) records of decisions that a system using alternative filtration technologies can consistently achieve a 99 percent removal of *Cryptosporidium* oocysts as well as the required levels of removal and/or inactivation of *Giardia* and viruses for systems using alternative filtration technologies, including State-set enforceable turbidity limits for each system. A copy of the decision must be kept until the decision is reversed or revised and the State must provide a copy of the decision to the system, and; (6) records of systems required to do filter self-assessments, CPE or CCP. These decision records must be kept for 40 years (as currently required by § 142.14 for other State decision records) or until a subsequent determination is made, whichever is shorter.

C. State Reporting Requirements

Currently States must report to EPA information under 40 CFR 142.15 regarding violations, variances and exemptions, enforcement actions and general operations of State public water supply programs. Today's proposal requires States to report a list of direct recycle plants performing self assessments, whether the State required these systems to modify recycle practice, and the reason(s)modifications were or were not required and a list of direct filtration plants performing self assessments, whether the State required these systems to modify recycle practice, and the reason(s) modifications were or were not required

D. Interim Primacy

On April 28, 1998, EPA amended its State primacy regulations at 40 CFR 142.12 (63 FR 23362) (EPA 1998i) to incorporate the new process identified in the 1996 SDWA amendments for granting primary enforcement authority to States while their applications to modify their primacy programs are under review. The new process grants interim primary enforcement authority for a new or revised regulation during the period in which EPA is making a determination with regard to primacy for that new or revised regulation. This interim enforcement authority begins on the date of the primacy application submission or the effective date of the new or revised State regulation, whichever is later, and ends when EPA makes a proposed determination. However, this interim primacy authority is only available to a State that has primacy for every existing national primary drinking water regulation in effect when the new regulation is promulgated.

As a result, States that have primacy for every existing NPDWR already in effect may obtain interim primacy for this rule, beginning on the date that the State submits its final application for primacy for this rule to EPA, or the effective date of its revised regulations, whichever is later. Interim primacy is available for the following rules:

- Stage 1 Disinfectants and Disinfection Byproducts Rule (December 16, 1998)(EPA,1998c)
- Interim Enhanced Surface Water Treatment Rule (EPA,1998a)
- Consumer Confidence Report Rule (EPA, 1998f)
- Variances and Exemptions Rule (EPA, 1998g)
- Drinking Water Contaminant Candidate List (EPA, 1998h)
- Revisions to State Primacy Requirements (EPA,1998i)
- Public Notification Rule (EPA, 1999i)

In addition, a State which wishes to obtain interim primacy for future NPDWRs must obtain primacy for this rule. After the effective date of the final rule, any State that does not have primacy for this rule cannot obtain interim primacy for future rules.

E. Compliance Deadlines

Section 1412(b)(10) of SDWA provides that drinking water rules become effective 36 months after promulgation unless the Administrator determines that an earlier time is practicable. The Administrator may also extend the effective date by an additional 24 months if capital improvements are necessary. The Agency believes the three year effective date is appropriate for all of the provisions in today's notice except for those provisions that address the return of recycle flows. The Agency believes providing a five year compliance period for systems making modifications to recycle practice is appropriate and warranted under 1412(b)(10). To effectively modify recycle practice, capital improvements, such as installing additional equipment and/or constructing new facilities, will likely be required. Specific examples of potential capital improvements are installing new piping and pumps to convey recycle flow prior to the point of primary coagulant addition and constructing equalization basins or recycle flow treatment facilities. A limited number of systems may be able to make operational modifications, per the State's determination, that will effectively address potential risks. However, the Agency believes the great majority of systems required to either relocate their recycle return location or modify recycle practice as directed by the State will need to perform capital improvements. The capital improvement process is lengthy; systems will need to engage in preliminary planning activities, consult with State and local officials, develop engineering and construction designs, obtain financing, and construct the facilities. The Agency believes the widespread need that systems making modifications to recycle practice will have for capital improvements warrants the additional 24 months for compliance purposes. The Agency solicits comment on the appropriateness of providing an additional two years for compliance with the recycle provisions. EPA seeks comment on extending the compliance deadline an extra two years because systems are expected to make capital improvements to address recycle practice. EPA also seeks comment on a similar two year extension to comply with the turbidity provisions of today's proposed rule.

II. Economic Analysis

This section summarizes the Health Risk Reduction and Cost Analysis in support of the Long Term 1 Enhanced Surface Water Treatment and Filter Backwash Rule (LT1FBR) as required by Section 1412(b)(3)(C) of the 1996 Amendments to the SDWA. In addition, under Executive Order 12866, Regulatory Planning and Review, EPA must estimate the costs and benefits of LT1FBR in a Regulatory Impact Analysis (RIA) and submit the analysis to the Office of Management and Budget (OMB) in conjunction with publication of the proposed rule. EPA has prepared an RIA to comply with the requirements of this Order and the SDWA Health Risk Reduction and Cost Analysis (EPA, 1999h). The RIA has been published on the Agency's web site, and can be found at *http://www.epa.gov/safewater.* The RIA can also be found in the docket for this rulemaking.

The goal of the following section is to provide an analysis of the costs, benefits, and other impacts of the proposed rule to support future decisions regarding the development of the LT1FBR.

A. Overview

The analysis for this rule examines the costs and benefits for five rule provisions: filter effluent turbidity, applicability monitoring, disinfection benchmark profiling, uncovered finish water reservoirs, and recycle. Several options were considered for each provision. Costs were estimated for three individual turbidity options, three profiling options, and three applicability monitoring options. In addition, costs were estimated for four different recycle options. All four recycle options require spent filter backwash, thickener supernatant, and liquids from dewatering be returned to the treatment process prior to the point of primary coagulant addition. The extent of modifications to recycle practice varies among the rule options.

The value of health benefits from the turbidity provision was estimated for the preferred option. The benefits from the other rule provisions are described qualitatively. Several non-health benefits from this rule were also considered by EPA but were not monetized. The non-health benefits of this rule include: avoided outbreak response costs and possibly reduced uncertainty and averting behavior costs. By adding the non-monetized benefits with those that are monetized, the overall benefits of these rule options increase beyond the dollar values reported.

Additional analysis was conducted by EPA to look at the incremental impacts of the various rule options, impacts on households, benefits from reductions in co-occurring contaminants, and possible increases in risk from other contaminants. Finally, the Agency evaluated the uncertainty regarding the risk, benefits, and cost estimates.

B. Quantifiable and Non-Quantifiable Costs

In estimating the costs of each rule option, the Agency considered impacts on public water systems and on States (including territories and EPA implementation in non-primacy States). The LT1FBR will result in increased costs to public water systems for improved turbidity treatment, applicability monitoring, disinfection benchmarking, covering new finished water reservoirs and modification to recycle practice. States will also face implementation costs. Most of the provisions of this rule, except the recycle provision, apply to systems using surface water or ground water under the direct influence of surface water that serve less than 10,000 people. The recycle provisions, however, apply to all surface water systems that recycle filter backwash, thickener supernatant, or liquids from dewatering.

1. Total Annual Costs

EPA estimates that the annualized cost of the preferred alternatives for the proposed rule will be $97.5 million. This estimate includes capital costs for treatment changes and start-up labor costs for monitoring and reporting activities that have been annualized assuming a 7% discount rate and a 20-year amortization period. Other cost estimates reported in this section also use these same amortization assumptions. The estimated cost of the preferred alternatives also includes annual operating and maintenance costs for treatment changes and annual labor for turbidity monitoring activities.

The turbidity provisions (including treatment changes, monitoring, and exceptions reporting) account for 70% ($68.6million annually) of total costs and the recycling provisions (*i.e.,* recycle to headworks, self assessment, and direct filtration) account for 25% ($24.5 million annually) of total costs. Utility expenditures for all provisions equal almost 93% ($90.2 million annually) of total costs; State expenditures make up the other 7% ($6.7 million annually).

To reduce the potential cost to small systems, EPA developed and evaluated the cost implications of several regulatory alternatives for four of the proposed LT1FBR provisions: individual filter turbidity monitoring, applicability monitoring, disinfection benchmark profiling, and recycle. Many of these alternatives reduce the labor burden on small systems relative to what it would be if the proposed rule used the same requirements as IESWTR. The total national costs previously discussed only included the costs of the preferred alternatives. The following section will describe the cost estimates for each provision and discuss the cost of other alternatives that were considered.

2. Annual Costs of Rule Provisions

The national estimate of annual utility costs for the proposed turbidity provisions is based on estimates of system-level costs for the various provisions of the rule and estimates of the number of systems expected to incur each type of cost. The following paragraphs describe the cost estimates for each of the rule provisions.

Turbidity Provision Costs

The turbidity provisions are estimated to cost $69.0 million annually. This cost is associated with three primary activities that result from this provision: treatment changes, monitoring, and exceptions reporting.

The treatment costs associated with meeting the revised turbidity standard of 0.3 NTU or less are the main costs associated with the turbidity provision. EPA estimates that 2,406 systems will modify their turbidity treatment in response to this rule. These costs are estimated to be $52.2 million annually. O&M expenditures account for 59% of annual costs and the remain 41% percent is annualized capital costs.

In addition to the turbidity treatment costs, turbidity monitoring costs apply to all small surface water or GWUDI systems using conventional or direct filtration methods. There are an estimated 5,896 systems that fall under this criteria. EPA estimated the costs to utilities for three turbidity monitoring alternatives. Alternative B, the preferred alternative, excludes the exceptions report for an individual filter exceeding 0.5 NTU in two consecutive measurements, enabling systems to shift from daily to weekly analysis and review of the monitoring data. The annualized individual filter turbidity cost to public water systems for this preferred option is approximately $10.1 million. In contrast, under the IESWTR monitoring requirements of Alternative A, small systems would expend $63.3 million annually for turbidity monitoring. Alternative C, which only requires monthly analysis is estimated to cost $5.6 million annually. The total state turbidity start-up and monitoring annual costs are $4.98 million annually and is assumed to be the same for all of the three alternatives.

In addition to the turbidity treatment and monitoring costs, individual filter turbidity exceptions are estimated to cost utilities $120 thousand annually for the preferred option. State costs will be approximately $1.17 million. This cost includes the annual exception reports and annual individual filter self assessment costs. Costs are slightly higher for the other two alternative individual filter turbidity monitoring options because they result in increased number of exception reports.

Disinfection Benchmarking Costs

Disinfection benchmarking involves three components: profiling, applicability monitoring, and benchmarking. Four options were costed for applicability monitoring. Alternative 3, which uses the critical monitoring period, is estimated to cost less than $0.4 million annually. This is substantially lower than the $6.0 million estimated for Alternative 1, which has the same requirements as IESWTR. Alternative 2 requires sampling once per quarter for 4 quarters for systems serving 501–10,000, but allows systems under 500 to sample once during the critical monitoring period. This option has an annualized cost of $1.1 million. The preferred option, Alternative 4, makes it optional to sample during the critical monitoring period and is estimated to cost $0.04 million annualized.

Three options were considered for disinfection profiling and benchmarking. They differed in the frequency and duration of data collection. The preferred alternative, Alternative 2, requires weekly monitoring for one year and is estimated to have an annualized cost of $0.8 million. In comparison, Alternative 1 which requires daily data collection for one year, has an annualized cost of approximately $1.3 million. The final option, Alternative 3, requires daily monitoring for 1 month and has an estimated annualized cost of $0.5 million.

State disinfection benchmarking annualized costs are estimated to be $0.4 million. This estimate includes start-up, compliance tracking/recordkeeping, and benchmark related costs.

Covered Finished Water Reservoir Provision Costs

The proposed LT1FBR requires that new systems cover all finished water reservoirs, holding tanks, or other storage facilities for finished water. Historical construction rates suggest that new reservoirs over the next 20 years will roughly equal to five percent of the existing number of systems. Assuming then that 580 new uncovered finished water reservoirs would be built in the next 20 years, total annual costs, including annualized capital costs and one year of O&M costs are expected to be $2.6 million for this provision using a 7% discount rate. This estimate is calculated from a projected construction rate of new reservoirs and unit cost assumptions for covering new finished water reservoirs.

Recycle Provision Cost

EPA considered four different regulatory options for recycle. Each of the four options requires spent filter backwash, thickener supernatant, and liquids from dewatering be returned prior to the point of primary coagulant addition. Alternative 1, is estimated to result in an annualized cost of $16.7 million. Of the total costs of this alternative, State start-up and review costs for this alternative are only $20 to $30 thousand annually.

Alternative 2, the preferred option, further requires that conventional rapid granular filtration plants using surface water or GWUDI perform a self assessment if they recycle spent filter backwash and thickener supernatant, employ 20 or less filters, and practice direct recycle (treatment for the recycle flow or equalization in a basin that has a volume equal to the volume of spent filter backwash produced by a single filter backwash event is not provided). The results of the self assessment are reported to the State, and it specifies whether modifications to recycle practice are necessary. PWSs are required to implement the modification specified by the State. Under Alternative 2, direct filtration plants are required to submit data to the State on current recycle practice, and the State specifies whether changes to recycle practice are required. The total annualized cost of Alternative 2 is $17.4 to $24.5 million. $0.4 to $5.9 million of the total annualized cost is for the direct recycle component, $0.1 to $1.7 million is for the direct filtration component, and the remaining cost is for the requirement to return recycle prior to the point of primary coagulant addition. Of the total costs of this alternative, State start-up, review, and self assessment costs for this alternative is only $115 thousand annually.

Alternative 3 contain the same requirements for direct filtration plants and also requires the three recycle flows mentioned above be returned prior to the point of primary coagulant addition. Direct recycle plants are required to install equalization basins with a volume equal to or greater than the volume produced by two filter backwash events. The annualized cost of Alternative 3 is $55.0 to $56.7 million. Of this range, $38.1 million of the annualized cost is directly associated with requiring direct recycle plants to install equalization, and $0.1 to $1.7 million is associated with the direct filtration component. State start-up and self assessment costs for this alternative is $95 thousand annually.

Alternative 4 requires the three recycle flows mentioned above be returned prior to the point of primary coagulant addition and also requires that all systems that recycle (conventional and direct systems) install sedimentation basins for recycle flow treatment. Systems may also install recycle flow treatment technologies that provide treatment capability equivalent or superior to sedimentation. For cost estimation purposes, sedimentation basins with tube settlers and polymer addition where used. The Agency approximated the annualized costs of this option to be $151.8 million. The sedimentation basin treatment requirement for conventional and direct filtration plants is 88% ($133.3 million) of the total annualized cost of Alternative 4. State start-up and self assessment costs for this alternative is $100 thousand annually.

3. Non-Quantifiable Costs

Although EPA has estimated the cost of all the rule's components on drinking water systems and States, there are some costs that the Agency did not quantify. These non-quantifiable costs result from uncertainties surrounding rule assumptions and from modeling assumptions. For example, EPA did not estimate a cost for systems to acquire land if they needed to build a treatment facility or significantly expand their current facility. This was not costed because many systems will be able to construct new treatment facilities on land already owned by the utility. In addition, if the cost of land was prohibitive, a system may choose another lower cost alternative such as connecting to another source. A cost for systems choosing this alternative is unquantified in our analysis.

C. Quantifiable and Non-Quantifiable Health Benefits

The primary benefits of today's proposed rule come from reductions in the risks of microbial illness from drinking water. In particular, LT1FBR focuses on reducing the risk associated with disinfection resistant pathogens, such as *Cryptosporidium*. Exposure to other pathogenic protozoa, such as *Giardia*, or other waterborne bacteria, viral pathogens, and other emerging pathogens are likely to be reduced by the provisions of this rule as well but are not quantified. In addition, LT1FBR produces nonquantifiable benefits associated with the risk reductions that result from the recycle provision, uncovered reservoirs provision, including *Cryptosporidium* in GWUDI definition, and including *Cryptosporidium* in watershed requirements for unfiltered systems.

1. Quantified Health Benefits

a. Turbidity Provisions

The quantification of benefits from this rule is focused solely on reductions in the risk of cryptosporidiosis. Cryptosporidiosis is an infection caused by *Cryptosporidium* which is an acute, self-limiting illness lasting 7 to 14 days with symptoms that include diarrhea, abdominal cramping, nausea, vomiting and fever (Juranek, 1995). The cost of illness avoided of cryptosporidiosis is estimated to have a mean of $2,016 (Harrington et al., 1985; USEPA 1999h)

The benefits of the turbidity provisions of LT1FBR come from improvements in filtration performance at water systems. The benefits analysis attempts to take into account some of the uncertainties in the analysis by estimating benefits under two different current treatment and three improved removal assumptions. The benefits analysis also used Monte Carlo simulations to derive a distribution of estimates, rather than a single point estimate.

The benefits analysis focused on estimating changes in incidence of cryptosporidiosis that would result from the rule. The analysis included estimating the baseline (pre-LT1FBR) level of exposure from *Cryptosporidium* in drinking water, reductions in such exposure resulting from treatment changes to comply with the LT1FBR, and resultant reductions of risk.

