

The Groundwater Rule for Public Water Systems

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Introduction

Course Materials

In this student workbook you can follow along today and take notes as necessary. It will also make a good reference for you later on.

- CWS Demonstration of 4-Log Treatment of Viruses (and instructions)
- 4-Log Spreadsheet and paper worksheet
- Tier 1 Public Notice Templates
- SDWA-1 Form



Introduction Objectives:

After completing this introduction, you will be able to:

- Describe the history of the Groundwater Rule.
- Identify which water systems are affected by the GWR.
- List the general requirements of the rule.

Groundwater Rule History and Justification:

Groundwater has been traditionally regarded to be safer than surface water due to the **natural filtering** that occurs as groundwater travels through the various materials in the ground.

Groundwater may be susceptible to viral contamination despite this natural filtering.

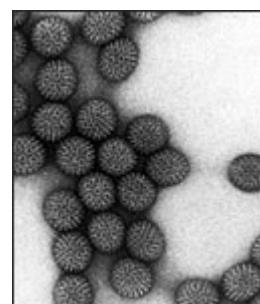
- Karst (limestone) aquifers are vulnerable to contamination due to their geology.
- High densities of livestock farming operations or on-lot sewage treatment systems can overwhelm non-karst aquifers.
- Poor well construction or maintenance.

Figure I-1: Swallow hole draining Conewego Creek, Adams County.



Fecally contaminated groundwater often contains viral pathogens including enteric viruses such as:

- Echovirus
- Coxsackie viruses
- Hepatitis A and E
- Rotavirus
- Noroviruses



Rotavirus (CDC)

Vulnerable groundwater sources have also been found to contain enteric bacterial pathogens such as:

- *E. coli*
- *Salmonella* spp.
- *Shigella* spp.
- *Vibrio cholera*.



Shigella sp. (CDC)

Between 1991 and 2000 groundwater source contamination and inadequate treatment accounted for 51% of all waterborne disease outbreaks in the United States (US Centers for Disease Control and Prevention).

Notable example (Canada):

Walkerton, Ontario groundwater fecal contamination event:

- Hundreds of people sickened
- At least 7 killed



Smaller outbreaks are even more threatening:

- Can go undetected
- Often wrongly attributed to “stomach flus” or foodborne illnesses

Previously, community groundwater systems in Pennsylvania have not been regulated with respect to source water viral contamination. Instead, they must:

- Provide continuous disinfection.
- Ensure a detectable disinfectant residual throughout the distribution system.

Some systems can potentially satisfy that requirement with entry point disinfectant residuals that are too low to effectively inactivate viruses.

To alleviate this risk to public health, EPA developed new regulations in 2006 focused on systems that use groundwater sources. DEP was required to update the State regulations in Chapter 109 (Safe Drinking Water Regulations) to be at least as stringent as the Federal Rule.

DEP's Groundwater Rule:

1. Defines adequate **treatment technique** requirements for the inactivation of viruses.
2. Creates guidelines including **corrective action alternatives** for systems to respond in a timely and appropriate manner to significant deficiencies identified by the Department during inspections.

3. Includes additional requirements for **Public Notification**.

Groundwater Rule Overview

Who is affected by the Groundwater Rule?

The Groundwater Rule applies to all public water systems that use groundwater sources. This includes:

1. Systems that exclusively use one or more groundwater sources.
2. Systems that supplement surface water sources with groundwater downstream of surface water treatment.
3. Systems that seasonally or intermittently use groundwater sources.
4. Systems that purchase raw groundwater from another system.

Systems that combine groundwater with surface water or GUDI and treat the combined flow under the surface water treatment requirements are **exempt** from the Groundwater Rule Requirements.

General Requirements

PA's Groundwater Rule essentially has 5 components:

- Triggered Monitoring
- Assessment Monitoring
- Treatment Technique Requirements
- Compliance Monitoring
- Sanitary Surveys

Triggered Monitoring

- Triggered monitoring is raw source water sampling that is tied to the results of distribution samples collected under the Total Coliform Rule. See Lesson 1 for full explanation.
- Community water systems must comply with the triggered monitoring requirements until they begin DEP-approved 4-log treatment of viruses.

Assessment Monitoring

Assessment monitoring only applies to certain at-risk **non-community** water systems (NCWS).

- 12 months of source water *E. coli* monitoring for vulnerable NCWSs.

Treatment Technique Requirements

The groundwater rule establishes treatment technique requirements for community water systems designed to ensure 4-log removal and/or inactivation of viruses (4-log treatment). All community water systems must:

- Maintain a certain level of treatment of viruses at each entry point. This level of treatment is called 4-log treatment and it is designed to ensure 4-log removal and/or inactivation of viruses. See Lesson 2 for full explanation.
- Demonstrate to the DEP that they are providing 4-log treatment for each of their groundwater sources.

Compliance Monitoring

- Monitoring of the treatment processes used to achieve 4-log treatment of viruses.
- Systems are no longer subject to Triggered Monitoring once they begin Compliance Monitoring.

Sanitary Surveys

- Sanitary surveys are full inspections conducted by DEP.
- The “new” EPA requirements have been long standard practice in PA.
 - 8 essential components of sanitary surveys:
 1. source
 2. treatment
 3. distribution system
 4. finished water storage
 5. pumps, pump facilities, and controls
 6. monitoring, reporting, and data verification
 7. System management and operation
 8. Operator compliance with Department requirements
 - Minimum inspection frequency of every 3 years

Significant Deficiencies

- Defects in design, operation, or maintenance, or a failure or malfunction of the sources, treatment, storage, or distribution system that the State determines to be causing, or has the potential for causing, the introduction of contamination into the water delivered to consumers.
- Similar to what the Department has previously called:
 - imminent health violations
 - priority violations

The Groundwater Rule establishes specific actions and timelines that a system must take if any significant deficiencies are identified during a DEP inspection. If the Department identifies a significant deficiency at your water system, the required actions and due dates will be clearly explained to you.

Today's Agenda

For the rest of this course, we will cover the following lessons:

Lesson 1: Source Water Monitoring Requirements

Lesson 2: GWR Treatment Technique Requirements

Lesson 3: Compliance Monitoring

Lesson 4: Demonstrating 4-Log Treatment

Summary:



Key Points:

To summarize, the key points of this chapter are:

- Groundwater sources are susceptible to contamination when they are located in karst areas or in the vicinity of high concentrations of livestock or on-lot wastewater treatment systems.
- The purpose of the Groundwater Rule is to reduce public exposure to groundwater viral contamination, particularly in at-risk areas.
- PA's Groundwater Rule consists of:
 - Triggered Monitoring
 - Assessment Monitoring
 - Treatment Techniques
 - Compliance Monitoring
 - Sanitary Surveys

Lesson 1: **Source Water Monitoring Requirements**



Objectives:

After completing this lesson, you will be able to:

- Describe the “Triggered Monitoring” requirements
- Identify proper source water sampling locations
- List the proper responses to a distribution TCR+
- List the proper responses to a source water *E. coli* +
- Describe the “Assessment Monitoring” requirements
- Describe how to avoid triggered monitoring requirements

Triggered Monitoring

Triggered Monitoring is a Federal requirement and went into effect Dec. 1, 2009.

The purpose of triggered monitoring is to rule out source water contamination as a potential cause of the distribution contamination that was detected by distribution coliform samples. If source water fecal contamination is detected, it must be addressed by a corrective action.

What are Triggered Monitoring Samples?

- ▶ Source water samples that are collected in response to any Total Coliform Rule (TCR) distribution sample that tests positive for total coliform.
- ▶ Tested for the presence of *E. coli* as an indicator of fecal contamination.

Question: The Groundwater Rule is targeting viral pathogens. Why do you think we test source water sample for *E. coli* and not viruses?

Responding to a TCR Positive

(Triggered Monitoring is outlined in the flow chart in **Appendix A**, beginning on page A-3)

- ▶ 24 hours to collect a water sample from each source that is not provided with 4-log treatment
 - Each sample must be collected upstream of all treatment (Figure 2-1).
 - Be sure proper sampling taps are installed prior to the effective date of the rule.

All of the collected samples must be tested for the presence of *E. coli* according to EPA approved methods. A sample is not considered to be a raw or source water sample if it contains any disinfectant residual at the time of sample collection.

Figure 1-1: Proper sampling location for a groundwater system served by a single well.

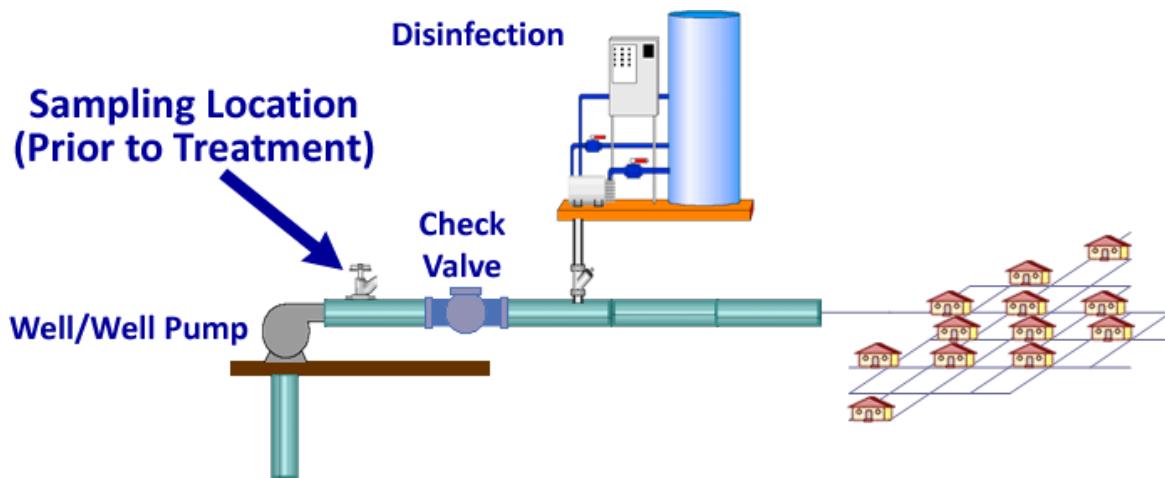
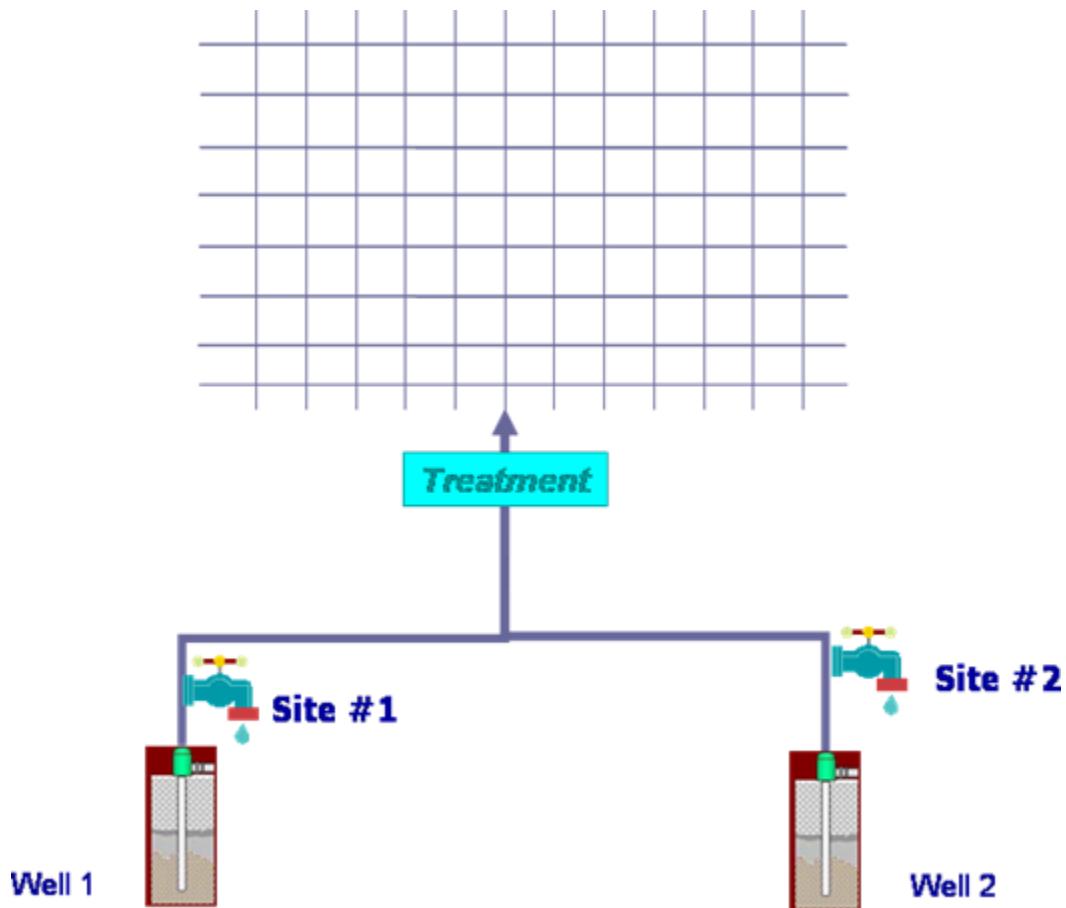


Figure 1-2: This system has two wells that are combined prior to treatment.



Question - True or False: If the system in Figure 1-2 alternates their wells, only pumping one well at a time, they only have to sample the well that was pumping at the time the positive TCR sample was collected.

***E. coli* Positive Triggered Source Water Samples**

- ▶ Triggered water samples are analyzed for the presence of *E. coli* using an EPA approved analytical method.
- ▶ If one or more of the triggered source water samples tests positive for *E. coli*, The system must:
 - Notify DEP within 1 hour and issue Tier 1 PN.
 - Plan for issuing the additional Special Notice.

DEP may ask the system to collect 5 follow-up source water samples from the same source where *E. coli* was detected.

If any of these follow-up samples test positive for *E. coli*, then the system must perform a corrective action. In all likelihood, though, DEP will require the corrective action following the initial *E. coli* positive source water sample.

So the three actions that a groundwater system must take in response to source water fecal contamination indicated by *E. coli* are:

- 1) Issue Tier 1 Public Notice.
- 2) perform a **corrective action**.
- 3) Issue a “**Special Notice**” to the consumers.

1) Public Notification for Source Water *E. coli* contamination

Any source water sample that tests positive for the presence of *E. coli* automatically requires that a Tier 1 public notification be issued to notify consumers that their water supply is fecally contaminated.

- ▶ Notify DEP within 1 hour of learning of the positive sample result.
- ▶ Issue Tier 1 Public Notice within 24 hours.
- ▶ Sensitive sub populations have priority (hospitals, assisted living facilities, etc.).
- ▶ Certify to DEP that PN requirements have been met.

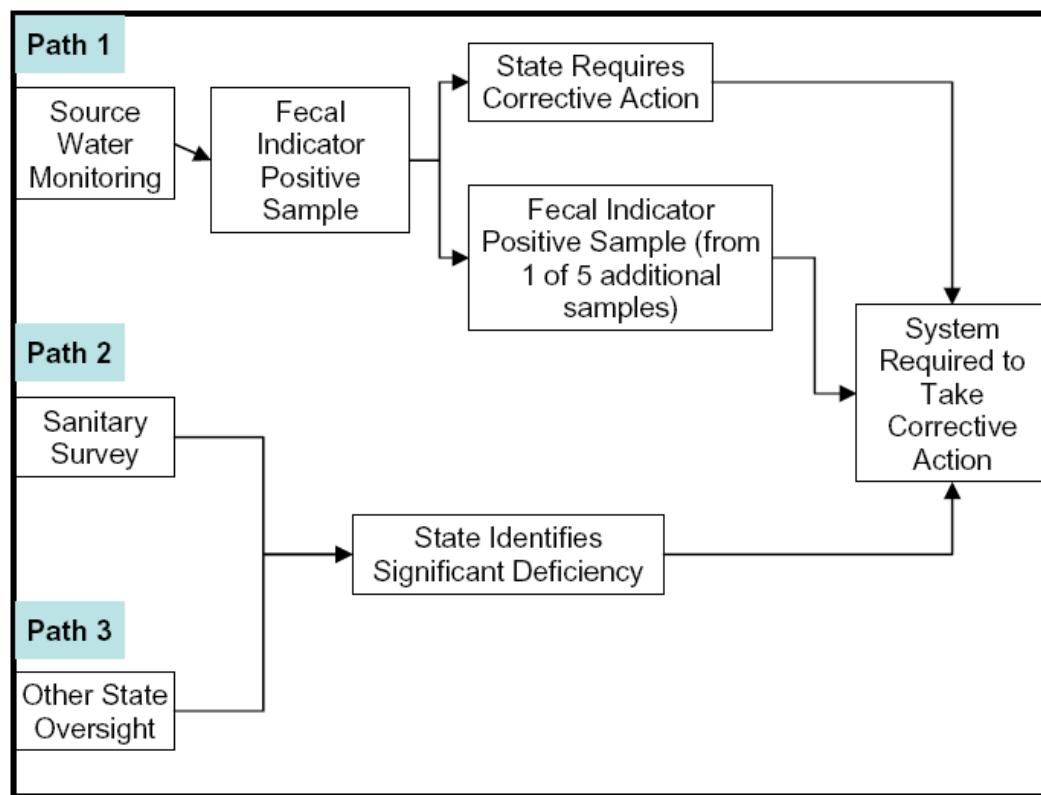
DEP has a new draft template for Tier 1 public notice related to *E. coli* positive source water samples (Appendix B).

2) Corrective Actions

Corrective actions are actions taken by a water supplier at DEP's direction to fix a problem within their system. DEP can require a community groundwater system to perform a corrective action in response to:

- a) Any source water sample that tests positive for the presence of *E. coli*.
- b) A significant deficiency that is identified as a result of a sanitary survey or other state oversight.

Figure 1-3: Overview of Corrective Action Process



Here, we're concerned with Path 1: Systems performing a corrective action to address fecal contamination must do one of the following:

- A. Abandon the contaminated water source.

- ▶ Must have other available sources to avoid disrupting service
- B. Eliminate the source of the contamination.
 - ▶ Difficult for fecally contaminated aquifers
- C. Permanently provide DEP-approved 4-log treatment of viruses.
 - ▶ Likely the best option for community water systems

Compliance Tip:

Remember, once 4-log treatment has been approved by DEP and the system begins compliance monitoring, groundwater systems are no longer subject to any of the requirements under triggered monitoring.

Deadlines for corrective action:

- ▶ A system must consult with DEP within **30 days** of notification of an *E. coli* positive or significant deficiency.
- ▶ Corrective action should be completed within **120 days** of being notified of the significant deficiency.

Corrective Action Plans:

Systems that can't meet the 120-day deadline must have a formal DEP-approved **corrective action plan** which will set milestones as well as establishing a final completion date.

Corrective action plans are developed as a cooperative effort between the water system and DEP staff.

3) Special Notice

In addition to the regular public notification requirements, community water systems that have an *E. coli* positive triggered source water sample or have an uncorrected significant deficiency must include a special notice in their consumer confidence report (CCR).

The special notice must:

- ▶ describe the deficiency or contamination

- ▶ discuss the plan for correcting the situation
- ▶ relay any potential health effects

To help systems that must include a special notice in their CCR, the *Consumer Confidence Report Handbook* has been updated to provide guidance on developing Special Notices for the Groundwater Rule.

