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Interim Enhanced Surface Water Treatment Rule (IESWTR) Guidance Handbook for Colorado Public Water Systems

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Colorado Department
of Public Health
and Environment

This guidance handbook is provided by the State of Colorado for Public Water Systems and addresses requirements for the Interim Enhanced Surface Water Treatment Rule. This handbook offers guidance to systems to ensure compliance with the Interim Enhanced Surface Water Treatment Rule of the Colorado Primary Drinking Water Regulations.

This document provides guidance to public water systems. The document is not, however, the actual Environmental Protection Agency or State of Colorado regulation, nor is it a regulation itself. The actual regulation can be found in 40 CFR (Code of Federal Regulations) Part 141.

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INTRODUCTION

PURPOSE: This guidance document provides a summary of the applicable regulatory requirements associated with the Interim Enhanced Surface Water Treatment Rule (IESWTR) promulgated by the Environmental Protection Agency (EPA) on December 16, 1998 and adopted by reference by the Colorado Department of Public Health and Environment (CDPHE). This guidance provides a summary of the applicable requirements and the dates by which the requirements must be met. It is a basic "what and when" summary for all public water systems. While all systems should feel comfortable using this document as a complete and accurate summary of IESWTR requirements, the applicable full legal language is contained in the Code of Federal Regulation adopted by reference. The actual text of these requirements is provided, under separate cover, and is titled Interim Enhanced Surface Water Treatment Rule Level 2 Line of Sight Document. This document is available on the CDPHE web site at www.cdphe.state.co.us/wq .

APPLICABILITY:

This CDPHE Guidance applies to…	
Systems:	CWSs, NTNCWSs, TNCWSs
Source:	Surface water or GWUDI
Persons Served:	10,000 or more
Treatment:	All types

Please note that this guidance handbook provides a summary of "what and when" requirements. Additional references that provide guidance for plant owners and operators with respect to how to control plant operations to meet these requirements are provided throughout the document and summarized in Section 3.1.

ACKNOWLEDGEMENTS: The Colorado Department of Public Health and Environment would like to recognize members of the stakeholder work group who contributed their time and expertise to develop content and forms to assist all Colorado public water systems to comply with the requirements of the Stage 1 Disinfectants and Disinfection Byproducts Rule. Work group members included*: Greg Moore, Sarah Clark, David Pier, Randy Giffin, Bruce Hale, Steve Lohman, Vic Lucero, Mike Wild, Steve Grooters, Lois Rellergert, Leigh Fenton, Jim Miller, Ed Young, Hallie Mahan, Al Baker, Sharon Bernia, Jim McCarthy, Judy Schmidt, Ruth Hund, Kenneth Pollock, Ray Reling, Julia Lew, Andrew Degner, Frank Watt, Kevin Linder, Kathy Bill, Mark Hartman, Angela Miles, Brad Segal, Jon Brooks, Kevin Fitzpatrick, Chuck Guilmette, Robert Olivas, Jeff Monson, Tom Settle, Phil Gee, Bill Fulbright.

* This acknowledgement is not an endorsement by CDPHE of any individual or business and conveys no implication that listed individuals or businesses has or does not have specialized expertise to assist public water systems in the design, operation, management, monitoring or compliance evaluation associated with these regulations.

ACRONYMS

BAT	Best Available Technology
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CWS	Community Water System
EPA	United States Environmental Protection Agency
HAA5	Sum of five haloacetic acids (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, dibromoacetic acid)
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/L	Milligrams per liter
NCWS	Non-Community Water System
NTNCWS	Non-Transient Non-Community Water System
OGWDW	Office of Ground Water and Drinking Water
PWS	Public Water System
SDWA	Safe Drinking Water Act
TNCWS	Transient Non-Community Water System
TTHMs	Total trihalomethanes (Sum of chloroform, bromoform, chlorodibromomethane, and bromodichloromethane)

PART I REQUIREMENTS

1.0 Scope and Applicability

1.0.1 The Interim Enhanced Surface Water Treatment Rule (IESWTR) sets new requirements to better protect consumers against *Cryptosporidium* and other pathogens.

1.0.2 The IESWTR applies to all public water systems (CWSs, NTNCWSs, and TNCWSs) that use surface water or ground water under direct influence (GWUDI) of surface water, and serve 10,000 persons or more. [1]

1.0.3 This CDPHE Guidance Handbook applies only to surface water systems and systems using GWUDI and serving 10,000 persons or more.

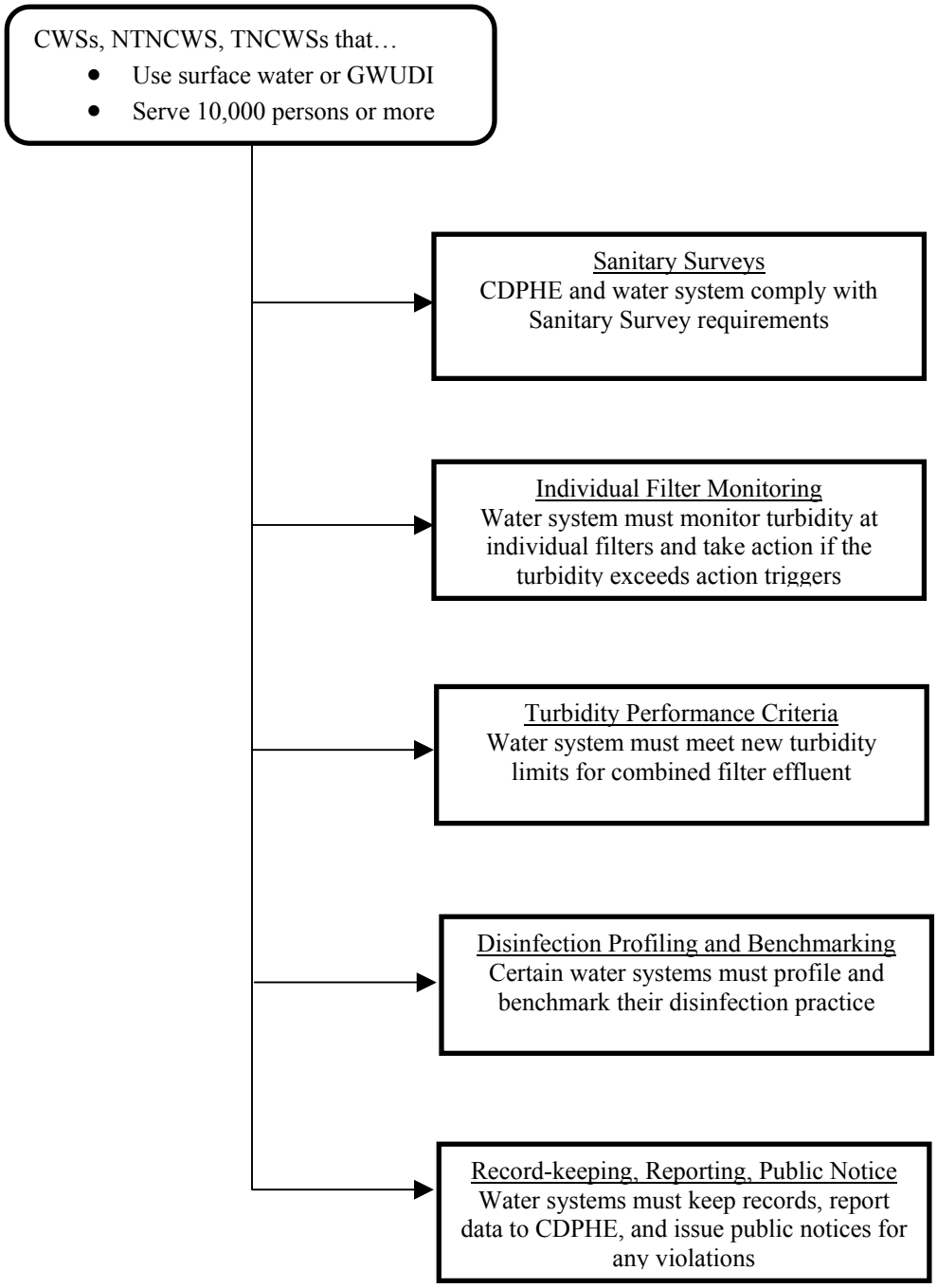
1.0.4 Refer to CDPHE *Stage 1 Disinfectants and Disinfection Byproducts Rule Guidance Handbook*, for the requirements of the companion Stage 1 Disinfectants and Disinfection Byproducts Rule.

1.1. Key Compliance Dates

- February 16, 1999—Construction of uncovered finished water storage reservoirs is prohibited.
- March 2000—Systems determining if they must develop a disinfection profile must submit TTHM/HAA5 data to the State.
- April 1, 2000—Systems begin developing a disinfection profile if either their annual average TTHM ≥0.064 mg/L or their annual average HAA5 ≥0.048 mg/L.
- March 2001—Systems complete disinfection profile.
- January 1, 2002—Requirements of IESWTR (40 CFR Subpart P) apply.
- December 2004—CDPHE to have completed first round of sanitary surveys for Subpart H CWSs.
- December 2006—CDPHE to have completed first round of sanitary surveys for Subpart H NCWSs.

[1] Water systems that use surface water and ground water under direct influence (GWUDI) are also known as Subpart H systems, because they are regulated under 40 CFR 141 Subpart H (known as the Surface Water Treatment Rule).