Baseline levels of *Cryptosporidium* in finished water were estimated by assuming national source water occurrence distribution (based on data by LeChevallier and Norton, 1995) and a national distribution of *Cryptosporidium* removal by treatment.

In the LT1FBR RIA, the following two assumptions were made regarding the current *Cryptosporidium* oocyst performance to estimate finished water *Cryptosporidium* concentrations. First, based on treatment removal efficiency data presented in the 1997 IEWSTR, EPA assumed a national distribution of physical removal efficiencies with a mean of 2.0 logs and a standard deviation of ± 0.63 logs. Because the finished water concentrations of oocysts represent the baseline against which improved removal from the LT1FBR is compared, variations in the log removal assumption could have considerable impact on the risk assessment. Second, to evaluate the impact of the removal assumptions on the baseline and resulting improvements, an alternative mean log removal/inactivation assumption of 2.5 logs and a standard deviation of ± 0.63 logs was also used to calculate finished water concentrations of *Cryptosporidium*.

For each of the two baseline assumptions, EPA assumed that a certain number of plants would show low, mid or high improved removal, depending upon factors such as water matrix conditions, filtered water turbidity effluent levels, and coagulant treatment conditions. As a result, the RIA considers six scenarios that encompass the range of endemic health damages avoided based on the rule.

The finished water *Cryptosporidium* distributions that would result from additional log removal with the turbidity provisions, were derived assuming that additional log removal was dependent on current removal, i.e., that sites currently operating at the highest filtered water turbidity levels would show the largest improvements or high improved removal assumption (e.g., plants now failing to meet a 0.4 NTU limit would show greater removal improvements than plants now meeting a 0.3 NTU limit).

Table VI.1 indicates estimated annual benefits associated with implementing the LT1FBR. The benefits analysis quantitatively examines endemic health damages avoided based on the LT1FBR for each of the six scenarios mentioned above. For each of these scenarios, EPA calculated the mean of the distribution of the number of illnesses avoided. The 10th and 90th percentiles imply that there is a 10 percent chance that the estimated value could be as low as the 10th percentile and there is a 10 percent chance that the estimated value could be as high as the 90th percentile. EPA's Office of Water has evaluated drinking water consumption data from USDA's 1994–1996 Continuing Survey of Food Intakes by Individuals (CSFII) Study. EPA's analysis of the CSFII Study resulted in a daily water ingestion lognormally distributed with a mean of 1.2 liters per person (EPA, 2000a). The risk and benefit analysis contained within the RIA reflects this distribution.

TABLE VI.1.—NUMBER AND VALUE OF ILLNESSES AVOIDED ANNUALLY FROM TURBIDITY PROVISIONS [a]

[Dollar amounts in billions]

Improved Log-Removal Assumption	Daily Drinking Water Ingestion and Baseline *Cryptosporidium* Log-Removal Assumptions (Mean = 1.2 Liters per person)	
	2.0 log	2.5 log
Illnesses Avoided with Low Improved *Cryptosporidium* Removal Assumption:		
Mean	62,800.0	22,800.0
10th Percentile	0.0	0.0
90th Percentile	152,000.0	43,900.0
COI Avoided with Low Improved *Cryptosporidium* Removal Assumption:		
Mean	$150.3	$53.9
10th Percentile	$0.0	$0.0
90th Percentile	$288.2	$81.4
Illnesses Avoided with Mid Improved *Cryptosporidium* Removal Assumption:		
Mean	77,500.0	27,900.0
10th Percentile	0.0	.00
90th Percentile	184,000.0	52,900.0
COI Avoided with Mid Improved *Cryptosporidium* Removal Assumption:		
Mean	$185.3	$66.2
10th Percentile	$0.0	$0.0
90th Percentile	$350.9	$98.8
Illnesses Avoided with High Improved *Cryptosporidium* Removal Assumption:		
Mean	83,600.0	30,000.0
10th Percentile	0.0	0.0
90th Percentile	196,000.0	56,500.0
COI Avoided with High Improved *Cryptosporidium* Removal Assumption:		
Mean	$199.5	$71.1
10th Percentile	$0.0	$0.0
90th Percentile	$376.7	$105.8

[a] All values presented are in January 1999 dollars.

According to the RIA performed for the LT1FBR published today, the rule is estimated to reduce the mean annual number of illnesses caused by *Cryptosporidium* in water systems with improved filtration performance by 22,800 to 83,600 cases depending upon which of the six baseline and improved *Cryptosporidium* removal assumptions was used, and assuming the 1.2 liter drinking water consumption distribution. Based on these values, the mean estimated annual benefits of reducing the illnesses ranges from $54 million to $200 million per year. The RIA also indicated that the rule could result in a mean reduction of 3 to 10 fatalities each year, depending upon the varied baseline and improved removal assumptions. Using a mean value of $5.7 million per statistical life saved, reducing these fatalities could produce benefits in the range of $16.0 million to $60 million.

Combining the value of illnesses and mortalities avoided, the total benefits range from $70 million to $260 million assuming a 1.2 liter drinking water consumption distribution.

b. Sensitivity Analysis for Recycle Provisions

Available literature research demonstrates that increased hydraulic loading or disruptive hydraulic currents, such as may be experienced when plants exceed State-approved operating capacity or when recycle is returned directly into the sedimentation basin, can disrupt filter (Cleasby, 1963; Glasgow and Wheatley, 1998; McTigue et al, 1998) and sedimentation (Fulton, 1987; Logsdon, 1987; Cleasby, 1990) performance. However, the literature does not quantify the extent to which performance can be lowered and, more specifically, does not quantify the log reduction in *Cryptosporidium* removal that may be experienced during direct recycle events.

In the absence of quantified log reduction data, the Agency performed a sensitivity analysis to estimate a range of potential benefit provided by the recycle provisions. The analysis assumes a baseline *Cryptosporidium* log removal value of 2.0. The analysis estimates the effect of recycle by reducing the average baseline log removal by a range of values (reduction ranged from 0.05 to 0.50 log) to account for the reduction in removal performance plants may experience if they exceed State-approved operating capacity or return recycle to the sedimentation basin. The installation of equalization to eliminate exceedence of State-approved operating capacity or moving the recycle return location from the sedimentation basin to prior to the point of primary coagulant addition will result in the health benefit. The benefit estimate is conservative, because it does not account for the fact that recycle returns additional oocysts to the plant.

Benefits are estimated by assuming that the installation of equalization or moving the recycle return point prior to the point of primary coagulant addition will return the plant to the baseline *Cryptosporidium* removal of 2.0 log. The difference between the number of illnesses that result from the baseline situation and the reduced performance is used to calculate the monetary benefit. The benefit is compared to the cost of returning recycle prior to the point of primary coagulant additional and the cost of installing equalization for two service populations. Service populations of 1,900 persons, which represents a plant serving fewer than 10,000 people, and a service population of 25,108, which represents a plant serving greater than 10,000 people, are used. Results are summarized in Tables IV.2 and IV.3 below.

TABLE IV.2.—BENEFIT FOR SERVICE POPULATION OF 1,900

Log removal reduction	Benefit [a] for population of 1,900	Cost [a] of moving recycle return	Cost [a] of installing equalization
0.05	$1,400	$5,200	$25,200
0.50	30,700	5,200	25,200

[a] Cost and benefit are annualized with a 7% capital cost over 20 years.

TABLE IV.3.—BENEFIT RANGE FOR SERVICE POPULATION OF 25,108

Log removal reduction	Benefit [a] for population of 25,108	Cost [a] of moving recycle return	Cost [a] of installing rqualization
0.05	$18,700	$18,700	$57,200
0.50	405,800	18,700	57,200

[a] Cost and benefit are annualized with a 7% capital cost over 20 years.

Although literature research does not quantify the log reduction caused by specific recycle practices, the results of the sensitivity analysis show that the benefit a plant serving 25,108 people would realize by improving its baseline performance to 2.0 logs would range from $18,700 to $405,800. $27,256 Benefits would range from $1,400 to $30,700 for a plant serving 1,900. This benefit range supports the Agency's determination that unquantified benefits will justify costs. The determination is discussed in the Benefit Cost Determination section.

2. Non-Quantified Health and Non-Health Related Benefits

a. Recycle Provisions

The benefits associated with the filter backwash provision are unquantified because of data limitations. Specifically, there is a lack of treatment performance data to accurately model the oocysts removal achieved by individual full-scale treatment processes and the impact recycle may have on treatment unit performance and finished water quality. Additional data on the ability of unit processes (sedimentation, DAF, contact clarification, filtration) to remove oocysts from source and recycle flows, the extent to which recycle may generate hydraulic surge within plants and lower the performance of individual treatment processes, data on the potential for recycle to threaten the integrity of chemical treatment, and additional information on the occurrence of oocysts in recycle streams are all needed before an impact model can be calibrated and used as a predictive tool.

However, available data demonstrate that oocysts occur in recycle streams, often at concentrations higher than found in source water, and returning recycle streams to the plant will increase intra-plant oocyst concentrations. Data also shows that oocysts frequently occur in the finished water of treatment plants that are not operating under stressed conditions. Engineering literature also shows that proper coagulation and the maintenance of balanced hydraulic conditions within the plant (*i.e.,* not exceeding State approved sedimentation/clarification and filtration operating rates) are important to protect the integrity of the entire treatment process. Some recycle practices, such as direct recycle, can potentially upset coagulation and the proper hydraulic operation of sedimentation/clarification and filtration processes. The benefits of the recycle provisions are derived from protecting the coagulation process and the hydraulic performance of sedimentation/clarification and filtration processes. Today's recycle provisions reduce the risk posed by recycle and provided additional public health protection in the following ways:

(1) Returning spent filter backwash, thickener supernatant, and liquids from dewatering into, or downstream of, the point of primary coagulant addition may disrupt treatment chemistry by introducing residual coagulant or other treatment chemicals to the process stream. The wide variation in plant influent flow can also result in chemical over-or under-dosing if chemical dosage is not adjusted to account for flow variation. Returning the above flows prior to the point of primary coagulant addition will help protect the integrity of coagulation and protect the performance of downstream unit processes, such as clarification and filtration, that require proper coagulation be conducted to maintain proper performance. This will provide an additional measure of public health protection.

(2) The direct recycle of spent filter backwash without first providing treatment, equalization, or some form of hydraulic detention for the flow, may cause plants to exceed State-approved operating capacity during recycle events. This may lead to lower overall oocyst removal performance due to the hydraulic overload unit processes (i.e., clarification and filtration) experience and increase finished water oocyst concentrations. The self assessment provision in today's rule will help the States identify direct recycle systems that may experience this problem so modifications to recycle practice can be made to protect public health.

(3) Direct filtration plants do not employ a sedimentation basin in their primary treatment process to remove solids and oocysts; all oocyst removal is achieved by the filters. If treatment for the recycle flow is not provided prior to its return to the plant, all of the oocysts captured by a filter during a filter run will be returned to the plant and again loaded to the filters. This may lead to ever increasing levels of oocysts being applied to the filters and could increase the concentration of oocysts in finished water. Today's provision for direct recycle systems will help States identify those systems that are not obtaining sufficient oocyst removal from the recycle flow. Public health protection will be increased when systems implement modifications to recycle practice specified by the State.

The goal of the recycle provisions is to reduce the potential for oocysts getting into the finished water and causing cases of cryptosporidiosis. Other disinfection resistant pathogens may also be removed more efficiently due to implementation of these provisions.

b. Issues Associated With Unquantified Benefits

The monetized benefits from filter performance improvements are likely not to fully capture all the benefits of the turbidity provisions. EPA monetized the benefits from reductions in cryptosporidiosis by using cost-of-illness (COI) estimates. This may underestimate the actual benefits of these reductions because COI estimates do not include pain and suffering. In general, the COI approach is considered a lower bound estimate of willingness-to-pay (WTP) to avoid illnesses. EPA requests comment on the use of an appropriate WTP study to calculate the benefits of this rule.

Several non-health benefits from this rule were also considered by EPA but were not monetized. The non-health benefits of this rule include avoided outbreak response costs and possibly reduced uncertainty and averting behavior costs. By adding the non-monetized benefits with those that are monetized, the overall benefits of this rule would increase beyond the dollar values reported.

D. Incremental Costs and Benefits

EPA evaluated the incremental or marginal costs of today's proposed turbidity option by analyzing various turbidity limits, 0.3 NTU, 0.2 NTU, and 0.1 NTU. For each turbidity limit, EPA developed assumptions about which process changes systems might implement to meet the turbidity level and how many systems would adopt each change. The comparison of total compliance cost estimates show that costs are expected to increase significantly across turbidity limits. The total cost of a 0.1 NTU limit, $404.6 million, is almost eight times higher than the cost of the 0.3 NTU limit, which is $52.2 million. Similarly, the total cost of the 0.2 NTU limit, $134.1 million, is more than twice as great as the 0.3 NTU cost.

Analytical limitations in the estimation of the benefits of LT1FBR prevent the Agency from quantitatively describing the incremental benefits of alternatives. The Agency requests comment on how to analyze and the appropriateness of analyzing incremental benefits and costs for treatment techniques that address microbial contaminants.

E. Impacts on Households

The cost impact of LT1FBR at the household level was also assessed. Household costs are a way to represent water system treatment costs as costs to the system's customers. As expected, costs per household increase as system size decreases. Costs to households are higher for households served by smaller systems than larger systems for two reasons. First, smaller systems serve far fewer households than larger systems, and consequently, each household must bear a greater percentage share of capital and O&M costs. Second, filter backwash recycling may pose a greater risk because the flow of water from filter backwash recycling is a larger portion of the total water flow in smaller systems. This greater risk potential in small systems makes it more likely that some form of recycle treatment might be needed.

The average (mean) annual cost for the turbidity, benchmarking, and covered finished water provision per household is $8.66. For almost 86 percent of the 6.6 million households affected by these provisions, the per-household costs are $10 per year or less, and costs of $120 per year (i.e., $10 per month) or less for approximately 99 percent of the households. Costs exceeding $500 per household occur only for the smallest size category, and the number of affected households represent about 34 of the smallest systems. The highest per-household cost estimate is $2,177. This extreme estimate, however, is an artifact of the way the system cost distribution was generated. It is unlikely that any small system will incur annual costs of this magnitude because less costly options are available.

The average household cost for the recycle provisions is $1.80 per year for households that are served by systems that recycle. The cost per household is less than $10 per year for almost 99% of 12.9 million households potentially affected by the proposed rule. The cost per household exceeds $120 per year for less than 1800 households and it exceeds $500 per year for approximately 100 households. The maximum cost of $1,238 per year would only be incurred if a direct filtration system that serves less than 100 customers installed a sedimentation basin for backwash treatment.

There are approximately 1.5 million households served by small drinking water systems that may be affected by the recycling provisions in addition to the turbidity, benchmarking, and covered finished water provisions. The expected aggregate annual cost to these households can be approximated by the sum of the expected cost for each distribution, which is $10.45 per year.

The assumptions and structure of this analysis tend to overestimate the highest costs. To face the highest household costs, a system would have to implement all, or almost all, of the treatment activities. These systems, however, might seek less costly alternatives, such as connecting into a larger regional water system.

F. Benefits From the Reduction of Co-Occurring Contaminants

If a system chooses to install treatment, it may choose a technology that would also address other drinking water contaminants. For example, some membrane technologies installed to remove bacteria or viruses can reduce or eliminate many other drinking water contaminants including arsenic.

The technologies used to reduce individual filter turbidities have the potential to reduce concentrations of other pollutants as well. Reduction in turbidity that result from today's proposed rule are aimed at reducing *Cryptosporidium* by physical removal. It is reasonable to assume that similar microbial contaminants will also be reduced as a result of improvements in turbidity removal. Health risks from *Giardia lamblia* and emerging disinfection resistant pathogens, such as microsporidia, *Toxoplasma,* and *Cyclospora,* are also likely to be reduced as a result of improvements in turbidity removal and recycle practices. The frequency and extent that LT1FBR would reduce risk from other contaminants has not been quantitatively evaluated because of the Agency's lack of data on the removal efficiencies of various technologies for emerging pathogens and the lack of co-occurrence data for microbial pathogens and other contaminants from drink water systems.

G. Risk Increases From Other Contaminants

It is unlikely that LT1FBR will result in any increased risk from other contaminants. Improvements in plant turbidity performance will not result in any increases in risk. In addition, the benchmarking and profiling provisions were designed to minimize the potential reductions in microbial disinfection in order to lower disinfection byproduct levels to comply with the Stage 1 Disinfection Byproducts Rule. Furthermore, the filter backwash provision does not potentially increase the risk from other contaminants.

H. Other Factors: Uncertainty in Risk, Benefits, and Cost Estimates

There is uncertainty in the baseline number of systems, the risk calculation, and the cost estimates. Many of these uncertainties are discussed in more detail in previous sections of today's proposal.