Consecutive Systems

For systems that obtain some or all of their water from another public water system using groundwater, an additional notification requirement applies when the system **supplying** the water is **not** providing DEP-approved 4-log treatment of viruses.

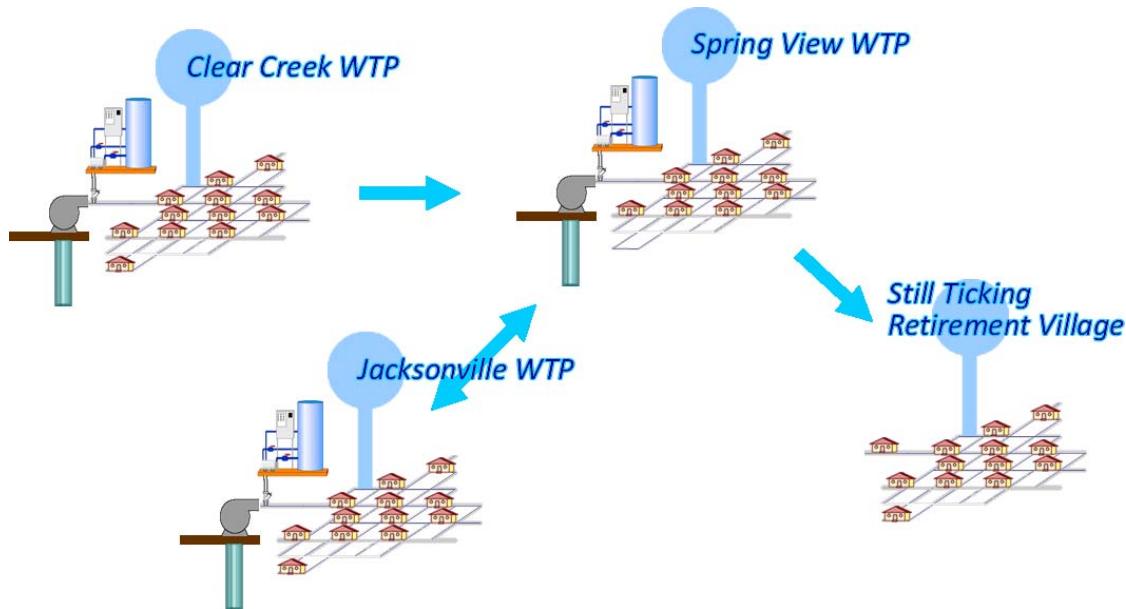
Purchasing systems:

- ▶ should be kept aware of whether the system supplying has gotten approval for 4-log treatment
- ▶ must notify the supplying system within 24 hours of receiving notice of a routine distribution total coliform testing positive
- ▶ Must issue Tier 1 PN to its own customers if supplier finds *E. coli* in the source

Supplying systems:

- ▶ Conduct triggered monitoring upon notice from a purchasing system of a TCR positive.
 - Tier 1 PN if *E. coli* is detected

Figure 1-4: Possible Consecutive Systems Scenario (none are providing 4-log treatment, so they all fall under triggered monitoring):



If Spring View Water Treatment Plant finds total coliform in its distribution system, who must they notify and when?

What actions must each system take in response to Spring View's TCR+?

What happens if Jacksonville then finds *E. coli* in their source water?

Avoiding Triggered Monitoring Requirements:

Systems will not have to take any action under the triggered monitoring requirements if:

- ▶ No TCR distribution samples test positive for total coliform during the interim period.
or
- ▶ The system successfully demonstrated 4-log treatment to DEP and began compliance monitoring by December 1st, 2009.

Note: The triggered monitoring requirements also apply to NCWSs using groundwater sources.

Assessment Monitoring

Assessment monitoring applies only to non-community water systems. This monitoring is a tool for identifying at-risk groundwater sources that are vulnerable to fecal contamination.

- Source aquifer geology
- Density of nearby on-lot wastewater systems or agricultural fecal sources
- System bacteriological history

Noncommunity systems identified for assessment monitoring will be required to collect 12 monthly source water samples:

- Analyzed for the presence of ***E. coli***

If *E. coli* is detected in any sample, assessment monitoring is stopped and the positive sample is handled much like a positive triggered source water sample:

- Tier 1 PN, including 1-hour notification to DEP
- Corrective Action

There is no set timeline for assessment monitoring to be implemented statewide. DEP Regional Offices will identify at-risk systems for assessment monitoring as their priorities allow.

Representative Sampling

Wells Representing Other Wells

Systems utilizing multiple wells for a single entry point may submit a source water sampling plan to obtain approval from DEP to sample a well or wells which are representative of all the wells supplying that entry point.

- ▶ Reduces the number of samples required during source water sampling for these systems.
- ▶ Must obtain DEP approval of sampling plan **in advance** of a TCR positive.

The burden of proof is on the system to show that a well or wells are representative other wells. The system must:

- ▶ Submit a sampling plan indicating which well or wells will be used as the representative sources.
- ▶ Submit aquifer test data describing drawdown in adjacent wells.
- ▶ Show that the wells are of similar construction, age, and yield.
- ▶ Show proximity and similar well-depth.
- ▶ Demonstrate that the multiple wells are drawing from the same hydrogeologic setting (recharge area).
- ▶ Present sampling results that demonstrate comparable water quality characteristics.

Consider NO₃-N concentration

- ▶ High nitrates may indicate fecal contamination (not be eligible for representative sampling)

The sampling plan and/or the supporting evidence must be submitted by a **professional geologist**.

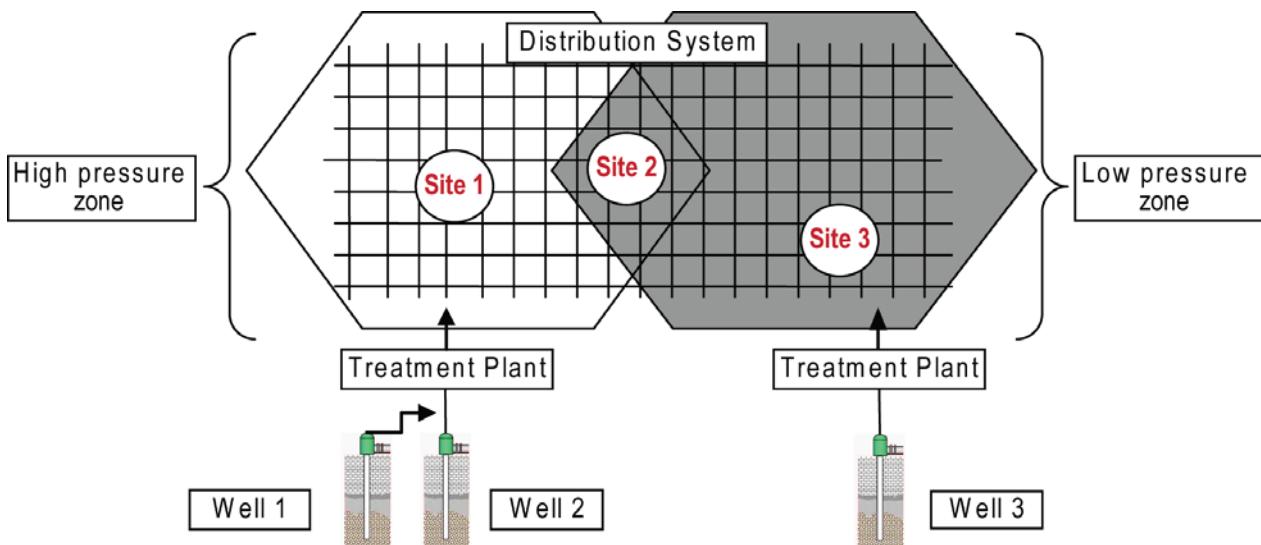
Wells Representing Zones in the Distribution System

Systems with multiple wells supplying separate distribution systems which there are no interconnections may also submit a source water sampling plan for the reduction of triggered source water samples.

- ▶ The system must submit all information necessary for the Department to confirm there are no interconnections between distribution systems.
- ▶ The system must identify which source(s) will be sampled for each distribution system Total Coliform Rule (TCR) sampling location.
- ▶ Pressure zones
 - Pressure zones are dynamic – demonstrate which sources supply which distribution sampling locations
 - Source may be dependent upon demand
 - all possible sources must be sampled
 - Hydraulic modeling
 - DS map showing: pressure zones, TCR monitoring locations, and sources
 - **Pressure zone study must be submitted by a PE**

All requests for routine sampling must be made and approved prior to the need to conduct source water monitoring (i.e., before the system gets any TCR positive results).

Figure 1-5: Distribution system pressure zones, from Ground Water Rule Triggered and Representative Monitoring: A Quick Reference Guide - EPA



Representative Sampling References**Triggered and Representative Source Water Monitoring Guidance Manual:**

- Appendix A & B – templates for representative sampling plans

Ground Water Rule Triggered and Representative Monitoring: A Quick Reference Guide (“Fact Sheet”)

Both, and others, are available at:

<http://water.epa.gov/lawsregs/rulesregs/sdwa/gwr/compliancehelp.cfm>

Summary:**Key Points:**

To summarize, the key points of this chapter are:

- Distribution TCR+ triggers the need for source water *E. coli* samples
- Source water *E. coli* + requires Tier 1 PN and Corrective Action
- Assessment Monitoring applies only to NCWS
- Assessment Monitoring is 12 months of source water monitoring for *E. coli*
 - Seasonal: 12 samples evenly distributed over operational period
- Representative sampling plans MUST be approved prior to the need for sampling
- **Demonstrating 4-log treatment eliminates the Triggered Monitoring and Representative Sampling requirements for your system**

Lesson 2: GWR Treatment Technique Requirements



Objectives:

After completing this lesson, you will be able to:

- Define treatment technique.
- Describe the Groundwater Rule treatment techniques and deadlines.
- Define 4-log treatment.
- Explain why community water systems are required to provide 4-log treatment of viruses.
- Discuss the justification for the default minimum residual of 0.40 mg/L free chlorine at the entry point.

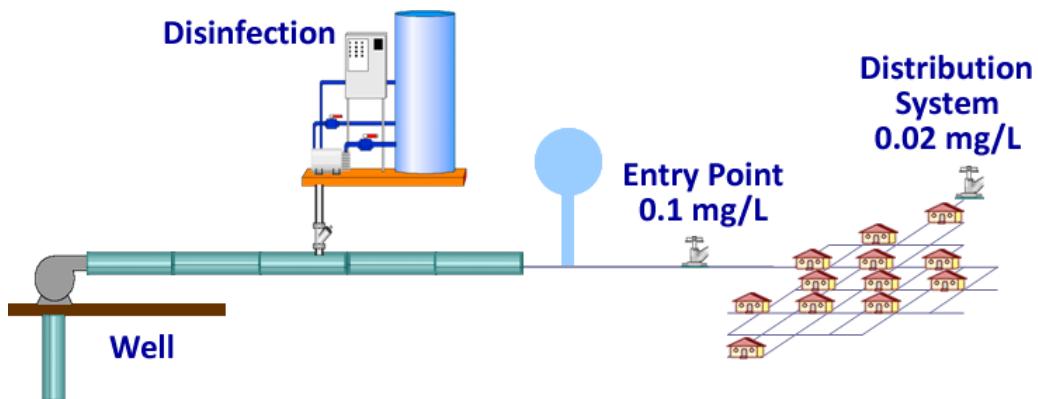
Treatment Technique Requirements

Previous PA treatment regulations for community groundwater systems:

- Continuous disinfection
- Maintain a **measureable** residual in the **distribution system**

There were no previous requirements for groundwater systems to maintain any minimum measure of disinfectant effectiveness at the entry point.

Figure 2-1: One example of a system satisfying the current requirement with a disinfectant residual that is likely too low to inactivate viruses.



Now, under the newly adopted Groundwater Rule provisions, all **community water systems** must:

- Maintain 0.40 mg/L Minimum Entry Point Free Chlorine Residual (Note: this minimum residual may change based on the system's 4-log treatment demonstration).
- Provide a minimum of 4-Log treatment of viruses, phased in over three years based on system size.

Noncommunity water systems must:

- Follow Triggered Monitoring Requirements.
- 4-Log Treatment only required as a corrective action if *E. coli* is found in their source water.

4-Log Treatment of Viruses

The PA Groundwater Rule requires that all community systems will be **required to maintain at least 4-log treatment of viruses** for each entry point served by groundwater sources.

What is 4-Log Treatment?

4-log treatment is a measure of total treatment effectiveness, meaning that raw water has been treated, either by physical or chemical means, or both, so that 4-logs of the original targeted contaminant or organism have been removed or inactivated. “4-log” refers to the logarithmic scale and simply means **99.99%**.

- ▶ Removal = Filtration
- ▶ Inactivation = Disinfection

Log Removal + Log Inactivation = Log Treatment

The Groundwater Rule requirement is **4-log treatment of viruses**. So, for community groundwater systems, the total treatment process must effectively remove and/or inactivate 99.99% of the raw water virus loading.

To ensure 4-log treatment of viruses, the Groundwater Rule establishes treatment techniques that are known to achieve that result.

Treatment Techniques

A **treatment technique** is an established **operating practice** that, when executed properly, has been demonstrated in scientific studies to achieve a desired result that cannot be easily measured directly.

We cannot directly measure the removal/inactivation of viruses but we know from various studies how chlorine disinfection works to deactivate viruses. From this, we can establish minimum residuals and contact times that will ensure 4-log treatment under specific water quality conditions.

For most systems, 4-log is achieved with:

- 0.40 mg/L free chlorine
- 20 minutes effective contact time

The deadlines for providing 4-log treatment of viruses are phased in based on population served and is planned to occur in the period from 2010 to 2013:

Table 2-1: Deadlines* for submitting demonstrations of 4-log treatment of viruses to DEP and for having the described treatment in place.

| Population Served | 4-Log Treatment Submission Deadline | Begin Approved 4-Log Treatment |
|-------------------|-------------------------------------|--------------------------------|
| >500 | October 1, 2010 | April 1, 2011 |
| 100-500 | October 1, 2011 | April 1, 2012 |
| <100 | October 1, 2012 | April 1, 2013 |

*All new groundwater sources at community water systems are required to have approved 4-log treatment in order to be permitted.

In the meantime, all public groundwater systems will need to comply with triggered monitoring requirements until you receive DEP notification that you have successfully demonstrated at least 4-log treatment. At that time, you will be directed to begin compliance monitoring.

4-log for Non-Community Water Systems:

- Not automatically required for NCWS
 - NCWS may provide 4-log as a corrective action to source water *E. coli* contamination (permit req'd)
 - Must meet the Compliance Monitoring requirements (next lesson)
- NCWS can later abandon contaminated source
 - Assessment monitoring to confirm clean source
 - Rescind 4-log permit and return to triggered monitoring

Chlorine Disinfection

With the publication of the Groundwater Rule in December 2009, all community groundwater systems are required to maintain a default entry point free chlorine minimum residual of **0.40 mg/L** or its equivalent. This minimum residual may change based on the system's 4-log treatment demonstration.

The default residual will:

- **Protect public health** during the interim period between the effective date of the rule and the beginning of DEP-approved 4-log treatment of viruses.
- 0.40 mg/L free Cl will achieve 4-log treatment for most systems.



Other systems may need to provide a higher residual in order to achieve 4-log. Systems with the following may need to use a higher residual:

- Limited storage capacity (<20 minutes effective contact time)

- Cold winter water temperatures (<5°C)
- High pH (>9)

Systems that can't achieve 4-log treatment with a reasonable chlorine residual will have to explore other options like adding storage capacity or supplemental treatment.

CT Calculations

In order to determine whether the default 0.40 mg/L minimum residual will be enough for your system, you will need to be able to calculate CT values.

CT is a measure of the disinfectant concentration multiplied by the time the disinfectant is in contact with the water. The value is used in conjunction with "CT Tables" to determine the effectiveness of the disinfection that is achieved in your treatment process.

Example: DEP's calculation for the 0.40 mg/L default residual

The default residual of 0.40 mg/L was determined using the accepted calculation for CT:

$$\text{CT (mg*min/L)} = \text{Chlorine Residual (mg/L)} \times \text{Theoretical Contact Time (min)} \times \text{Baffling Factor}$$

We can rearrange the equation so that the Chlorine Residual is alone on one side, then we can fill in the other variables and solve for the residual that will provide 4-log treatment:

$$\text{Chlorine Residual (mg/L)} = \frac{\text{CT (min*mg/L)}}{\text{Contact Time (min)} * \text{Baffling Factor}}$$

Now let's fill in the other variables:

Conservative assumptions of groundwater characteristics in Pennsylvania:

- Temperature no less than 5°C
- pH less than 9

These assumptions suggest that a CT value of **8 mg*min /L** is required to achieve 4-log inactivation of viruses (Table 1-1, EPA Disinfection Profiling and Benchmarking Guidance).

Table 2-2: CT Values (mg*min/L) for Inactivation of Viruses by Free Chlorine, pH 6.0-9.0

| Inactivation (log) | Temperature (°C) | | | | | | | | | | | | | |
|--------------------|------------------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 0.5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 2 | 6.0 | 5.8 | 5.3 | 4.9 | 4.4 | 4.0 | 3.8 | 3.6 | 3.4 | 3.2 | 3.0 | 2.8 | 2.6 | 2.4 |
| 3 | 9.0 | 8.7 | 8.0 | 7.3 | 6.7 | 6.0 | 5.6 | 5.2 | 4.8 | 4.4 | 4.0 | 3.8 | 3.6 | 3.4 |
| 4 | 12.0 | 11.6 | 10.7 | 9.8 | 8.9 | 8.0 | 7.6 | 7.2 | 6.8 | 6.4 | 6.0 | 5.6 | 5.2 | 4.8 |

So let's plug that into our CT equation:

$$\text{Chlorine Residual (mg/L)} = \frac{8.0 \text{ mg*min/L}}{\text{Contact Time (min)} * \text{Baffling Factor}}$$

Now, if we can substitute in the other variables (contact time and baffling factor) we can solve for the free chlorine residual that will achieve 4-log inactivation of viruses.

The theoretical contact time is equal to volume of a tank divided by the flow rate through the tank:

$$\text{Theoretical Contact Time (min)} = \text{Volume (gal)} / \text{Flow Rate (gal/min)}$$

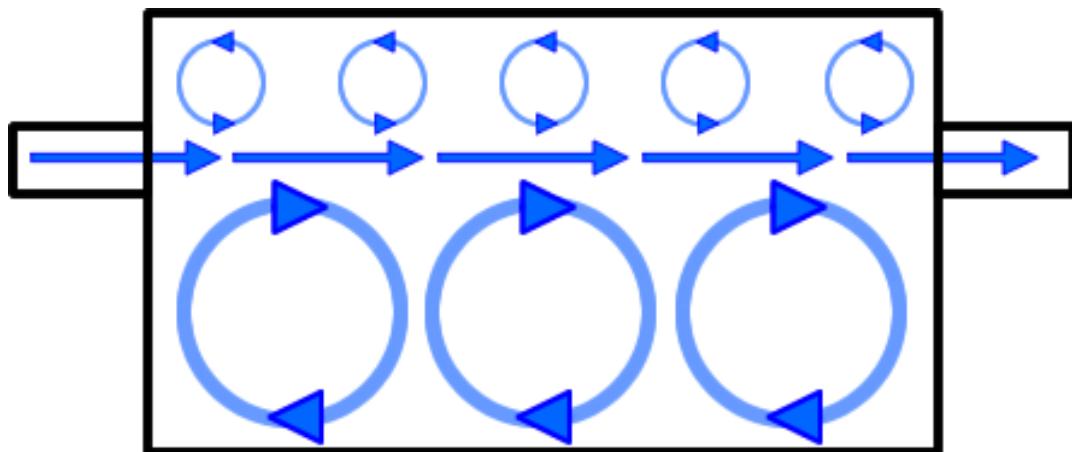
The existing Design Standards in Part II of DEP's "Public Water Supply Manual" require that 20 minutes of contact time be provided prior to each entry point, so let's plug that into our equation:

$$\text{Chlorine Residual (mg/L)} = \frac{8.0 \text{ min*mg/L}}{20 \text{ min} * \text{Baffling Factor}}$$

Next we need to look at the Baffling Factor.