FIGURE 1-1
IESWTR General Overview



1.2 Elements of the IESWTR

- Sanitary surveys ➔ CDPHE will conduct for all subpart H systems.
- *Cryptosporidium removal* ➔ New removal requirements are set.
- Individual filter monitoring ➔ Continuous turbidity monitoring is required; action triggers set.
- Turbidity performance criteria ➔ Current SWTR limits are strengthened.
- Disinfection profiling and benchmarking ➔ To ensure microbial protection.
- Uncovered finished water storage facilities ➔ Prohibited after Feb. 16, 1999.
- Record-keeping, Reporting, and Public Notice ➔ New requirements set.

1.3 Sanitary Surveys

1.3.1 'Sanitary survey' is an onsite review of the water source (identifying sources of contamination using results of source water assessments where available), facilities, equipment, operation, maintenance, and monitoring compliance of a public water system to evaluate the adequacy of the system, its sources and operations and the distribution of safe drinking water.

1.3.2 For details on sanitary surveys, see USEPA's *Guidance Manual for Conducting Sanitary Surveys of Public Water Systems; Surface Water and Ground Water Under the Direct Influence (GWUDI)*.

1.3.3 CDPHE will conduct a sanitary survey for all surface water systems and systems using GWUDI. Community systems ➔ no less frequently than every three years. Noncommunity systems ➔ no less frequently than every five years.

1.3.4 Sanitary surveys will address the following eight elements discussed in the USEPA *Guidance Manual*: Source, Treatment, Distribution Systems, Finished Water Storage, Pumps/Pump Facilities and Controls, Monitoring/Reporting/Data Verification, Water System Management/Operation; and Operator Compliance with CDPHE Requirements.

1.3.5 Sanitary surveys conducted after December 1995 may serve as the first set of required sanitary surveys if the survey addresses the required eight sanitary survey components.

1.3.6 CWSs determined by CDPHE to have outstanding performance based on prior sanitary surveys, may conduct subsequent sanitary surveys no less than every five years. A recommendation of whether a system should be considered to have outstanding performance will be included in the sanitary survey report. A recommendation for outstanding performance status is contingent upon the water system continuing to meet the state's specifications for that status.

1.3.7 In general, outstanding performance means that a system is well-operated and managed, has a good record of performance in past sanitary surveys, and has not had any violations (at least in recent years).

1.3.8 Significant deficiencies identified during the sanitary survey must be addressed by the water system. CDPHE considers a significant deficiency to be

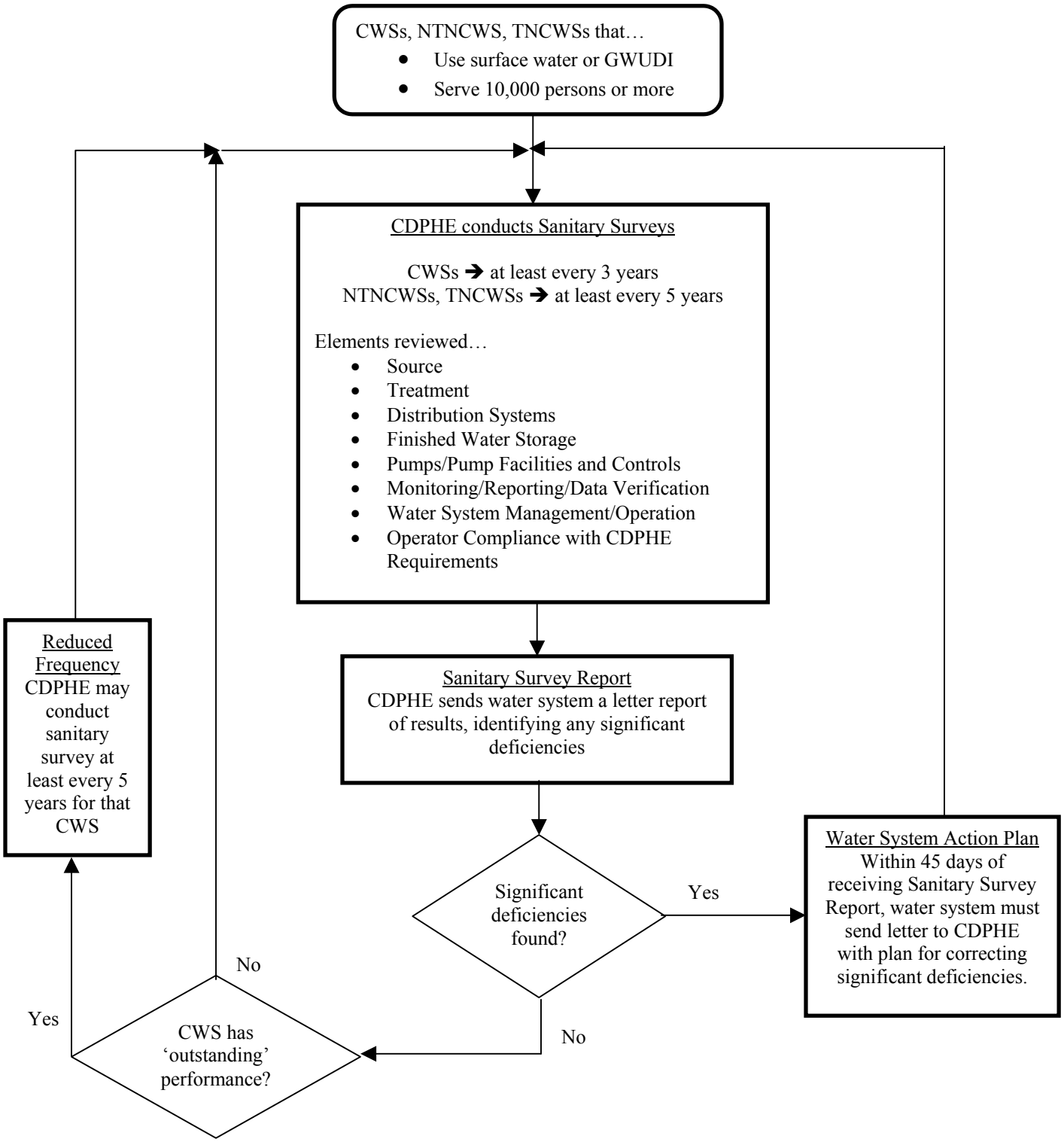
"Any situation, practice, or condition in a public water system with respect to design, operation, maintenance, or administration, that the State determines may result in or have the potential to result in production of finished drinking water that poses an unacceptable risk to health and welfare of the public served by the water system."

A list of significant deficiencies can be found in Appendix #1. NOTE: The WQCD inspector may suggest additional issues discovered during the sanitary survey that could be considered a significant deficiency. These issues will be discussed with the WQCD Drinking Water management prior to being noted in the sanitary survey letter.

1.3.9 The water system will receive a letter along with the final sanitary survey report that should be retained. If any significant deficiencies were found, they will be listed in the letter. The water system will have 45 days to respond in writing to CDPHE, and must indicate how and on what schedule the system plans to address each significant deficiency.

1.3.10 The Division maintains a checklist or similarly formatted document regarding the information a public water supplier should have available when the WQCD conducts a sanitary survey. This checklist can be found in Appendix #2.

FIGURE 1-2
Sanitary Survey Requirements



PART II MONITORING, COMPLIANCE, AND REPORTING

2.0 Cryptosporidium *Removal*

2.0.1 The IESWTR sets a maximum contaminant level goal (MCLG) of zero for the protozoan *Cryptosporidium*.

2.0.2 A 2-log (99%) removal of *Cryptosporidium* is required.

2.0.3 Systems using conventional or direct filtration meet this requirement if they comply with the new turbidity performance standards for combined filter effluent (discussed below) and results of Microscopic Particulate Analyses (MPA) show at least a 3 log removal/disinfection efficacy or can demonstrate plant optimization. The Microscopic Particulate Analyses policy can be found in Appendix #3.

2.0.4 Systems using slow sand or diatomaceous earth filtration meet the 2-log removal requirement if they are in compliance with the existing turbidity performance standards under the existing Surface Water Treatment Rule (SWTR).

2.0.5 Water systems who meet the goals of the *Partnership for Safe Water* are considered optimized for protection against microbial pathogens, and with CDPHE approval, are not required to sample for microscopic particulate analyses. Those goals are:

- Minimum Data Monitoring Requirements
  - Daily raw water turbidity
  - Settled water turbidity at 4-hour time increments from each sedimentation basin
  - On-line (continuous) turbidity from each filter
- Individual Sedimentation Basin Performance Goals
  - Settled water turbidity less than 1 NTU 95 percent of the time when annual average raw water turbidity is less than or equal to 10 NTU.
  - Settled water turbidity less than 2 NTU 95 percent of the time when annual average raw water turbidity is greater than 10 NTU.
  - **Note:** The Partnership goals regarding settled water turbidity are written to cover a wide variety of water treatment plants nationwide. The settled water turbidity goals may not be applicable during the cold water months in Colorado. It would not be uncommon for a conventional treatment plant to have a raw water turbidity of less than 1 NTU and a settled water turbidity of greater than 1 NTU during the winter. In this scenario, the plant would not be meeting the Partnership goals but may be optimized for particulate removal.
- Individual Filter Performance Goals
  - Filtered water turbidity less than 0.1 NTU 95 percent of the time (excluding 15-minute period following backwashes) based on the maximum values recorded during 4-hour time increments.