First, the baseline number of systems is uncertain because of data limitation problems in SDWIS. For example, some systems use both ground and surface water but because of other regulatory requirements are labeled in SDWIS as surface water. Therefore, EPA does not have a reliable estimate of how many of these mixed systems exist. The SDWIS data on non-community water systems does not have a consistent reporting convention for population served. Some states may report the population served over the course of a year, while others may report the population served on an average day. Also, SDWIS does not require states to provide information on current filtration practices and, in some cases, it may overestimate the daily population served. For example, a park may report the population served yearly instead of daily. EPA is looking at new approaches to address these issues and both are discussed below in request for comment.

Second, there are several important sources of uncertainty that enter the benefits assessment. They include the following:

- Occurrence of *Cryptosporidium* oocysts in source waters
- Baseline occurrence of *Cryptosporidium* oocysts in finished waters
- Reduction of *Cryptosporidium* oocysts due to improved treatment, including filtration and disinfection
- Viability of *Cryptosporidium* oocysts after treatment
- Infectivity of *Cryptosporidium*
- Incidence of infections (including impact of under reporting)
- Characterization of the risk Willingness-to-pay to reduce risk and avoid costs.
- The baseline water system treatment efficiency for the removal of *Cryptosporidium* is uncertain. Turbidity measurements have been used as a means of estimating removal treatment efficiency (*i.e.* log removal). In addition to the baseline treatment efficiency estimates, improvements in treatment efficiency for *Cryptosporidium* removal that result from this rule are uncertain.

The benefit analysis incorporates all of the uncertainties associated with the benefits assessment in either the Monte Carlo simulations or the assumption of two baselines—2.0 log removal and 2.5 log removal. The results in table VI.1 show that benefits are more sensitive to the baseline log removal assumptions than the range of low to high improved removal assumptions. Third, some costs of today's proposed rule are uncertain because of the diverse nature of the modifications that may be made to address turbidity limits. Cost analysis uncertainties are primarily caused by assumptions made about how many systems will be affected by various provisions and how they will likely respond. Capital and O&M expenditures account for a majority of total costs. EPA derived these costs for a ''model'' system in each size category using engineering models, best professional judgement, and existing cost and technology documents. Costs for systems affected by the proposed rule could be higher or lower, which would affect total costs. Also, the filter backwash provision's flexibility for States to assess plants' need to modify recycle practices leads to some uncertainty in the estimates of how many plants will have to potentially install some form of recycle equalization or treatment. These uncertainties could either under or overestimate the costs of the rule.

I. Benefit Cost Determination

The Agency has determined that the benefits of the LT1FBR justify the costs. EPA made this determination for both the LT1 and the FBR portions of the rule separately as described below.

The Agency has determined that the benefits of the LT1 provisions justify their costs on a quantitative basis. The LT1 provisions include enhanced filtration, disinfection benchmarking and other non-recycle related provisions. The quantified benefits of $70 million to $259.4 million annually exceed the costs of $73 million at the seven percent cost of capital over a substantial portion of the range of benefits. In addition, the non-quantified benefits include avoided outbreak response costs and possibly reduced uncertainty and averting behavior costs.

The Agency has determined that the benefits of the recycle provisions (FBR) justify their cost on a qualitative basis. The recycle provisions will reduce the potential for certain recycle practices to lower or upset treatment plant performance during recycle events; the provisions will therefore help prevent *Cryptosporidium* oocysts from entering finished drinking water supplies and will increase public health protection.

The Agency strongly believes that returning *Cryptosporidium* to the treatment process in recycle flows, if performed improperly, can create additional public health risk. The Agency holds this belief for three reasons. First, returning recycle flow directly to the plant, without equalization or treatment, can cause large variations in the influent flow magnitude and influent water quality. If chemical dosing is not adjusted to reflect this, less than optimal chemical dosing can occur, which may lower the performance of sedimentation and filtration. Returning recycle flows prior to the point of primary coagulant addition will help diminish the risk of less than optimal chemical dosing and diminished sedimentation and filtration performance. Second, exceeding State-approved operating capacity, which is likely to occur if recycle equalization or treatment is not in place, can hydraulically overload plants and diminish the ability of individual unit processes to remove *Cryptosporidium*. Exceeding approved operating capacity violates fundamental engineering principles and water treatment objectives. States set limits on plant operating capacity and loading rates for individual unit processes to ensure treatment plants and individual treatment processes are operated to within their capabilities so that necessary levels of public health protection are provided. Third, returning recycle flows directly into flocculation or sedimentation basins, which can generate disruptive hydraulic currents, may lower the performance of these units and increase the risk of *Cryptosporidium* in finished water supplies.

The recycle provisions in today's proposal are designed to address those recycle practices that are inconsistent with fundamental engineering and water treatment principles. The objective of the provisions is to eliminate practices that are counter to common sense, sound engineering judgement, and that create additional and preventable risk to public health. EPA believes the public health protection benefit provided by the recycle provisions justifies their cost because they are based upon sound engineering principles and are designed to eliminate recycle practices that are very likely to create additional public health risk.

J. Request for Comment

Pursuant to Section 3142(b)(3)(C), the Agency requests comment on all aspects of the rule's economic impact analysis. Specifically, EPA seeks input into the following two issues.

NTNC and TNC Flow Estimates

As part of the total cost estimates for LT1FBR, EPA estimated the cost of the rule on NTNC and TNC water systems by using flow models. However, these flow models were developed to estimate flows only for CWS and they may not accurately represent the much smaller flows generally found in NTNC and TNC systems. The effect of the overestimate in flow would be to inflate the cost of the rule for these systems. The Agency requests comment on an alternative flow analysis for NTNC and TNC water systems described below.

Instead of using the population served to determine the average flow for use in the rule's cost calculations, this alternative approach would re-categorize NTNC and TNC water systems based on service type (*e.g.,* restaurants or parks). Service type would be obtained from SDWIS data. However, service type data is not always available because it is a voluntary SDWIS data field. Where unavailable, the service type would be assigned based on statistical analysis. Estimates of service type design flows would be obtained from engineering design manuals and best professional judgement if no design manual specifications exist.

In addition, each service type category would also have corresponding rates for average population served and average water consumption. These would be used to determine contaminant exposure which is used in the benefit determination. For example, schools and churches would be two separate service type categories. They each would have their own corresponding average design flow, average population served (rather than the population as reported in SDWIS), and average water consumption rates. These elements could be used to estimate a rule's benefits and costs for the average church and the average school.

Mixed Systems

Current regulations require that all systems that use any amount of surface water as a source be categorized as surface water systems. This classification applies even if the majority of water in a system is from a ground water source. Therefore, SDWIS does not provide the Agency with information to identify how many mixed systems exist. This information would help the Agency to better understand regulatory impacts.

EPA is investigating ways to identify how many mixed systems exist and how many mix their ground and surface water sources at the same entry point or at separate entry points within the same distribution systems. For example, a system may have several plants/entry points that feed the same distribution system. One of these entry points may mix and treat surface water with ground water prior to its entry into the distribution system. Another entry point might use ground water exclusively for its source while a different entry point would exclusively use surface water. However, all three entry points would supply the same system classified in SDWIS as surface water.

One method EPA could use to address this issue would be to analyze CWSS data then extrapolate this information to SDWIS to obtain a national estimate of mixed systems. CWSS data, from approximately 1,900 systems, details sources of supply at the level of the entry point to the distribution system and further subdivides flow by source type. The Agency is considering this national estimate of mixed systems to regroup surface water systems for certain impact analyses when regulations only impact one type of source. For example, surface water systems that get more than fifty percent of their flow from ground water would be counted as a ground water system in the regulatory impact analysis for this rule. The Agency requests comment on this methodology and its applicability for use in regulatory impact analysis.

VII. Other Requirements

A. Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), 5 USC 601 et seq.

1. Background

The RFA, generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

2. Use of Alternative Definition

The RFA provides default definitions for each type of small entity. It also authorizes an agency to use alternative definitions for each category of small entity, ''which are appropriate to the activities of the agency'' after proposing the alternative definition(s) in the **Federal Register** and taking comment. 5 U.S.C. secs. 601(3)–(5). In addition to the above, to establish an alternative small business definition, agencies must consult with SBA's Chief Counsel for Advocacy.

EPA is proposing the LT1FBR which contains provisions which apply to small PWSs serving fewer than 10,000 persons. This is the cut-off level specified by Congress in the 1996 Amendments to the Safe Drinking Water Act for small system flexibility provisions. Because this definition does not correspond to the definitions of ''small'' for small businesses, governments, and non-profit organizations, EPA requested comment on an alternative definition of ''small entity'' in the preamble to the proposed Consumer Confidence Report (CCR) regulation (63 FR 7620, February 13, 1998). Comments showed that stakeholders support the proposed alternative definition. EPA also consulted with the SBA Office of Advocacy on the definition as it relates to small business analysis. In the preamble to the final CCR regulation (63 FR 4511, August 19, 1998). EPA stated its intent to establish this alternative definition for regulatory flexibility assessments under the RFA for all drinking water regulations and has thus used it in this proposed rulemaking.

In accordance with Section 603 of the RFA, EPA prepared an initial regulatory flexibility analysis (IRFA) that examines the impact of the proposed rule on small entities along with regulatory alternatives that could reduce that impact. The IRFA is available for review in the docket and is summarized below.

3. Initial Regulatory Flexibility Analysis

As part of the 1996 amendments to the Safe Drinking Water Act (SDWA), Congress required the U.S. Environmental Protection Agency (EPA) to develop a Long Term Stage 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) under Section 1412(b)(2)(C) which focuses on surface water drinking water systems that serve fewer than 10,000 persons. Congress also required EPA to develop a companion Filter Backwash Recycle Rule (FBRR) under Section 1412(b)(14) which will require that all surface water public water systems, regardless of size, meet new requirements governing the recycle of filter backwash within the drinking water treatment process. The goal of both the LT1ESWTR and the related FBRR is to provide additional protection from disease-causing microbial pathogens for community and non-community public water systems (PWSs) utilizing surface water.

For purposes of assessing the impacts of today's rule on small entities, small entity is defined by systems serving fewer than 10,000 people. The small entities directly regulated by this proposed rule are surface water and systems using ground water under the direct influence of surface water (GWUDI), using filtration and serving fewer than 10,000 people. We have determined that the final rule would result in approximately 2,400 systems needing capital improvement to meet the turbidity requirements, approximately 3,360 systems would need to significantly change their disinfection practices, and approximately 790 systems would need to make capital improvements to change the location of return of their filter backwash recycle stream. A discussion of the impacts on small entities is described in more detail in chapters six and seven of the Regulatory Impact Analysis of the LT1FBR (EPA, 1999).

The following recordkeeping and reporting burdens were projected in the IRFA:

Turbidity Monitoring and Reporting Costs

Utility monitoring activities at the plant level include data collection, data review, data reporting and monthly reporting to the State. The labor burden hours for data collection and review were calculated under the assumption that plants are using on-line monitoring, in the form of a SCADA or other automated data collection system. The data collection process requires that a plant engineer gather and organize turbidimeter readings from the SCADA output and enter them into either a spreadsheet or a log once per 8-hour shift (three times per day).

After data retrieval, the turbidity data from each turbidimeter will be reviewed by a plant engineer once per 8-hour shift (three times per day) to ensure that the filters are functioning properly and are not displaying erratic or exceptional patterns. A monthly summary data report would be prepared. This task involves the review of daily spreadsheets and the compilation of a summary report. It is assumed to take one employee 8 hours per month to prepare. Recordkeeping is expected to take 5 hours per month. Recordkeeping entails organizing daily monitoring spreadsheets and monthly summary reports.

Plant-level data will also be reviewed monthly at the system level to ensure that each plant in a system is in compliance with the rule. A system-level manager or technical worker will review the daily monitoring spreadsheets and monthly summary reports that are generated at the plant level. This task is estimated to take about 4 hours per month. Once the plant-level data have been reviewed, the system manager or technical worker will also compile a monthly system summary report. These reports are estimated to take 4 hours each month to prepare.

Disinfection Benchmarking Monitoring and Reporting Costs

It is assumed that all Subpart H systems currently collect the daily inactivation data required to generate a disinfection profile, in either an electronic or paper format, and therefore would not incur additional data collection expenses due to microbial profiling. Costs per plant are divided into costs per plant using paper data, costs per plant using mainframe data and costs per plant using PC data. Plants with paper data were assumed to represent half of the number of plants needing benchmarking, while plants with mainframe and plants with PC data each represent a quarter.

Filter Backwash Monitoring and Reporting Costs

The proposed requirements are as follows: All subpart H systems, regardless of size, that use conventional rapid granular filtration, and that return spent filter backwash, thickener supernatant, or liquids from dewatering process to submit a schematic diagram to the State showing their intended changes to move the return location above the point of primary coagulant addition.

All subpart H systems, regardless of size, that use conventional rapid granular filtration and employ 20 or fewer filters during the highest production month and that use direct recycling, to perform a self assessment of their recycle practice and report the results to the State.

All subpart H systems, regardless of system size that use direct filtration must submit a report of their recycling practices to the State. The State would then determine whether changes in recycling practices were warranted.

EPA believes that the skill level required for compliance with all of the above recordkeeping, reporting and other compliance activities are similar or equivalent to the skill level required to pass the first level of operator certification required by most States.

Relevant Federal Rules

EPA has issued a Stage 1 Disinfectants/Disinfection Byproducts Rule (DBPR) along with an Interim Enhanced Surface Water Treatment Rule (IESWTR) in December 1998, as required by the Safe Drinking Water Act Amendments of 1996. EPA proposed these rules in July 1994. The Stage 1 DBPR includes a THM MCL of 0.080 mg/L (reduced from the existing THM MCL of 0.10 mg/L established in 1979) and an MCL of 0.060 mg/L for five haloacetic acids (another group of chlorination) as well as MCLs for chlorite (1.0 mg/L) and bromate (0.010 mg/L) byproducts. The Stage 1 DBPR also finalized MRDLs for chlorine (4 mg/L as Cl_2), chloramine (4 mg/L as Cl_2) and chlorine dioxide (0.8 mg/L as ClO_2).

In addition, the Stage 1 DBPR includes requirements for enhanced coagulation to reduce the concentration of TOC in the water and thereby reduce DBP formation potential. The IESWTR was proposed to improve control of microbial pathogens and to control potential risk trade-offs related to the need to meet lower DBP levels under the Stage 1 DBPR.

None of these regulations duplicate, overlap or conflict with this proposed rule.

Significant Alternatives

As a result of consultations during the SBREFA process, and public meetings held subsequently, EPA has developed several alternative options to those presented in the IRFA, and has selected preferred alternatives for each of the turbidity, disinfection benchmarking and filter backwash recycle provisions. These alternatives were developed based on feedback from small system operators and trade associations and are designed to protect public health, while minimizing the burden to small systems. In summary, the proposed turbidity requirements are structured to require recordkeeping once a week as opposed to daily which was written in the IRFA; the proposed disinfection profile requirements are structured to be taken once per week, as opposed to daily which was written in the IRFA; and the filter backwash requirements have been scaled back significantly from those included in the IRFA, *i.e.* a ban on recycle is no longer being considered, nor are several treatment techniques now being considered that were in the IRFA prior to discussions with stakeholders. The provisions being proposed are: systems that recycle will be required to return recycle flows prior to the rapid mix unit; direct recycle systems will need to perform a self assessment to determine whether capacity is exceeded during recycle events, and States will determine whether recycle practices need to be changed based on the self-assessment; and direct filtration systems will need to report their recycle practices to the State, which will determine whether changes to recycle practices are required.

4. Small Entity Outreach and Small Business Advocacy Review Panel

As required by section 609(b) of the RFA, as amended by SBREFA, EPA also conducted outreach to small entities and convened a Small Business Advocacy Review Panel to obtain advice and recommendations of representatives of the small entities that potentially would be subject to the rule's requirements. The SBAR Panel produced two final reports; one for the LT1 provisions and the other for the filter backwash provisions. Although the LT1 and filter backwash provisions have since been combined into the same rule, the projected economic impact of the provisions have not significantly changed, and the relevance of SERs' comments has not been affected.

The Agency invited 24 SERs to participate in the SBREFA process, and 16 agreed to participate. The SERs were provided with background information on the Safe Drinking Water Act and the LT1FBR in preparation for a teleconference on April 28, 1998. This information package included data on options as well as preliminary unit costs for treatment enhancements under consideration. Eight SERs provided comments on these materials.

On August 25, 1998, EPA's Small Business Advocacy Chair person convened the Panel under section 609(b) of the Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA). In addition to its chairperson, the Panel consisted of the Director of the Standards and Risk Management Division of the Office of Ground Water and Drinking Water within EPA's Office of Water, the Administrator of the Office of Information and Regulatory Affairs within the Office of Management and Budget, and the Chief Counsel for Advocacy of the Small Business Administration. The SBAR Panels reports, Final Report of the SBREFA Small Business Advocacy Review Panel on EPA's Planned Proposed Rule: Long Term 1 Enhanced Surface Water Treatment (EPA, 1998k) and the Final Report of the SBREFA Small Business Advocacy Review Panel on EPA's Planned Proposed Rule: Filter Backwash Recycling (EPA, 1998l), contain the SERs comments on the components of the LT1FBR.