Short circuiting within vessels allows some water to flow through the tank in concentrated currents. This reduces the time that some water remains in the tank and in contact with the disinfectant.

Figure 2-3: Short circuiting in a contact basin.



We account for short circuiting with a **Baffling Factor**. The baffling factor is a number between 0 and 1 that accounts for the reducing effect that short circuiting has on contact time.

Baffling Factor * Theoretical Contact Time = Effective Contact Time

- ▶ If there is no short circuiting, the baffling factor is 1.0 and the theoretical and effective contact times are equivalent.
- ▶ The Design Standards require that short circuiting be minimized during the 20 minutes of theoretical contact time, so we assumed a baffling factor of 1.0:

Effective contact time = 20 minutes * 1.0

Now we can solve for the chlorine residual that is necessary to ensure 4-log inactivation of viruses. Assuming the Design Standards are met, a minimum residual of 0.40 mg/L multiplied by 20 minutes contact time results in the required CT value of 8 mg-min/L.

$$0.40 \text{ mg/L} = \frac{8.0 \text{ min}^* \text{mg/L}}{20 \text{ min}^* 1.0}$$

You'll use this same formula to calculate CT's that your disinfection process achieves, but you'll need to account for the different shapes and sizes of the pipes and vessels in your treatment process.

Disinfection Segments

In order to determine the total CT value for your entire chlorine disinfection process, you need to:

1. Divide your disinfection process into discrete segments between the point of disinfectant application and the entry point.
2. Calculate the CT value for each discrete segment.
3. Sum them together.

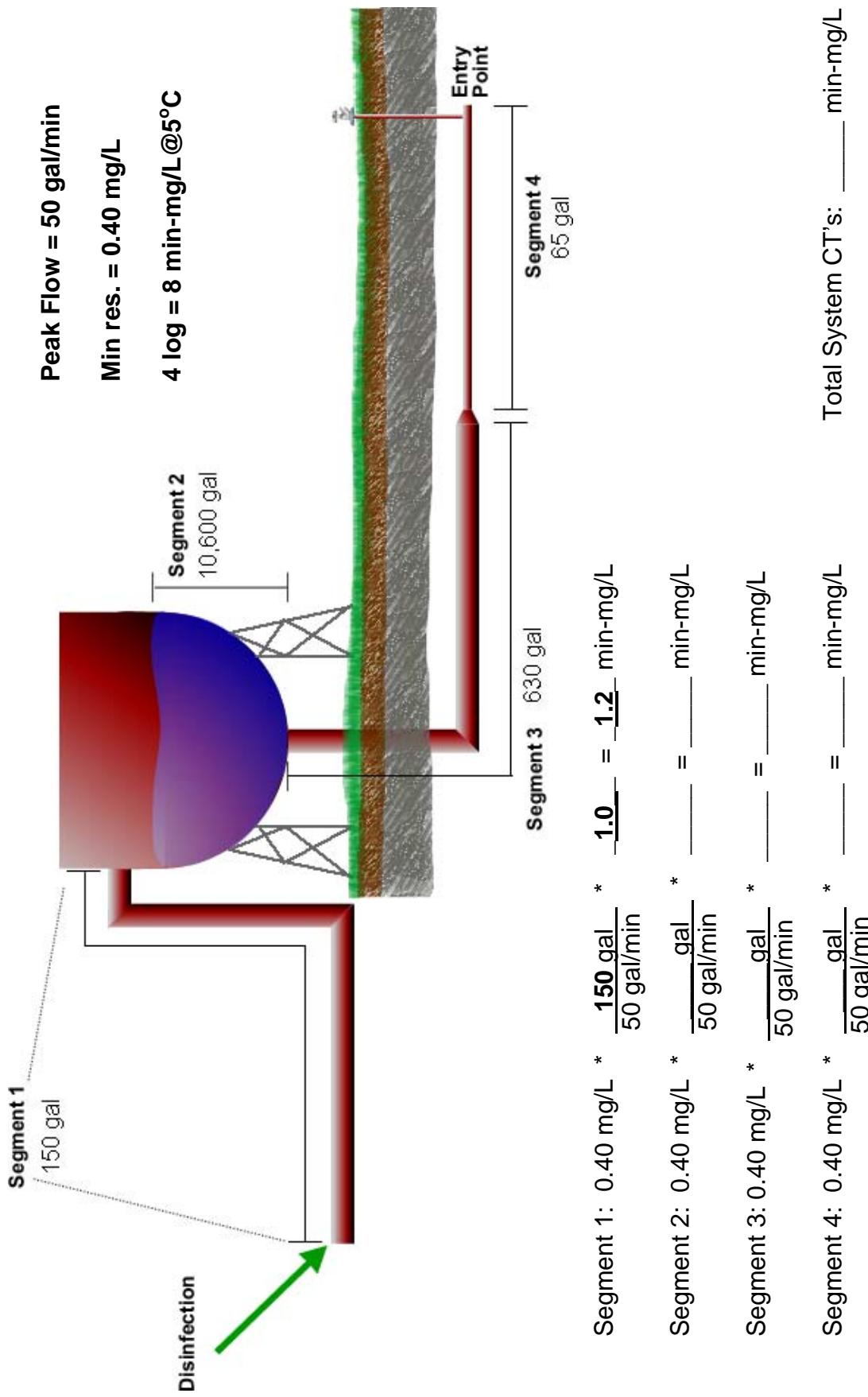
A simple example is shown in Figure 2-4.

We need to divide the disinfection process into segments because each contact chamber, pipe, and other vessel has unique properties that dictate its baffling factor – the baffling factor is the variable that accounts for the short-circuiting that reduces contact time in a vessel.

Since a pipe has a different baffling factor than a storage tank, the CT for each piece, or segment, must be calculated separately. Once you know the CT for the pipe and the CT for tank, you simply sum them to arrive at the CT for the both segments combined.

TURN TO APPENDIX D

Figure 2-4: Example of a simple disinfection process made up of pipes and an upbaffled storage tank, divided into segments. Assume that this system has a peak flow rate of **50 gal/minute** and complete the calculations to determine its total CT value.



Most systems can readily maintain a 0.40 mg/L minimum residual simply by adjusting their level of disinfectant application.

- 93% of PA's community water systems disinfect with chlorine.
- 60% presently maintain an average residual of 0.40 mg/L or greater **in the distribution system** (based on available compliance data).

To help systems evaluate their chlorine disinfection for the Groundwater Rule, DEP has developed a spreadsheet that can be used to determine the log inactivation of viruses by free chlorine (Lesson 4).

Supplemental & Alternative Technologies

Removal/Filtration Technologies

- ▶ Some membrane technologies have been proven to be effective at removing viruses, but...
 - currently there is no standard methodology for challenge testing for virus removal.
 - There are no integrity tests / pressure decay tests to ensure that the membrane has not been compromised at the level that would allow viruses to pass.
- ▶ Systems considering membrane treatment or that have membranes in place **should not count on getting any treatment credit for viruses under the Groundwater Rule.**

Alternative Disinfection Technologies

- ▶ Disinfectants other than chlorine such as chloramines, chlorine dioxide and ozone offer varying degrees of effectiveness for virus inactivation.
- ▶ EPA has created CT tables for each of these three disinfectants than can be used in place of Table 1-1 provided earlier (Appendix F).

The calculation for determining the minimum required residual is performed in the same manner the CT calculation for free chlorine was performed.

If your system is using or considering using one of these disinfectants the calculation for determining the minimum required residual is performed in the same manner the CT calculation for free chlorine was performed. To have any of these technologies count toward compliance of the Groundwater Rule, you will need to demonstrate to DEP that you can reliably achieve the inactivation necessary to achieve 4-log treatment. This means that:

- 1) If you are relying solely on one of these technologies for 4-log treatment, you will need to maintain a minimum residual that achieves the CT's necessary for 4-log treatment of viruses indicated in Appendix F and Table 1-3.
- 2) If you are using any combination of treatments, you must maintain a minimum effectiveness of each technology that, when combined, equate to 4-log treatment.
- 3) You'll also be required to monitor and report your disinfectant residual(s) as part of the compliance monitoring requirement.

Table 2-3: Required residuals to achieve 4-log inactivation of viruses assuming 20 minutes of effective contact time (Temp $\geq 5^{\circ}\text{C}$, pH ≤ 9).

$$\text{CT (mg*min/L)} = \text{Residual (mg/L)} * \text{Effective Contact Time}$$

| Disinfectant | Required CT's | Required EP Residual |
|------------------|--|----------------------|
| Free Chlorine | 8.0 | 0.40 mg/L |
| Chlorine Dioxide | 33.4 | 1.67 mg/L |
| Chloramine | 1,988 | 99.4 mg/L |
| Ozone | 1.20 | 0.06 mg/L |
| UV | 39 mJ/cm ³ for a max credit of 0.50 log | |

*The CT calculation for ozone is more complicated than for chlorine-based disinfectants. Also, ozone is not allowable as a sole disinfectant for a community water system because it does not provide a sustainable residual for the distribution system.

Similarly, ultraviolet light may also be used to achieve some virus inactivation. However, due to the resistance of one family of virus, the adenovirus, EPA is suggesting that a single UV light be awarded a maximum of **0.5 log inactivation credit**.

Summary:**Key Points:**

To summarize, the key points of this chapter are:

- All CWS will be required to provide 4-log treatment of viruses.
- Community water systems are required to provide a minimum entry point free chlorine residual of 0.40 mg/L as of December 29, 2009.
- Most CWS will be able to achieve 4-log treatment with the default residual of 0.40 mg/L; others may need to maintain a higher residual or modify storage.
- Supplemental or alternative treatment requirements have yet to be finalized.

Lesson 3: *Compliance Monitoring*



Objectives:

After completing this lesson, you will be able to:

- Describe the Compliance Monitoring requirements.
- List the violations that can be identified by compliance monitoring.
- Properly report chlorine residuals using the SDWA-1 Form.
- Describe the public notification and other follow-up actions a system must take after receiving a violation under this rule.

Compliance Monitoring

Eventually, every community water system will provide 4-log treatment of viruses and no longer need to comply with the triggered monitoring requirements. When these systems demonstrate their 4-log treatment to DEP, one of the requirements for making that demonstration is describing the plan for conducting compliance monitoring.



What is Compliance Monitoring?

Compliance monitoring refers to the activities that a system takes to ensure that the technology being used to provide 4-log treatment of viruses is being properly operated and maintained.

- ▶ Compliance monitoring results are reported monthly to DEP.
- ▶ Compliance monitoring for most systems will consist of monitoring the free chlorine residual at the entry point.

Systems using supplemental or alternative treatment technologies are required to conduct monitoring specific to their technology.

- ▶ Requirements for other technologies will be added as special conditions to a system's operation permit.

Compliance Monitoring of Free Chlorine

Compliance monitoring for systems using chlorine disinfection involves monitoring the free chlorine residual at the entry point to ensure that it remains at or above the minimum residual identified in the 4-log demonstration.

- ▶ 0.40 mg/L free chlorine unless an alternative residual is approved by DEP.



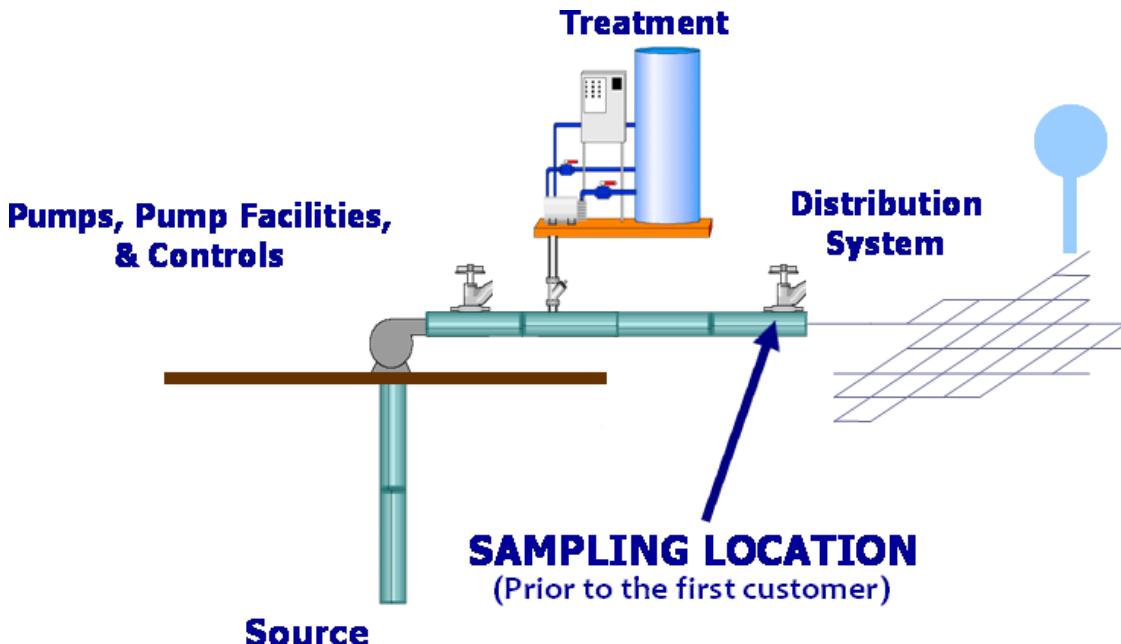
Monitoring Location

4-log treatment of viruses must occur prior to the first customer, so:

- ▶ Monitoring for the minimum residual must also occur before the first customer.
 - Traditional entry point (where you collect your nitrate and VOC samples)
 - Remote location upstream of the first customer

CT's for log inactivation are calculated between the point of disinfectant application and sampling location.

Figure 3-4: Sampling location for compliance monitoring of free chlorine.



Question: Would the system in Figure 3-4 be allowed to include the volume in the elevated storage tank when calculating CT's for their 4-log demonstration?

Systems that can't generate enough CT's for 4-log inactivation prior to their traditional entry point have some options available for achieving the necessary disinfection level:

1. Apply for an alternative, **higher minimum residual** at the entry point (using the 4-log Demonstration Form).

Other options include:

2. **Install additional storage or add baffling** to existing storage (requires a permit application).

3. Install **supplemental treatment** - (requires a permit application and is subject to Department approval for log credit.)
4. Install a **remote monitoring** location downstream of the traditional entry point, but upstream of the first customer (to gain CT's from the additional pipe volume).
5. Conduct a **pilot study of chlorine degradation** in the pipe between the entry point and first customer.
 - ▶ This study allows the system to include the additional pipe volume in the CT calculation while maintaining the traditional entry point as the compliance monitoring location.

We'll go into more depth about your options for achieving 4-log treatment of viruses in **Lesson 4**.

Your choice of a monitoring location for chlorine will depend on your particular system configuration and how you can most efficiently achieve 4-log treatment.

Grab or Continuous Sampling?

Systems serving ≤ 3300 :

- ▶ Must take a daily grab sample at approved compliance monitoring location
 - During the hour of peak flow.
 - Analyze for free chlorine concentration.
- ▶ May conduct continuous monitor as described below

If any daily grab sample measurement falls below the Department-required minimum residual disinfectant concentration, the groundwater system is required to take follow up samples every 4 hours until the residual disinfectant concentration is restored to the Department-determined minimum level.

Systems serving >3300:

- ▶ **Required to continuously monitor** the residual disinfectant concentration at the entry point or other location approved by the Department.
- ▶ Record the results at least **every 15 minutes** each day that water from the groundwater source is served to the public.
- ▶ Continuous monitors must use an EPA approved method.
 - EPA lists the acceptable methods in CFR 141.74(a)(2).
 - Waste streams must be discharged to a sanitary sewer or via a registered injection well.

If the continuous monitoring equipment fails or is taken offline for any reason, systems serving >3300 are required to perform grab sampling.

- ▶ Must have a working benchtop chlorine analyzer as a backup
- ▶ Collect grab samples every 4 hours
- ▶ 14 days to resume continuous monitoring

Reporting Results

Each month that a system serves water to the public, it must report to DEP the following (SDWA-1 form, in Appendix E):

1. The lowest residual free chlorine concentration at the compliance monitoring location for each day.

And, each time that the recorded residual falls below the designated minimum:

2. The date and time when the residual fell below the minimum.
3. The date and time when the minimum residual was restored.

In addition, the system **must notify DEP within 1 hour** anytime the chlorine residual falls below the minimum for more than 4 hours.

Electronic Reporting

- Eventually all systems will need to report data to the Department electronically.
- DEP will notify you in writing 90 days prior to your required electronic reporting begin date.

The eReporting begin dates are as follows:

| Size: Pop'n Served | eReporting begin date |
|--------------------|--|
| > 2,200 | Already required (2010 and early 2011) |
| 1,901-2,200 | 4/11/2011 |
| 1,151-1,900 | 5/11/2011 |
| 801-1,150 | 6/11/2011 |
| 701-800 | 7/11/2011 |
| 501-700 | 8/11/2011 |
| 351-500 | 9/11/2011 |
| 341-350 | 10/11/2011 |
| 251-340 | 11/11/2011 |
| 176-250 | 12/11/2011 |
| 151-175 | 1/11/2012 |
| 111-150 | 2/11/2012 |
| 99-110 | 3/11/2012 |
| 90-98 | 4/11/2012 |
| 75-89 | 5/11/2012 |
| 60-74 | 6/11/2012 |
| 46-59 | 7/11/2012 |
| 35-45 | 8/11/2012 |
| <35 | 9/11/2012 |

You may choose to begin reporting electronically prior to notification from the Department. For more information on electronic reporting, including instructions, please the DWELR page by following these instructions:

- Go to <http://www.dep.state.pa.us/>
- Click on “DEP Programs A-Z” from the left menu
- Find the link for DWELR under “D”

Minimum Residual/Treatment Technique Violations and PN

Whenever a groundwater system that relies solely on chlorine disinfection for 4-log treatment allows its residual disinfectant level to fall below the approved minimum for **more than 4 hours**, it is in violation of the treatment technique requirement for the Groundwater Rule.

► Tier 1 Public Notice

The system must:

1. Contact DEP within 1 hour and consult with the Department within 24 hours.
2. Issue the Public Notice with 24 hours using the appropriate language and delivery methods.
3. Certify to DEP that you have met the PN requirements.