- If particle counters are available, maximum filtered water measurements of less than 10 particles (in the 3 to 18 micron range) per milliliter. (Note: The current state-of -the-art regarding calibration of the particle counters and the inherent problems in comparisons of readings between different counters must be considered in using particle count information to assess optimized performance. Higher readings than above the 10 particles/mL goal from a counter that is properly calibrated may be a function of differences between instruments. Relative changes in particle count data will be of greater use in assessing optimized performance than the absolute values form the particle counter).
- Maximum filtered water measurements of 0.3 NTU.
- Initiate filter backwash immediately after turbidity breakthrough has been observed and before effluent turbidity exceeds 0.1 NTU.
- Maximum filtered water turbidity following backwash of less than 0.3 NTU.
- Maximum backwash recovery period of 15 minutes (e.g., return to less than 0.1 NTU).

- Disinfection Performance Requirements
  - CT values to achieve required log inactivation of Giardia and virus.

2.1 Individual Filter Monitoring Requirements

2.1.1 Conventional filtration systems and direct filtration systems must monitor individual filters and report data as summarized in Table 2-1.

TABLE 2-1
Individual Filter Turbidity Monitoring and Reporting Requirements.[2]

Activity	Requirement
Turbidity Monitoring at Individual Filters	• All systems using conventional filtration treatment or direct filtration conduct continuous turbidity monitoring for each individual filter using an approved method and the turbidimeters must be calibrated using the procedure specified by the manufacturer. • Systems record the results of individual filter monitoring every 15 minutes. • If continuous turbidity monitoring equipment fails, the system conducts grab sampling every 4 hours in lieu of continuous monitoring for no more than 5 days.
Triggers for Turbidity Exceptions Reporting for Individual Filters[3]	• For any individual filter that has a measured turbidity level of greater than 1.0 NTU in 2 consecutive measurements taken 15 minutes apart, the system must report the filter number, turbidity measurement, and date of exceedance. The system must either produce a filter profile for the filter within 7 days of the exceedance and report that the profile has been produced or report the obvious reason for the exceedance. The profile itself is not required to be submitted, but must be available for review upon request. • For any individual filter that has a measured turbidity level of greater than 0.5 NTU in 2 consecutive measurements taken 15 minutes apart after the first 4 hours of operation after the filter has been backwashed or otherwise taken offline, the system must report the filter number, turbidity measurement, and date of exceedance. The system must either produce a filter profile for the filter within 7 days of the exceedance and report that the profile has been produced or report the obvious reason for the exceedance. The profile itself is not required to be submitted, but must be available for review upon request. • For any individual filter that has a measured turbidity level of greater than 1.0 NTU in 2 consecutive measurements taken 15 minutes apart in each of 3 consecutive months, the system must report the filter number, turbidity measurement, and date of exceedance. The system must conduct a self-assessment of the filter within 14 days of the exceedance and report 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. The filter self-assessment report does not need to be submitted with the monthly report, but must be available upon request. You will find a FILTER SELF ASSESSMENT WORKSHEET in Appendix 4. • For any individual filter that has a measured turbidity level of greater than 2.0 NTU in 2 consecutive measurements taken 15 minutes apart in 2 consecutive months, the system must report the filter number, turbidity measurement, and date of exceedance. The system must contact the State or 3rd party to conduct a CPE 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.
Reporting and Record-keeping	<u>Individual Filter Data</u> • Results of individual filter monitoring must be maintained for at least 3 years. • Individual filter data must be reported only if there has been a turbidity exceedance.

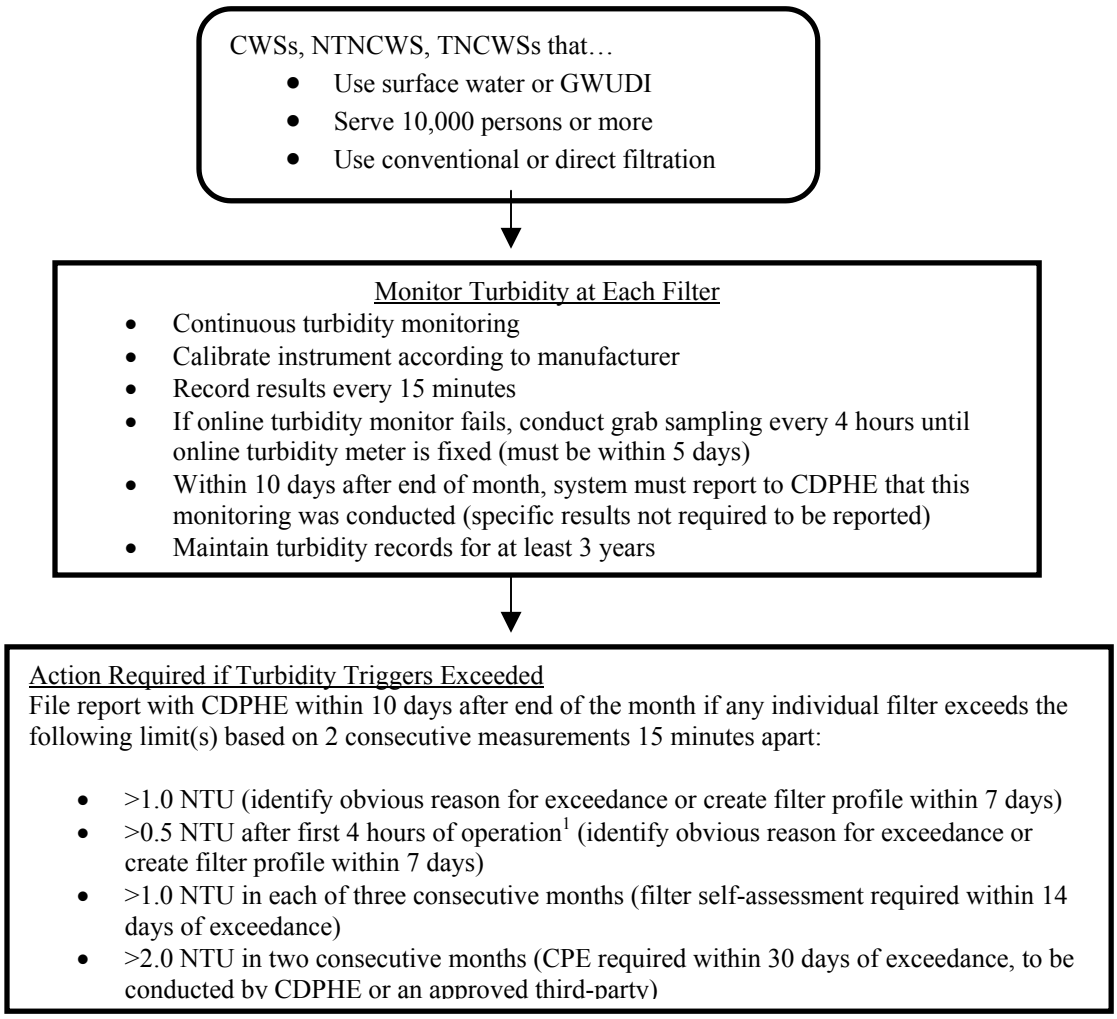
[2]Refer to the USEPA guidance manuals listed in Section XV for specific procedures to comply with individual filter turbidity monitoring and disinfection profiling and benchmarking.

[3]Systems using lime softening may apply to the State for alternative exceedance levels to those specified if they can demonstrate that higher turbidity levels in individual filters are due to lime carryover only and not due to degraded filter performance.

2.1.2 Continuous measurement of the effluent turbidity of each individual filter using a USEPA-approved method. Results must be recorded every 15 minutes.

2.1.3 If continuous turbidity monitoring equipment fails, the system conducts grab sampling every four hours in place of continuous monitoring until the turbidimeter is repaired or replaced (allowed for up to 5 days).

FIGURE 2-1
Individual Filter Monitoring



[1] These measurements are specific to exactly 4 hours and 4 hours 15 minutes after placing a filter back online either following a filter backwash cycle or otherwise having the filter offline.

2.2 Turbidity Performance Criteria

2.2.1 New combined filter effluent turbidity limits (Table 2-2) must be met. Failure to meet these requirements is a treatment technique violation.

TABLE 2-2
Combined Filter Effluent Turbidity Requirements

Filtration Technology	95th Percentile Turbidity (NTU)	Maximum Turbidity (NTU)[1]
Conventional filtration	0.3	1
Direct filtration	0.3	1
Diatomaceous earth filtration	1.0	5
Slow sand filtration	1.0	5
Approved bag or cartridge	1.0	5
Filtration technologies not listed above	0.3	1

[1] For purposes of determining compliance with the Maximum Turbidity MCL and associated public and/or Department notification, systems will need to round turbidity results that exceed 1 NTU to the nearest whole number; however, the actual reading must be recorded in the turbidity monthly operational report (MOR). In other words, results with two or three significant numbers would need to be rounded to the nearest whole number when determining compliance with the turbidity MCL. For instance, a recorded value of 1.4 or 1.49 would be rounded down to 1 and would not be considered a violation; however, a recorded value of 1.5 or 1.50 would be rounded up to 2 and would be considered an MCL violation requiring the appropriate Department and/or public notification. The same would apply to values above 5 for systems required to comply with that turbidity limit.

2.2.2 If a PWS is using an on-line continuous turbidimeter for measuring the combined filter effluent turbidity, only analytical results taken every four hours will be used when determining compliance with the 95th percentile requirement; however, all analytical results shall be used when determining compliance with the maximum turbidity MCL.

2.2.3 Any time a system exceeds the appropriate Maximum Turbidity MCL for the associated filter technology in use within their treatment plants, the system must notify the Water Quality Control Division within 24 hours of that exceedance using IESWTR Form 3 – Violation Notification by faxing it to the Division. After consulting with the Division in accordance with the regulation, the violation will require either Tier 1 or Tier 2 public notification depending upon the decision made by the Water Quality Control Division. Please refer to Part IV for violation notification requirements.