The SERs were provided with additional information on potential costs related to LT1FBR regulatory options during teleconferences on September 22 and 25, 1998. Nine SERs provided additional comments during the September 22 teleconference, four SERs provided additional comments during the September 25 teleconference, and three SERs provided written comment on these materials.

In general, the SERs that were consulted on the LT1FBR were concerned about the impact of the proposed rule on small water systems (because of their small staff and limited budgets), small systems' ability to acquire the technical and financial capability to implement requirements, and maintaining flexibility to tailor requirements to the needs and limitations of small systems. Consistent with the RFA/SBREFA requirements, the Panel evaluated the assembled materials and small-entity comments on issues related to the elements of the IRFA. The background information provided to the SBAR Panel and the SERs are available for review in the water docket. A copy of the Panel report is also included in the docket for this proposed rule. The Panel's recommendations to address the SERs concerns are described next.

a. Number of Small Entities Affected

When the IRFA was prepared, EPA initially estimated that there were 5,165 small public water systems that use surface water or GWUDI. A more detailed discussion of the impact of the proposed rule and the number of entities affected is found in Section VI. None of the commenters questioned the information provided by EPA on the number and types of small entities which may be impacted by the LT1FBR. This information is based upon the national Safe Drinking Water Information System (SDWIS) database, which contains data on all public water systems in the country. The Panel believed this was a reasonable data source to characterize the number and types of systems impacted by the proposed rule.

b. Recordkeeping and Reporting

The Panel noted that some small systems are operated by a sole, part time operator with many duties beyond operating and maintaining the drinking water treatment system and that several components of the proposed rule may require significant additional operator time to implement. These included disinfection profiling, individual filter monitoring, and ensuring that short-term turbidity spikes are corrected quickly.

One SER stated that assumptions can be made that small systems will have to add an additional person to comply with the monitoring and recordkeeping portions of the rule. Another SER commented that the most viable and economical option would be to use circuit riders (a trained operator who travels between plants) to fill staffing needs, but the LT1FBR would increase the amount of time that a circuit rider would be required to spend at each plant. An additional option recommended by several SERs to reduce monitoring burden and cost was to allow the use of one on-line turbidimeter to measure several filters. This would entail less frequent monitoring of each filter but might still be adequate to ensure that individual filter performance is maintained.

The proposed LT1FBR takes into consideration the recordkeeping and reporting concerns identified by the Panel and the SERs. For example, initially the Agency considered requiring systems to develop a profile of individual filter performance. Based on concerns from the SERs this requirement was eliminated. In addition, the Agency initially considered requiring operators to record pH, temperature, residual chlorine and peak hourly flow every day. This requirement has been scaled back to once per week to meet difficulties faced by small system operators. Finally, in today's proposed rule the Agency is requesting comment on a modification to allow one on-line turbidimeter instead of several to be used at the smallest size systems (systems serving fewer than 100 people).

c. Interaction With Other Federal Rules

The Panel noted that the LT1FBR and Stage 1 DBP rules will affect small systems virtually simultaneously and that the Agency should analyze the net impact of these rules and consider regulatory options that would minimize the impact on small systems.

One SER commented that any added responsibility or workload due to regulations will have to be absorbed by him and his staff. He noted that many systems, including his own, are losing staff through attrition and are unable to hire replacements. The SER stated that he hoped the Panel was aware of the volume of rules and regulations to which small systems are currently subject. As an example, the SER stated that he had spent a week's time collecting samples for the mandated tests of the Lead and Copper rule. He noted that the sampling had delayed important maintenance to his system by over a month.

The Agency considered these comments when developing the requirements of today's proposed rule, and developed the alternatives with the realization that small systems will be required to implement several rules in a short time frame. In today's proposed rule, the preferred options attempt to minimize the impact on small systems by reducing the amount of monitoring and the amount of operator's time necessary to collect and analyze data. For example, under the IESWTR, large systems are required to monitor disinfection byproducts for 1 year to determine whether or not they must develop a disinfection profile (based on daily measurements of operating conditions). In response to SERs concerns, the Agency is proposing to eliminate the requirement for disinfection byproduct monitoring all together. Under the proposed requirements, all systems would develop a disinfection profile based on weekly measurements of operating parameters for 1 year. Overall, this will save small system operators both time and money. The proposed rule also requests comment on several additional strategies for reducing impacts.

d. Significant Alternatives

During the SBAR panel several alternatives were discussed with the Panel and SERs. These alternatives and the Panel's recommendations are discussed next.

i. Turbidity Provisions

During the SBAR Panel, the Agency presented the IESWTR turbidity provisions as appropriate components for the LT1FBR. The Panel noted that one SER commented that it was a fair assumption that turbidity up to 1 NTU maximum and 0.3 NTU in 95% of all monthly samples is a good indicator of two log removal of *Cryptosporidium*, but stressed the need to allow operators adequate time to respond to exceedances in automated systems. They were referring to the fact the small system operators are often away from the plant performing other duties, and cannot respond immediately if the turbidity levels exceed a predetermined level. The Panel recommended that EPA consider this limitation when developing reporting and recordkeeping requirements.

The Panel also noted that another SER agreed that lowered turbidity level is a good indicator of overall plant performance but thought the 0.3 NTU limit for the 95th percentile reading was too low in light of studies which appear to show variability and inaccuracies in low level turbidity measurements. This SER referenced specific data suggesting that current equipment used to measure turbidity levels below the 0.3 NTU may nonetheless give readings above 0.3 which would put the system out of compliance. EPA has evaluated this issue in the context of the 1997 IESWTR FACA negotiations and believes that readings below the 0.3 NTU are reliable. Moreover, EPA notes that the SERs' concern was based on raw performance evaluation data that had not been fully analyzed.

Finally, the Panel recognized that several SERs supported individual filter monitoring, provided there was flexibility for short duration turbidity spikes. Other SERs, however, noted that the assumption that individual filter monitoring was necessary was unreasonable. The Panel recommended that EPA consider the likelihood and significance of short duration spikes (*i.e.,* during the first 15–30 minutes of filter operation) when evaluating the frequency of individual filter monitoring and reporting requirements and the number and types of exceedances that will trigger requirements for Comprehensive Performance Evaluations (CPEs). The Panel also noted the concern expressed by several SERs that individual filter monitoring may not be practical or feasible in all situations.

The Agency has structured today's proposed rule with an emphasis on providing flexibility for small systems. The individual filter provisions have been tailored to be easier to understand and implement and require less data analysis. For example, the operator can look at monitoring data once per week under this rule, as opposed to having to review turbidity data every day as the larger systems are required to do. The proposed rule also requests comment on several modifications to provide additional flexibility to small systems.

ii. Disinfection Benchmarking: Applicability Monitoring Provisions

None of the SERs commented specifically on the applicability monitoring provisions which are designed to identify systems that may consider cutting back on their disinfection doses in order to avoid problems with disinfection byproducts formation. The Panel noted, however, that burden on small systems might be reduced if alternative applicability monitoring provisions were adopted. In consideration of the Panel's suggestions, the Agency first considered limiting the applicability monitoring, and has now eliminated this requirement from the proposal. It is optional, however, for systems who believe their disinfection byproduct levels are below 80% of the MCL—as required under the Stage 1 DBPR.

The Panel noted SER comments that monitoring and computing *Giardia lamblia* inactivation on a daily basis for a year would place a heavy burden on operators that may only staff the plant for a few hours per day. The Panel therefore recommended that EPA consider alternative profiling strategies which ensure adequate public health protection, but will minimize monitoring and recordkeeping requirements for small system operators.

The Agency considered several alternatives to the profile development strategies, and decided to propose that systems perform the necessary monitoring and record the results once per week, instead of every day as the larger systems are required to do. This will significantly reduce burden and costs for small systems.

iii. Recycling Provisions

During the SBAR Panel, the Agency proposed several alternatives for consideration in the LT1FBR including a ban on recycle, a requirement to return recycle flow to the head of the plant, recycle flow equalization, and recycle flow treatment. The Panel noted the concern of the SERs regarding a ban on the recycle of filter backwash water. These concerns included the expense of filter backwash disposal and the economic and operational concerns of western and southwestern drinking water systems which depend on recycled flow to maintain adequate supply. The Panel strongly recommended that EPA explore alternatives to an outright ban on the recycle of filter backwash and other recycle flows.

The Panel noted that SERs supported a requirement that all recycled water be reintroduced at the head of the plant. This was considered an element of sound engineering practice. The Panel recommended that EPA consider including such a requirement in the proposed rule, and investigate whether there are small systems for which such a requirement would present a significant financial and operational burden.

The Panel noted that SERs agreed with the appropriateness of flow equalization for filter backwash. The Panel supported the concept of flow equalization as a means to minimize hydraulic surges that may be caused by recycle and the reintroduction of a large number of *Cryptosporidium* oocysts or other pathogenic contaminants to the plant in a brief period of time. The Panel noted that there are various ways of achieving flow equalization and suggested that specific requirements remain flexible.

The Panel noted the concerns of SERs regarding installation of treatment, solely for the purpose of treating filter backwash water and/or recycle streams may be costly and potentially prohibitive for small systems. The Agency addressed this concern by allowing the States to determine whether recycle flow equalization or treatment is necessary based on the results of the self assessment prepared by the system rather than requiring universal flow equalization or treatment. This will allow site-specific factors to be considered and help minimize cost and burden.

e. Other Comments

The Panel also noted the concern of several SERs that flexibility be provided in the compliance schedule of the rule. SERs noted the technical and financial limitations that some small systems will have to address, the significant learning curve for operators with limited experience, and the need to continue providing uninterrupted service as reasons why additional compliance time may be needed for small systems. The panel encouraged EPA to keep these limitations in mind in developing the proposed rule and provide as much compliance flexibility to small systems as is allowable under the SDWA. We invite comments on all aspects of the proposal and its impacts on small entities.

The Agency structured the timing of the LT1ESWTR provisions specifically to follow the promulgation of the IESWTR. Since the IESWTR served as a template for the establishment of the LT1ESWTR provisions, the Agency decided that small systems would have an advantage by giving them an opportunity to see what was in the rule, and how it was implemented by larger systems.

Under SDWA, systems have 3 years to comply with the requirements of the final rule. If capital improvements are necessary for a particular PWS, a State may allow the system up to an additional 2 years to comply with the regulation. The Agency is developing guidance manuals to assist the compliance efforts of small entities.

B. Paperwork Reduction Act

The information collection requirements in this proposed rule have been submitted for approval to the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* An Information Collection Request (ICR) document has been prepared by EPA (ICR No. 1928.01) and a copy may be obtained from Sandy Farmer by mail at OP Regulatory Information Division; U.S. Environmental Protection Agency (2137); 401 M St., S.W.; Washington, DC 20460, by email at farmer.sandy@epamail.epa.gov, or by calling (202) 260–2740. A copy may also be downloaded off the Internet at *http://www.epa.gov/icr.* For technical information about the collection contact Jini Mohanty by calling (202) 260–6415.

The information collected as a result of this rule will allow the States and EPA to determine appropriate requirements for specific systems, in some cases, and to evaluate compliance with the rule. For the first three years after the effective date (six years after promulgation) of the LT1FBR, the major information requirements are (1) monitor filter performance and submit any exceedances of turbidity requirements (*i.e.* exceptions reports) to the State; (2) develop a 1 month recycle monitoring plan and submit both plan and results to the State; (3) submit flow monitoring plan and results to the State; and (4) report data on current recycle treatment (self assessment) to the State. The information collection requirements in Part 141, for systems, and Part 142, for States are mandatory. The information collected is not confidential.

Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal Agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

The preliminary estimate of aggregate annual average burden hours for LT1FBR is 311,486. Annual average aggregate cost estimate is $10,826,919 for labor, $2,713,815 for capital, and $1,898,595 for operation and maintenance including lab costs which is a purchase of service. The burden hours per response is 18.9. The frequency of response (average responses per respondent) is 2.7 annually. The estimated number of likely respondents is 6,019 (the product of burden hours per response, frequency, and respondents does not total the annual average burden hours due to rounding). Most of the regulatory provisions discussed in this notice entail new reporting and recordkeeping requirements for States, Tribes, and members of the regulated public. An Agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR Part 9 and 48 CFR Chapter 15.

Comments are requested on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques. Send comments on the ICR to the Director, OP Regulatory Information Division; U.S. Environmental Protection Agency (2137); 401 M St., S.W.; Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th St., N.W., Washington, DC 20503, marked "Attention: Desk Officer for EPA." Include the ICR number in any correspondence. Since OMB is required to make a decision concerning the ICR between 30 and 60 days after April 10, 2000, a comment to OMB is best assured of having its full effect if OMB receives it by May 10, 2000. The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

C. Unfunded Mandates Reform Act

1. Summary of UMRA requirements

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), Public Law 104–4, establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and tribal governments and the private sector. Under UMRA section 202, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "Federal mandates" that may result in expenditures by State, local, and tribal governments, in the aggregate, or to the private sector, of $100 million or more in any one year. Before promulgating an EPA rule, for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost effective or least burdensome alternative if the Administrator publishes with the final rule an explanation why that alternative was not adopted.

Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it must have developed, under section 203 of the UMRA, a small government agency plan. The plan must provide for notification to potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant Federal intergovernmental mandates and informing, educating, and advising small governments on compliance with the regulatory requirements.

2. Written Statement for Rules With Federal Mandates of $100 Million or More

EPA has determined that this rule does not contain a Federal mandate that may result in expenditures of $100 million or more for the State, local and Tribal governments, in the aggregate, or the private sector in any one year. Thus today's rule is not subject to the requirements of sections 202 and 205 of the UMRA. Nevertheless, since the estimate of annual impact is close to $100 million under certain assumptions EPA has prepared a written statement, which is summarized below, even though one is not required. A more detailed description of this analysis is presented in EPA's Regulatory Impact Analysis of the LT1FBR (EPA, 1999h) which is available for public review in the Office of Water docket under docket number W–99–10. The document is available for inspection from 9 a.m. to 4 p.m., Monday through Friday, excluding legal holidays. The docket is located in room EB 57, USEPA Headquarters, 401 M St. SW, Washington, D.C. 20460. For access to docket materials, please call (202) 260–3027 to schedule an appointment.

a. Authorizing Legislation

Today's rule is proposed pursuant to Section 1412 (b)(2)(C) and 1412(b)(14) of the SDWA. Section 1412 (b)(2)(C) directs EPA to establish a series of regulations including an interim and final enhanced surface water treatment rule. Section 1412(b)(14) directs EPA to promulgate a regulation to govern the recycling of filter backwash water. EPA intends to finalize the LT1FBR in the year 2000 to allow systems to consider the dual impact of this rule and the Stage 1 DBP rule on their capital investment decisions.

b. Cost Benefit Analysis

Section VI of this preamble discusses the cost and benefits associated with the LT1FBR. Also, the EPA's Regulatory Impact Analysis of the LT1FBR (EPA, 1999h) contains a detailed cost benefit analysis. Today's proposal is expected to have a total annualized cost of approximately $ 97.5 million using a 7 percent discount rate. At a 3 percent discount rate the annualized costs drop to $87.6 million. The national cost estimate includes cost for all of the rule's major provisions including turbidity monitoring, disinfection benchmarking monitoring, disinfection profiling, covered finished storage, and recycling. The majority of the costs for this rule will be incurred by the public sector. A more detailed discussion of these costs is located in Section VI of this preamble.

In addition, the regulatory impact analysis includes both monetized benefits and descriptions of unquantified benefits for improvements to public health and safety the rule will achieve. Because of scientific uncertainty regarding LT1FBR's exposure and risk assessment, the Agency has used Monte Carlo methods and sensitivity analysis to assess the quantified benefits of today's rule. The monetary analysis was based upon quantification of the number of cryptosporidiosis illnesses avoided due to improved particulate removal that results from the turbidity provisions. The Agency was not able to monetize the benefits from the other rule provisions such as disinfection benchmarking and covered finished storage. The monetized annual benefits of today's rule range from $70.1 million to $259.4 million depending on the baseline and removal assumptions. Better management of recycle streams required by the proposal also result in nonquantifiable health risk reductions from disinfection resistant pathogens. The rule may also decrease illness caused by *Giardia* and other emerging disinfection resistant pathogens, further increasing the benefits.

Several non-health benefits from this rule were also identified by EPA but were not monetized. The non-health benefits of this rule include outbreak response costs avoided, and possibly reduced uncertainty and averting behavior costs. By adding the non-monetized benefits with those that are monetized, the overall benefits of this rule increase beyond the dollar values reported.

Various Federal programs exist to provide financial assistance to State, local, and Tribal governments in complying with this rule. The Federal government provides funding to States that have primary enforcement responsibility for their drinking water programs through the Public Water Systems Supervision Grants program. Additional funding is available from other programs administered either by EPA, or other Federal Agencies. These include EPA's Drinking Water State Revolving Fund (DWSRF), U.S. Department of Agriculture's Rural Utilities' Loan and Grant Program, and Housing and Urban Development's Community Development Block Grant Program.