TURN TO APPENDIX E

Compliance Monitoring of Supplemental/Alternative Treatment

Operational and compliance monitoring requirements for systems that use technologies other than or in addition to free chlorine disinfection have yet to be finalized.

Summary:**Key Points:**

To summarize, the key points of this chapter are:

- Systems using chlorine must monitor the EP residual
- >3300 – Must use continuous analyzers
- ≤ 3300 – choice of grab sampling or continuous analyzers
- Monthly Reporting
 - Lowest daily residual at EP
 - Date and time when residual falls below min
 - Date and time when min residual is restored
- Tier 1 public notice for low residual > 4 hours

**Classroom Exercise**

Group Activity #1: *The instructor will assign small groups and distribute written scenarios. Complete the scenario with your small group.*

Lesson 4: *Demonstrating 4-Log Treatment of Viruses*



Objectives:

After completing this lesson, you will be able to:

- Describe the process for demonstrating 4-log treatment.
- Evaluate your system to see if you currently meet the 4-log treatment technique requirement.
- Explore options for increasing your treatment effectiveness in preparation for the Groundwater Rule.
- Prepare your 4-log demonstration and identify when an engineer is required to help with the preparation.

4-Log Demonstration Process

All of the forms we'll review in this lesson are available electronically:

- Go to: www.elibrary.dep.state.pa.us
- Type "groundwater rule" into the search box in the upper right

Or, Direct Link: <http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-10671>

There are a series of steps you have to complete to demonstrate your 4-log treatment of viruses to DEP. Let's take an overall look the process:

1. Evaluate your treatment process
2. Evaluate options for improving your treatment, if necessary
3. Prepare and submit your 4-log demonstration by your deadline
4. Implement the treatment and begin compliance monitoring once DEP has approved your 4-log submission

Evaluating Your System for 4-Log Treatment

The first step of this process is to evaluate your current treatment process to see if either:

- 1) You already meet the 4-log treatment requirement with the 0.40 mg/L minimum residual.
- 2) Your system is able to meet it with a reasonably higher residual.

The 4-log Spreadsheet (Available on the eLibrary as described above):

- ▶ Great tool for evaluating your disinfection process.
- ▶ One of the required enclosures that you must submit with your 4-log demonstration.

For most systems, the existing treatment process is capable of meeting the requirement for 4-log treatment of viruses with the 0.40 mg/L default minimum.

- ▶ Systems with less than 20 minutes effective contact time may need a higher alternative minimum residual.

| A | B | C | D | E | F | G | H | I | J | K | |
|-------------|--|--|----------------------------|-------------------------|--|--------------------------|-----------------------------|------------------------------------|-----------------------|--|------------------------------|
| Directions: | | | | | | | | Total Effective Contact Time (min) | Total CT's (mg/L·min) | Log Inactivation of Viruses (pH 6-9) | |
| 1 | 1) Identify all the segments of your treatment facility between the point of disinfectant application and the entry point (See the "System Example" worksheet). Enter the description for each segment into Column B (e.g., 2-inch pipe from the chlorinator to the storage tank). | | | | | | | | | | |
| 2 | 2) Enter the minimum temperature of your source water into cell K5. If your finished water storage becomes colder than your source water during winter and you wish to include that stored water in the CT calculation for log inactivation, use the lowest temperature that your stored finished water reaches in winter. | | | | | | | 22.28 | 8.91 | 4.46 | |
| 3 | 3) Enter the volume (gal) for each segment into Column D if known. | | | | | | | | | | |
| 4 | 4) If the volume for a segment is unknown, choose the shape of the segment from the drop-down selections in Column C and enter the dimensions in Columns E, F, and G (in feet - use the "Unit Conversions" worksheet to convert to feet if your data is another unit). | | | | | | | | | | |
| | Note: For box-shaped segments, enter the length, width, and height into Columns E, F, and G. For cylinders and cones enter only the diameter and the height into Columns F and G. For spheres and half-spheres enter only the diameter into Column F. (ex: for pipes, enter the diameter into Column F and the length into Column G). For horizontal cylindrical tanks, enter the total diameter into Column F, the horizontal length into Column E and the minimum water depth into Column G. | | | | | | | | | | |
| 5 | PWS Name | | PWS ID | | Entry Point ID | | | | | | |
| 6 | | | Peak Flow Rate (gal/min) = | 85 | Minimum Chlorine Residual at EP (mg/L) = | | | 0.40 | Minimum Temp (C) = | 5.0 | |
| 7 | A | B | C | D | E | F | G | H | I | J | |
| 8 | Segment # | Description of Segment | Shape | Volume (gal) (if known) | Tank Length (feet) | Width or Diameter (feet) | depth or Pipe-Length (feet) | Volume (cubic feet) | Volume (gal) | Choose a Baffling Condition for each segment | Effective Contact Time (min) |
| 9 | 1 | 2-inch pipe from the chlorinator to the storage tank | Cylinder Half-sphere | | | 0.5 | 100 | 19.64 | 146.88 | Near-PlugFlow Plugflow | 1.73 |
| 10 | 2 | cylindrical upper portion of the storage tank | Cylinder Half-sphere | | | 15 | 3 | 530.15 | 3965.76 | Unbaffled Poor | 4.67 |
| 11 | 3 | hemi-spherical bottom of storage tank | Half-sphere Cone | | | 15 | | 883.58 | 6609.60 | Unbaffled Poor | 7.78 |
| 12 | 4 | 6-inch pipe from the storage tank | Cylinder Half-sphere | | | 0.5 | 25 | 4.91 | 36.72 | Near-PlugFlow Plugflow | 0.43 |
| 13 | 5 | 6-inch underground pipe | Cylinder Half-sphere | | | 0.5 | 400 | 78.54 | 587.52 | Near-PlugFlow Plugflow | 6.91 |
| 14 | 6 | 2-inch pipe to the distribution system | Cylinder Half-sphere | | | 0.1667 | 400 | 8.73 | 65.31 | Near-PlugFlow Plugflow | 0.77 |
| 15 | | | Select a shape Sphere | | | | | | 0.00 | Select a baffling condition Unbaffled | |
| 16 | | | Select a shape Sphere | | | | | | 0.00 | Select a baffling condition Unbaffled | |

The 4-log Longhand Worksheet

In addition to the spreadsheet, you also have a worksheet that you can use to calculate the log-inactivation by free chlorine by longhand.

- ▶ The spreadsheet and the worksheet perform the same function.
 - Both should give the same result for log inactivation.
- ▶ Either form can be submitted with your 4-log demonstration.

Evaluating Options for Improving CT's

Carrying a Higher EP Free-Chlorine Residual

A higher residual may help you achieve 4-log treatment if, when you complete the spreadsheet you find that you are close, but not quite there.

- ▶ Effective contact time <20 minutes
- ▶ Water Temperature <5°C
- ▶ pH>9

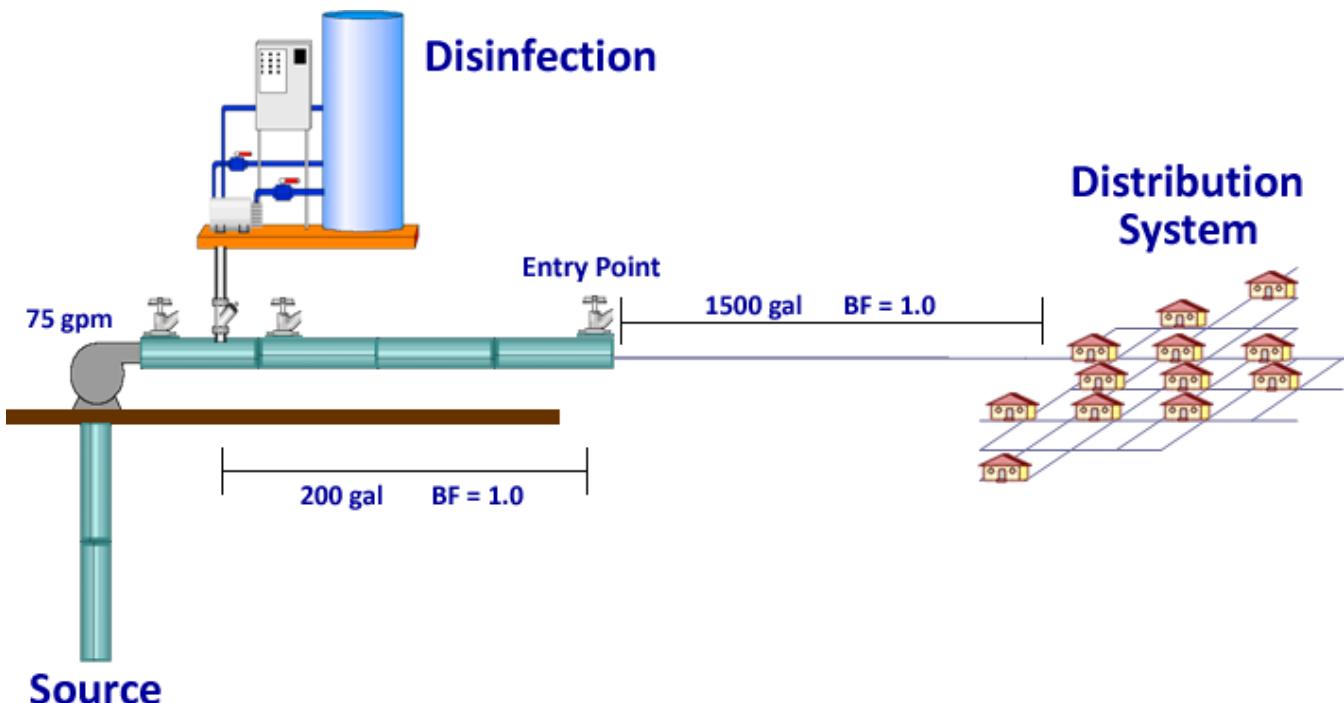
Applying for an alternative minimum residual of 0.50 or 0.60 mg/L may be all the modification necessary to achieve 4-log treatment of viruses.

Including Pipe between EP and 1st Customer in CT Calculations

There are three ways that you can obtain CT credit for the transmission line to the first customer:

1. Install a new sampling tap/continuous monitor just upstream from the first customer to be used as your compliance monitoring location.
2. Run a line from just upstream of the first customer back to the plant for compliance monitoring.
3. Have a pilot study performed to measure chlorine degradation between the existing entry point and the first customer.

Figure 4-2: A system that would be a candidate for including pipe between the EP and the 1st customer in their CT calculations.



Considerations:

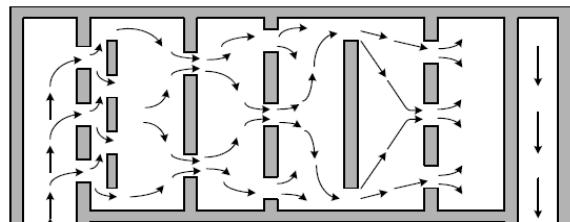
1. Unless you are small system that can perform grab sampling, you will need to think about how to handle the discharge generated by DPD continuous monitors. If you do not have access to a sanitary sewer, you will need to register the discharge with EPA's Underground Injection Control Program in advance of demonstrating 4-log.
2. Construction costs and permitting
3. Engineering costs for the degradation study and report.

Future development along that transmission line: If new customers come on line and tap into that section of pipe, you will lose some of those additional CT's because your first customer would then be farther upstream than shown in your original 4-log treatment demonstration.

Improving Baffling, or Adding Storage or Treatment

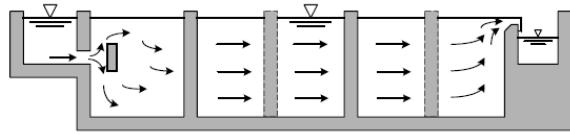
If you cannot achieve 4-log by maintaining an increased residual or counting transmission line upstream of the 1st customer in your CT calculations, your remaining options are:

- ▶ Add new or additional storage
- ▶ Modify existing storage by adding baffles
- ▶ Add supplemental treatment



Plan View

Any of these options will require that you complete and submit the appropriate applications for minor or major permit amendments depending on the type and quantity of work to be done on your system.



Section View

How do I “Prove” 4-log Treatment?

Systems that do not need to make substantial modifications only need to submit:

1. 4-Log Demonstration Form
2. 4-log Spreadsheet
3. Treatment schematic that shows all of your treatment, storage, conveyances, and monitoring equipment

These systems do not need to complete a permit application or hire an engineer.

Systems will need to hire an engineer and submit applications for minor or major permit amendments if they must:

- ▶ Add chlorine disinfection
- ▶ Add or modify storage
- ▶ Add supplemental treatment
- ▶ Perform other system modifications

The 4-Log Treatment Demonstration Form

Appendix C

This form is set up so that it walks you through everything that you need for your 4-log demonstration.

- ▶ Includes thorough instructions
- ▶ Contains a checklist enclosures, and helps you decide which apply to your system
- ▶ Walks you through the required compliance monitoring description

The 4-Log Spreadsheet and Schematic

Once you know how you'll be achieving 4-log treatment and start preparing your demonstration to DEP, you'll need to complete the spreadsheet to be printed and included with your demonstration package. When you are preparing your official spreadsheet for the 4-log demonstration, be sure to think about the following:

1. All treatment segments must be clearly described on the spreadsheet and labeled by number on your schematic.
2. Be sure that you use the appropriate baffling category for each segment.
 - a. Systems can dispute DEP-assigned baffling factors by hiring an Professional Engineer (PE) to conduct a tracer study.
3. DEP will confirm all information submitted in the 4-log treatment demonstration.
4. The submitted form must be signed by either a certified operator or PE.

Tracer Studies for Contact Time

It can be quite involved and more expensive, but a system can submit a tracer study instead of the 4-log spreadsheet provided. Tracer study reveals the actual travel time through your disinfection segments.

Example: A system may find it beneficial to conduct a tracer study if they believe the actual time of travel through the system after disinfection is longer than the calculated value.

Using the tracer study results the actual CT values for the system are determined. The study data and report must be submitted under the seal of a PE.

There is a specific form with instructions available on the eLibrary:

- www.elibrary.dep.state.pa.us
- In the search box type “tracer study”
- Find the documents called:
 - Public Water System Tracer Study Demonstration Form.doc
 - Public Water System Tracer Study Demonstration Instructions.pdf

Supplemental Treatment and Permit Applications

The spreadsheet only accounts for inactivation of viruses by free chlorine. Supplemental treatment will require a permit that describes the operational and compliance monitoring requirements.

- ▶ New permit for new treatment
- ▶ Special conditions will be added to existing permits for existing treatment

If your system currently uses only UV or some other disinfection technology other than chlorine and you wish to add chlorine disinfection to your treatment process, you will need to obtain the appropriate permits.

DEP is currently working on finalizing guidance regarding 4-log treatment and compliance monitoring for some of the more common treatment technologies, especially UV and Ozone.

DEP's requirements will be based on existing EPA Guidance:

Ultraviolet Disinfection Guidance Manual (EPA 815-R-06-007)

Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources – Appendix O: Guidelines to Evaluate Ozone Disinfection (68-01-6989)

For more specific details on log-demonstration and compliance monitoring requirements, contact:

Kevin McLeary
Chief, Permitting Section
(717) 783-1820
kmcleary@state.pa.us

Table 4-1: Enclosure requirements for your 4-log submission

| Changes to meet 4-log | 4-Log Demonstration form | 4-Log Spreadsheet or Worksheet* | Treatment Schematic [†] | Application for Minor/Major Permit Amendment | Engineer's Report of Chlorine Degradation Pilot Study | Engineer's Report of Tracer Study for Eff. Contact Time |
|--|--------------------------|---------------------------------|----------------------------------|--|---|---|
| None | X | X* | X** | | | optional |
| Increase residual to >0.40 mg/L only | X | X* | X** | | | optional |
| Must use Pipe btwn EP & 1 st Customer | X | X* | X** | | X | optional |
| Must Add Storage, Baffles, or Treatment | X | X* | X** | X | | optional |

* Not needed if an engineer's tracer study report is included that meets DEP's requirements for the 4-log submission.

[†]Schematic must show the location and specifications of all treatment, conveyances, and monitoring equipment.



Classroom Exercise (Handout)

Summary:



Key Points:

To summarize, the key points of this chapter are:

- Demonstrating 4-log treatment involves evaluating your system for treatment effectiveness, exploring options for improving treatment of viruses (if necessary), and submitting the appropriate completed forms.
- The 4-log spreadsheet can help you evaluate the effectiveness of your chlorine disinfection in treating for viruses.
- A properly conducted and reported tracer study can be used in place of the 4-log spreadsheet in the 4-log demonstration.

- You can increase your chlorine residual, use transmission line CT's, or add storage or treatment to improve your treatment process and meet the 4-log treatment requirement.
- An engineer is required to sign off on all tracer or pilot studies and all permit applications.

Appendix A

Groundwater Rule Flowchart

GROUND WATER RULE

- Applies to all public water systems using ground water (if not combined with surface water prior to treatment).
- Includes purchasing systems receiving finished ground water.

