

**Drinking Water Section Guidance
For The
Determination Of
Groundwater Under The Direct Influence Of Surface Water**



State of Connecticut
Department Of Public Health
Drinking Water Section
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Background

The United States Environmental Protection Agency (USEPA) promulgated the Surface Water Treatment Rule (SWTR) in June 1989, with an effective date of December 1990. The overall goal of the SWTR is to protect consumers from pathogens in surface water. For most affected public water systems, protection entails the use of a multiple-barrier approach including source water protection, filtration and disinfection when surface water is used as a public drinking water source. The requirements of the SWTR also apply to groundwater under the direct influence (GWUDI) of surface water.

The SWTR defines **Groundwater Under The Direct Influence Of Surface Water** as "*any water beneath the surface of the ground with:*

1. "significant occurrence of insects or other microorganisms, algae or large-diameter pathogens such as *Giardia*, or
2. significant and relatively rapid shifts in water characteristics such as temperature, conductivity, turbidity, or pH which correlate closely with climatological change or surface water conditions."

"Under the direct influence of surface water" also means the groundwater source is located close enough to nearby surface water, such as a river, lake or wetland, to receive direct surface water recharge. Since a portion of the groundwater source's recharge is presumed to be from surface water, the groundwater source is considered at risk of contamination from pathogens such as *Giardia*, *Cryptosporidium* and viruses, which are not normally found in true groundwaters. Groundwater sources determined to be GWUDI by the Drinking Water Section (DWS) are subject to the provisions of SWTR and must be treated pursuant to Section 19-13-B102(j)(2)(D) of the Regulations of Connecticut State Agencies (RCSA).

GWUDI Determination Criteria

The Drinking Water Section uses criteria developed pursuant to the USEPA SWTR to determine if groundwater sources are under the direct influence of surface water. The intent is to apply the SWTR to any groundwater sources, which are at risk to contamination from *Giardia*, *Cryptosporidium*, or other pathogenic organisms associated with surface water. The DWS criteria listed in Table 1 are applicable to the following well types: existing, new, or replacement wells. All proposed new wells must comply with the separation distances provided in Section 19-13-B51d of the RCSA and Section 19-13-B102 (d)(1)(A) of the RCSA.

The criteria listed in Table 1 also apply to existing sand and gravel wells that have not yet undergone an evaluation to determine if the source is under the direct influence of surface water and bedrock wells that do not comply with Section 19-13-B51d of the RCSA. Any existing groundwater source determined to be under the direct influence of surface water that is presently filtering and disinfecting must reliably achieve the levels of removal and inactivation specified in Section 19-13-B102(j) of the RCSA. Sources determined to be under the direct influence of surface water that disinfect only are not in compliance with Section 19-13-B102(j) of the RCSA.

The criteria in Table 1 do not apply to existing bedrock wells that are in compliance with Section 19-13-B51d of the RCSA.

Table 1 GWUDI Determination Criteria For A New, Existing Or Replacement Well

Item	Criterion	New, Existing Or Replacement Well In An Existing Wellfield ^(a)	New Well In A New Wellfield
1.	The casing or nearest collector lateral of the proposed new well is over 200 feet horizontally from the high water mark ^(b) of any surface water body as measured from the water surface elevation for a flood event with a one-year frequency of occurrence or the top of the bank of the surface water body; whichever is closest to the source.	√	√
2.	The casing or nearest collector lateral is over 50 feet horizontally from the high water mark ^(b) of any surface water body, as measured from the water surface elevation for a flood event with a one-year frequency of occurrence or the top of the bank; whichever is closest to the source and the well screen is separated from the surface water body by a confining layer “Confining layer” means a continuous areally extensive, permanent geologic unit of low permeability. A written report of how and why the confining layer separates the well from any surface water body located within 200 feet must be provided to the DWS. The report’s conclusion must be based on an adequate number of borings and documented by a geologist’s or driller’s log for any observation or monitoring wells confirming the continuity and areal extent of the confining layer and any other evidence such as surficial geological maps or pump test data which confirms existence of the confining layer.	√	√
3.	Source construction and separation distances meet the requirements of Section 19-13-B51(d) of the Regulations of Connecticut State Agencies (RCSA)	√	√
4.	There is no history of a known or suspected waterborne disease outbreak due to <i>Giardia</i> or other pathogenic organisms for existing wells.	√	N/A
5.	There is no history of total coliform or <i>E. coli</i> bacteria in the raw source water of an existing well (i.e., before treatment and distribution). Where total coliform or <i>E. coli</i> bacteria have been confirmed in distribution system samples, the presence of these bacteria shall be considered to be from the source unless documentation is submitted to and conferred upon by the Drinking Water Section that untreated source samples indicate otherwise.	√	N/A
6.	The source water turbidity has not exceeded 1.49 NTU within the past 3 years. If this is the only criterion that the source fails to meet and if the utility can demonstrate to the satisfaction of DPH that the turbidity is due to iron and/or manganese then the source is not considered potentially under the direct influence of surface water.	√	N/A

(a) “Wellfield” means one or more wells in reasonable proximity to one another and under the control of the same Public Water System

(b) If the location of the high water mark cannot be reliably determined, then the public water system must retain a qualified consultant to make the determination. The consultant’s findings must be concurred upon by the DWS.

Applying The GWUDI Determination Criteria

If an existing or new groundwater source fails to meet any of the applicable criteria in Table 1, it is potentially under the direct influence of surface water and the public water systems must take one of the actions outlined in Table 2. Alternatively, an existing or new groundwater source, which meets all of the applicable items listed in Table 1 is not under the direct influence of surface water. If an existing or new groundwater source is considered not to be under the direct influence of surface water based on the criteria in Table 1, that does not preclude a future determination of potential direct surface water influence should any of factors listed in Table 1 change or new information suggests that the well may be GWUDI.