For example, SDWA authorizes the Administrator of the EPA to award capitalization grants to States, which in turn can provide low cost loans and other types of assistance to eligible public water systems. The DWSRF helps public water systems finance the cost of infrastructure necessary to achieve or maintain compliance with SDWA requirements. Each State has considerable flexibility to design its program and to direct funding toward the most pressing compliance and public health protection needs. States may also, on a matching basis, use up to ten percent of their DWSRF allotments each fiscal year to run the State drinking water program.

Furthermore, a State can use the financial resources of the DWSRF to assist small systems. In fact, a minimum of 15% of a State's DWSRF grant must be used to provide infrastructure loans to small systems. Two percent of the State's grant may be used to provide technical assistance to small systems. For small systems that are disadvantaged, up to 30% of a State's DWSRF may be used for increased loan subsidies. Under the DWSRF, Tribes have a separate set-aside which they can use. In addition to the DWSRF, money is available from the Department of Agriculture's Rural Utility Service (RUS) and Housing and Urban Development's Community Block Grant (CDBG) program. RUS provides loans, guaranteed loans, and grants to improve, repair, or construct water supply and distribution systems in rural areas and towns up to 10,000 people. In fiscal year 1997, the RUS had over $1.3 billion in available funds. Also, three sources of funding exist under the CDBG program to finance building and improvements of public faculties such as water systems. The three sources of funding include: (1) Direct grants to communities with populations over 200,000; (2) direct grants to States, which they in turn award to smaller communities, rural areas, and colonias in Arizona, California, New Mexico, and Texas; and (3) direct grants to US. Territories and Trusts. The CDBG budget for fiscal year 1997 totaled over $4 billion dollars.

c. Estimates of Future Compliance Costs and Disproportionate Budgetary Effects

To meet the UMRA requirement in section 202, EPA analyzed future compliance costs and possible disproportionate budgetary effects. The Agency believes that the cost estimates, indicated previously and discussed in more detail in Section VI of this preamble, accurately characterize future compliance costs.

In analyzing the disproportionate impacts, EPA considered four measures:

(1) The impacts of small versus large systems and the impacts within the five small system size categories;

(2) The costs to public versus private water systems;

(3) The costs to households, and;

(4) The distribution of costs across States.

First, small systems will experience a greater impact than large systems under LT1FBR because large systems are subject only to the recycle provisions. The Interim Enhanced Surface Water Treatment Rule (IESWTR) promulgated turbidity, benchmarking, and covered finished storage provisions for large systems in December, 1998. However, small systems have realized cost savings over time due to their exclusion from the IESWTR. Also, some provisions in the LT1FBR have been modified so they would not be as burdensome for small systems. Further information on these changes can be found in section VII.A.3.of this proposal.

The second measure of impact is the relative total cost to privately owned water systems compared to the incurred by publicly owned water systems. A majority of the systems are publicly owned (60 percent of the total). As a result, publicly owned systems will incur a larger share of the total costs of the rule.

The third measure, household costs, is described in further detail in VI.E of this preamble. The fourth measure, distribution of costs across States, is described in greater detail in the RIA for today's proposed rule (EPA, 1999h). There is nothing to suggest that costs to individual systems would vary significantly from State to State, but as expected, the States with the greatest number of systems experience the greatest costs.

d. Macro-Economic Effects

As required under UMRA Section 202, EPA is required to estimate the potential macro-economic effects of the regulation. These types of effects include those on productivity, economic growth, full employment, creation of productive jobs, and international competitiveness. Macro-economic effects tend to be measurable in nationwide econometric models only if the economic impact of the regulation reaches 0.25 percent to 0.5 percent of Gross Domestic Product (GDP). In 1998, real GDP was $7,552 billion. This proposal would have to cost at least $18 billion to have a measurable effect. A regulation of less cost is unlikely to have any measurable effect unless it is highly focused on a particular geographic region or economic sector. The macro-economic effects on the national economy from LT1FBR should not have a measurable effect because the total annual cost of the preferred option is approximately $ 97.5 million per year (at a seven percent discount rate). The costs are not expected to be highly focused on a particular geographic region or sector.

e. Summary of EPA's Consultation with State, Local, and Tribal Governments and Their Concerns

Consistent with the intergovernmental consultation provisions of section 204 of UMRA EPA has already initiated consultation with the governmental entities affected by this rule.

EPA began outreach efforts to develop the LT1FBR in the summer of 1998. Two public stakeholder meetings, which were announced in the **Federal Register**, were held on July 22–23, 1998, in Lakewood, Colorado, and on March 3–4, 1999, in Dallas, Texas. In addition to these meetings, EPA has held several formal and informal meetings with stakeholders including the Association of State Drinking Water Administrators. A summary of each meeting and attendees is available in the public docket for this rule. EPA also convened a Small Business Advocacy Review (SBAR) Panel in accordance with the Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) to address small entity concerns including those of small local governments. The SBAR Panel allows small regulated entities to provide input to EPA early in the regulatory development process. In early June, 1999, EPA mailed an informal draft of the LT1FBR preamble to the approximately 100 stakeholders who attended one of the public stakeholder meetings. Members of trade associations and the SBREFA Panel also received the draft preamble. EPA received valuable comments and stakeholder input from 15 State representatives, trade associations, environmental interest groups, and individual stakeholders. The majority of concerns dealt with reducing burden on small systems and maintaining flexibility. After receipt of comments, EPA made every effort to make modifications to address these concerns.

To inform and involve Tribal governments in the rulemaking process, EPA presented the LT1FBR at three venues: the 16th Annual Consumer Conference of the National Indian Health Board, the annual conference of the National Tribal Environmental Council, and the OGWDW/Inter Tribal Council of Arizona, Inc. tribal consultation meeting. Over 900 attendees representing tribes from across the country attended the National Indian Health Board's Consumer Conference and over 100 tribes were represented at the annual conference of the National Tribal Environmental Council. At both conferences, an OGWDW representative conducted two workshops on EPA's drinking water program and upcoming regulations, including the LT1FBR.

At the OGWDW/Inter Tribal Council of Arizona meeting, representatives from 15 tribes participated. The presentation materials and meeting summary were sent to over 500 tribes and tribal organizations. Additionally, EPA contacted each of our 12 Native American Drinking Water State Revolving Fund Advisors to invite them, and representatives of their organizations to the stakeholder meetings described previously. A list of tribal representatives contacted can be found in the docket for this rule.

The primary concern expressed by State, local and Tribal governments is the difficulty the smallest systems will encounter in adequately staffing drinking water treatment facilities to perform the monitoring and reporting associated with the new requirements. Today's proposal attempts to minimize the monitoring and reporting burden to the greatest extent feasible and still accomplish the rule's objective of protecting public health. The Agency believes the monitoring and reporting requirements are necessary to ensure consumers served by small systems receive the same level of public health protection as consumers served by large systems. Summaries of the meetings have been included in the public docket for this rulemaking.

f. Regulatory Alternatives Considered

As required under Section 205 of the UMRA, EPA considered several regulatory alternatives for individual filter monitoring and disinfection benchmarking, as well as several alternative strategies for addressing recycle practices. A detailed discussion of these alternatives can be found in Section IV and also in the RIA for today's proposed rule (EPA, 1999h). Today's proposal also seeks comment on several regulatory alternatives that EPA will consider for the final rule.

g. Selection of the Least Costly, Most-Cost Effective or Least Burdensome Alternative That Achieves the Objectives of the Rule

As discussed previously, EPA has considered and requested comment on various regulatory options that would reduce *Cryptosporidium* occurrence in the finished water of surface water systems. The Agency believes that the preferred option for turbidity performance, disinfection benchmarking, and recycle management are the most cost effective combination of options to achieve the rule's objective; the reduction of illness and death from *Cryptosporidium* occurrence in the finished water of PWSs using surface water. The Agency will carefully review comments on the proposal and assess suggested changes to the requirements.

3. Impacts on Small Governments

In developing this proposal, EPA consulted with small governments to address impacts of regulatory requirements in the rule that might significantly or uniquely affect small governments. As discussed previously, a variety of stakeholders, including small governments, were provided the opportunity for timely and meaningful participation in the regulatory development process through the SBREFA panel, public stakeholder and Tribal meetings. EPA used these processes to notify potentially affected small governments of regulatory requirements being considered and provided officials of affected small governments with an opportunity to have meaningful and timely input to the regulatory development process.

In addition, EPA will educate, inform, and advise small systems, including those run by small governments, about LT1FBR requirements. One of the most important components of this outreach effort will be the Small Entity Compliance Guide, required by the Small Business Regulatory Enforcement Fairness Act of 1996. This plain-English guide will explain what actions a small entity must take to comply with the rule. Also, the Agency is developing fact sheets that concisely describe various aspects and requirements of the LT1FBR and detailed guidance manuals to assist the compliance effort of PWSs and small government entities.

D. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTAA), Public Law No. 104–113, section 12(d) (15 U.S.C. 272 note), directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, business practices) that are developed or adopted by voluntary consensus standards bodies. The NTAA directs EPA to provide Congress, through the Office of Management and Budget, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

Today's rule requires the use of previously approved technical standards for the measurement of turbidity. In previous rulemakings, EPA approved three methods for measuring turbidity in drinking water. These can be found in 40 CFR, Part 141.74 (a). Turbidity is a method-defined parameter and therefore modifications to any of the three approved methods requires prior EPA approval. One of the approved methods was published by the Standard Methods Committee of American Public Health Association, the American Water Works Association, and the Water Environment Federation, the latter being a voluntary consensus standard body. That method, Method 2130B (APHA, 1995), is published in Standard Methods for the Examination of Water and Wastewater (19th ed.). Standard Methods is a widely used reference which has been peer-reviewed by the scientific community. In addition to this voluntary consensus standard, EPA approved two additional methods for the measurement of turbidity. One is the Great Lakes Instrument Method 2, which can be used as an alternate test procedure for the measurement of turbidity (Great Lakes Instruments, 1992). Second, the Agency approved revised EPA Method 180.1 for turbidity measurement in August 1993 in Methods for the Determination of Inorganic Substances in Environmental Samples (EPA–600/R–93–100) (EPA, 1993).

In 1994, EPA reviewed and rejected an additional technical standard, a voluntary consensus standard, for the measurement of turbidity, the ISO 7027 standard, an analytical method which measures turbidity at a higher wavelength than the approved test measurement standards. ISO 7027 measures turbidity using either 90° scattered or transmitted light depending on the turbidity concentration evaluated. Although instruments conforming to ISO 7027 specifications are similar to the GLI instrument, only the GLI instrument uses pulsed, multiple detectors to simultaneously read both 90° scattered and transmitted light. EPA has no data upon which to evaluate whether the separate 90° scattered or transmitted light measurement evaluations, according to the ISO 7027 method, would produce results that are equivalent to results produced using GLI Method 2, Standard Method 2130B (APHA, 1995), or EPA Method 180.1 (EPA, 1993).

Today's proposed rule also requires continuous individual filter monitoring for turbidity and requires PWSs to calibrate the individual turbidimeter according to the turbidimeter manufacturer's instructions. These calibration instructions may constitute technical standards as that term is defined in the NTTAA. EPA has looked for voluntary consensus standards with regard to calibration of turbidimeters. The American Society for Testing and Materials (ASTM) is developing such voluntary consensus standards, however, there do not appear to be any voluntary consensus standards available at this time. EPA welcomes comments on this aspect of the proposed rulemaking and, specifically invites the public to identify potentially applicable voluntary consensus standards and to explain why such standards should be used in this regulation.

EPA plans to implement in the future a performance-based measurement system (PBMS) that would allow the option of using either performance criteria or reference methods in its drinking water regulatory programs. The Agency is currently determining the specific steps necessary to implement PBMS in its programs and preparing an implementation plan. Final decisions have not yet been made concerning the implementation of PBMS in water programs. However, EPA is currently evaluating what relevant performance characteristics should be specified for monitoring methods used in the water programs under a PBMS approach to ensure adequate data quality. EPA would then specify performance requirements in its regulations to ensure that any method used for determination of a regulated analyte is at least equivalent to the performance achieved by other currently approved methods.

Once EPA has made its final determinations regarding implementation of PBMS in programs under the Safe Drinking Water Act, EPA would incorporate specific provisions of PBMS into its regulations, which may include specification of the performance characteristics for measurement of regulated contaminants in the drinking water program regulations.

E. Executive Order 12866: Regulatory Planning and Review

Under Executive Order 12866, (58 FR 51735 (October 4, 1993) the Agency must determine whether the regulatory action is ''significant'' and therefore subject to OMB review and the requirements of the Executive Order. The Order defines ''significant regulatory action'' as one that is likely to result in a rule that may:

1. Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, tribal governments or communities;

2. Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

3. Materially alter the budgetary impact of entitlement, grants, user fees, or loan programs or the rights and obligations of recipients thereof, or;

4. Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Pursuant to the terms of Executive Order 12866, it has been determined that this rule is a ''significant regulatory action.'' As such, this action was submitted to OMB for review. Changes made in response to OMB suggestions or recommendations will be documented in the public record.

F. Executive Order 12898: Environmental Justice

Executive Order 12898 establishes a Federal policy for incorporating environmental justice into Federal agency missions by directing agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The Agency has considered environmental justice related issues concerning the potential impacts of this action and consulted with minority and low-income stakeholders.

This preamble has discussed many times how the IESWTR served as a template for the development of the LT1FBR. As such, the Agency also built on the efforts conducted during the IESWTRs development to comply with E.O. 12898. On March 12, 1998, the Agency held a stakeholder meeting to address various components of pending drinking water regulations and how they may impact sensitive sub-populations, minority populations, and low-income populations. Topics discussed included treatment techniques, costs and benefits, data quality, health effects, and the regulatory process. Participants included national, State, tribal, municipal, and individual stakeholders. EPA conducted the meetings by video conference call between eleven cities. This meeting was a continuation of stakeholder meetings that started in 1995 to obtain input on the Agency's Drinking Water Programs. The major objectives for the March 12, 1998 meeting were:

(1) Solicit ideas from stakeholders on known issues concerning current drinking water regulatory efforts;

(2) Identify key issues of concern to stakeholders, and;

(3) Receive suggestions from stakeholders concerning ways to increase representation of communities in OGWDW regulatory efforts.

In addition, EPA developed a plain-English guide specifically for this meeting to assist stakeholders in understanding the multiple and sometimes complex issues surrounding drinking water regulation.

The LT1FBR applies to community water systems, non-transient non-community water systems, and transient non-community water systems that use surface water or ground water under the direct influence (GWUDI) as their source water for PWSs serving less than 10,000 people. The recycle provisions apply to all conventional and direct surface water or GWUDI systems regardless of size.

EPA believes this rule will provide equal health protection for all minority and low-income populations served by systems regulated under this rule from exposure to microbial contamination. These requirements will also be consistent with the protection already afforded to people being served by systems with larger population bases.

G. Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 13045: ''Protection of Children from Environmental Health Risks and Safety Risks'' (62 FR 19885, April 23, 1997) applies to any rule that: 1) is determined to be economically significant as defined under E.O. 12866, and; 2) concerns an environmental health or safety risk that EPA has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, the Agency must evaluate the environmental health or safety effects of the planned rule on children and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

While this proposed rule is not subject to the Executive Order because it is not economically significant as defined by E.O. 12866, we nonetheless have reason to believe that the environmental health or safety risk addressed by this action may have a disproportionate effect on children. Accordingly, EPA evaluated available data on the health effect of *Cryptosporidium* on children. The results of this evaluation are contained in Section II.B of this preamble and in the LT1FBR RIA (EPA, 1999h). A copy of the RIA and supporting documents is available for public review in the Office of Water docket at 401 M St. SW, Washington, D.C.

The risk of illness and death due to cryptosporidiosis depends on several factors, including the age, nutrition, exposure, and the immune status of the individual. Information on mortality from diarrhea shows the greatest risk of mortality occurring among the very young and elderly (Gerba et al., 1996). Specifically, young children are a vulnerable population subject to infectious diarrhea caused by *Cryptosporidium* (CDC 1994). Cryptosporidiosis is prevalent worldwide, and its occurrence is higher in children than in adults (Fayer and Ungar, 1986).

Cryptosporidiosis appears to be more prevalent in populations that may not have established immunity against the disease and may be in greater contact with environmentally contaminated surfaces, such as infants (DuPont, et al., 1995). Once a child is infected it may spread the disease to other children or family members. Evidence of such secondary transmission of cryptosporidiosis from children to household and other close contacts has been found in many outbreak investigations (Casemore, 1990; Cordell et al., 1997; Frost et al., 1997). Chapell et al., 1999, found that prior exposure to *Cryptosporidium* through the ingestion of a low oocyst dose provides protection from infection and illness. However, it is not known whether this immunity is life-long or temporary. Data also indicate that either mothers confer short term immunity to their children or that babies have reduced exposure to *Cryptosporidium*, resulting in a decreased incidence of infection during the first year of life. For example, in a survey of over 30,000 stool sample analyses from different UK patients, the 1–5 year age group suffered a much higher infection rate than individuals less than one year of age. For children under one year of age, those older than six months of age showed a higher rate of infection than individuals aged fewer than six months (Casemore, 1990).