2.2.4 Colorado will grant approval for the use of alternative technologies provided that the technology will treat water to a consistent quality where the turbidity must not exceed 0.3

NTU at least 95% of the time and the turbidity limit of the system may not exceed 1 NTU at any time. Technologies will be evaluated not only on the basis of finished water, but also with consideration of operational complexities, the ability to handle variable water qualities, long term reliability, and the potential for cross-connections. Additionally, the system must meet the criteria for acceptance of the alternative technology set forth in the design criteria. This criteria includes the following:

1. System component evaluation for leaching of contaminants. (ANSI/NSF Standard 61 certification is the preferred documentation)
2. Demonstration of at least 3-log Giardia lamblia and 2-log Cryptosporidium removal.
    a) Microscopic Particulate Analysis (MPA)
    b) Giardia/Cryptosporidium surrogate particle removal evaluations.
    c) Particle size demonstration for Giardia/Cryptosporidium removal credit.
    d) Live Giardia/Cryptosproridium challenge studies.
    e) EPA/NSF Environmental Technology Verification Program (ETV)
3. On-site demonstration of performance effectiveness.
    a) Prior testing of an identical system on a similar water.
    b) Conditional acceptance with a performance guarantee.
    c) Pilot testing with MPAs, appropriate monitoring, and final engineering report.

2.2.5 Combined filter effluent turbidity is monitored as specified under the SWTR (Table 2-3). Turbidity measurements are performed on representative samples of the system's filtered water every four hours (or more frequently) that the system serves water to the public.

TABLE 2-3
Combined Filter Effluent Monitoring Requirements

Activity	Requirement
Combined filter effluent monitoring	All systems continue to monitor the combined filter effluent at the same location and frequency as under the SWTR, but meet the new combined filter turbidity limits presented in Table 2-2.
Reporting and Record-keeping	Combined Filter Effluent Data Reporting • Turbidity measurements every four hours. • Total number of combined filter effluent turbidity measurements taken during last month that do not exceed the turbidity limits. • Date and value of any turbidity measurements taken during the month that exceed 1 NTU for systems using conventional or direct filtration. Turbidity measurements must be reported within 10 days after the end of each month the system serves water to the public.

2.2.6 Continuous turbidity monitoring may be substituted for grab sample monitoring if the system validates the continuous measurement for accuracy on a regular basis using a protocol approved by the State. (Please refer to Appendix #5 "Calibration Document")

2.2.7 For any system using slow sand filtration or filtration treatment other than conventional treatment, direct filtration, or diatomaceous earth filtration, the State may reduce the sampling frequency to once per day if it determines that less frequent monitoring is sufficient to indicate effective filtration performance.

2.2.8 Turbidity must be measured using methods approved by USEPA and by a party approved by the State. Turbidimeters must be calibrated as outlined in Appendix #5. A system using lime softening may acidify representative samples prior to analysis using a protocol approved by the State. Failure to meet these requirements is a monitoring violation.

2.2.9 Reporting requirements for combined filter effluent turbidity are unchanged from those established under the SWTR (Table 2-3), except where reporting levels have been modified to reflect the more stringent turbidity requirements established under the IESWTR.

2.2.10 Required turbidity measurements must be reported within 10 days after the end of each month the system serves water to the public. Information to be reported includes:

- the total number of filtered water turbidity measurements taken during the month;
- the number and percentage of filtered water turbidity measurements taken during the month which are less than or equal to the turbidity limits established under the SWTR for diatomaceous earth and slow sand filtration systems, and under the IESWTR for conventional, direct, and alternative filtration systems; and
- the date and value of **any** turbidity measurements taken during the month which exceed 1 NTU for conventional and direct filtration systems, 5 NTU for slow sand and diatomaceous earth filtration systems, and the maximum level established by the State for alternative filtration technology systems.
- Turbidity measurement every four hours.

2.2.11 Failure to meet the requirements above is a reporting/record-keeping violation.

2.2.12 **Computer Accessibility:** As we move into the future and technologies continue to be developed and refined, the Division envisions having the capability to receive all reporting and monitoring forms electronically thus creating a more cost efficient and time effective mechanism for reporting and, at the same time, reducing the amount of paper being used. Although the Division doesn't have the ability to do so at this time, we have begun to look at ways to develop those technologies and will continue to move in that direction. We strongly suggest that all public water systems start planning for the future so that when the Division has the technology in place, all systems in Colorado will have both the hardware and software necessary to take advantage of these technologies. In addition, a computer can be a useful tool for any public water system. Beyond the simple use of reporting and monitoring, computers can ease the burden of the day-to-day plant operation. For example, they can assist in determining CT values and/or any other calculation necessary on a day-to-day basis. They can also make individual filter profiling as simple as one touch of a button. These are only a few examples and since there are numerous other applications and uses for computers, the benefits of having a computer would far outweigh the cost when everything is taken into consideration.

2.3 Disinfection Profiling and Benchmarking

2.3.1 Disinfection benchmarking is a procedure to evaluate the impact on microbial risk of proposed changes in disinfection practice and is intended to assure that pathogen control is maintained while the provisions of the Stage 1 DBPR are implemented.

2.3.2 Disinfection benchmarking involves charting daily levels of pathogen inactivation for a period of at least one year to create a profile of inactivation performance. The water system uses this profile to determine a baseline or benchmark of inactivation against which proposed changes in disinfection practices can be measured.

2.3.3 Profiling and benchmarking are explained in detail in USEPA's *Disinfection Profiling and Benchmarking Guidance Manual.*

2.3.4 Water systems are required to prepare a disinfection profile if either TTHM or HAA5 levels are at least 0.064 or 0.048 mg/L, respectively, as an annual average.

2.3.5 To determine applicability, water systems that collected TTHM and HAA5 data under the ICR must use the results of the last 12 months of ICR monitoring unless the State determines there is a more representative data set. Non ICR systems may either use existing TTHM and HAA5 data, if approved by the State, or must conduct TTHM and HAA5 monitoring for four quarters. This monitoring must be completed by March 2000. Alternatively, systems can elect to forgo this monitoring if they construct a disinfection profile.

2.3.6 A disinfection profile consists of a compilation of daily *Giardia lamblia* log inactivations (plus virus inactivations for systems using either chloramines or ozone for primary disinfection) computed over a period of at least one year.

2.3.7 The profile is based on daily measurements of disinfectant residual concentration(s), contact time(s), temperature, and pH. It may be developed using up to 3 years of existing (i.e. grand fathered) data if the State finds the data acceptable.

2.3.8 Systems having less than 3 years of acceptable grand fathered data are required to conduct one year of monitoring to create the profile. This monitoring must be completed by March 2001.

2.3.9 The disinfection benchmark is equal to the lowest monthly average inactivation level in the disinfection profile (or average of low months for multi-year profiles).

2.3.10 The Division will accept disinfection profiling and benchmarking data that has been recorded and retained in the Utah software that was developed for this purpose. If this

software is not used, utilities are referred to the Federal Disinfection Profiling and Benchmarking Guidance Manual, March 1999, EPA-815-R-99-013, for advice on developing a disinfection profile and benchmark that meets the requirements of the rule. The State will accept the disinfection profile in its existing form.

2.3.11 The State will not require utilities that were not required to conduct initial disinfection profiling by the IESWTR to begin doing so at this time.

2.3.12 Any system that decides to make a significant change to its disinfection practice must calculate its benchmark and consult with the State prior to and only if making a significant change.