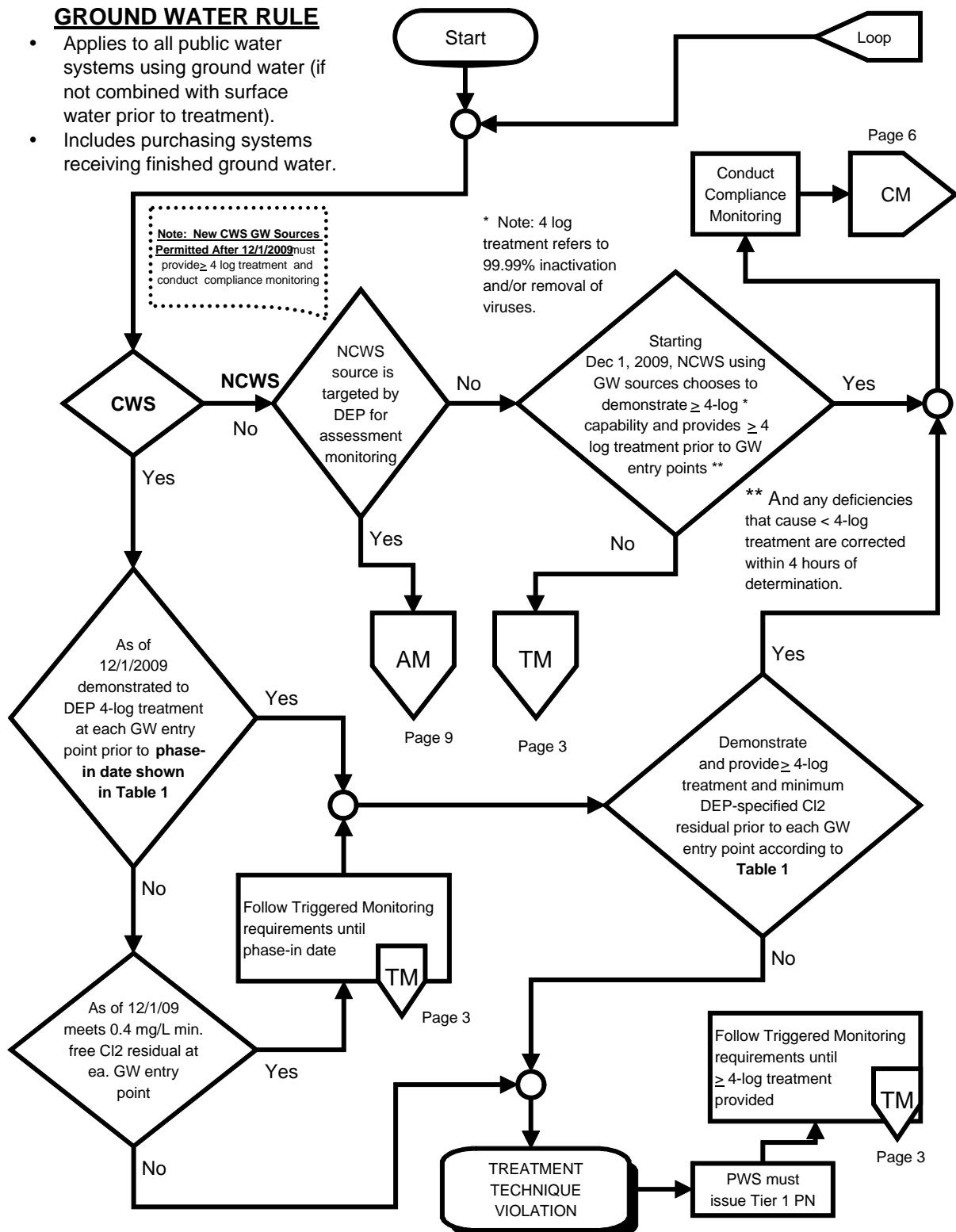
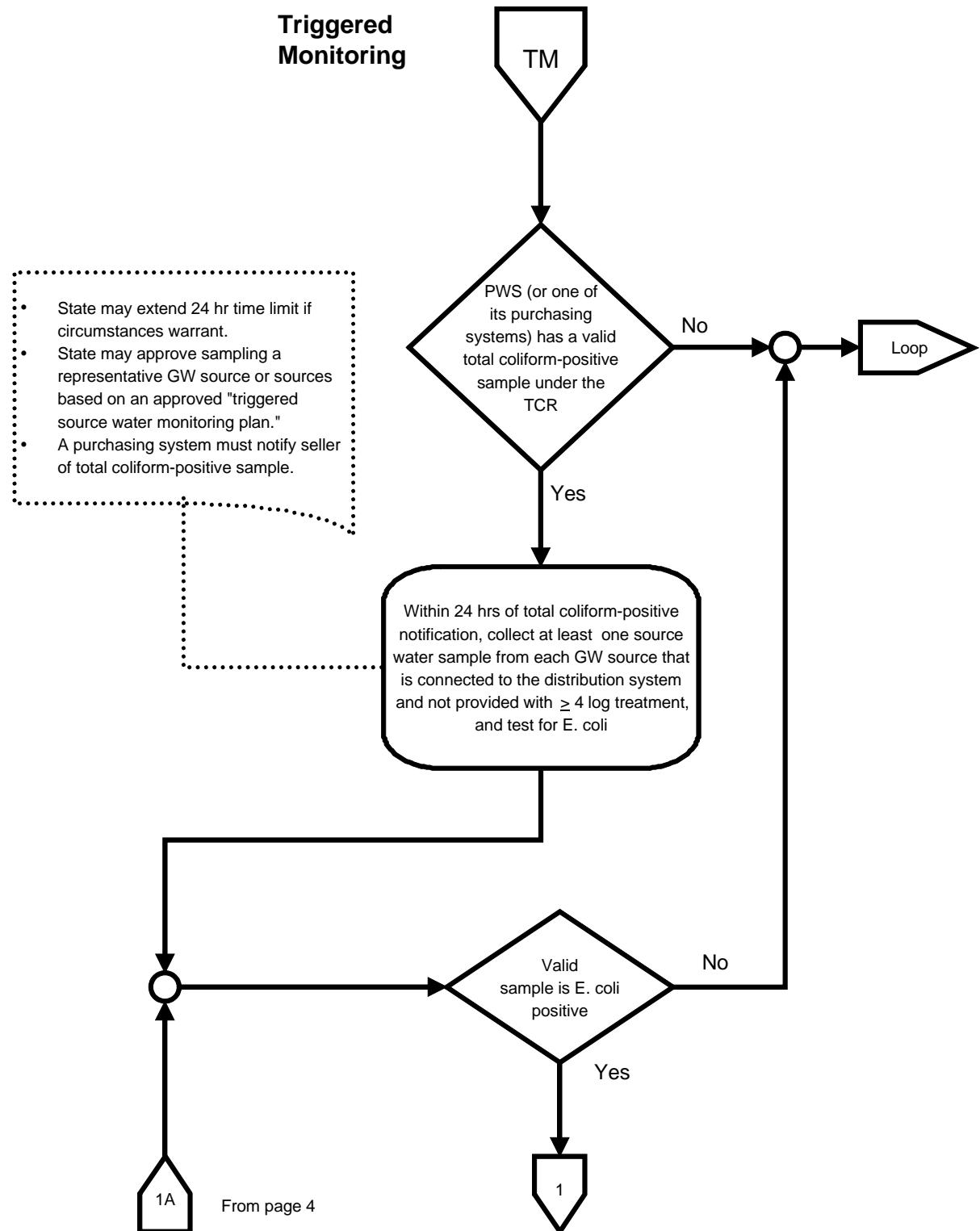
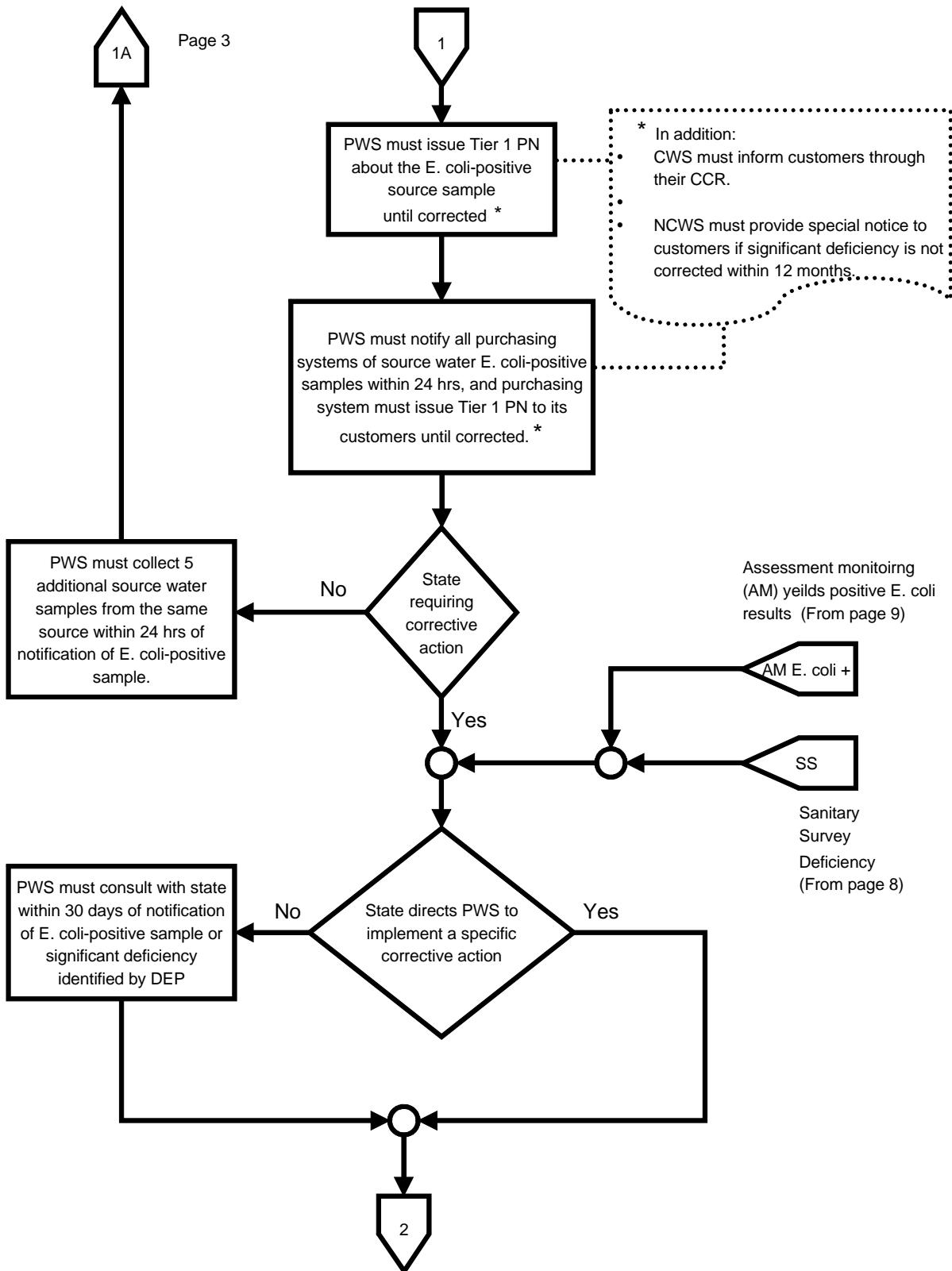
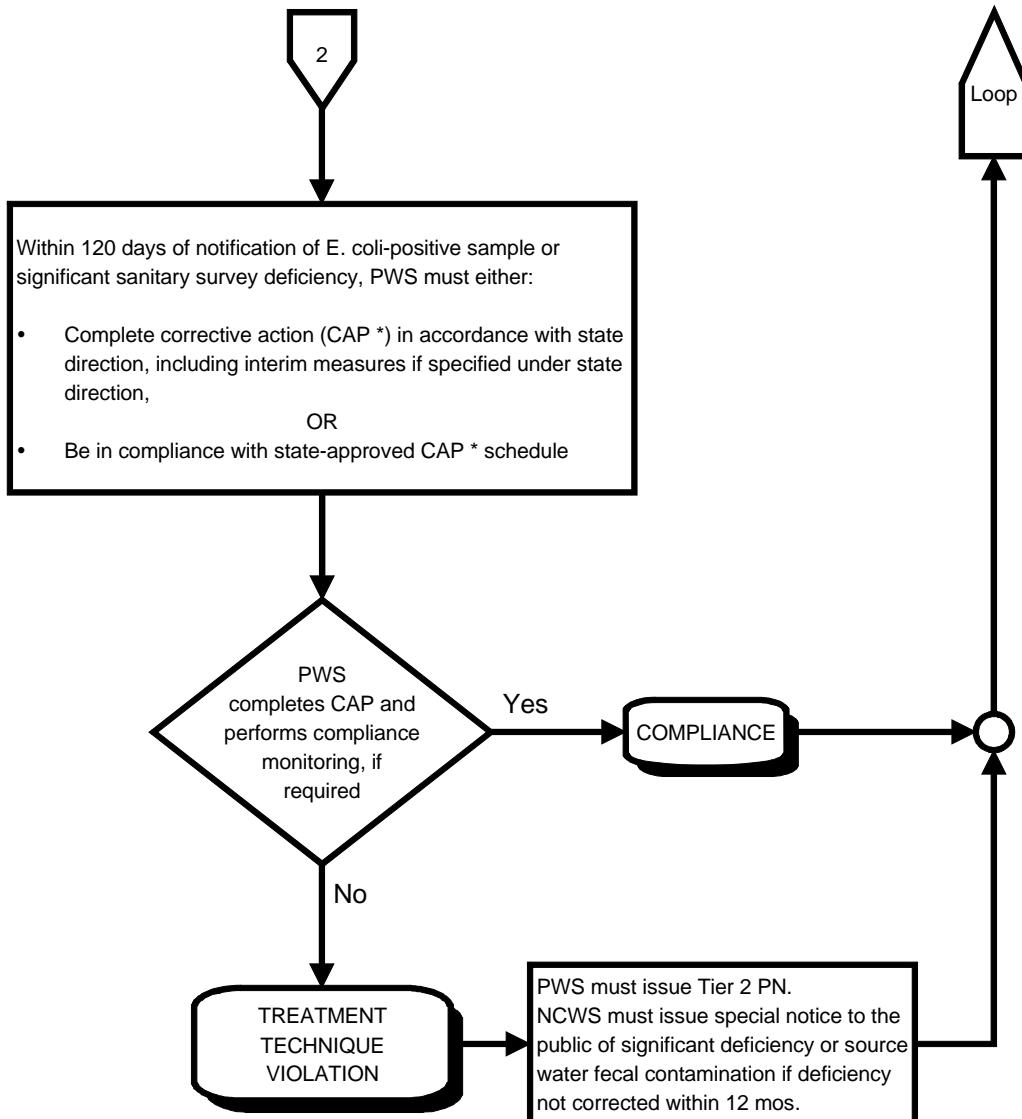


Table 1
Phase-in of 4-log Treatment Requirement
For
Community Water System (CWS) Groundwater Sources

| CWS Category | Demonstrate how \geq 4-log Treatment Will Be Provided by: | <u>Phase-In Date</u> Provide At Least 4-log Treatment To Each GW Source by: |
|--|---|--|
| Population Greater Than 500 | October 1, 2010 | April 1, 2011 * |
| Population 100 - 500 | October 1, 2011 | April 1, 2012 * |
| Population Less Than 100 | October 1, 2012 | April 1, 2013 * |
| Any CWS that did not provide \geq 4-log treatment prior to GW entry point by Phase-in Date * | As directed/ordered by DEP | As directed/ordered by DEP |
| Any new permitted GW source | In permit application | First day of placing entry point in service with new source |



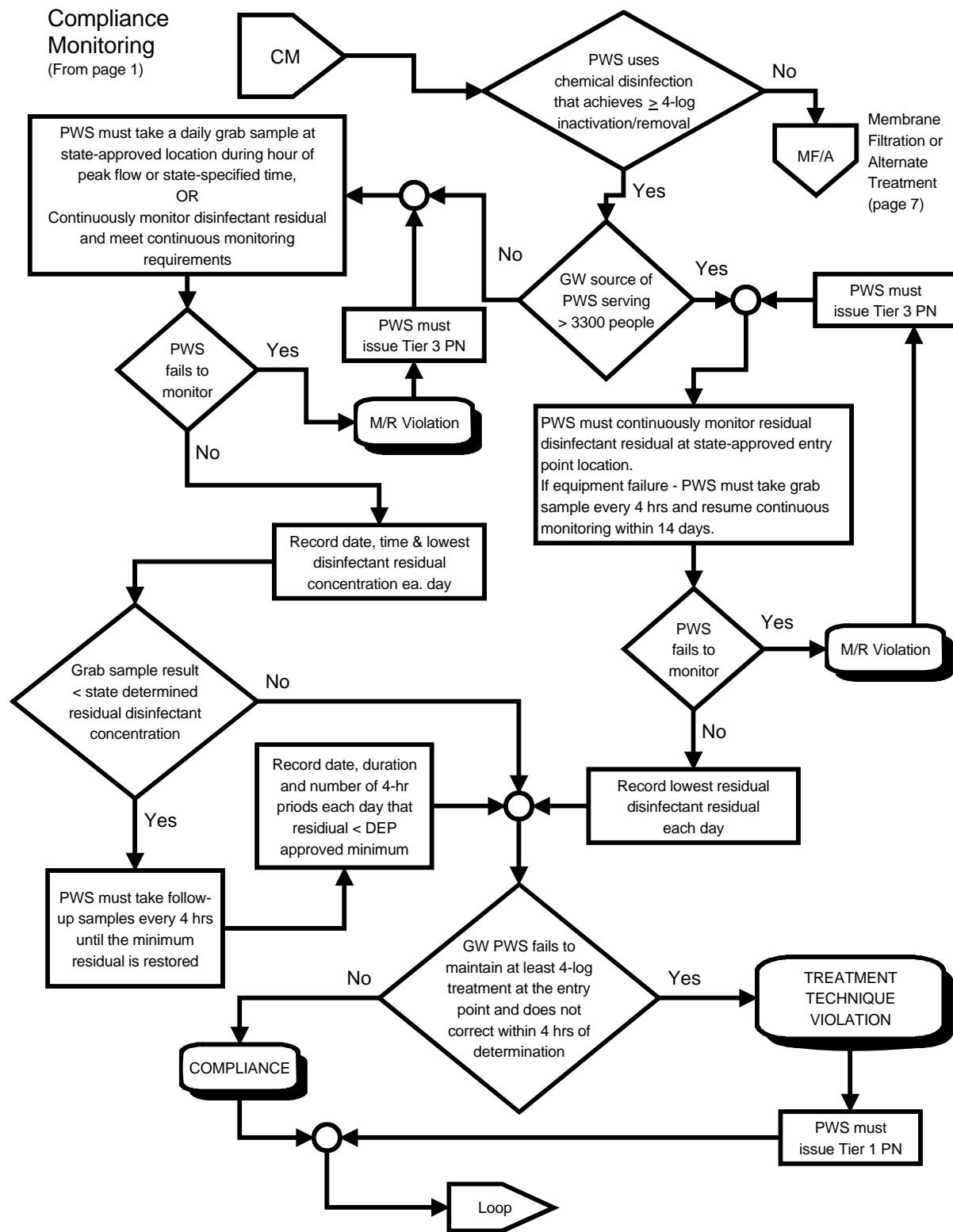


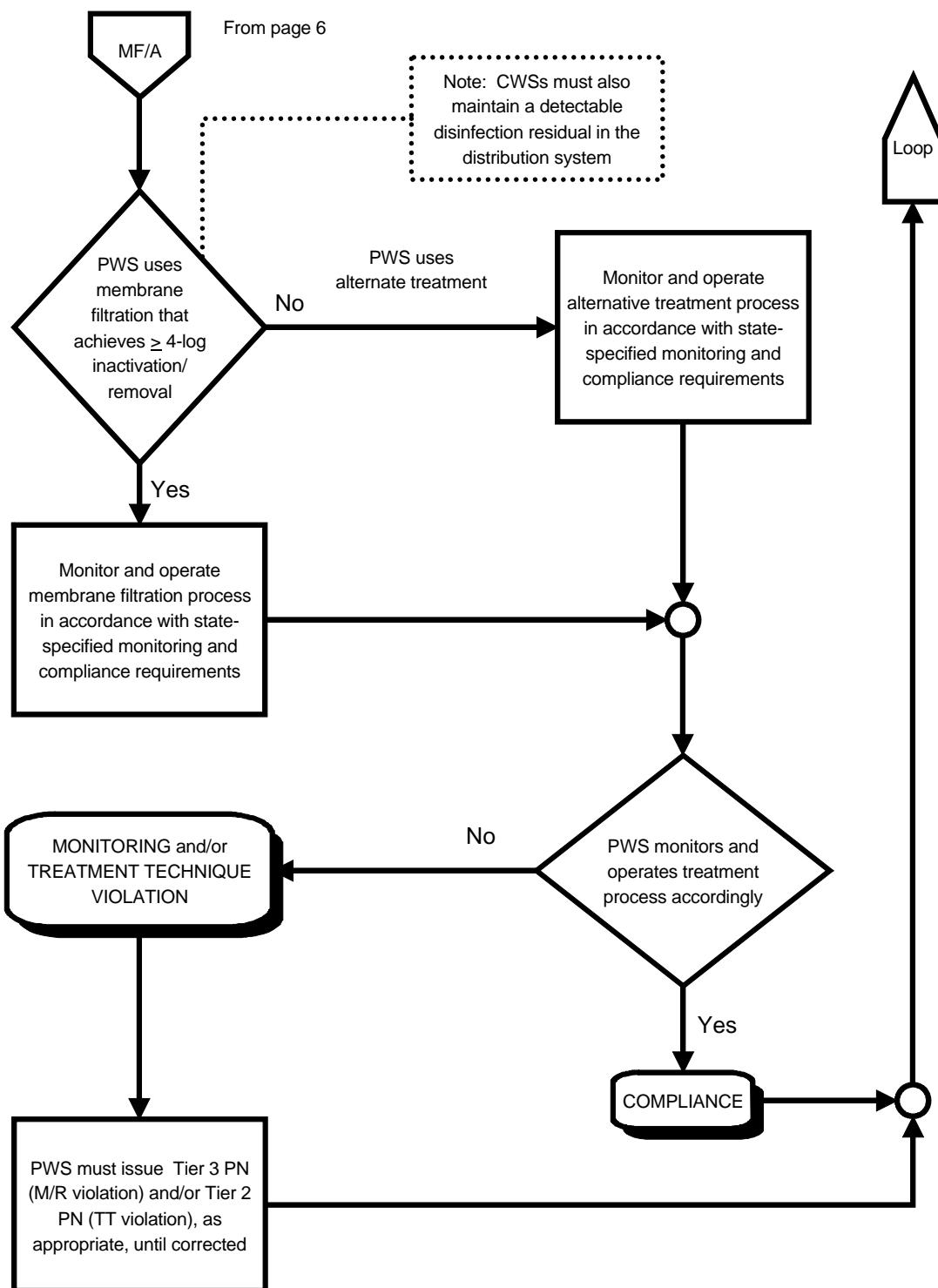


* Corrective Action (CAP) Alternatives

Systems must correct all significant deficiencies and, if directed by DEP, complete one or more of the following:

1. Provide alternate water source(s)
2. Eliminate source of contamination
3. Provide treatment that reliably achieves ≥ 4 -log treatment of viruses before first customer.