EPA has not been able to quantify the differential health effects for children as a result of *Cryptosporidium*-contaminated drinking water. However, the result of the LT1FBR will be a reduction in the risk of illness for the entire population, including children. Furthermore, the available anecdotal evidence indicates that children may be more vulnerable to cryptosporidiosis than the rest of the population. The LT1FBR would, therefore, result in greater risk reduction for children than for the general population.

The public is invited to submit or identify peer-reviewed studies and data, of which EPA may not be aware, that assessed results of early life exposure to *Cryptosporidium*.

H. Consultations with the Science Advisory Board, National Drinking Water Advisory Council, and the Secretary of Health and Human Services

In accordance with section 1412 (d) and (e) of the SDWA, the Agency will consult with the National Drinking Water Advisory Council (NDWAC) and the Secretary of Health and Human Services and request comment from the Science Advisory Board on the proposed LT1FBR.

I. Executive Order 13132: Executive Orders on Federalism

Executive Order 13132, entitled ''Federalism'' (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure ''meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications.'' ''Policies that have federalism implications'' is defined in the Executive Order to include regulations that have ''substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.''

Under section 6 of Executive Order 13132, EPA may not issue a regulation that has federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by State and local governments, or EPA consults with State and local officials early in the process of developing the proposed regulation. EPA also may not issue a regulation that has federalism implications and that preempts State law, unless the Agency consults with State and local officials early in the process of developing the proposed regulation.

If EPA complies by consulting, Executive Order 13132 requires EPA to provide to the Office of Management and Budget (OMB), in a separately identified section of the preamble to the final rule, a federalism summary impact statement (FSIS). The FSIS must include a description of the extent of EPA's prior consultation with State and local officials, a summary of the nature of their concerns and the agency's position supporting the need to issue the regulation, and a statement of the extent to which the concerns of State and local officials have been met. Also, when EPA transmits a draft final rule with federalism implications to OMB for review pursuant to Executive Order 12866, EPA must include a certification from the agency's Federalism Official stating that EPA has met the requirements of Executive Order 13132 in a meaningful and timely manner.

EPA has concluded that this proposed rule may have federalism implications since it may impose substantial direct compliance costs on local governments, and the Federal government will not provide the funds necessary to pay those cost. Accordingly, EPA provides the following FSIS as required by section 6(b) of Executive Order 13132.

As discussed further in section VII.C.2.e, EPA met with a variety of State and local representatives, who provided meaningful and timely input in the development of the proposed rule. Summaries of the meetings have been included in the public record for this proposed rulemaking. EPA consulted extensively with State, local, and tribal governments. For example, two public stakeholder meetings were held on July 22–23, 1998, in Lakewood, Colorado, and on March 3–4, 1999, in Dallas, Texas. Several key issues were raised by stakeholders regarding the LT1 provisions, many of which were related to reducing burden and maintaining flexibility. The Office of Water was able to significantly reduce burden and increase flexibility by tailoring requirements to reduce monitoring, reporting, and recordkeeping requirements faced by small systems. These modifications and others aided in lowering the cost of the LT1FBR by $87 million (from $184.5 million to $97.5 million). It should be noted that this rule is important because it will reduce the level of *Cryptosporidium* in filtered finished drinking water supplies through improvements in filtration and recycle practices resulting in a reduced likelihood of outbreaks of cryptosporidiosis. The rule is also expected to increase the level of protection from exposure to other pathogens (i.e., *Giardia* and other waterborne bacterial or viral pathogens). Because consultation on this proposed rule occurred before the November 2, 1999 effective date of Executive Order 13132, EPA will initiate discussions with State and local elected officials regarding the implications of this rule during the public comment period.

J. Executive Order 13084: Consultation and Coordination With Indian Tribal Governments

Under Executive Order 13084, EPA may not issue a regulation that is not required by statute, that significantly or uniquely affects the communities of Indian tribal governments, and that imposes substantial direct compliance costs on those communities, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by the tribal governments or EPA consults with those governments. If EPA complies by consulting, Executive Order 13084 requires EPA to provide to the Office of Management and Budget, in a separately identified section of the preamble to the rule, a description of the extent of EPA's prior consultation with representatives of affected tribal governments, a summary of the nature of their concerns, and a statement supporting the need to issue the regulation. In addition, Executive Order 13084 requires EPA to develop an effective process permitting elected officials and other representatives of Indian tribal governments ''to provide meaningful and timely input in the development of regulatory policies on matters that significantly or uniquely affect their communities.''

EPA has concluded that this rule may significantly or unique affect the communities of Indian tribal governments. It may also impose substantial direct compliance costs on such communities. The Federal government will not provide the funds necessary to pay all the direct costs incurred by the Tribal governments in complying with the rule. In developing this rule, EPA consulted with representatives of Tribal governments pursuant to UMRA and Executive Order 13084. EPA held extensive meetings that provided Indian Tribal governments the opportunity for meaningful and timely input in the development of the proposed rule. Summaries of the meetings have been included in the public docket for this rulemaking. EPA's consultation, the nature of the government's concerns, and the position supporting the need for this rule are discussed in Section VII.C.2.e, which addresses compliance with UMRA.

K. Likely Effect of Compliance with the LT1FBR on the Technical, Financial, and Managerial Capacity of Public Water Systems

Section 1420(d)(3) of the SDWA as amended requires that, in promulgating a NPDWR, the Administrator shall include an analysis of the likely effect of compliance with the regulation on the technical, financial, and managerial capacity of public water systems. This analysis can be found in the LT1FBR RIA (EPA, 1999h).

Overall water system capacity is defined in EPA guidance (EPA, 1998j) as the ability to plan for, achieve, and maintain compliance with applicable drinking water standards. Capacity has three components: technical, managerial, and financial.

Technical capacity is the physical and operational ability of a water system to meet SDWA requirements. Technical capacity refers to the physical infrastructure of the water system, including the adequacy of source water and the adequacy of treatment, storage, and distribution infrastructure. It also refers to the ability of system personnel to adequately operate and maintain the system and to otherwise implement requisite technical knowledge. A water system's technical capacity can be determined by examining key issues and questions, including:

- *Source water adequacy.* Does the system have a reliable source of drinking water? Is the source of generally good quality and adequately protected?
- *Infrastructure adequacy.* Can the system provide water that meets SDWA standards? What is the condition of its infrastructure, including well(s) or source water intakes, treatment, storage, and distribution? What is the infrastructure's life expectancy? Does the system have a capital improvement plan?
- *Technical knowledge and implementation.* Is the system's operator certified? Does the operator have sufficient technical knowledge of applicable standards? Can the operator effectively implement this technical knowledge? Does the operator understand the system's technical and operational characteristics? Does the system have an effective operation and maintenance program?

Managerial capacity is the ability of a water system to conduct its affairs to achieve and maintain compliance with SDWA requirements. Managerial capacity refers to the system's institutional and administrative capabilities. Managerial capacity can be assessed through key issues and questions, including:

- *Ownership accountability.* Are the system owner(s) clearly identified? Can they be held accountable for the system?
- *Staffing and organization.* Are the system operator(s) and manager(s) clearly identified? Is the system properly organized and staffed? Do personnel understand the management aspects of regulatory requirements and system operations? Do they have adequate expertise to manage water system operations? Do personnel have the necessary licenses and certifications?
- *Effective external linkages.* Does the system interact well with customers, regulators, and other entities? Is the system aware of available external resources, such as technical and financial assistance?

Financial capacity is a water system's ability to acquire and manage sufficient financial resources to allow the system to achieve and maintain compliance with SDWA requirements. Financial capacity can be assessed through key issues and questions, including:

- *Revenue sufficiency.* Do revenues cover costs? Are water rates and charges adequate to cover the cost of water?
- *Credit worthiness.* Is the system financially healthy? Does it have access to capital through public or private sources?
- *Fiscal management and controls.* Are adequate books and records maintained? Are appropriate budgeting, accounting, and financial planning methods used? Does the system manage its revenues effectively?

Systems not making significant modifications to the treatment process to meet LT1FBR requirements are not expected to require significantly increased technical, financial, or managerial capacity.

L. Plain Language

Executive Order 12866 and the President's memorandum of June 1, 1998, require each agency to write its rules in plain language. We invite your comments on how to make this proposed rule easier to understand. For example: Have we organized the material to suit your needs? Are the requirements in the rule clearly stated? Does the rule contain technical language or jargon that is not clear? Would a different format (grouping and order of sections, use of headings, paragraphing) make the rule easier to understand? Would shorter sections make the final rule easier to understand? Could we improve clarity by adding tables, lists, or diagrams? What else could we do to make the rule easier to understand?

VIII. Public Comment Procedures

EPA invites you to provide your views on this proposal, approaches we have not considered, the potential impacts of the various options (including possible unintended consequences), and any data or information that you would like the Agency to consider. Many of the sections within today's proposed rule contain ''Request for Comment'' portions which the Agency is also interested in receiving comment on.

A. Deadlines for Comment

Send your comments on or before June 9, 2000. Comments received after this date may not be considered in decision making on the proposed rule. Again, comments must be received or post-marked by midnight June 9, 2000.

B. Where To Send Comment

Send an original and 3 copies of your comments and enclosures (including references) to W–99–10 Comment Clerk, Water Docket (MC4101), USEPA, 401 M, Washington, D.C. 20460. Comments may also be submitted electronically to ow-docket@epamail.epa.gov. Electronic comments must be submitted as an ASCII, WP5.1, WP6.1 or WP8 file avoiding the use of special characters and form of encryption. Electronic comments must be identified by the docket number W–99–10. Comments and data will also be accepted on disks in WP 5.1, 6.1, 8 or ASCII file format. Electronic comments on this notice may be filed online at many Federal Depository Libraries. Those who comment and want EPA to acknowledge receipt of their comments must enclose a self-addressed stamped envelope. No facsimiles (faxes) will be accepted. Comments may also be submitted electronically to ow-docket@epamail.epa.gov.

C. Guidelines for Commenting

To ensure that EPA can read, understand and therefore properly respond to comments, the Agency would prefer that commenters cite, where possible, the paragraph(s) or sections in the notice or supporting documents to which each comment refers. Commenters should use a separate paragraph for each issue discussed. Note that the Agency is not soliciting comment on, nor will it respond to, comments on previously published regulatory language that is included in this notice to ease the reader's understanding of proposed language. You may find the following suggestions helpful for preparing your comments:

1. Explain your views as clearly as possible.
2. Describe any assumptions that you used.
3. Provide solid technical information and/or data to support your views.
4. If you estimate potential burden or costs, explain how you arrived at the estimate.
5. Indicate what you support, as well as what you disagree with.
6. Provide specific examples to illustrate your concerns.
7. Make sure to submit your comments by the deadline in this proposed rule.
8. At the beginning of your comments (*e.g.,* as part of the ''Subject'' heading), be sure to properly identify the document you are commenting on. You can do this by providing the docket control number assigned to the proposed rule, along with the name, date, and **Federal Register** citation.

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List of Subjects

40 CFR Part 141

Environmental protection, Chemicals, Indians-lands, Intergovernmental relations, Radiation protection, Reporting and recordkeeping requirements, Water supply.

40 CFR Part 142

Environmental protection, Administrative practice and procedure, Chemicals, Indians-lands, Radiation protection, Reporting and recordkeeping requirements, Water supply.

Dated: March 27, 2000.

Carol M. Browner,

Administrator.

For the reasons set forth in the preamble, title 40 chapter I of the Code of Federal Regulations is proposed to be amended as follows:

PART 141—NATIONAL PRIMARY DRINKING WATER REGULATIONS

3. The authority citation for part 141 continues to read as follows:

Authority: 42 U.S.C. 300f, 300g–1, 300g–2, 300g–3, 300g–4, 300g–5, 300g–6, 300j–4, 300j–9, and 300j–11.

4. Section 141.2 is amended by revising the definition of ''Ground water under the direct influence of surface water'' and ''Disinfection profile'' and adding the following definitions in alphabetical order to read as follows:

§ 141.2 Definitions.

* * * * *

Direct recycle is the return of recycle flow within the treatment process of a public water system without first passing the recycle flow through a treatment process designed to remove solids, a raw water storage reservoir, or some other structure with a volume equal to or greater than the volume of spent filter backwash water produced by one filter backwash event.

* * * * *

Disinfection profile is a summary of *Giardia* lamblia inactivation through the treatment plant, from the point of disinfectant application to the first customer. The procedure for developing a disinfection profile is contained in § 141.172 (Disinfection profiling and benchmarking) in subpart P and §§ 141.530–141.536 (Disinfection profile) in subpart T of this part.

* * * * *

Equalization is the detention of recycle flow in a structure with a volume equal to or greater than the volume of spent filter backwash produced by one filter backwash event.

* * * * *

Ground water under the direct influence of surface water (GWUDI) means any water beneath the surface of the ground with significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Direct influence must be determined for individual sources in accordance with criteria established by the State. The State determination of direct influence may be based on site-specific measurements of water quality and/or documentation of well construction characteristics and geology with field evaluation.

* * * * *

Membrane Filtration means any filtration process using tubular or spiral wound elements that exhibits the ability to mechanically separate water from other ions and solids by creating a pressure differential and flow across a membrane with an absolute pore size <1 micron.

* * * * *

Operating capacity is the maximum finished water production rate approved by the State drinking water program.

* * * * *

Recycle is the return of any water, solid, or semisolid generated by plant treatment processes, operational processes, maintenance processes, and residuals treatment processes into a PWS's primary treatment processes.

* * * * *

5. Section 141.32 is amended by revising paragraph (e)(10) to read as follows:

§ 141.32 Public notification.

* * * * *

(e) * * *

(10) *Microbiological contaminants* (for use when there is a violation of the treatment technique requirements for filtration and disinfection in subpart H, subpart P, or subpart T of this part). The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that the presence of microbiological contaminants are a health concern at certain levels of exposure. If water is inadequately treated, microbiological contaminants in that water may cause disease. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice, and any associated headaches and fatigue. These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water. EPA has set enforceable requirements for treating drinking water to reduce the risk of these adverse health effects. Treatment such as filtering and disinfecting the water removes or destroys microbiological contaminants. Drinking water which is treated to meet EPA requirements is associated with little to none of this risk and should be considered safe.

* * * * *

6. Section 141.70 is amended by revising paragraph (b)(2) and adding paragraph (e) to read as follows:

§ 141.70 General requirements.

* * * * *

(b) * * *

(2) It meets the filtration requirements in § 141.73, the disinfection

requirements in § 141.72(b) and the recycle requirements in § 141.76.

* * * * *

(e) *Additional requirements for systems serving fewer than 10,000 people.* In addition to complying with requirements in this subpart, systems serving fewer than 10,000 people must also comply with the requirements in subpart T of this part.

7. Section 141.73 is amended by adding paragraph (a)(4) and revising paragraph (d) to read as follows:

§ 141.73 Filtration.

* * * * *

(a) * * *

(4) Beginning [DATE 36 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER], systems serving fewer than 10,000 people must meet the turbidity requirements in §§ 141.550 through 141.553.

* * * * *

(d) *Other filtration technologies.* A public water system may use a filtration technology not listed in paragraphs (a) through (c) of this section if it demonstrates to the State, using pilot plant studies or other means, that the alternative filtration technology, in combination with disinfection treatment that meets the requirements of § 141.72(b), consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses. For a system that makes this demonstration, the requirements of paragraph (b) of this section apply. Beginning December 17, 2001, systems serving at least 10,000 people must meet the requirements for other filtration technologies in paragraph (b) of this section. Beginning [DATE 36 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER], systems serving fewer than 10,000 people must meet the requirements for treatment technologies in §§ 141.550 through141.553.

8. Subpart H is amended by adding a new § 141.76 to subpart H to read as follows:

§ 141.76 Recycle Provisions.

(a) Public water systems employing conventional filtration or direct filtration that use surface water or ground water under the direct influence of surface water and recycle within the treatment process must meet all applicable requirements of this section. Requirements are summarized in the following table.

RECYCLE PROVISIONS FOR SUBPART H SYSTEMS

If you are a . . .	You are required to meet the requirements in . . .
(1) subpart H public water system employing conventional or direct filtration returning spent filter backwash, thickener supernatant, or liquids from dewatering processes concurrent with or downstream of the point of primary coagulant addition.	§ 141.76 (b).
(2) Plant that is part of a subpart H public water system, employ conventional filtration treatment, practice direct recycle, employ 20 or fewer filters to meet production requirements during the highest production month in the 12 month period [date 60 months after publication of final rule], and recycle spent filter backwash or thickener supernatant to the treatment process.	§ 141.76 (c).
(3) subpart H public water system practicing direct filtration and recycling to the treatment process.	§ 141.76 (d).