2.3.13 Significant changes in disinfection practice include:

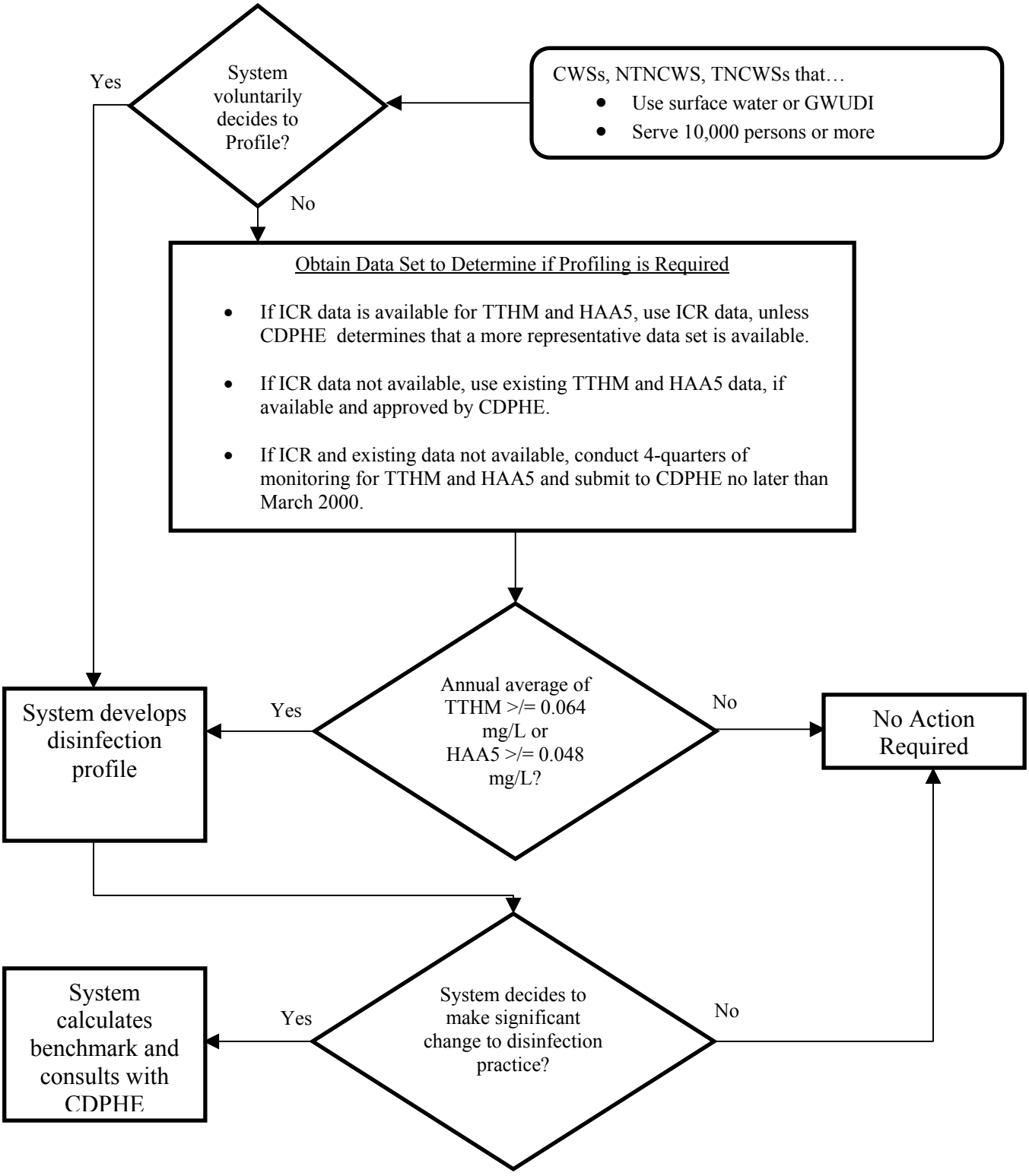
- moving the point of disinfection, not including routine seasonal changes;
- changing the type of disinfectant;
- changing the disinfection process; and
- other modifications designated as significant by the State.

2.3.14 The following information must be submitted by the water system as part of the consultation process:

- a description of the proposed change;
- the disinfection profile for *Giardia lamblia* (and, if necessary, viruses) and benchmark;
- and an analysis of how the proposed change will affect the current levels of disinfection.

2.3.15 CDPHE will review the disinfection profile as part of its periodic sanitary survey.

FIGURE 2-2
Disinfection Profiling and Benchmarking



PART III RECORD KEEPING

3.0 Record Keeping, Reporting, and Public Notification

3.0.1 The IESWTR sets record keeping, reporting and public notice requirements. Record keeping and reporting associated with specific requirements have been reviewed above in prior sections.

3.0.2 Report monitoring and compliance data to the State using IESWTR Form 1 (Version 2) within 10 days after the end of each month the system serves water to the public.

3.0.3 If a PWS has an individual filter(s) that exceeds 0.5 NTU in two consecutive 15 minute measurements after 4 hours of operation following a filter backwash or otherwise offline and does not have an obvious reason for the exceedance, the PWS must report the filter number, the turbidity measurement, the date(s) that the exceedance occurred and the date(s) that filter profile(s) was produced. The filter profile(s) does not need to be included with the monthly report, but must be available for review upon request.

3.0.4 If a PWS has an individual filter(s) that exceeds 1.0 NTU in two consecutive 15 minute measurements and does not have an obvious reason for the exceedance, the PWS must report the filter number, the turbidity measurement, the date(s) that the exceedance occurred and the date(s) that filter profile(s) was produced. The filter profile(s) does not need to be included with the monthly report, but must be available for review upon request.

3.0.5 If a PWS has an individual filter(s) that exceeds 1.0 NTU in two consecutive 15 minute measurements for 3 consecutive months, the PWS must report the filter number, the turbidity measurement, the date(s) that the exceedance occurred and the date(s) that filter self-assessment(s) was produced. The filter self-assessment(s) does not need to be included with the monthly report, but must be available for review upon request. Please refer to Appendix #4 for information that must be included in the filter self-assessment(s).

3.0.6 If a PWS has an individual filter(s) that exceeds 2 NTU in two consecutive 15 minute measurements for 2 consecutive months, the PWS must report the filter number, the turbidity measurement and the date(s) that the exceedance occurred. In addition the PWS must arrange for a conduct of a CPE (comprehensive performance evaluation) within 30 days of the exceedance and must have the CPE completed and submitted to the Water Quality Control Division within 90 day of the exceedance.

3.0.7 Failure to comply with IESWTR reporting requirements is a reporting violation. However, the exceedance criteria are not treatment technique requirements; therefore, the water system is not in violation of the treatment technique requirements when the turbidity limits for individual filters are exceeded.

3.0.8 Violation of treatment technique requirements occurs when the limits for combined filter effluent turbidity are exceeded. Public notification is required. Refer to Part IV of this guidance manual for a description of the possible violations associated with the IESWTR.

3.0.9 Refer to CDPHE *Public Notification Rule Guidance Handbook* for procedure and language to be used in notices.

3.1 Guidance Manuals

USEPA developed the following guidance manuals to help water utilities comply with the IESWTR:

3.1.1 *Guidance Manual for Conducting Sanitary Surveys of Public Water Systems.* EPA 815-R-99-016 (April 1999)—Describes the eight required elements of a sanitary survey.

3.1.2 *Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions* EPA 815-R-99-010 (April 1999)—Describes how to comply with individual filter turbidity monitoring and combined effluent turbidity monitoring.

3.1.3 *Alternative Disinfectants and Oxidants Guidance Manual.* EPA 815-R-99-014 (April 1999)—Explains how to select and apply alternative disinfectants and oxidants.

3.1.4 *Uncovered Finished Water Reservoirs Guidance Manual.* EPA 815-R-99-011 (April 1999)—Describes how to cover reservoirs.

3.1.5 *Disinfection Profiling and Benchmarking Guidance Manual* EPA 815-R-99-013 (August 1999)—Explains how to comply with disinfection profiling and benchmarking requirements.

3.1.6 *Microbial and Disinfection Byproduct Rules Simultaneous Compliance Guidance Manual*. EPA 815-R-99-015 (August 1999)—Explains how to avoid compliance problems when attempting to comply with more than one rule.

See the Office of Ground Water and Drinking Water (OGWDW) web page at http://www.epa.gov/safewater/standards.html. The USEPA guidance documents are located at www.epa.gov/safewater/mdbp/implement.html .

PART IV VIOLATIONS REPORTING

Routine monitoring reports are to be submitted within 10 days after the end of each quarter in which samples were collected. Systems required to sample less frequently than quarterly must report to CDPHE within 10 days after the end of each monitoring period in which samples were collected. Table 4-1 summarizes all D/DBP rule violations

4.1 Tier 2 and Tier 3 Violations Reporting

4.1.1 For each monitoring period that a system has a Tier 2 or a Tier 3 violation of any provision of the IESWT Rule, it must use IESWTR Form 3 - Violation Notification to report the violation to the CDPHE rule manager for the D/DBP rule within 48 hours of becoming aware of the violation and report to the public in accordance with Article 10 or the *Colorado Primary Drinking Water Regulations*. In addition, the system must identify the violation in their routine monitoring report.

Tier 2 Violations include the following:

- All violations of the MCL, MRDL, and treatment technique requirements of the regulations, except where a Tier 1 notice is required or where the Water Quality Control Division determines that a Tier 1 notice is required. Examples include:
  - **TT violation related to combined filter effluent turbidity exceeding 1 NTU**
  - **TT violation when system fails to achieve combined filter effluent turbidity level of 0.3 NTU in 95% of monthly measurements**
- Violations of the monitoring and testing procedure requirements, where the Water Quality Control Division determines that a Tier 2 rather than a Tier 3 public notice is required, taking into account potential health impacts and persistence of the violation.
- Failure to comply with the terms and conditions of any variance or exemption.

Tier 3 Violations include the following:

- All monitoring violations, except where a Tier 1 notice is required or where the - Water Quality Control Division determines that a Tier 2 notice is required. Examples include, but are not limited to, the following:
  - **Failure to monitor for individual filter turbidities**
  - **Failure to monitor for combined filter effluent turbidities**
  - **Failure to submit Monthly Operational Report for turbidity by proper date**
  - **Failure to complete required filter profiles or filter self-assessments**
- Failure to comply with a testing procedure, except where a Tier 1 notice is required or where the Water Quality Control Division determines that a Tier 2 notice is required.
- Operation under a variance or exemption granted in accordance with the Safe Drinking Water Act.
- Availability of unregulated contaminant monitoring results
- Exceedance of the fluoride secondary maximum contaminant level (SMCL)

4.2 Tier 1 Violations Reporting

4.2.1 For each Tier 1 violation of the IESWT Rule, the system must complete IESWTR Form 3 - Violation Notification and send it via fax to the CDPHE rule manager for the D/DBP rule. Such fax is to be received by CDPHE within 24 hours of the system becoming aware of the violation. In the event that the violation becomes known on a holiday, Saturday or Sunday, the system must in addition call the CDPHE Emergency Management Unit (1-877-518-5608) to report the auto violation. In addition, the system must notify the public within 24 hours in accordance with Article 10 of the *Colorado Primary Drinking Water Regulations*.