Sanitary Surveys

Following a sanitary survey, state provides GW PWS with written notice describing any significant deficiencies NLT 30 days after state identifies the significant deficiency.

This includes, but is not limited to defects in design, operation, or maintenance, or a failure or malfunction of sources, treatment, storage, or distribution system that is causing, or has the potential for causing contamination of the finished water.

NOTE: If requested, the PWS must provide the state with any existing information that will enable the state to conduct a sanitary survey (SS)

* In addition:
CWS must inform customers through their CCR.
NCWS must inform customer in manner approved by the state if not corrected within 12 months.

PWS must issue Tier 2 PN about the significant deficiency until corrected. *

8 Sanitary Survey Components

1. Source
2. Treatment
3. Distribution system
4. Finished water storage
5. Pumps, pump facilities, and controls
6. Monitoring, reporting, and data verification
7. System management and operation
8. Operator compliance with state requirements

Page 4

NOTE: The state must conduct sanitary surveys that address the 8 sanitary survey components no less frequently than:

CWSs - every 3 yrs *
NCWSs - every 5 yrs

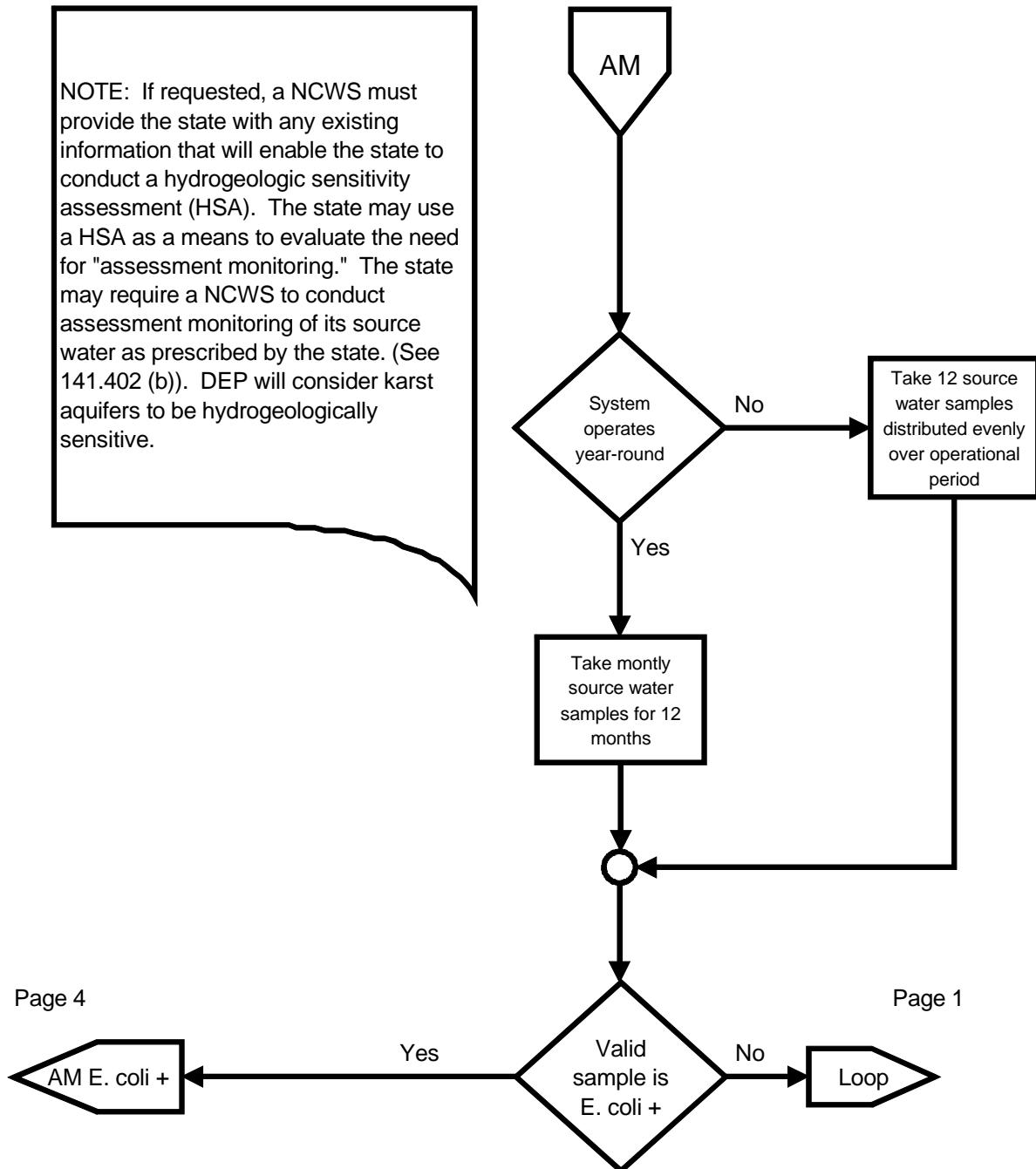
The initial sanitary survey must be conducted by:

CWSs - by 12/31/2012 *
NCWSs - by 12/31/2014

* Initial sanitary surveys for CWSs may be delayed until 12/31/2014 and conducted every 5 years (instead of 3) if the PWS either provides \geq 4-log treatment before or at first customer for all GW sources, and if it has an outstanding performance record, as determined and documented by the state and has no history of total coliform MCL or monitoring violations under the TCR since the last sanitary survey.

Source Water Assessment Monitoring

NOTE: If requested, a NCWS must provide the state with any existing information that will enable the state to conduct a hydrogeologic sensitivity assessment (HSA). The state may use a HSA as a means to evaluate the need for "assessment monitoring." The state may require a NCWS to conduct assessment monitoring of its source water as prescribed by the state. (See 141.402 (b)). DEP will consider karst aquifers to be hydrogeologically sensitive.



Appendix B

GWR Tier 1 Public Notice Templates



Instructions for Completing a Tier 1 Public Notice for Failure to Meet 4-log Disinfection Treatment Requirements

For groundwater systems providing 4-log treatment of viruses: Failure to maintain a minimum 0.40-mg/L disinfectant residual (or other Department-approved minimum residual) in the water delivered to the distribution system (that extends beyond 4 hours) OR failure to maintain adequate CTs for more than 4 hours constitutes a breakdown in treatment. This situation has significant potential to have serious adverse effects on human health as a result of short-term exposure. Tier 1 notices should convey the urgency of the situation and make it clear to consumers what actions they must take.

Beginning on May 10, 2010, water suppliers must provide within 24 hours, a Tier 1 public notice to each **service connection** using one or more of the following forms of direct delivery:

- Hand delivery
- Electronic mail
- Automatic telephone dialing systems
- Another form of direct delivery approved in writing by the Department

In addition to providing public notification to each service connection, water suppliers that also serve transient and nontransient service connections must provide an abbreviated notice using broadcast media.

Title:

Public notices for Tier 1 violations and situations should have an attention-getting title. For example, "DRINKING WATER WARNING" is better than "PUBLIC NOTICE". You should also identify the targeted audience or the population at risk, such as "People served by _____ Water System". If the area you serve does not follow municipal boundaries or if only a portion of the distribution system is affected, define the area at the top of your notice.

The instructions to consumers should be next in your notice. This should be a short phrase, such as "BOIL YOUR WATER BEFORE USING". As soon as consumers read this phrase, they will want to know why. A short description of the violation or situation should follow instructions to consumers. However, it should be kept short and concise. A more detailed explanation of the violation or situation should be given in the next section of the notice.

In order to meet the multilingual requirements, you must include, at a minimum, information in Spanish regarding the importance of the notice. The Department will notify you if, and when, you need to include information in any other language.

Description of the Violation or Situation:

Provide a detailed description of the violation or situation, including the contaminant(s) of concern, the contaminant level(s) and when the violation or situation occurred.

Other Consumer Actions (What should I do?):

Provide a detailed description of actions consumers should take. Include the appropriate **mandatory health effects language** indicated in ***italics*** on the following template. You may not change this wording.

Corrective Actions (What happened? What is being done? When do you expect to return to compliance?):

If you know why the disinfectant residual is low, explain it in your notice. You may choose from the following, as applicable, and modify to fit your situation.

• **Contact Time:**

In order to ensure proper disinfection, water in the treatment plant must be in contact with chlorine or a similar disinfectant for a minimum amount of time. On _____, this did not occur. Although chlorine quickly kills most bacteria, it is less effective against organisms such as viruses and parasites. For this reason, water needs to mix with chlorine for a longer time period to kill such organisms. The amount of time necessary, or the "contact time", depends on the amount of disinfectant in the water and the temperature of the water.

• **Disinfectant Residual:**

We routinely monitor for a disinfectant residual. This measurement tells us whether we are effectively disinfecting the water supply. The disinfectant residual is the amount of chlorine or related disinfectant present in the water. If the amount of disinfectant is too low, organisms may not be killed.

- On _____, disinfectant levels dropped below _____ mg/L for _____ hours. The standard is that levels may not drop below _____ mg/L for more than 4 hours.

-or-

- On _____, it was determined that the disinfection equipment was not operating. This constitutes a breakdown in treatment.

Contact Information:

Provide your name, business address and phone number or those of a designee of the public water system as a source for additional information concerning the notice.

Mandatory Statement to Encourage Distribution of the Notice to Others:

Use the **mandatory** statement provided in ***italics*** on the following template to encourage notice recipients to distribute the notice to others, where applicable. You may not change this wording.

Template Form Field Instructions:

When you place the cursor in the form field of the following template, look in the bottom left corner of your computer (row above the START button) for instructions about the information you enter in that field.

(i.e. first form field instructions read: Insert system name)

**DRINKING WATER WARNING
BOIL YOUR WATER BEFORE USING**

HIERVAN EL AGUA ANTES DE USARLA.

ESTE INFORME CONTIENE INFORMACION IMPORTANTE ACERCA DE SU AGUA POTABLE.
HAGA QUE ALGUIEN LO TRADUZCA PARA USTED, O HABLE CON ALGUIEN QUE LO ENTIENDA.

does not meet treatment requirements.

We routinely monitor your water's disinfectant residual concentration. This tells us whether we are effectively disinfecting the water supply. A water sample taken _____ showed a disinfectant residual concentration of _____ mg/L. This is below the required standard of _____ mg/L and constitutes a breakdown in treatment. There is an increased chance that the water may contain disease-causing organisms.

What should I do?

DO NOT DRINK THE WATER WITHOUT BOILING IT FIRST. Bring all water to a boil, let it boil for one minute, and let it cool before using, or use bottled water. Boiled or bottled water should be used for drinking, making ice, brushing teeth, washing dishes, and food preparation **until further notice**. Boiling kills bacteria and other organisms in the water.

Inadequately treated or inadequately protected water may contain disease-causing organisms. These organisms can cause symptoms such as diarrhea, nausea, cramps, and associated headaches.

If you have specific health concerns, you may wish to consult your doctor.

What happened? What is being done?

- We'll let you know when adequate disinfection has resumed.

We anticipate resolving the problem by _____.

For more information, please contact:

at

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

This notice is being sent to you by

PWS ID#:

Date distributed:

Appendix C

4-Log Treatment of Viruses Demonstration Form

Remove and recycle these instructions prior to sending the completed form to DEP

Instructions for CWS Demonstration of 4-Log Treatment of Viruses for Groundwater Sources

PURPOSE

Pennsylvania's Groundwater Rule requires all community water systems to provide 4-log treatment of viruses prior to the first customer for each of their groundwater sources and demonstrate to the Department that they are capable of such treatment according to the deadlines shown in Table 1. Additionally, all new groundwater sources permitted after December 1, 2009 must also be provided with 4-log treatment of viruses prior to the first customer. This document, along with the required enclosures, serves as the mechanism by which community groundwater systems will demonstrate their treatment efficacy to the Department.

Table 1: Deadlines for demonstrating and providing 4-log treatment of viruses.

| Population Served | 4-Log Treatment Submission Deadline | Begin Approved 4-Log Treatment |
|-------------------|-------------------------------------|--------------------------------|
| >500 | October 1, 2010 | April 1, 2011 |
| 100-500 | October 1, 2011 | April 1, 2012 |
| <100 | October 1, 2012 | April 1, 2013 |

Community water systems demonstrating 4-log treatment of viruses must complete all three sections of this form and enclose all required documentation in order for the submittal to be considered complete. Incomplete submissions will delay processing and may be returned to the applicant.

Section I

Section I is general information to identify the community water system and the entry point for which the system is submitting its treatment demonstration. The information collected here is also used to determine the system's deadline category and other population-specific requirements.

Section II

Section II is a checklist of the enclosures required for the submittal to be considered complete. Some of these enclosures may require significant time and resources to produce and may need to be prepared under the supervision of a professional engineer. Pay special attention to ensure that all enclosures are properly prepared and bear the appropriate signatures and/or seals.

Section III

Section III is a description of how the system will conduct compliance monitoring. Compliance monitoring consists of monitoring the free chlorine residual at the entry point and performing other monitoring as necessary when alternative technologies are in use to ensure that 4-log treatment of viruses is maintained. Systems begin compliance monitoring following approval by the Department that they have successfully demonstrated 4-log treatment of viruses for their groundwater source(s).

ITEM-BY-ITEM INSTRUCTIONS

Section I: General Information

PWS Name: Name of the public water system.

PWS ID: The seven-digit public water system identification number assigned by DEP.

Owner Name: Name of the person or entity that legally owns the water system.

Municipality: Name of the municipality served by the water system.

County: The county in which the water system is located.

Mailing Address, City/State, ZIP and Telephone Number: The mailing address of the water system. This may or may not be the actual location of the facility. Include the telephone number of the water system contact person.

Population Served: The number of people served by the water system.

Entry Point ID#: The DEP identification number of the entry point for which this submission is being made. If the system supplies more than one entry point served by groundwater, a separate submission is required for each entry point.

Minimum Water Temperature (°C): The lowest annual water temperature measured in any vessel used for disinfectant contact time. For most groundwater systems, this will be the raw water temperature during the coldest month of the year. For systems with exposed above-ground storage, however, this will likely be the temperature of the water in that vessel during the coldest month of the year. If there is no available data, enter 5°C and use that value for all log-inactivation determinations.

Peak Flow (GPM): The peak flow of all of the combined sources flowing through the entry point, including surface water and/or groundwater under the direct influence of surface water (GUDI) sources that may be supplementing groundwater sources.

Section II: Checklist of Enclosures

A. Required Enclosures:

Completed 4-log Spreadsheet: Water systems demonstrating 4-log treatment of viruses to the Department must enclose, along with this form, one completed Groundwater Rule 4-Log Treatment Demonstration Free Chlorine Log-Inactivation of Viruses (pH 6.0-9.0) Spreadsheet (3800-FM-WSFR0470d) for each entry point served by groundwater sources. This spreadsheet calculates the log inactivation of viruses by chlorine disinfection by looking at the system in terms of segments. Each segment is assigned a baffling factor and, together with peak flow, a minimum effective contact time is determined. The minimum effective contact times for all of the segments are then summed for a total effective contact time. The spreadsheet uses the total effective contact time along with the minimum residual disinfectant level and minimum annual water temperature to calculate the minimum log inactivation under normal operating conditions. This minimum log inactivation must be greater than or equal to 4.0* for the system to be approved for 4-log treatment of viruses.

The Department has also developed a paper worksheet version of the spreadsheet (3800-FM-WSFR0470c) that can be used and submitted in place of the Excel worksheet.

*The log inactivation generated by the spreadsheet and/or worksheet may be less than 4.0 only if the system is using supplemental treatment with approved log-treatment credit for viruses. The total log treatment must be greater than or equal to 4.0.

Tracer Study Report: Water systems may choose to hire a professional engineer to conduct a tracer study of the treatment system in lieu of submitting the 4-log spreadsheet. The tracer study must, at a minimum, define the minimum effective contact time from the point of disinfectant application to the entry point. The tracer study must also include the calculations for total CT and minimum annual log-inactivation of viruses by free chlorine (taking into account the minimum annual water temperature). For specific tracer study requirements consult your DEP Regional Office.

Plant or System Schematic: Enclose a plant or treatment system schematic that shows all sources, treatment processes, and conveyances between the sources and the entry point. The treatment segments identified in the 4-log Spreadsheet must be clearly labeled on the schematic. The location(s) where compliance monitoring grab sampling or continuous monitoring will be conducted must also be clearly labeled.

- B. Describe your justification for the minimum temperature noted above and used in your log-inactivation calculation (the minimum temperature used on the submitted spreadsheet or worksheet):**
- C. Did you include any length of pipe downstream of the entry-point but upstream of the first customer in the CT calculations?:** Some water systems may benefit by including pipe volume between the compliance monitoring location at the traditional entry point and the first customer in their CT calculation for determining 4-log inactivation by free chlorine. However, the residual disinfectant level may degrade as the finished water travels over that distance. Systems wishing to use pipe volumes between the entry point and first customer may either conduct a pilot study to measure the free chlorine residual degradation and set their minimum entry point residual accordingly, or install a new monitoring location downstream of the traditional entry point, but still upstream of the first customer. If a system chooses to have a pilot study performed, the study must be conducted by a professional engineer and the engineer's report, along with data gathered, must be submitted with this demonstration form. If a system chooses to install a new sampling tap for monitoring purposes, the installation may require a permit amendment. For specific pilot study requirements or remote monitoring requirements consult your regional DEP office.
- D. Will you need to make any physical changes to your treatment system or processes that will require you to obtain a minor or major permit amendment?:** Most systems will be able to meet the requirement for 4-log treatment of viruses with their existing system configuration. Some systems, such as those with limited storage capacity or those using residual-free disinfection technologies, will have to make system modifications to comply with the Groundwater Rule. Such systems may need to add storage capacity, modify existing storage by adding baffles, or install new or additional treatment. Changes such as these will require minor or major permit amendments prior to installation.