(b) Recycle return location. All subpart H systems employing conventional filtration or direct filtration and returning spent filter backwash, thickener supernatant, or liquids from dewatering processes at or after the point of primary coagulant addition must return these recycle flows prior to the point of primary coagulant addition by [DATE 60 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER]. The system must apply to the State for approval of the change in recycle location before the system implements it.

(1) All subpart H systems employing conventional filtration or direct filtration, returning spent filter backwash, thickener supernatant, or liquids from dewatering processes at or after the point of primary coagulant addition must submit a plant schematic to the State by [DATE 42 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER] showing the current recycle return location(s) for the recycle stream(s) and the new return location that will be used to establish compliance. The system must keep the plant schematic on file for review during sanitary surveys.

(2) Softening systems may recycle process solids at the point of lime addition preceding the softening process to improve treatment efficiency. Process solids may not be returned prior to the point of lime addition. Softening systems shall not return spent filter backwash, thickener supernatant, or liquids from dewatering processes to a location other than prior to the point of primary coagulant addition unless an alternate location is granted by the State.

(3) Contact clarification systems may recycle process solids directly into the contactor. Contact clarification systems shall not return spent filter backwash, thickener supernatant, or liquids from dewatering processes to a location other than prior to the point of primary coagulant addition unless an alternate location is granted by the State.

(4) Systems may apply to the State to return spent filter backwash, thickener supernatant, or liquids from dewatering processes to an alternate location other than prior to the point of primary coagulant addition.

(c) Plants that are part of subpart H public water systems that employ conventional rapid granular filtration, practice direct recycle, employ 20 or fewer filters to meet production requirements during the highest production month in the 12 month period prior to [DATE 60 MONTHS AFTER PUBLICATION OF FINAL RULE IN THE **Federal Register**], and recycle spent filter backwash or thickener supernatant to the primary treatment process shall complete a recycle self assessment, as stipulated in paragraphs(c)(1) and (c)(2) by [Date 51 Months After Date of Publication of Final Rule in the **Federal Register**]. Systems required to perform the self assessment shall:

(1) Submit a recycle self assessment monitoring plan to the State no later than [Date 39 Months After Date of Publication of Final Rule in the **Federal Register**]. At a minimum, the monitoring plan must identify the highest water production month during

which monitoring will be conducted, contain a schematic identifying the location of raw and recycle flow monitoring devices, describe the type of flow monitoring devices to be used, identify the system's State approved operating capacity, and describe how data from the raw and recycle flow monitoring devices will be simultaneously retrieved and recorded.

(2) Implement the following recycle self assessment monitoring and analysis steps:

(i) *Steps for Implementation of Recycle Self Assessment:*

(A) Identify the highest water production month during the 12 month period preceding [Date 36 Months After Date of Publication of Final Rule in the **Federal Register**].

(B) Perform the monitoring described in paragraph (c)(2)(i)(C) of this section during the 12 month period after submission of the monitoring plan to the State. The twelve month period must begin no later than [Date 39 Months After Date of Publication of Final Rule in the **Federal Register**].

(C) For each day of the month identified in paragraph (c)(2)(i)(A) of this section, separately monitor source water influent flow and recycle flow before their confluence during one filter backwash recycle event per day, at three minute intervals during the duration of the event. Monitoring must be performed between 7:00 a.m. and 8:00 p.m. Systems that do not have a filter backwash recycle event every day between 7:00 am and 8:00 p.m. must monitor one filter backwash recycle event per day, any three days of the week, for each week during the month of monitoring, between 7:00 a.m. and 8:00 p.m. Record the time filter backwash was initiated, the influent and recycle flow at three minute intervals during the duration of the event, and the time the filter backwash recycle event ended. Record the number of filters in use when the filter backwash recycle event is monitored.

(D) Calculate the arithmetic average of all influent and recycle flow values taken at three minute intervals in paragraph (c)(2)(i)(c) of this section. Sum the arithmetic average calculated for raw water influent and recycle flows. Record this value and the date the monitoring was performed. This value is referred to as event flow.

(E) After the month of monitoring is complete, order the event flows in a list of increasing order, from lowest to highest. Highlight the event flows that exceed State approved operating capacity and then sum the number of event flows highlighted.

(ii) [Reserved]

(3) Subpart H systems performing recycle self assessments are required to report the results of the self assessment and supporting documentation to the State within one month of completing raw water influent and recycle flow monitoring. The report must be submitted no later than [DATE 52 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER]. If the State determines the self assessment is incomplete or inaccurate, it may require the system to correct deficiencies or perform an additional self assessment. At a minimum, the report must contain the following information:

(i) *Minimum Information Included in Recycle Assessment Report to State:*

(A) All source and recycle flow measurements taken and the dates they were taken. For all events monitored, report the times the filter backwash recycle event was initiated, the flow measurements taken at three minute intervals, and the time the filter backwash recycle event ended. Report the number of filters in use when the backwash recycle event is monitored.

(B) All data used and calculations performed to determine whether the system exceeded operating capacity during monitored recycle events and the number of event flow values that exceeded State approved operating capacity.

(C) A plant schematic showing the origin of all recycle flows, the hydraulic conveyance used to transport them, and their final destination in the plant.

(D) A list of all the recycle flows and the frequency at which they are returned to the plant's primary treatment process.

(E) Average and maximum backwash flow rate through the filters and the average and maximum duration of the filter backwash process, in minutes.

(F) Typical filter run length and a written summary of how filter run length is determined (preset run time, headloss, turbidity breakthrough, *etc.).*

(ii) [Reserved]

(4) All subpart H systems performing self assessments are required to modify their recycle practice in accordance with the State determination by [DATE 60 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER] and keep a copy of the self assessment report submitted to the State on file for review during sanitary surveys.

(d) Subpart H public water systems practicing direct filtration and recycling to the primary treatment process are required to submit data to the State on their current recycle treatment no later than [DATE 42 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER.]

(1) Direct filtration systems submitting data to the State shall report the following information, at a minimum:

(i) *Data Submitted to States by Direct Filtration Systems:*

(A) A plant schematic showing the origin of all recycle flows, the hydraulic conveyance used to transport them, and their final destination in the plant.

(B) The number of filters used at the plant to meet average daily production requirements and average and maximum backwash flow rate through the filter and the average and maximum duration of the filter backwash process, in minutes.

(C) Whether recycle flow treatment or equalization is in place.

(D) The type of treatment provided for the recycle flow.

(E) For recycle equalization and treatment units: data on the physical dimensions of the unit (length, width (or circumference), depth,) sufficient to allow calculation of volume; typical and maximum hydraulic loading rate; type of treatment chemicals used and average dose and frequency of use, and frequency at which solids are removed from the unit, if applicable.

(ii) [Reserved]

(2) All direct filtration systems submitting data to the State are required to modify their recycle practice in accordance with the State determination no later than [DATE 60 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER] and keep a copy of the report submitted to the State on file for review during sanitary surveys.

9. Section 141.153 is amended by revising the first sentence of paragraph (d)(4)(v)(C) to read as follows:

§ 141.153 Content of the reports.

* * * * *

(d) * * *

(4) * * *

(v) * * *

(C) When it is reported pursuant to § 141.73 or § 141.173 or § 141.551: the highest single measurement and the lowest monthly percentage of samples meeting the turbidity limits specified in § 141.73 or § 141.173, or § 141.551 for the filtration technology being used. * * *

* * * * *

10. The heading to Subpart P is revised as follows:

Subpart P—Enhanced Filtration and Disinfection-Systems Serving 10,000 or More People

* * * * *

11. Section 141.170 is amended by adding paragraph (d) to read as follows:

§ 141.170 General requirements.

* * * * *

(d) Subpart H systems that did not conduct applicability monitoring under § 141.172 because they served fewer than 10,000 persons when such monitoring was required but serve more than 10,000 persons prior to [DATE 36 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER] must comply with §§ 141.170, 141.171, 141.173, 141.174, and 141.175. These systems must also consult with the State to establish a disinfection benchmark. A system that decides to make a significant change to its disinfection practice, as described in § 141.172(c)(1)(i) through (iv) must consult with the State prior to making such change.

* * * * *

12. Part 141 is amended by adding a new subpart T to read as follows:

Subpart T—Enhanced Filtration and Disinfection—Systems Serving Fewer than 10,000 People

Sec.

General Requirements

Finished Water Reservoirs

Additional Watershed Control Requirements

Disinfection Profile

Disinfection Benchmark

Combined Filter Effluent Requirements

Individual Filter Turbidity Requirements

Reporting and Recordkeeping Requirements

Subpart T—Enhanced Filtration and Disinfection—Systems Serving Fewer Than 10,000 People

General Requirements

§ 141.500 General requirements.

The requirements of subpart T constitute national primary drinking water regulations. These regulations establish requirements for filtration and disinfection that are in addition to criteria under which filtration and disinfection are required under subpart H of this part. The regulations in this subpart establish or extend treatment technique requirements in lieu of maximum contaminant levels for the following contaminants: *Giardia lamblia,* viruses, heterotrophic plate count bacteria, *Legionella, Cryptosporidium* and turbidity. The treatment technique requirements consist of installing and properly operating water treatment processes which reliably achieve:

(a) At least 99 percent (2 log) removal of *Cryptosporidium* between a point where the raw water is not subject to recontamination by surface water runoff and a point downstream before or at the first customer for filtered systems, or *Cryptosporidium* control under the watershed control plan for unfiltered systems.

(b) Compliance with the profiling and benchmark requirements in §§ 141.530 through 141.544.

§ 141.501 Who is subject to the requirements of subpart T?

You are subject to these requirements if your system:

(a) Is a public water system;

(b) Uses surface water or GWUDI as a source; and

(c) Serves fewer than 10,000 persons annually.

§ 141.502 When must my system comply with these requirements?

You must comply with these requirements beginning [DATE 36 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER] except where otherwise noted.

§ 141.503 What does subpart T require?

There are six requirements of this subpart which your system may need to comply with. These requirements are discussed in detail later in this subpart. They are:

(a) Any finished water reservoir for which construction begins on or after [DATE 60 DAYS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER] must be covered;

(b) Unfiltered systems must comply with updated watershed control requirements;

(c) All systems subject to the requirements of this subpart must develop a disinfection profile;

(d) All systems subject to the requirements of this subpart that are considering a significant change to their disinfection practice must develop a disinfection benchmark and receive State approval before changing their disinfection practice;

(e) Filtered systems must comply with specific combined filter effluent turbidity limits and monitoring and reporting requirements; and

(f) Filtered systems using conventional or direct filtration must comply with individual filter turbidity limits and monitoring and reporting requirements.

Finished Water Reservoirs

§ 141.510 Is my system subject to the new finished water reservoir requirements?

All subpart H systems which serve populations fewer than 10,000 are subject to this requirement.

§ 141.511 What is required for new finished water reservoirs?

If your system initiates construction of a finished water reservoir after [DATE 60 DAYS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER the reservoir must be covered. Finished water reservoirs constructed prior to [DATE 60 DAYS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER are not subject to this requirement.

Additional Watershed Control Requirements

§ 141.520 Is my system subject to the updated watershed control requirements?

If you are a subpart H system serving fewer than 10,000 persons which does not provide filtration, you must continue to comply with all of the watershed control requirements in § 141.71, as well as the additional watershed control requirements in § 141.521.

§ 141.521 What additional watershed control requirements must my system comply with?

Your system must also maintain the existing watershed control program to minimize the potential for contamination by *Cryptosporidium* oocysts in the source water. Your system's watershed control program must, for *Cryptosporidium*:

(a) Identify watershed characteristics and activities which may have an adverse effect on source water quality; and

(b) Monitor the occurrence of activities which may have an adverse effect on source water quality.

§ 141.522 How does the State determine whether my system's watershed control requirements are adequate?

During an onsite inspection conducted under the provisions of § 141.71(b)(3), the State must determine whether your watershed control program is adequate to limit potential contamination by *Cryptosporidium* oocysts. The adequacy of the program must be based on the comprehensiveness of the watershed review; the effectiveness of your program to monitor and control detrimental activities occurring in the watershed; and the extent to which your system has maximized land ownership and/or controlled land use within the watershed.

Disinfection Profile

§ 141.530 Who must develop a Disinfection Profile and what is a Disinfection Profile?

All subpart H community and non-transient non-community water systems which serve fewer than 10,000 persons must develop a disinfection profile. A disinfection profile is a graphical representation of your system's level of *Giardia lamblia* or virus inactivation measured during the course of a year. Your system must develop a disinfection profile unless you can demonstrate to the State that your TTHM and HAA5 levels are less than 0.064 mg/l and 0.048 mg/l respectively, prior to January 7, 2003.

§ 141.531 How does my system demonstrate TTHM and HAA5 levels below 0.064 mg/l and 0.048 mg/l respectively?

In order to demonstrate that your TTHM and HAA5 levels are below 0.064 mg/L and 0.048 mg/L, respectively your system must have collected one TTHM and one HAA5 sample taken between 1998–2002. Samples must have been collected during the month with the warmest water temperature, at the point of maximum residence time in your distribution system which indicate TTHM levels below 0.064 mg/l and HAA5 levels below 0.048 mg/L. By January 7, 2003, you must submit a copy of the results to the State along with a letter indicating your intention to forgo development of a disinfection profile because of the results of the sampling. This letter, along with a copy of your TTHM and HAA5 sample lab results must be kept on file for review by the State during a sanitary survey. If the data you have collected is either equal to or exceeds either 0.064 mg/l for TTHM and/or 0.048 mg/l for HAA5s, you must develop a disinfection profile.

§ 141.532 How does my system develop a Disinfection Profile and when must it begin?

A disinfection profile consists of three steps:

(a) First, your system must collect measurements for several treatment parameters from the plant as discussed in § 141.533. Your system must begin this monitoring no later than January 7, 2003.

(b) Second, your system must use these measurements to calculate inactivation ratios as discussed in §§ 141.534 and 141.535; and

(c) Third, your system must use these inactivation ratios to develop a disinfection profile as discussed in § 141.536.

§ 141.533 What measurements must my system collect to calculate a Disinfection Profile?

Your system must monitor the parameters necessary to determine the total inactivation ratio using analytical methods in § 141.74 (a), once per week on the same *calendar* day each week as follows:

(a) The temperature of the disinfected water must be measured at each residual disinfectant concentration sampling point during peak hourly flow;

(b) If the system uses chlorine, the pH of the disinfected water must be measured at each chlorine residual disinfectant concentration sampling point during peak hourly flow;

(c) The disinfectant contact time(s) (''T'') must be determined during peak hourly flow; and

(d) The residual disinfectant concentration(s) (''C'') of the water before or at the first customer and prior to each additional point of disinfection must be measured during peak hourly flow.

§ 141.534 How does my system use these measurements to calculate an inactivation ratio?

Calculate the total inactivation ratio as follows, and multiply the value by 3.0 to determine log inactivation of *Giardia lambia*:

If a system...	The system must determine...
(a) Uses only one point of disinfectant application	(1) One inactivation ratio ($CTcalc/CT_{99.9}$) before or at the first customer during peak hourly flow, or

If a system...	The system must determine...
	(2) Successive CTcalc/$CT_{99.9}$ values, representing sequential inactivation ratios, between the point of disinfectant application and a point before or at the first customer during peak hourly flow. Under this alternative, the system must calculate the total inactivation ratio by determining (CTcalc/$CT_{99.9}$) for each sequence and then adding the (CTcalc/$CT_{99.9}$) values together to determine (Σ (CTcalc/$CT_{99.9}$)). You may use a spreadsheet that calculates CT and/or contains the necessary inactivation tables.
(b) Uses more than one point of disinfectant application before the first customer.	(1) The CTcalc/$CT_{99.9}$ 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 using the procedure described in the above paragraph.

§ 141.535 How does my system develop a Disinfection Profile if we use chloramines, ozone, or chlorine dioxide for primary disinfection?

If your system uses either chloramines, ozone or chlorine dioxide for primary disinfection, you must also calculate the logs of inactivation for viruses. You must develop an additional disinfection profile for viruses using a method approved by the State.

§ 141.536 If my system has developed an inactivation ratio, what must we do now?

Each inactivation ratio serves as a data point in your disinfection profile. Your system will have obtained 52 measurements (one for every week of the year). This will allow your system and the State the opportunity to evaluate how microbial inactivation varied over the course of the year by looking at all 52 measurements (your Disinfection Profile). Your system must retain the Disinfection Profile data in graphic form, as a spreadsheet, or in some other format acceptable to the State for review as part of sanitary surveys conducted by the State. Your system will need to use this data to calculate a benchmark if considering changes to disinfection practices.

Disinfection Benchmark

§ 141.540 Who has to develop a Disinfection Benchmark?

If you are a subpart H system required to develop a disinfection profile under §§ 141.530 through 141.536, your system must develop a Disinfection Benchmark if you decide to make a significant change to disinfection practice. State approval must be obtained before you can implement a significant disinfection practice change.

§ 141.541 What are significant changes to disinfection practice?