Tier 1 Violations include the following:

- Violation of the MCL for total coliforms when fecal coliform or E. coli are present in the water distribution system, or when the water system fails to test for fecal coliforms or E. coli when any repeat sample tests positive for coliform.
- Violation of the MCL for nitrate, nitrite, or total nitrate and nitrite or when the water system fails to take a confirmation sample within 24 hours of the system's receipt of the first sample showing an exceedance of the nitrate or nitrite MCL.
- Exceedance of the nitrate MCL by non-community water systems, where permitted to exceed the MCL by the Water Quality Control Division.
- Violation of the MRDL for chlorine dioxide when one or more samples taken in the distribution system the day following an exceedance of the MRDL at the entrance of the distribution system exceed the MRDL, or when the water system does not take the required samples in the distribution system.
- **Violation of the turbidity MCL where the Water Quality Control Division determines, after consultation, that a Tier 1 notice is required or where consultation does not take place within 24 hours after the system learns of the violation.**
- **Violation of the Surface Water Treatment Rule (SWTR) or Interim Enhanced Surface Water Treatment rule (IESWTR) treatment technique requirement resulting from a single exceedance of the maximum allowable turbidity limit, where the Water Quality Control Division determines, after consultation, that a Tier 1 notice is required or where consultation does not take place within 24 hours after the system learns of the violation.**
- Occurrence of a waterborne disease outbreak or other waterborne emergency (such as a failure or significant interruption in key water treatment processes, a natural disaster that disrupts the water supply or distribution system, or a chemical spill or unexpected loading of possible pathogens into the source water that significantly increases the potential for drinking water contamination);
- Other violations or situations with significant potential to have serious adverse effects on human health as a result of short-term exposure, as determined by the Water Quality Control Division either in regulation or on a case-by-case basis.

TABLE 4-1
Interim Enhanced Surface Water Treatment Rule Violation Reporting List

SDWIS Violation/ Contaminant Code	Regulated Contaminant/ Requirement	Citation	Violation Type	System Size and Type Affected	Violation	Initial Compliance Date
TREATMENT TECHNIQUE (TT) VIOLATIONS						
37/0300	Disinfection and Consultation	§141.172(b) & (c)	TT	All subpart H systems serving 10,000 people	Failure to consul with the Water Quality Control Division before making a significant change to a disinfection practice if required to develop a disinfection profile	January 1, 2002
43/0300	Filtration	§141.173(a)(2) & (b)	TT	Subpart H systems serving 10,000 using conventional or direct filtration Subpart H systems serving 10,000 using alternative filtration technologies	Failure to achieve combined filter effluent turbidity level that at no time exceeds 1 NTU. Or Exceedance of the state-set maximum turbidity performance requirements of 5 NTU.	January 1, 2002
44/0300	Filtration	§141.173(a)(1)	TT	Subpart H systems serving 10,000 using conventional or direct filtration Subpart H systems serving 10,000 using alternative filtration technologies	Failure to achieve combined filter effluent turbidity level of 0.3 NTU in 95% of monthly measurements Or Failure to achieve the state-set turbidity performance requirements of 1 NTU in 95% of monthly measurements	January 1, 2002
47/0300	Finished Water Storage Facilities	§141.170(c)	TT	All subpart H systems serving at least 10,000 people	Systems are not allowed to start construction of any uncovered finished water storage facility (reservoir, holding tank, or other storage facility)	February 16, 1999
MONITORING AND REPORTING (M/R) VIOLATIONS						
29/0300	Filtration – Response to Individual Filter Trigger	§141.175(b)(1) & (2)	M/R Major	Subpart H systems serving 10,000 using conventional or direct filtration	Failure to produce and/or report to the state an individual filter profile within 7 days of an exceedance (>0.5 NTU in 2 consecutive measurements taken 15 minutes apart after 4	January 1, 2002

SDWIS Violation/ Contaminant Code	Regulated Contaminant/ Requirement	Citation	Violation Type	System Size and Type Affected	Violation	Initial Compliance Date
					hours of operation or >1.0 NTU in 2 consecutive measurements taken 15 minutes apart) if the PWS is unable to ID an obvious reason for abnormal filter performance.	
29/0300	Filtration – Response to Individual Filter Trigger	§141.175(b)(3)	M/R Major	Subpart H systems serving 10,000 people using conventional or direct filtration	Failure to conduct and./or report to the state a self-assessment of an individual filter within 14 days of a turbidity exceedance (>1.0 NTU in 2 consecutive measurements taken 15 minutes apart in each of 3 consecutive months)	January 1, 2002
29/0300	Filtration – Response to Individual Filter Trigger	§141.175(b)(4)	M/R Major	Subpart H systems serving 10,000 people using conventional or direct filtration	Failure to have a comprehensive performance evaluation conducted by the state or a third party no later than 30 days after a turbidity exceedance (>2.0 NTU in 2 consecutive measurements taken 15 minutes apart in 2 consecutive months) and have the evaluation completed and submitted to the state no later than 90 days following the exceedance.	January 1, 2002
38/0300	Filtration/ Combined Filter Effluent	§141.175(a)	M/R Major – Failure to collect & report at least 90% of required samples	All Subpart H systems serving at least 10,000 people	Failure to sample combined filter effluent for turbidity at required frequency using required collection and analytical methods and report the following within 10 days after the end of each month the PWS serves water to the public: 1. Total number of samples taken, the number and percentage of samples less than or equal to the limits specified in 141.73 or 141.173; and/or 2. Date and level of any measurements over 1 NTU for conventional or direct filtration or which exceed the maximum of 5 NTU for alternative filtration technologies.	January 1, 2002
		§141.174	M/R Minor – Any other failure to monitor or report			

SDWIS Violation/ Contaminant Code	Regulated Contaminant/ Requirement	Citation	Violation Type	System Size and Type Affected	Violation	Initial Compliance Date
38/0300	Filtration	§141.175(b)	M/R Major	Subpart H systems serving 10,000 using direct or conventional filtration	Failure to report that the system has conducted all individual filter monitoring to the state within 10 days following end of month	January 1, 2002
38/0300	Filtration	§141.175(c)	M/R Major	All subpart H systems serving at least 10,000 people	Failure to report that the system has exceeded 1 NTU in representative samples by the next business day if the PWS uses conventional or direct filtration Or Failure to report that the system has exceeded 5 NTU for filtration technologies other than conventional filtration.	January 1, 2002
Recordkeeping Violation						
09/0300	Filtration	§141.175(b)	Record-keeping	Subpart H systems serving 10,000 using direct or conventional filtration	Failure to maintain the results of individual filter monitoring for at least 3 years, documenting that the system has collected and recorded individual filter results every 15 minutes	January 1, 2002
Public Notification Violations						
06/0300	Filtration & Disinfection	§141 Subpart Q	PN	All Subpart H systems serving at least 10,000 people	Failure to notify public and use approved public notification language when there is a violation of the treatment technique and/or monitoring requirements for filtration and disinfection in Subpart H or Subpart P	January 1, 2002

APPENDIX #1

Significant Deficiencies List

1. Customer raw water taps.
2. No disinfection or disinfection not operating – Surface or Groundwater.
3. Disinfection by-pass piping.
4. No filtration – Surface water or Groundwater Under the Influence of Surface water.
5. Inadequate spring catchment.
6. Recent construction since last inspection without Plans Review and Approval.
7. Critical records inadequate or missing.
8. Uncontrolled cross-connection.

Source

1. Raw water quality monitoring that indicates water will cause an immediate sanitary risk.
2. Activities or pollution sources in the immediate source water area that will cause sanitary risks.
3. Location of a well causing it to be impacted by surface contamination.

Treatment

1. One or more of the unit processes is inoperable or incapable of producing water that meets standards under all conditions of raw water quality.
2. There are no provisions to warn operators of treatment systems failures in unattended facilities.
3. Systems with point-of-entry or point-of-use treatment devices must adhere to written operation and maintenance plans.

Distribution and transmission

1. Raw water transmission line is equipped with a bypass around the water treatment plant.

Finished water storage

1. Storage tank is not adequately sealed to prevent entry of contamination or condition of the tank allows or introduces contamination into the system.

Pumps, pump facilities, and controls

1. Auxiliary power is not available for critical processes during power outages in which the treatment plant continues to discharge water into the distribution system.

Monitoring, reporting and data verification

1. Operators are using improper procedures or methods when performing lab analyses.

2. System is falsifying data.

System management and operation

Operator compliance with State requirements

Other requirements

1. The Water Quality Control Division (WQCD) inspector may identify additional issues during the Sanitary Survey that could be considered a significant deficiency. These issues will be discussed with the WQCD Drinking Water management prior to being noted in the Sanitary Survey letter.