Appropriate Completed Permit Applications: Changes to your treatment system or processes may require a minor or major permit amendment prior to installation. Consult with your DEP regional office to determine which permit applications are required for your proposed changes. Obtain these permits in advance or include the completed permit applications with the appropriate signatures and seals with this demonstration form.

- E. Do you plan to use any treatment technologies other than or in addition to chlorine disinfection (i.e., ultraviolet disinfection, ozone, etc.) to achieve 4-log treatment of viruses for groundwater?:** Section III is focused on compliance monitoring for chlorine disinfection since most systems will use that technology to satisfy the requirement for 4-log treatment of viruses. Systems using other technologies in lieu of, or in addition to chlorine disinfection, must prepare and submit enclosures that describe how they plan to satisfy the compliance monitoring requirements. Systems using alternative technologies should contact their DEP Regional Office for information about acceptable compliance monitoring for specific technologies. Systems obtaining a permit to provide 4-log treatment of viruses using an alternative treatment technology will be assigned special conditions relating to compliance monitoring in their operation permit.
- F. Are you requesting an alternative minimum entry-point free chlorine residual?:** Systems with limited storage capacity may be able to satisfy the requirement for 4-log treatment of viruses by maintaining a reasonable free chlorine residual greater than the default minimum of 0.40 mg/L. These systems must propose an alternative entry point free chlorine residual that will provide 4-log treatment of viruses.

In addition, systems with excessive storage capacity and long effective contact times may be able to provide 4-log treatment of viruses with entry point free chlorine residuals that are less than the default minimum of 0.40 mg/L. These systems may also propose an alternative entry point residual that provides 4-log treatment of viruses. The alternative entry point residual may be no less than 0.20 mg/L free chlorine or its equivalent. The alternative minimum entry point free chlorine residual will be added as a special condition to the existing permit.

Section III: Compliance Monitoring of Entry Point Free Chlorine Residual

A. List all of the sources supplying this entry point: List ID#, name, type, and maximum yield of all of sources supplying the entry point, including surface water and groundwater under the direct influence of surface water (GUDI). Systems can visit the online Drinking Water Reporting System to find their source and entry point ID numbers: (http://www.drinkingwater.state.pa.us/dwrs/HTM/DEP_frm.html)

B. Indicate whether the system will use a continuous analyzer(s) or grab sampling to measure the free chlorine residual at the entry point(s). Systems serving greater than 3,300 people are required to continuously monitor the residual disinfectant concentration at the entry point or other location approved by the Department and record the results at least every 15 minutes each day that water from the groundwater source is served to the public. Systems serving 3,300 people or fewer may also continuously monitor and record the residual disinfectant concentration, or at a minimum, are required to take a daily grab sample at the approved compliance monitoring location during the hour of peak flow or at any other time specified by the Department. If any daily grab sample measurement falls below the Department-required minimum residual disinfectant concentration, the groundwater system shall take follow up samples at least every 4 hours until the residual disinfectant concentration is restored to the Department-approved minimum level. Systems must indicate here which type of monitoring they intend to perform to satisfy the compliance monitoring requirement.

C. If grab sampling will be conducted for regular compliance monitoring of free chlorine residuals, indicate the hour of peak flow when samples will be collected: All grab samples for compliance monitoring of the free chlorine residual must be collected during the hour of peak flow or other time acceptable to the Department. Consult with your DEP Regional Office for acceptable sampling times and indicate on this form the hour when daily grab sampling will occur.

D. Provide the manufacturers name and model number of each instrument used to monitor free chlorine residual. Indicate which instruments serve as back-up only, and whether each instrument is a continuous chlorine analyzer or portable/benchtop chlorine analyzer. List the equipment to be used to measure the chlorine residual at the compliance monitoring location for this entry point. If you are using a grab sampling method, list both the primary and back-up benchtop chlorine analyzers indicating which instrument serves as the back-up. Systems using continuous analyzers must also keep and maintain a back-up benchtop chlorine analyzer to measure grab samples whenever a continuous analyzer fails or is taken off-line. List all chlorine analyzing instruments here.

Do all of the instruments listed above use an EPA-approved analytical method? All free chlorine entry point residual results reported to the Department to meet the compliance monitoring requirements must be measured by instruments using EPA-approved analytical methods. Refer to the Code of Federal Regulations, CFR 141.74(a)(2), for the current methods acceptable to EPA for measuring free chlorine residuals.

E. On the enclosed schematic, identify the compliance monitoring location for this entry point. If you are planning to conduct compliance monitoring at a location other than the traditional entry point, explain: The compliance monitoring location for continuous monitoring or grab sampling must be indicated on the treatment plant schematic included with this submission. If you are planning to conduct compliance monitoring at a location other than the traditional entry point (e.g., a location downstream of the entry point but still upstream of the first customer in order to gain additional CT volume), explain why this alternative monitoring location is necessary. Include in your explanation why other options for attaining 4-log treatment of viruses were ruled out or deemed to be insufficient.

MAILING

Mail all submittals to your DEP Regional Office:

Northwest Regional Office

WSM Program
230 Chestnut Street
Meadville, PA 16335

Northcentral Regional Office

WSM Program
208 West Third Street, Suite 101
Williamsport, PA 17701-6448

Northeast Regional Office

WSM Program
2 Public Square
Wilkes-Barre, PA 18711-0790

Southwest Regional Office

WSM Program
400 Waterfront Drive
Pittsburgh, PA 15222

Southcentral Regional Office

WSM Program
909 Elmerton Avenue
Harrisburg, PA 17110

Southeast Regional Office

WSM Program
2 East Main Street
Norristown, PA 19401



CWS Demonstration of 4-Log Treatment of Viruses for Groundwater Sources

I. General Information

CWS Name: _____ PWS ID #: _____
 Owner Name: _____
 Municipality: _____ County: _____
 Mailing Address: _____
 City/State: _____, _____ Zip Code: _____ Telephone #: (____) _____
 Pop. Served: _____ Entry Point ID: _____ Min. Water Temp. (°C)**: _____ Peak Flow (GPM)*: _____

*GPM = Gallons Per Minute, peak flow through the entry point.

**Annual minimum temperature of your raw water or of the water in your disinfectant contact storage vessel, whichever is lower.

II. Checklist of Enclosures

A. Required enclosures:

- Plant or system schematic showing the location where compliance monitoring will be conducted
And,
- Completed Groundwater Rule 4-Log Treatment Demonstration Free Chlorine Log-Inactivation of Viruses (pH 6.0-9.0) Spreadsheet or Worksheet (3800-FM-WSFR0470c or 3800-FM-WSFR0470d)
Or,
- Tracer Study Data and Report Bearing PE Seal (in lieu of 4-Log Spreadsheet)

B. Describe your justification for the minimum temperature noted above and used in your log-inactivation calculation (the minimum temperature used on the submitted spreadsheet or worksheet)*.

*Attach additional sheets, if necessary.

C. Did you include any length of pipe downstream of the entry-point but upstream of the first customer in the CT calculation for determining 4-log treatment of viruses? Yes No

If yes, how do you plan on accounting for chlorine degradation in the pipe downstream of the entry point?

- Chlorine degradation pilot study (attach pilot study results bearing PE seal)
- Remote monitoring location upstream of the first customer

D. Will you need to make any physical changes to your treatment system or processes that will require you to obtain a minor or major permit amendment (consult with DEP if you are unsure)? Yes No

- If yes, attach the appropriate completed permit application(s) bearing PE seal.

E. Do you plan to use any treatment technologies other than, or in addition to, chlorine disinfection (i.e., ultraviolet disinfection, ozone, etc.) to achieve 4-log treatment of viruses for groundwater? Yes No

If yes, attach descriptions of all technologies used including manufacturer, model, and/or pilot study report confirming each technology's level of effectiveness at removing and/or inactivating viruses. Include a description of how compliance monitoring will be conducted for each technology.

F. Are you requesting an alternative minimum entry-point free chlorine residual? Yes No

If yes, indicate the requested alternative minimum residual and describe your justification for not using the default minimum residual*: _____ mg/L Free Cl

*Attach additional sheets, if necessary.

III. Compliance Monitoring of Entry Point Free Chlorine Residual

A. List all of the sources supplying this entry point*:

Source ID#, Name, Type (Surface, GUDI, or Groundwater), and max yield.

| | | | | |
|---|---|---|---|-----|
| # | , | , | , | GPM |
| # | , | , | , | GPM |
| # | , | , | , | GPM |
| # | , | , | , | GPM |

*Attach additional sheets if necessary.

B. Indicate whether the system will use a continuous analyzer(s) or grab sampling to measure the free chlorine residual at the entry point.

Continuous Chlorine Analyzer(s) Grab Sampling

C. If performing grab sampling for compliance monitoring, indicate the hour of peak flow when grab samples will be collected and analyzed: _____

D. Provide the manufacturer's name and model number of each instrument used to monitor the entry point free chlorine residual. Indicate which instruments serve as back-up only and whether each instrument is a continuous chlorine analyzer or portable/benchtop chlorine analyzer.

| Manufacturer and Model # | Back-up | Type |
|--------------------------|--------------------------|--|
| # | <input type="checkbox"/> | <input type="checkbox"/> Continuous <input type="checkbox"/> Portable/benchtop |
| # | <input type="checkbox"/> | <input type="checkbox"/> Continuous <input type="checkbox"/> Portable/benchtop |
| # | <input type="checkbox"/> | <input type="checkbox"/> Continuous <input type="checkbox"/> Portable/benchtop |
| # | <input type="checkbox"/> | <input type="checkbox"/> Continuous <input type="checkbox"/> Portable/benchtop |

Do all of the chlorine analyzers listed above use an EPA-approved analytical method*? Yes No

*All chlorine analyzers used for compliance monitoring must use an EPA-approved analytical method.

E. On the enclosed schematic, identify the compliance monitoring location for this entry point. If you are planning to conduct compliance monitoring at a location other than the traditional entry point, explain:

CERTIFICATION AND SIGNATURES

I hereby certify that the completeness report and all plans, modules, and documents designated therein are attached to this application, and made a part hereof.

| | |
|---|--|
| <p>Address:</p> <hr/> <hr/> <hr/> <hr/> | <hr/> <p>(Signature of Certified Operator)</p> <hr/> <p>(Name of Certified Operator)</p> <hr/> <p>(Title of Certified Operator)</p> <hr/> <p>(Date of Application)</p> |
|---|--|

AFFIDAVIT

Commonwealth of Pennsylvania/State of _____
(Circle one)

County of

I, _____ being duly sworn, according to law, depose and say that
I (am the applicant) (am an officer or official of the applicant) (have the authority to make this application) and that
(Circle one)
the plans, reports and documents submitted as part of the application are true and correct to the best of my
knowledge and belief.

Sworn and Subscribed to before me this Day of ,

(Signature of Certified Operator)

(Notary Public)

Notary Seal

Engineering (if applicable)

Name of Design Engineer _____

Name of Engineering Firm

Address:

(Signature of Design Engineer)

(Date)

Phone:

Design Engineer's Seal

Appendix D

4-Log Longhand Worksheet



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

Groundwater Rule 4-log Treatment Demonstration
Free Chlorine Log-Inactivation of Viruses (pH 6.0-9.0) Worksheet

PWS Name: _____ PWS ID: _____

EP ID: _____

| | |
|--|--------------|
| Disinfection Segment #1 (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). | A _____ |
| B Enter the baffling factor for the segment (See Appendix A). | B _____ |
| C Calculate the effective volume of the segment (Multiply Line A by Line B). | C _____ |
| | |
| Disinfection Segment #2 (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). | A _____ |
| B Enter the baffling factor for the segment (See Appendix A). | B _____ |
| C Calculate the effective volume of the segment (Multiply Line A by Line B). | C _____ |
| | |
| Disinfection Segment #3 (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). | A _____ |
| B Enter the baffling factor for the segment (See Appendix A). | B _____ |
| C Calculate the effective volume of the segment (Multiply Line A by Line B). | C _____ |
| | |
| Disinfection Segment #4 (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). | A _____ |
| B Enter the baffling factor for the segment (See Appendix A). | B _____ |
| C Calculate the effective volume of the segment (Multiply Line A by Line B). | C _____ |
| | |
| Disinfection Segment #5 (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). | A _____ |
| B Enter the baffling factor for the segment (See Appendix A). | B _____ |
| C Calculate the effective volume of the segment (Multiply Line A by Line B). | C _____ |
| | |
| Disinfection Segment #6 (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). | A _____ |
| B Enter the baffling factor for the segment (See Appendix A). | B _____ |
| C Calculate the effective volume of the segment (Multiply Line A by Line B). | C _____ |

| | |
|---|-------------------------------|
| Disinfection Segment # (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). B Enter the baffling factor for the segment (See Appendix A). C Calculate the effective volume of the segment (Multiply Line A by Line B). | A _____ B _____ C _____ |
| Disinfection Segment # (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). B Enter the baffling factor for the segment (See Appendix A). C Calculate the effective volume of the segment (Multiply Line A by Line B). | A _____ B _____ C _____ |
| Disinfection Segment # (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). B Enter the baffling factor for the segment (See Appendix A). C Calculate the effective volume of the segment (Multiply Line A by Line B). | A _____ B _____ C _____ |
| Disinfection Segment # (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). B Enter the baffling factor for the segment (See Appendix A). C Calculate the effective volume of the segment (Multiply Line A by Line B). | A _____ B _____ C _____ |
| Disinfection Segment # (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). B Enter the baffling factor for the segment (See Appendix A). C Calculate the effective volume of the segment (Multiply Line A by Line B). | A _____ B _____ C _____ |
| Disinfection Segment # (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). B Enter the baffling factor for the segment (See Appendix A). C Calculate the effective volume of the segment (Multiply Line A by Line B). | A _____ B _____ C _____ |
| Disinfection Segment # (Attach system schematic with segments identified by number) | Description: |
| A Enter the <u>minimum</u> volume maintained in the segment (gal). B Enter the baffling factor for the segment (See Appendix A). C Calculate the effective volume of the segment (Multiply Line A by Line B). | A _____ B _____ C _____ |

| | | | | |
|---|----|--|----|-------|
| Entry Point CT | ΣC | Calculate the <u>total</u> effective volume (sum all Line C's, above). | ΣC | _____ |
| | D | Enter the peak flow rate through the entry point (gal/min). | D | _____ |
| | E | Calculate the total effective contact time (min) (divide Line ΣC by Line D). | E | _____ |
| | F | Enter the <u>minimum</u> free chlorine residual at the entry point (mg/L). | F | _____ |
| | G | Calculate the total CT's achieved by free chlorine (multiply Line E by Line F). | G | _____ |
| Entry Point Log Inactivation | H | Enter the minimum temperature* of your source water. | H | _____ |
| | I | Enter the total CT value required for 4-log inactivation of viruses at the temperature you entered in Line H (Refer to Table 1). | I | _____ |
| | J | Calculate the total log inactivation of viruses by free chlorine in your disinfection process (Divide Line G by Line I and multiply by 4.0). | J | _____ |

*You must provide support for the designated minimum temperature on the 4-Log Demonstration Form and submit the appropriate data.

Table 1: CT Values (mg*min/L) Required for 4-Log Inactivation of Viruses by Free Chlorine, pH 6.0-9.0

| Temperature | CT Value Required |
|-------------|-------------------|
| 0.5 | 12 |
| 1 | 11.6 |
| 2 | 10.7 |
| 3 | 9.8 |
| 4 | 8.9 |
| 5 | 8.0 |
| 6 | 7.6 |
| 7 | 7.2 |
| 8 | 6.8 |
| 9 | 6.4 |
| 10 | 6.0 |
| 11 | 5.6 |
| 12 | 5.2 |
| 13 | 4.8 |
| 14 | 4.4 |
| 15 | 4.0 |
| 16 | 3.8 |
| 17 | 3.6 |
| 18 | 3.4 |
| 19 | 3.2 |
| 20 | 3.0 |
| 21 | 2.8 |
| 22 | 2.6 |
| 23 | 2.4 |
| 24 | 2.2 |
| 25 | 2.0 |

Signature of Certified Operator or Professional Engineer _____

Date _____

Appendix A

Common Vessel Configurations with Corresponding Baffling Factors

| Baffling Condition: | No contact time | Unbaffled | Poor |
|---------------------|--|--|--|
| Description: | Atmospheric or hydropneumatic storage vessels with a single combined inlet/outlet. | No intrabasin baffles, mixed flow, agitated basin, very low length to width ratio, high inlet and outlet flow velocities | Single or multiple unbaffled inlets and outlets, no intrabasin baffles |
| Baffling Factor: | 0 | 0.1 | 0.3 |
| Example: | | | |
| | | | |

| Baffling Condition: | Average | Superior | Near-Plugflow | Plugflow |
|-------------------------|--|---|---|---|
| Description: | Baffled inlet or outlet with at least 2 or more intrabasin baffles | Perforated inlet baffle with at least 2 or more serpentine or perforated intrabasin baffles. An outlet weir or perforated launders. | High length to width ratio of 5:1 or greater pipeline flow. | Very high length to width ratio of 40:1 or greater pipeline flow. |
| Baffling Factor: | 0.5 | 0.7 | 0.9 | 1.0 |
| Example: | | | | |
| | | | | |

Appendix E

SDWA-1 Form

(For Reporting Entry Point Free-Chlorine Residuals)



BACTERIOLOGICAL/RESID

PWS Name: Crystal Clear Water Company
 Address: 234 Main Street
 Anytown, PA 12345

This example contains:

1 Reporting violation

and

2 Tier 1 violations for the breakdown of 4-log treatment.

See if you can find them, and circle them on this form.

| PWS ID | TRANS* | CONTAM ID | CONTAMINANT NAME | | | SAMPLE PERIOD MMDDYY TO MMDDYY | |
|----------|---------------------------|------------|---------------------|---------------------|------------|-----------------------------------|------|
| 1234567 | 03 | 0999 | Free Chlorine | | | 01/01/13 to 01/31/13 | |
| ANALYSIS | | | LOCATION ID 1 | LOCATION ID 2 | SAMPLE | | |
| METHOD | RESULT (Incl. Decimal) | MMDDYY | (Loc, EP, or Plant) | (Individual Filter) | MMDDYY | TYPE | TIME |
| 301 | 0.45 | 01/01/2013 | 101 | | 01/01/2013 | E | 0810 |
| 301 | 0.51 | 01/02/2013 | 101 | | 01/02/2013 | E | 0825 |
| 301 | 1.10 | 01/03/2013 | 101 | | 01/03/2013 | N | 0817 |
| 301 | 0.89 | 01/04/2013 | 101 | | 01/04/2013 | E | 0801 |
| 301 | 0.75 | 01/05/2013 | 101 | | 01/05/2013 | E | 0913 |
| 301 | 0.46 | 01/06/2013 | 101 | | 01/06/2013 | E | 0819 |
| 301 | 0.22 | 01/07/2013 | 101 | | 01/07/2013 | E | 0822 |
| 301 | 0.41 | 01/07/2013 | 101 | | 01/07/2013 | E | 1230 |
| 301 | 0.96 | 01/08/2013 | 101 | | 01/08/2013 | E | 0834 |
| 301 | 0.83 | 01/09/2013 | 101 | | 01/09/2013 | E | 0811 |
| 301 | 0.55 | 01/10/2013 | 101 | | 01/10/2013 | E | 0810 |
| 301 | 0.39 | 01/11/2013 | 101 | | 01/11/2013 | E | 0816 |
| 301 | 0.48 | 01/12/2013 | 101 | | 01/12/2013 | E | 0809 |
| 301 | 0.57 | 01/13/2013 | 101 | | 01/13/2013 | E | 0825 |
| 301 | 0.55 | 01/14/2013 | 101 | | 01/14/2013 | E | 0819 |
| 301 | 0.69 | 01/16/2013 | 101 | | 01/16/2013 | E | 0815 |

*TRANSACTION CODE: COLIFORM = 05 DIS. RES. & TTHM = 03

| | | |
|---------------------------------|-----------------------|--------|
| LAB. NAME: _____ | PHONE: _____ | LAB ID |
| APPROVED BY: <u>John Pieman</u> | DATE: <u>02/03/13</u> | |

NOTE: Notify the department in writing of any MCL or PLR violation within 48 hours of its determination, or of any individual filter turbidity triggers within 24 hours of determination.