Significant changes to disinfection practice are:

(a) Changes to the point of disinfection;

(b) Changes to the disinfectant(s) used in the treatment plant;

(c) Changes to the disinfection process; or

(d) Any other modification identified by the State.

§ 141.542 How is the Disinfection Benchmark Calculated?

If your system is making a significant change to its disinfection practice, it must calculate a disinfection benchmark using the following procedure:

(a) To calculate a disinfection benchmark a system must perform the following steps:

Step 1: Using the data your system collected to develop the Disinfection Profile, determine the average *Giardia lamblia* inactivation for each calender month by dividing the sum of all *Giardia lamblia* inactivations for that month by the number of values calculated for that month.

Step 2: Determine the lowest monthly average value out of the twelve values. This value becomes the disinfection benchmark.

(b) [Reserved]

§ 141.543 What if my system uses chloramines or ozone for primary disinfection?

If your system uses chloramines, ozone or chlorinated dioxide for primary disinfection your system must calculate the disinfection benchmark from the data your system collected for viruses to develop the disinfection profile in addition to the *Giardia lamblia* disinfection benchmark calculated under § 141.542. The disinfection benchmark must be calculated as described in § 141.542.

§ 141.544 What must my system do if considering a significant change to disinfection practices?

If your system is considering a significant change to the disinfection practice, it must complete a disinfection benchmark(s) as described in §§ 141.542 and 141.543 and provide the benchmark(s) to your State. Your system may only make a significant disinfection practice change after receiving State approval. The following information must be submitted to the State as part of their review and approval process:

(a) A description of the proposed change;

(b) The disinfection profile for *Giardia lamblia* (and, if necessary, viruses) and disinfection benchmark;

(c) An analysis of how the proposed change will affect the current levels of disinfection; and

(d) Additional information requested by the State.

Combined Filter Effluent Requirements

§ 141.550 Is my system required to meet subpart T combined filter effluent turbidity limits?

All subpart H systems which serve populations fewer than 10,000, and are required to filter, must meet combined filter effluent requirements. Unless your system consists of slow sand or diatomaceous earth filtration, you are required to meet the combined filter effluent turbidity limits in § 141.551. If your system uses slow sand or diatomaceous earth filtration you must continue to meet the combined filter effluent turbidity limits in § 141.73.

§ 141.551 What strengthened combined filter effluent turbidity limits must my system meet?

Your system must meet two strengthened combined filter effluent turbidity limits.

(a) The first combined filter effluent turbidity limit is a ‘‘95th percentile’’ turbidity limit which your system must meet in at least 95 percent of the turbidity measurements taken each month. Measurements must continue to be taken as described in § 141.74(a) and (c). The following table describes the required limits for specific filtration technologies.

If your system consists of . . .	Your 95th percentile turbidity value is . . .
(1) Conventional filtration or direct filtration	0.3 NTU.
(2) Membrane filtration	0.3 NTU or a value determined by the State (not to exceed 1 NTU) based on a demonstration conducted by the system as described in § 141.552.
(3) All other ''alternative'' filtration	A value determined by the State (not to exceed 1 NTU) based on the demonstration described in § 141.552.

(b) The second combined filter effluent turbidity limit is a ''maximum'' turbidity limit which your system may at no time exceed during the month. Measurements must continue to be taken as described in § 141.74(a) and (c). The following table describes the required limits for specific filtration technologies.

If your system consists of . . .	Your maximum turbidity value is . . .
(1) Conventional filtration or direct filtration	1 NTU.
(2) Membrane filtration	1 NTU or a value determined by the State (not to exceed 5 NTU) based on a demonstration conducted by the system as described in § 141.552.
(3) All other ''alternative'' filtration	A value determined by the State (not to exceed 5 NTU) based on the demonstration as described in § 141.552.

§ 141.552 If my system consists of ''alternative filtration'' and is required to conduct a demonstration, What is required of my system and how does the State establish my turbidity limits?

(a) If your system is required to conduct a demonstration (see tables in § 141.551), your system must demonstrate to the State, using pilot plant studies or other means, that your system's filtration, in combination with disinfection treatment, consistently achieves:

(1) 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts;

(2) 99.99 percent removal and/or inactivation of viruses; and

(3) 99 percent removal of *Cryptosporidium* oocysts.

(b) If the State approves your demonstration, it will set turbidity performance requirements that your system must meet:

(1) At least 95 percent of the time (not to exceed 1 NTU); and

(2) That your system must not exceed at any time (not to exceed 5 NTU).

§ 141.553 If my system practices lime softening, is there any special provision regarding my combined filter effluent?

If your system practices lime softening, you may acidify representative combined filter effluent turbidity samples prior to analysis using a protocol approved by the State.

Individual Filter Turbidity Requirements

§ 141.560 Is my system subject to individual filter turbidity requirements?

If your system is a subpart H system serving fewer than 10,000 people and utilizing conventional filtration or direct filtration, you must conduct continuous monitoring of turbidity for each individual filter at your system. The following requirements apply to individual filter turbidity monitoring:

(a) Monitoring must be conducted using an approved method in § 141.74(a);

(b) Calibration of turbidimeters must be conducted using procedures specified by the manufacturer;

(c) Results of individual filter turbidity monitoring must be recorded every 15 minutes;

(d) Monthly reporting must be completed according § 141.570; and

(e) Records must be maintained according to § 141.571.

§ 141.561 What happens if my system's turbidity monitoring equipment fails?

If there is a failure in the continuous turbidity monitoring equipment, the system must conduct grab sampling every four hours in lieu of continuous monitoring until the turbidimeter is back on-line. A system has five working days to resume continuous monitoring before a violation is incurred.

§ 141.562 What follow-up action is my system required to take based on turbidity monitoring of individual filters?

Follow-up action is required according to the following tables:

If the turbidity of an individual filter exceeds...	The system must...
(a) If the turbidity of an individual filter exceeds 1.0 NTU (in two consecutive recordings).	Submit an exceptions report to the State by the 10th of the month which includes the filter number(s), corresponding date(s), and the turbidity value(s) which exceeded 1.0 NTU.

If an exceptions report is submitted for the same filter...	The system must...
(b) If an exceptions report is submitted for the same filter three months in a row.	Conduct a self-assessment of the filter within 14 days of the exceedance and report that the self assessment was conducted by the 10th of the following month. The self assessment must consist of at least the following components: Assessment of filter performance; development of a filter profile; identification and prioritization of factors limiting filter performance; assessment of the applicability of corrections; and preparation of a filter self-assessment report.

If an exceptions report is submitted for the same filter...	The system must...
(c) If an exceptions report is submitted for the same filter two months in a row and both months contain exceedances of 2.0 NTU (in 2 consecutive recordings).	(1) Arrange to have a comprehensive performance evaluation (CPE) conducted by the State or a third party approved by the State no later than 30 days following the exceedance and have the evaluation completed and submitted to the State no later than 90 days following the exceedance, Unless— (2) A CPE has been completed by the State or a third party approved by the State within the 12 prior months or the system and State are jointly participating in an ongoing Comprehensive Technical Assistance (CTA) project at the system.

§ 141.563 My system practices lime softening. Is there any special provision regarding my individual filter turbidity monitoring?

If your system utilizes lime softening, you may apply to the State for alternative turbidity exceedance levels for the levels specified in the table in § 141.562. You must be able to demonstrate to the State that higher turbidity levels in individual filters are due to lime carryover only, and not due to degraded filter performance.

Reporting and Recordkeeping Requirements

§ 141.570 What does subpart T require that my system report to the State?

This subpart T requires your system to report several items to the State. The following table describes the items which must be reported and the frequency of reporting. Your system is required to report the information described below, if it is subject to the specific requirement shown in the first column.

Corresponding requirement	Description of information to report	Frequency
(a) Combined Filter Effluent Requirements.	(1)The total number of filtered water turbidity measurements taken during the month.	By the 10th of the following month.
	(2) The number and percentage of filtered water turbidity measurements taken during the month which are greater than your system's required 95th percentile limit.	By the 10th of the following month.
	(3) The date and value of any turbidity measurements taken during the month which exceed the maximum turbidity value for your filtration system.	(i) Within 24 hours of exceedance and (ii) By the 10th of the following month.
(b) Individual Filter Turbidity Requirements.	(1) That your system conducted individual filter turbidity monitoring during the month.	By the 10th of the following month.
	(2) The filter number(s), corresponding date(s), and the turbidity value(s) which exceeded 1.0 NTU during the month..	By the 10th of the following month only if— (ii) 2 consecutive values exceeded 1.0 NTU.
	(3) That a self assessment was conducted within 14 days of the date it was triggered.	(i) By the 10th of the following month (or 14 days after the self assessment was triggered only if the self assessment was triggered during the last four days of the month) only if— (ii) A self-assessment is required.
	(4) That a CPE is required and the date that it was triggered	(i) By the 10th of the following month only if— (ii) A CPE is required.
	(5) Copy of completed CPE report	Within 90 days after the CPE was triggered.
(c) Disinfection Profiling	(1) Results of applicability monitoring which show TTHM levels <0.064 mg/l and HAA5 levels <0.048 mg/l. (Only if your system wishes to forgo profiling) or that your system has begun disinfection profiling.	No later than January 7, 2003.
(d) Disinfection Benchmarking	(1) A description of the proposed change in disinfection, your system's disinfection profile for *Giardia lamblia* (and, if necessary, viruses) and disinfection benchmark, and an analysis of how the proposed change will affect the current levels of disinfection.	Anytime your system is considering a significant change to its disinfection practice.

§ 141.571 What records does subpart T require my system to keep?

Your system must keep several types of records based on the requirements of subpart T. The following table describes the necessary records, the length of time these records must be kept, and for which requirement the records pertain. Your system is required to maintain records described in this table, if it is subject to the specific requirement shown in the first column. For example, if your system uses slow sand filtration, you would not be required to keep individual filter turbidity records:

Corresponding requirement	Description of necessary records	Duration of time records must be kept
(a) Individual Filter Turbidity Requirements.	Results of individual filter monitoring	At least 3 years.
(b) Disinfection Profiling	Results of Profile (including raw data and analysis)	Indefinitely.
(c) Disinfection Benchmarking	Benchmark (including raw data and analysis)	Indefinitely.
(d) Covered Reservoirs	Date of construction for all uncovered finished water reservoirs utilized by your system.	Indefinitely.

PART 142—NATIONAL PRIMARY DRINKING WATER REGULATIONS IMPLEMENTATION

13. The authority citation for Part 142 continues to read as follows:

Authority: 42 U.S.C. 300f, 300g–1, 300g–2, 300g–3, 300g–4, 300g–5, 300g–6, 300j–4, 300j–9, and 300j–11.

14. Section 142.14 is amended by revising paragraphs (a)(3), (a)(4)(i), (a)(4)(ii) introductory text, and (a)(7) to read as follows:

§ 142.14 Records kept by States.

(a)* * *

(3) Records of turbidity measurements must be kept for not less than one year. The information retained must be set forth in a form which makes possible comparison with the limits specified in §§ 141.71, 141.73, 141.173 and 141.175, 141.550–141.553 and 141.560–141.563 of this chapter. Until June 29, 1993, for any public water system which is providing filtration treatment and until December 30, 1991, for any public water system not providing filtration treatment and not required by the State to provide filtration treatment, records kept must be set forth in a form which makes possible comparison with the limits contained in § 141.13 of this chapter.

* * * * *

(4)(i) Records of disinfectant residual measurements and other parameters necessary to document disinfection effectiveness in accordance with §§ 141.72 and 141.74 of this chapter and the reporting requirements of §§ 141.75, 141.175, and 141.570, of this chapter must be kept for not less than one year.

(ii) Records of decisions made on a system-by-system and case-by-case basis under provisions of part 141, subpart H, subpart P, or subpart T of this chapter, must be made in writing and kept at the State.

* * * * *

(7) Any decisions made pursuant to the provisions of part 141, subpart P or subpart T of this chapter.

(i) Records of systems consulting with the State concerning a modification to disinfection practice under §§ 141.172(c), 141.170(d), and 141.544 of this chapter, including the status of the consultation or approval.

(ii) Records of decisions that a system using alternative filtration technologies, as allowed under §§ 141.173(b) and § 141.552 of this chapter, can consistently achieve a 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts, 99.99 percent removal and/or inactivation of viruses, and 99 percent removal of *Cryptosporidium* oocysts. The decisions must include State-set enforceable turbidity limits for each system. A copy of the decision must be kept until the decision is reversed or revised. The State must provide a copy of the decision to the system.

(iii) Records of systems required to do filter self-assessment, CPE, or CCP under the requirements of § 141.175 and § 141.562 of this chapter.

* * * * *

15. Section 142.15 is amended by adding paragraphs (c)(6) and (c)(7) and (c)(8).

§ 142.15 Reports by States.

* * * * *

(c) * * *

(6) Recycle return location. A list of all systems moving the recycle return location prior to the point of primary coagulant addition. The list must also contain all the systems the State granted alternate recycle locations, describe the alternative recycle return location, and briefly discuss the reason(s) the alternate recycle location was granted and is due [DATE 60 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER].

(7) Self assessment determination. A list of all systems performing self assessments must be reported to EPA. The list must state whether individual plants exceeded State approved operating capacity during self assessment monitoring and whether the State required modification to recycle practice. A brief description of the modification to recycle practice required at each plant must be provided. If a plant exceeded State approved operating capacity, and the State did not require modification of recycle practice, the State must provide a brief explanation for this decision. Self assessment results must be reported no later than [DATE 54 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER].

(8) Direct filtration determination. A list of all direct filtration systems recycling within the treatment process must be submitted to EPA. The list must state which systems were required to modify recycle practice and briefly describe the modification and the reason it was required. It must also identify systems not required to modify recycle practice and provide a brief description of the reason modification to recycle practice was not required. The list must be submitted no later than [DATE 54 MONTHS AFTER DATE OF PUBLICATION OF FINAL RULE IN THE FEDERAL REGISTER].

* * * * *

16. Section 142.16 is amended by adding paragraph (b)(2)(v), (b)(2)(vi), and (b)(2)(vii) and (i) to read as follows:

§ 142.16 Special primacy requirements.

* * * * *

(b) * * *

(2) * * *

(v) The application must describe the criteria the State will use to determine alternate recycle locations for public water systems applying to return spent filter backwash, thickener supernatant, or liquids from dewatering to an alternate location other than prior to the point of primary coagulant addition.

(vi) The application must describe the criteria the State will use to determine whether public water systems completing self assessments are required to modify recycle practice and the criteria that will be used to specify modifications to recycle practice.

(vii) The application must describe the criteria the State will use to determine whether direct filtration systems are required to change recycle practice and the criteria that will be used to specify changes to recycle practice.

* * * * *

(i) *Requirements for States to adopt 40 CFR part 141, subpart T Enhanced Filtration and Disinfection.* In addition to the general primacy requirements enumerated elsewhere in this part, including the requirement that State provisions are no less stringent than the federal requirements, an application for approval of a State program revision that adopts 40 CFR part 141, subpart T Enhanced Filtration and Disinfection, must contain the information specified in this paragraph:

(1) *Enforceable requirements.* States must have rules or other authority to require systems to participate in a Comprehensive Technical Assistance (CTA) activity, the performance improvement phase of the Composite Correction Program (CCP). The State shall determine whether a CTA must be conducted based on results of a CPE which indicate the potential for improved performance, and a finding by the State that the system is able to receive and implement technical assistance provided through the CTA. A CPE is a thorough review and analysis of a system's performance-based capabilities and associated administrative, operation and maintenance practices. It is conducted to identify factors that may be adversely impacting a plant's capability to achieve compliance. During the CTA phase, the system must identify and systematically address factors limiting performance. The CTA is a combination of utilizing CPE results as a basis for follow-up, implementing process control priority-setting techniques and maintaining long-term involvement to systematically train staff and administrators.

(2) *State practices or procedures.* (i) Section 141.536 of this chapter—How the State will approve a method to calculate the logs of inactivation for viruses for a system that uses either chloramines or ozone for primary disinfection.

(ii) Section 141.544 of this chapter—How the State will approve modifications to disinfection practice.

(iii) Section 141.552 of this chapter—For filtration technologies other than conventional filtration treatment, direct filtration, slow sand filtration, diatomaceous earth filtration, or membrane filtration, how the State will determine that a public water system may use a filtration technology if the PWS demonstrates to the State, using pilot plant studies or other means, that the alternative filtration technology (or membrane filtration), in combination with disinfection treatment that meets the requirements of § 141.72(b) of this chapter, consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses, and 99 percent removal of *Cryptosporidium* oocysts. For a system that makes this demonstration, how the State will set turbidity performance requirements that the system must meet 95 percent of the time and that the system may not exceed at any time at a level that consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts, 99.99 percent removal and/or inactivation of viruses, and 99 percent removal of *Cryptosporidium* oocysts.

[FR Doc. 00–8155 Filed 4–7–00; 8:45 am]

BILLING CODE 6560–50–P