APPENDIX #2

Sanitary Survey Components checklist

DRINKING WATER INSPECTION CHECK LIST		
	Completed by	
Description:	**Facility**	**State**
System Overview		
*General Info:		
Contact Name		
Contact Phone		
Contact Address		
Community Information		
*Operator Certification:		
Water Treatment Certification: Name, Number & Expiration Date		
Water Distribution Certification: Name, Number & Expiration Date		
X-con/Backflow Certification: Name, Number & Expiration Date		
Emergency Contact Information		
System Requirements/Monitoring		
*Bacti Sampling Plan		
*X-Con Cntrl Prog		
Fluoridation Program		
Surface Water Protection Plan		
Well Head Protection Plan		
*Emergency Action Plan		
System Requirements/Monitoring Cont.		
Lab Utilized		
Sampling Methods		
*Associated WW Permits		

DRINKING WATER INSPECTION CHECK LIST			
		Completed by	
Description:		**Facility**	**State**
Water Treatment System Review (Groundwater & Surface)			
	Water Treatment Overview info for CADMan		
	GPS Location		
	Microscopic Particulate Analysis (MPA)		
	*Treatment System Overview		
	Chemicals		
	Capacities		
	On Site Storage		
	Total Contact Time		
Surface Water Treatment System Review			
	Type of Treatment Utilized		
	Facility flow rates and loadings		
	Condition and Calibrations of Equipment		
Treatment Processes (Groundwater & Surface Water)			
	Specific Treatment Processes Review Beginning to End		
Records Review and O&M and Emergency Plans			
Distribution System Review			
	Distribution System Treatment		
	Pumps & Pumping Facilities, Controls, and Security/Safety		
Water Sources			
	Type & Location		
	Capacities and Applicable Permits		
	Security & Safety		
Water Storage Facilities			
	Type &		

DRINKING WATER INSPECTION CHECK LIST		
	Completed by	
Description:	**Facility**	**State**
Location		
Capacities and Applicable Permits		
Security & Safety		

Other Items will be reveiwed as needed

* Manditory or Regulatory Items

APPENDIX #3

Colorado Use of the Microscopic Particulate Analysis

AUTHORITY
The requirement is not directly spelled out in the regulations. It evolves from a combination of:

1. CDPHE primacy submittal and subsequent approval by EPA that articulated how we intended to implement the surface water treatment rule,
2. CDPHE general authority from articles 1.2.3(2) and 9.1.1(4) and,
3. The annual compliance monitoring letter we send to systems each year that outlines specific monitoring requirements.

BACKGROUND
Turbidity may not be a sufficient indicator of treatment plant efficacy in Colorado due to high quality raw water sources.

The presence of treatment processes alone is not sufficient to prove high quality water is being produced. Treatment processes need to be well operated. SWTR requires 3-log reduction/inactivation of Giardia cysts and 2 log removal of cryptosporidium cysts.

MPA is screening tool for removal processes

1. Approximately 200 Surface Water systems in state.
2. Limited number of WQCD staff to perform in-depth reviews of treatment efficacy.
3. Public expectations for delivery of high quality, safe drinking water.
4. Identifies systems presumptively working well.

Assumptions:

1. Test predictive of performance until next test
2. Good surrogate for removal of Giardia/Crypto sized particles

METHODOLOGYCDPHE recognizes the use of EPA Microscopic Particulate Analyses for Filter Plant Optimization(April 1996) as the analytical method for MPAs. Reference EPA 910-R-96-001. The Gelman Enviro-chek alternative sampling procedure is accepted.

USE OF MPA

- All Surface Water systems conduct an annual MPA test.
- MPA > 3-log reduction of microorganisms assumes compliance with filtration requirements. Assuming:
  1. No disease outbreak
  2. No cyst breakthrough
- MPA < 3 log reduction of microorganisms must consider disinfection (CT) inactivation. (Note: All surface Subpart H systems must provide at least 0.5 Giardia cyst inactivation by disinfection)
- MPA + CT Inactivation > 3 assumes compliance with surface water treatment requirements.

- MPA + CT Inactivation < 3
  1. System can demonstrate "well run" operations, and
  2. No design, operational maintenance performance limiting factors from Comprehensive Performance evaluation (CPE).
  3. "Well run" presumes $\geq$ 2.5 log removal.
  4. If "well run" and 0.5 CT inactivation, 3 log Giardia/ 2 log crypto removal/inactivation presumed.
- If not "well run" and MPA < 3, the water system is considered in violation of treatment technique requirements.
  1. Requires follow up to treatment inadequacies and Public Notification as determined by State/System consultation.
  2. If it is determined to not be an acute violation, public notification is required within 30 days of notification.
  3. If it is determined to be an acute violation, public notification is required within 24 hours.
  4. A decision on the issuance of a boil water advisory will be required.
  5. 3 LOG Removal but cysts found in finished water
     - Evaluate public health threat
     - Cyst concentration versus infectious dose req'd
     - CT inactivation values
     - Evidence of disease outbreak
     - Status of treatment processes and evidence of performance limiting factors

APPENDIX #4

Individual Filter Self-Assessment Worksheet

TOPIC	DESCRIPTION	INFORMATION
General Filter Information	Type (mono, dual, mixed)	
	Number of filters	
	Filter control (constant, declining)	
	Surface wash type(rotary, fixed, none)/Air Wash	
	Configuration (rectangular, circular, square)	
	Dimensions (length, width, diameter)	
	Filter-to-waste (capability/specify if used)	
	Surface area per filter (ft2)	
Hydraulic Loading Conditions	Average operating flow (mgd)	
	Peak Instantaneous operating flow (mgd)	
	Average hydraulic surface loading rate (gpm/ft2)	
	Peak hydraulic loading rate (gpm/ft2)	
Media Design Conditions	Depth, type	
	Media 1 – Sand	
	Media 2 (if applicable) - Anthracite	
	Media 3 (if applicable) - Garmet	
Actual Media Conditions	Depth	
	Media 1 – Sand	
	Media 2 (if applicable) - Anthracite	
	Media 3 (if applicable) - Garmet	
	Presence of mudballs, debris, excess chemical, cracking, worn media	

TOPIC	DESCRIPTION	INFORMATION
Support Medial/Underdrain Conditions	Is the support media evenly placed (deviation <2 inches) in the filter bed?	
	Evidence of media in the clearwell or plenum	
	Evidence of boils/vortexing during backwash	
Backwash Conditions	Backwash initiation (headloss, turbidity/particle counts, time)	
	Sequence (surface wash, air scour, flow ramping, filter-to-waste)	
	Duration (minutes)	
	Introduction of wash water (via pump, head tank, distribution system pressure)	
	Backwash rate (gpm/ft2)	
	Bed expansion (percent)	
	Coagulant or polymer added to wash water	
	Filter rested prior to return to service	
Other Considerations		

APPENDIX #5

Quality Assurance/Quality Control Plan (QA/QC Plan)

The Division recommends that all public water systems create and implement a QA/QC Plan to assist with operating under the IESWTR, and its companion, the Stage 1 D/DBP Rule. Utilities may find reference information for designing QA/QC Plans in various EPA documents, which are intended to serve other Rules. One such document is the Manual for the Certification of Laboratories Analyzing Drinking Water, EPA 815-B-97-001. While this resource is well beyond the scope of the analytical work required for IESWTR compliance, it addresses many of the same issues.

Most references on the subject suggest that QA/QC Plans be based upon "Data Quality Objectives" or "Quality Assurance Objectives". These terms refer to the philosophy behind how the data created under the Plan will be used, and what degree of quality supports or justifies these uses. Several components of a good QA/QC Plan should be incorporated in each systems Monitoring Plan (see Monitoring Plan Guidance). It is recommended that the QA/QC Plan include at least the following:

- ✓ State the Data Quality Objectives. For example, if a system also wishes to use its compliance data to also justify operational or capital improvements, etc., it may wish to have additional quality checks in place.
- ✓ Identify what parties are responsible for actions relative to the Rule, such as: who collects the data/information that will appear on compliance reports, who makes sure that data reflects reality, who is responsible for corrective actions (should they be necessary), who writes the compliance report, etc?
- ✓ Identify what procedures are followed to accomplish each of the above, such as: how, when, and where are water quality samples collected, how are analyses performed, how is equipment calibrated, what checks are in place to assure the results reflect reality, what corrective actions may be taken to maintain the quality of the results, etc? The Division strongly recommends that systems create Standard Operating Procedures (SOPs) which can help keep these operations consistent.
- ✓ Identify: what records are kept to document the results of the checks, how those records are used, how long those records are kept, etc.

A cornerstone of QA/QC Plans for the IESWTR is a SOP for instrument calibration.

The following is a <u>recommended</u> practice for all public water systems. A public water supplier may submit an alternative practice provided it is justified to the Division.

Instrument Calibration SOP

Terms

1. **Instrument calibration**: A procedure for relating instrument output to a known value. This generally requires making an instrument setting or adjustment.
2. **Calibration verification** (check): A procedure for determining if an instrument is still in calibration. There are generally specified tolerances which establish if it is or isn't. If the instrument is no longer in calibration, the appropriate corrective action is to recalibrate it.
3. **Calibration standard**: A solution of a known value. The standard may be used to set a calibration or to verify a calibration.
   - ✓ **Primary standard**: A solution, of indisputable quality, which is used solely for calibration. These are expensive and should be handled with care. *Standard Methods* describes a Primary Standard as one which is prepared from traceable raw materials, using precise methodologies and under controlled environmental conditions.
   - ✓ **Secondary standard**: A solution of verifiable quality which is used to check a calibration. These are generally cheaper and are used most frequently. *Standard Methods* defines a Secondary Standard as one that a manufacturer (or an independent testing organization) has certified to give instrument calibration results equivalent (within certain limits) to results obtained when an instrument is calibrated with a primary standard.
4. **Calibration range**: The range of instrument responses for which calibration is applicable, often referred to as "linearity". For instruments with a large linear range, a single calibration set point may be OK. The range can be verified by analyzing check standards at each end of the range to see if the results are within manufacturer's specifications. Often, the effective range may be extended by calibrating at multiple set points. This procedure is called running a "calibration curve".