 White - Data Processing Yellow - Water Supplier Pink - Laboratory

Groundwater Rule (GWR) Compliance Monitoring Job Aid

Public water systems providing DEP approved 4-log inactivation of viruses for its groundwater sources are required to submit daily entry point free chlorine residual concentrations to demonstrate compliance with treatment standards. Systems will receive notification in writing that DEP has approved their 4-log treatment submission and the date that compliance monitoring should begin.

Monitoring Requirements:

For systems serving a population greater than 3,300:

- Monitor free chlorine residual continuously and record results every 15 minutes.
- If continuous monitoring equipment fails, conduct grab sampling every 4 hours until the equipment is restored, but for a maximum of 14 days.

For systems serving a population less than or equal to 3,300:

- Systems may choose to monitor continuously. Systems monitoring continuously must follow the monitoring guidelines listed above for systems serving a population greater than 3,300.
- Or, systems may choose to conduct grab sampling. Grab sampling consists of monitoring free chlorine residual one time per day during hour of peak flow (or as specified by DEP in the permit conditions).
- If any routine daily sample result falls below the minimum residual, take follow-up samples (at least) every four hours until the chlorine residual is restored to the minimum concentration and record the results.

Reporting Results to DEP:

- Reporting to DEP is completed using an **SDWA-1** form.
- Report the lowest entry point residual recorded each day.
- Report free chlorine residuals to the hundredth decimal place (**0.40** mg/L). For example, if you measure 0.39 mg/L, report 0.39. Or, if you measure 0.40 mg/L, report 0.40.
- If the residual falls below the required level, the system must report:
 - the date and time the system discovers the residual to be below the required level.
 - the date and time the residual is determined to be at or above the required level.
 - any additional periods when the residual falls below the required level.
- If the entry point chlorine residual falls below the required level on the last day of the month and is not restored to an acceptable level until the first day of the next month, include the record of the restored concentration with the first month's reporting.
- Report which day or days the entry point was not in use for the entire day. For this purpose, there is a new sample type of 'N' (Not in Use/Operation). Whenever a record is submitted using the Sample Type of 'N':
 - **The following fields are not reported on the form:** Analysis Method, Result, Analysis Date, Location ID 2, and Sample Time.

- **The following fields are required:** PWSID, Contaminant ID, Location ID 1, and Sample Date. Sample Type 'N' is only valid with disinfectant contaminant codes and entry point locations.

Refer to the next pages for examples of proper reporting and the [Laboratory Reporting Instructions for Disinfectant Residuals, Disinfection Byproducts and Precursors](#) (document number 383-3301-306) for a list of disinfectant contaminant codes and analysis method codes.

Compliance Tips:

- A **breakdown in treatment** is defined as the failure to meet the minimum disinfectant residual or operate in accordance with maximum flow rate as specified in the approved demonstration or permit conditions for greater than four (4) continuous hours. This situation requires a water supplier to notify DEP within one (1) hour and issue a Tier 1 Public Notice (PN) Boil Water Advisory within 24 hours.
- To avoid this situation, water suppliers should do the following if they discover that the disinfectant concentration has fallen below the minimum residual:
 - Take action to increase the disinfectant residual at the entry.
 - Monitor the entry point chlorine residual closely until it is restored to the minimum concentration.
 - Record the sample time and free chlorine concentration to verify that the entry point disinfectant concentration has returned to the minimum residual within four (4) hours.
 - Refer to pages 3 and 4 for examples of how to report to DEP via SDWA-1 for
- Whenever special permit conditions related to the approved 4-Log Demonstrations are violated, systems must take action to adjust applicable parameters (e.g., flow rate) to return them to compliance within 4 hours.

Example of Permit Special Conditions

This permit is issued subject to all Department of Environmental Protection Rules and Regulations now in force and the following Special Conditions:

1. The Example Well Station treatment facilities shall be operated in accordance with the following conditions to provide 4-log treatment of viruses:
 - A. The instantaneous maximum flow through the treatment system shall not exceed 511 gallons per minute.
 - B. The minimum free chlorine residual at the entry point shall not be less than 0.4 mg/L.
 - C. Continuously monitor the free chlorine residual at the entry point and record the results at least every 15 minutes each day that water is served to the public. If there is a failure of the continuous monitoring equipment, conduct grab sampling every 4 hours until the continuous monitoring equipment is returned to service. The system shall return to continuous residual disinfectant monitoring within 14 days.

Maximum Flow Rate

Minimum Free Chlorine Residual

Monitoring Requirement

SDWA-1: Data Field Instructions for Reporting GWR Compliance Monitoring Results

3800-FM-WSFR0129 7/2005



pennsylvania

DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

**BACTERIOLOGICAL/RESIDUAL DISINFECTANT/TURBIDITY/DBP ANALYSIS
SDWA-1**

| PWS Name: [REDACTED] | Use "03" for Disinfectant Residual | Use "0999" for Chlorine | "Chlorine" | Phone: [REDACTED] | | |
|---|------------------------------------|--|---------------------|-----------------------------------|--|------------|
| PWS ID | RANS* | CONTAM ID | CONTAMINANT NAME | SAMPLE PERIOD MMDDYY TO MMDDYY | | |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] to [REDACTED] | | |
| ANALYSIS | | LOCATION ID 1 | LOCATION ID 2 | SAMPLE | | |
| METHOD | RESULT (Incl. Decimal) | MMDDYY (Loc, EP, or Plant) | (Individual Filter) | MMDDYY | TYPE | TIME |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| <p>Enter sample analysis date. NOTE: If Entry Point not in service that day, leave blank.</p> <p>Free Chlorine Residual in mg/l to two decimal places (lowest of the day for continuous analyzer or during hour of peak flow for grab sample). NOTE: If Entry Point not in service that day, leave blank.</p> | | <p>Enter sample collection date. There may be more than one entry per date if residual goes below minimum concentration. NOTE: Even if Entry Point not in service that day, be sure to enter date.</p> <p>3-digit Entry Point ID – Can be obtained from: http://www.drinkingwater.state.pa.us NOTE: Even if Entry Point not in service that day, be sure to enter the Entry Point ID.</p> | | | <p>Enter the time sample was collected. NOTE: If Entry Point not in service that day, leave blank.</p> | |
| <p>Method Code for All Approved Chlorine Analysis Methods is "301." NOTE: If Entry Point not in service that day, leave blank</p> | | | | | <p>Use Sample Type "E." NOTE: If Entry Point not in service that day, be sure to enter Sample Type "N."</p> | |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| *TRANSACTION CODE: COLIFORM = 05 | | DIS. RES. & TTHM = 03 | | | | |
| LAB. NAME: [REDACTED] | PHONE: [REDACTED] | | | LAB ID | | |
| APPROVED BY: [REDACTED] | DATE: [REDACTED] | | | | | |

SDWA-1: Example of a Properly Completed Report (Days 1 thru 15)

3800-FM-WSFR0129 7/2005



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

BACTERIOLOGICAL/RESIDUAL DISINFECTANT/TURBIDITY/DBP ANALYSIS SDWA-1

| PWS Name: Example Authority Address: 123 Main Street Anytown, PA 17555 | | Notes: • Minimum permit specified free chlorine residual is 0.40 mg/l • †EP chlorine residual went below 0.40 mg/l for < 2 hrs on 010610 • ††EP not in service on days 010810 and 011110 | | Phone: 717-555-1234 | | | |
|--|---------------------------|---|---------------------|-----------------------|------------------|------|------|
| PWS ID | TRANS* | CONTAM ID | CONTAMINANT NAME | | MMDDYY TO MMDDYY | | |
| 1234567 | 03 | 0999 | Chlorine | | 010110 to 013110 | | |
| ANALYSIS | | | LOCATION ID 1 | LOCATION ID 2 | SAMPLE | | |
| METHOD | RESULT (Incl. Decimal) | MMDDYY | (Loc, EP, or Plant) | (Individual Filter) | MMDDYY | TYPE | TIME |
| 301 | 0.40 | 010110 | 101 | | 010110 | E | 0900 |
| 301 | 0.75 | 010210 | 101 | | 010210 | E | 0900 |
| 301 | 0.83 | 010310 | 101 | | 010310 | E | 0900 |
| 301 | 0.88 | 010410 | 101 | | 010410 | E | 0900 |
| 301 | 0.75 | 010510 | 101 | | 010510 | E | 0900 |
| †301 | 0.33 | 010610 | 101 | | 010610 | E | 0900 |
| †301 | 0.55 | 010610 | 101 | | 010610 | E | 1100 |
| 301 | 0.79 | 010710 | 101 | | 010710 | E | 0900 |
| | | | ††101 | | 010810 | N | |
| 301 | 0.88 | 010910 | 101 | | 010910 | E | 0900 |
| 301 | 0.83 | 011010 | 101 | | 011010 | E | 0900 |
| | | | ††101 | | 011110 | N | 0900 |
| 301 | 0.76 | 011210 | 101 | | 011210 | E | 0900 |
| 301 | 0.69 | 011310 | 101 | | 011310 | E | 0900 |
| 301 | 0.41 | 011410 | 101 | | 011410 | E | 0900 |
| 301 | 0.56 | 011510 | 101 | | 011510 | E | 0900 |
| *TRANSACTION CODE: COLIFORM = 05 | | | | DIS. RES. & TTHM = 03 | | | |

| | | |
|-------------------------|---------------------|---------|
| LAB. NAME: Example PWS | PHONE: 717-555-1234 | LAB ID |
| APPROVED BY: Jane Smith | DATE: 013110 | 12-0345 |

SDWA-1: Examples of GWR Compliance Monitoring Results Reported to DWELR

DWELR SDWA-1 Template GWR Example

Appendix F

**CT Tables for Common
Disinfectants
(from EPA Disinfection Profiling
and Benchmarking Guidance
EPA 815-R-99-013)**

Table C-7. CT Values for Inactivation of Viruses by Free Chlorine, pH 6.0-9.0

| Inactivation (log) | Temperature (°C) | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|------------------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 0.5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 2 | 6.0 | 5.8 | 5.3 | 4.9 | 4.4 | 4.0 | 3.8 | 3.6 | 3.4 | 3.2 | 3.0 | 2.8 | 2.6 | 2.4 | 2.2 | 2.0 | 1.8 | 1.6 | 1.4 | 1.2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | |
| 3 | 9.0 | 8.7 | 8.0 | 7.3 | 6.7 | 6.0 | 5.6 | 5.2 | 4.8 | 4.4 | 4.0 | 3.8 | 3.6 | 3.4 | 3.2 | 3.0 | 2.8 | 2.6 | 2.4 | 2.2 | 2.0 | 1.8 | 1.6 | 1.4 | 1.2 | 1.0 |
| 4 | 12.0 | 11.6 | 10.7 | 9.8 | 8.9 | 8.0 | 7.6 | 7.2 | 6.8 | 6.4 | 6.0 | 5.6 | 5.2 | 4.8 | 4.4 | 4.0 | 3.8 | 3.6 | 3.4 | 3.2 | 3.0 | 2.8 | 2.6 | 2.4 | 2.2 | 2.0 |

Table C-9. CT Values for Inactivation of Viruses by Chlorine Dioxide, pH 6.0-9.0

| Inactivation (log) | Temperature (°C) | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 2 | 8.4 | 7.7 | 7.0 | 6.3 | 5.6 | 5.3 | 5.0 | 4.8 | 4.5 | 4.2 | 3.9 | 3.6 | 3.4 | 3.1 | 2.8 | 2.7 | 2.5 | 2.4 | 2.2 | 2.1 | 2.0 | 1.8 | 1.7 | 1.5 | 1.4 |
| 3 | 25.6 | 23.5 | 21.4 | 19.2 | 17.1 | 16.2 | 15.4 | 14.5 | 13.7 | 12.8 | 12.0 | 11.1 | 10.3 | 9.4 | 8.6 | 8.2 | 7.7 | 7.3 | 6.8 | 6.4 | 6.0 | 5.6 | 5.1 | 4.7 | 4.3 |
| 4 | 50.1 | 45.9 | 41.8 | 37.6 | 33.4 | 31.7 | 30.1 | 28.4 | 26.8 | 25.1 | 23.4 | 21.7 | 20.1 | 18.4 | 16.7 | 15.9 | 15.0 | 14.2 | 13.3 | 12.5 | 11.7 | 10.9 | 10.0 | 9.2 | 8.4 |

Table C-11. CT Values for Inactivation of Viruses by Chloramine

| Inactivation (log) | Temperature (°C) | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 2 | 1,243 | 1,147 | 1,050 | 954 | 857 | 814 | 771 | 729 | 686 | 643 | 600 | 557 | 514 | 471 | 428 | 407 | 385 | 364 | 342 | 321 | 300 | 278 | 257 | 235 | 214 |
| 3 | 2,063 | 1,903 | 1,743 | 1,583 | 1,423 | 1,352 | 1,281 | 1,209 | 1,138 | 1,067 | 996 | 925 | 854 | 783 | 712 | 676 | 641 | 605 | 570 | 534 | 498 | 463 | 427 | 392 | 356 |
| 4 | 2,883 | 2,659 | 2,436 | 2,212 | 1,988 | 1,889 | 1,789 | 1,690 | 1,590 | 1,491 | 1,392 | 1,292 | 1,193 | 1,093 | 994 | 944 | 895 | 845 | 796 | 746 | 696 | 646 | 597 | 547 | 497 |

Table C-13. CT Values for Inactivation of Viruses by Ozone

| Inactivation (log) | Temperature (°C) | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 2 | 0.90 | 0.83 | 0.75 | 0.68 | 0.60 | 0.58 | 0.56 | 0.54 | 0.52 | 0.50 | 0.46 | 0.42 | 0.38 | 0.34 | 0.30 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.23 | 0.21 | 0.19 | 0.17 | 0.15 |
| 3 | 1.40 | 1.28 | 1.15 | 1.03 | 0.90 | 0.88 | 0.86 | 0.84 | 0.82 | 0.80 | 0.74 | 0.68 | 0.62 | 0.56 | 0.50 | 0.48 | 0.46 | 0.44 | 0.42 | 0.40 | 0.37 | 0.34 | 0.31 | 0.28 | 0.25 |
| 4 | 1.80 | 1.65 | 1.50 | 1.35 | 1.20 | 1.16 | 1.12 | 1.08 | 1.04 | 1.00 | 0.92 | 0.84 | 0.76 | 0.68 | 0.60 | 0.58 | 0.56 | 0.54 | 0.52 | 0.50 | 0.46 | 0.42 | 0.38 | 0.34 | 0.30 |

Appendix G

Additional Information for Compliance Monitoring

Table of Contents

| Document Name | Page # |
|--|---------------|
| EPA's Overview of the Underground Injection Control Program | G-2 |
| Inventory Information for Public Water Supplies Utilizing Class 5 Injection Wells for Disposal of In-line Analytical Wastewater | G-3 |



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029**

Public Water System Operators:

If you are considering using continuous monitoring to comply with the new Ground Water Rule, you will have to decide how to dispose of the wastewater that flows through the monitors. The Underground Injection Control (UIC) Program, authorized under the Safe Drinking Water Act, regulates injection of fluids into the ground through injection wells (defined below) to ensure that those fluids do not endanger underground sources of drinking water (USDWs). In Pennsylvania, the UIC Program is directly implemented by the U.S. Environmental Protection Agency (EPA).

Public Water System Requirements

Public water systems (PWSs) may choose to install continuous monitoring devices to comply with the new Ground Water Rule. The monitoring devices (amperometric or DPD), generate a small amount of wastewater containing chlorine and/or reagents. If the wastewater cannot be discharged to a sewer, it may need to be discharged into the ground through a shallow injection well. Accordingly, PWS owners or operators using shallow injection wells for this purpose are required to submit the information listed in the enclosure to EPA. Please send the inventory information to Andre Hoyer (3WP32), Ground Water and Enforcement Branch, U.S. EPA Region III, at the address above.

Injection Wells

A shallow injection well is any hole bored, drilled, or driven whose depth is its largest dimension. Shallow injection wells consist of a wide array of structures, shapes and configurations and include dry wells, French drains, drain fields or septic systems which receive any amount of industrial wastes. Shallow injection wells are called "Class V" ("class five") wells. Other types of wells include deep injection wells which are deep multi-cased wells used for the disposal of a variety of wastewater and other waste fluids. In accordance with federal UIC regulations, owners and operators of injection wells are required to submit specific inventory information to the implementing authority, which in Pennsylvania is EPA.

EPA Actions

EPA will review the inventory information that you send. If EPA determines that there is no potential for endangerment to the USDWs, EPA will authorize the well and add it to an inventory. You will not be hearing back from us unless we have questions, need additional information or determine there may be an unacceptable risk of endangerment. We appreciate your cooperation in this matter. If you have any questions, please contact Andre Hoyer at (215) 814-5461 or hoyer.andre@epa.gov.

Sincerely,

Roger Reinhart, Acting Chief
Ground Water & Enforcement Branch

Enclosure

Inventory Information for Public Water Supplies Utilizing Class 5 Injection Wells for Disposal of In-line Analytical Wastewater

Contact Information:

Name of Public Water System (PWS)

PWS ID _____

Name of Owner/Operator/Contact for System

Telephone # _____ Fax # _____

Mailing Address (street address, city, county, state)

Injection Well Information:

Injection Well 1 (Provide same information for any additional injection wells)

Describe injection well (dry well, French drain, septic system, etc) Provide well diagram.

Description and/or characterization of wastewater

Discharge rate (gallons per day)

Location of injection well (street address (if applicable), city, county)

Locational Coordinates (or provide detailed map)

N _____ ° _____ ' _____ ", W _____ °, _____ ' _____ "

Provide map depicting locations of public and private water wells within 1/4 mile of injection well.

Note: Provide similar information for any additional injection wells. Also operator must notify EPA of any modifications in injection fluid and volume, or if ground water is adversely impacted by operation of injection well.