Calibration & Calibration Verification

Determine the appropriate technical requirements for calibration based on the following

- Manufacturer
- Model name and/or number
- Parameters to be calibrated
- Range to be calibrated
- Acceptance criteria
- Mandatory calibration procedures or standards
- Required calibration program

1. Flow measuring devices and rate-of-flow controllers should be calibrated at least once every 12 months.
2. Analytical equipment used for compliance testing shall be properly calibrated according to the manufacturers specifications.

a. pH meters:
   i. Benchtop pH meters should be calibrated ***once each day***.
   ii. The calibration of benchtop pH meters shall be checked/verified with at least one fresh aliquot of pH 7.00 buffer each time a series of samples is run (normal procedure would be a re-check after each 10 samples in a series were run, with a recalibration called for if the pH 7.00 buffer was out of range), and, if necessary recalibrated according to manufacturers specifications, using a minimum 2-point calibration with buffers selected to bracket the expected concentration of the samples (normally 7.00 and 10.00 buffers). Note:(normal variation allowed is ± 0.02 variation from the pH 7.00 standard), however for purposes of in-plant meters, ± 0.05 variation is acceptable).
   iii. On-line pH meters should be calibrated ***on a monthly basis***.

b. Turbidimeters:
   i Benchtop turbidimeters –
      1. Instrument calibration should be verified on a daily basis. Calibration verification can be completed using primary or secondary standards. If verification indicates significant deviation from the standard (true) value (greater than ±10%), thoroughly clean and recalibrate the instrument using a primary standard. If problems persist the manufacturer should be contacted. Regardless of calibration verification results, turbidimeters should be thoroughly cleaned and calibrated with primary standards ***on a quarterly basis***.
      2. After calibration, performance of the turbidimeter should be verified with a secondary standard. If the instrument has internal electronic diagnostics designed to assist in determining proper calibration, the operator should use these tools to verify proper calibration and operation. Each time the turbidimeters are calibrated with primary standards, the secondary standards shall be re-standardized.

   ii On-line turbidimeters should be calibrated with primary standards once every 90 days.
   iii CFE On-line turbidimeters should be checked every day with a secondary standard or the manufacturer's proprietary calibration confirmation device, or once every week provided that the calibration is verified daily with a properly calibrated benchtop turbidimeter.
   iv IFE On-line turbidimeters should be checked every 7 days with a secondary standard or the manufacturer's proprietary calibration confirmation device, or once every month provided that the calibration is verified weekly with a properly calibrated benchtop turbidimeter.

v On-line turbidimeter monitoring may be substituted for grab sample monitoring provided that the PWS validate the continuous measurement for accuracy on a regular basis. Regular validation frequency means:

a) Daily for combined filter effluent measurement.

b) More frequently where water quality conditions or equipment problems deem it necessary.

General guidelines for turbidity calibration frequency

Type of turbidimeter	Recommended frequency of calibration with a primary standard.	Recommended frequency of verification with either a primary or secondary standard.
Benchtop	Quarterly	Daily
On-line CFE	Quarterly	Daily
On-line IFE	Quarterly	Weekly

Determine the appropriate technical requirements for calibration based on the following

- Manufacturer
- Model name and/or number
- Parameters to be calibrated
- Range to be calibrated
- Acceptance criteria
- Mandatory calibration procedures or standards
- Required calibration program

c. **Disinfectant residual analyzers** shall be properly calibrated.

i. Manual disinfectant residual analyzers accuracy should be verified ***once every 30*** days using chlorine solutions of known concentrations.

ii. Continuous disinfectant residual analyzers should be calibrated ***once every 90 days*** using chlorine solutions of known concentrations.

iii. Continuous disinfectant residual analyzer calibration should be checked ***once each month*** with a chlorine solution of known concentration or by comparing the results from the on-line analyzer with the result of approved benchtop amperometric, spectrophotometric, or titration method.

More on Turbidity Standards

There are a variety of standards on the market today that are used to calibrate turbidimeters. They are most often characterized as Primary, Secondary, or "Alternative" standards. Standard Methods describes Primary Standards as a standard

which is prepared by the user from traceable raw materials, using precise methodologies and under controlled environmental conditions. (Standard Methods, 1995) Standard Methods defines Secondary Standards as those standards a manufacturer (or an independent testing organization) has certified to give instrument calibration results equivalent (within certain limits) to results obtained when an instrument is calibrated with a primary standard.

Standard Methods and EPA differ in their definitions of each of these standards. EPA recognizes the following three Standards for approved use in the calibration of turbidimeters.

- FORMAZIN (user prepared and commercially produced)
- AMCO-AEPA-1® MICROSPHERES
- STABLCAL® (STABILIZED FORMAZIN)

Users need to realize that some instruments have been designed and calibrated on specific primary standard(s) listed above. For optimal results, users should contact the manufacturer of the instrument to determine the recommended primary standard to be used for calibration.

Additionally, EPA recognizes Secondary Standards for use in monitoring the day-to-day accuracy of turbidimeters by checking the calibration. This check is used to determine if calibration with a Primary Standard is necessary. Secondary Standards are used to check whether an instrument produces measurements within acceptable limits around a nominal value (typically 10%). Examples of *SECONDARY STANDARDS* include:

- GELEX®
- GLASS/CERAMIC CUBES
- MANUFACTURER PROVIDED INSTRUMENT SPECIFIC SECONDARY STANDARDS

The need to reconcile the definitions and differences between Primary and Secondary Standards will be a continuing issue. It has been recognized that the standards need to be unbiased, easy to use, safe, available for a range of turbidities, and reproducible. Future efforts of the Agency, in concert with other organizations and manufacturers, will focus on ensuring the most appropriate, variation-free, and technologically feasible standards are available and used for calibration of turbidimeters.

More on Turbidity Calibration

All reputable turbidimeters have been factory-calibrated before leaving the manufacturer. Like most instrumentation, turbidimeters tend to lose accuracy over time due to a variety of factors, making periodic calibration very important to maintain accurate measurements. The most important point to remember is:

Calibration shall always be conducted according to manufacturer instructions.

Manufacturers differ in the steps to conduct a calibration, but the following points are applicable to all calibrations.

- Standards should be checked to ensure they have not expired. Never pour a standard back into its original container.
- Care should be taken when preparing Formazin. If a spill occurs, clean up immediately according to the Material Safety Data Sheets (MSDSs) provided with your chemicals. Make sure to inspect the tube/cuvette for scratches and chips prior to pouring the solution in.
- Check to make sure the tube/cuvette is lined up properly according to the indexing. Be sure not to scratch the tube when inserting, and ensure that the tube/cuvette is free of dust, smudges, and scratches.
- Make sure that standards are at room temperature to keep the tube/cuvette from developing condensation on its surfaces.
- When obtaining the reading, write the value legibly onto a form similar to the one found in Figure 3-1. Make sure to record the date of the calibration, the individual conducting the calibration, the value, and any peculiar situations or deviations from normal calibration procedures (e.g., switch to a new lot of Formazin, switch in standards, use of a new tube/cuvette, etc.) These measurements will allow for an understanding of whether the performance of a turbidimeter is in question. For example, if for 6 months a turbidimeter reads approximately 20.152 when calibrated using polystyrene beads and one morning it reads 25.768, this could be an indication that the bulb in the turbidimeter has a problem. Conversely, if the standard in use was switched that morning, the resulting change might be due to change in standards.
- Conduct the calibration the same way each time. Variations in how the calibration is conducted could yield inaccurate measurements.
- It is extremely important that individuals who conduct the calibration have been trained to do so. Systems should consider creating Standard Operating Procedures to be read, learned, posted next to the turbidimeter and followed by operators at the plant.
- Use the guidelines above to select a frequency for checking instrument calibration with secondary standards and for full re-calibration of instrument with primary standards.
- Establish the acceptable deviation from the primary standard during secondary verifications. Readings in excess of the deviation should trigger immediate re-calibration of the instrument. ("10% is recommended by EPA)
- Choose a time of day when full attention can be devoted to the calibration. Calibration at the end of a shift or right before a break can often lead to mistakes and sources of error. A calibration time should be established when operators are fully alert and focused on completing the task.
- Identify and schedule in advance on the plant calendar or work scheduling chart the dates for full turbidimeter calibration

- Make preparations and maintain adequate supplies to prevent delays in the calibration schedule. It is important to keep an appropriate stock of standards. Due to the limited shelf-life of various standards, the age of the stored standards should be monitored so they can be replaced or reformulated as needed.
- Assign calibration duties to a select group of individuals, and make it one of their standard activities. Train all appropriate individuals/operators in conducting a calibration in the event that one of the regular individuals is not available.
- Confirm the performance of continuous in the 0-1 or 0-2 NTU range. After the bench instrument's calibration has been verified, analyze a split sample finished water sample using the bench and continuous turbidimeters. If the bench model reading is 0.5 NTU or greater and the continuous meter reading varies by more than +/- 10% of the bench model, calibration of the continuous meter is necessary. In the case where the bench model reading is less than 0.5 NTU, and the continuous meter reading varies by more than +/- 0.05 NTU, calibration of the continuous meter is necessary. NOTE: There are situations where color in the finished water will read a lower turbidity in the continuous meter than the bench top meter. This is typically attributed to the color correction software in the bench top meter. In these situations, where both meters have been calibrated in accordance to manufacturers recommended procedures, the bench top reading should be considered the more accurate value.

Calibration Record

(insert name here) CALIBRATION RECORD

Month_____

Year _____

Date	Initials	Result	Standard (true value)	Comments

Calibration records for laboratory and on-line instruments and equipment shall be retained at the site for review by the State during sanitary surveys. The records and logs should include instrument, date, time, calibration values, re-check values and operator's name, signature or initials.