After completing a review of the GWUDI criteria listed in Table 1 the public water system must evaluate and select one or more of the options presented in Table 2. If the DWS makes a determination in writing that a source is potentially under the direct influence of surface water, the public water system must also take one or more of the actions specified in Table 2 within 18 months of the determination.

In the case of a wellfield with more than one source, if any of the sources in the wellfield fail to meet any of the criteria in Table 1, except for certain correctable source construction deficiencies, those sources and any sources within 200 feet (inclusive) radially are potentially under the direct influence of surface water. For this scenario, the public water system must take one of the actions in Table 2. Examples of single and multiple wells relative to nearby surface water bodies are illustrated in Figure 1.

A single well with a correctable construction deficiency per 19-13-B51 of the RCSA does not necessarily mean the entire wellfield is potentially under the direct influence of surface water. However, that particular well is potentially under the direct influence of surface water and must either be reconstructed or replaced. If DPH determines that reconstruction or replacement is not feasible, the source is then considered to be potentially under direct influence of surface water for the purposes the demonstration study.

Table 2 Options For New Or Existing Groundwater Wells Determined To Be Potentially Under The Direct Influence Of Surface Water

Option Number	Option
(1)	Perform a GWUDI demonstration study pursuant to the criteria presented in the GWUDI Demonstration Study section
(2)	Replace the source with a source that is more than 200 feet horizontally from the high water mark of any surface water body or is hydraulically separated from surface water by an impervious layer or interconnect with another public water system
(3)	Reconstruct the source pursuant to Section 19-13-b51 of the RCSA
(4)	Install treatment pursuant to the Section 19-13-B102(j) of the RCSA within 18 months after notification by the DWS that filtration is required.

Conducting A GWUDI Demonstration Study

A GWUDI demonstration study entails the collection and analysis of weekly surface and groundwater samples for select physical parameters, weekly testing for total coliform and *E. coli* bacteria, and quarterly testing for microscopic particulates. These tests are intended to show if: a) there is a relationship between surface and groundwater physical parameters; b) bacteria are present in the untreated groundwater; and c) biological indicators of surface water are present in the groundwater. The

demonstration study must be based on testing, which includes, at a minimum, the following analytical determinations at the specified frequencies:

1. Microscopic Particulate Analysis (MPA) conducted according to EPA approved methods by a laboratory certified to conduct MPA testing. Raw water samples must be taken once per quarter for a period of one year from each well and analyzed for the surface water indicators listed below. The quarterly MPA samples must be taken at least 60 days apart.
 - a. *Giardia* cysts
 - b. Live diatoms
 - c. Insect parts including larvae
 - d. Blue green algae, green algae or other algae containing chloroplasts
 - e. *Coccidia*
 - f. *Cryptosporidium*

Note: If any other particulates or microorganisms greater than 7 microns are found during the course of the MPA analysis, they must be identified and reported.

2. Weekly physical analyses of untreated groundwater and surface water samples for a period of 12 months according to the most recent Edition of Standard Methods for the following parameters:
 - a. Temperature
 - b. Conductivity
 - c. Turbidity
 - d. pH
 - e. Color
 - f. Rainfall (optional)

Note: Raw water samples prior to treatment must be taken from each well and from all surface water bodies within 200 ft. of the well(s) being evaluated or the nearest surface water body within 500 feet if there are none within 200 ft. If no surface water bodies are within 500 feet or a potential surface water contributor has not been identified, sampling locations shall be discussed on a case-by-case basis with the DWS. The location of surface sampling sites shall be based on the estimated limits of the area of influence and the suitability of the site for taking accurate measurements and samples. Surface water samples shall be collected at mid-depth if the surface water is a body of standing water. Sample collection is not required if the surface water body is inaccessible due to the presence of thick ice.

3. Weekly analysis for a period of one year of untreated groundwater samples for total coliform and *E. coli* bacteria according to the most recent Edition of Standard Methods.

Prior to weekly coliform bacteria and quarterly MPA sampling of a well that is not in continuous operation, the well must be pumped to waste until a stabilized drawdown is achieved pursuant to Section 25-32d-1a(32) of the RCSA. When sampling a well that is not in continuous operation for the weekly physical analyses, the well must be pumped to waste for a minimum of 2 hours before any samples are taken.

The final GWUDI demonstration study report must include the following elements and be submitted on a form provided by the DWS:

1. Analytical test reports from a certified laboratory for the 4 quarterly MPA samples;
2. Determination of relative risk factors as presented in EPA's Guidance Manual and shown in Tables 4 and 5);

3. Separate graphs of the weekly physical test data for a period of year, one (52 weeks), comparing the surface water to each well/spring for each physical parameter (i.e., temperature, conductivity, turbidity, pH, and color),
(*Note*: if surface water data could not be obtained because the source was covered by ice or was dry, the report must list the dates and reasons why such data could not be obtained);
4. A graph showing the seasonal temperature variation of the groundwater for each well/spring over the course of one year. The graph shall include boundary lines set at ± 15 to 20% of the mean groundwater temperature;
5. Compilation of weekly raw groundwater test results for total coliform and *E. coli* bacteria;
6. A discussion of the data presented and a conclusion stating that the well/spring is or is not GWUDI, and what action the PWS intends to take based on the study outcome; and
7. Additional supporting information, if available, should be provided including:
 - a. Well construction records;
 - b. Sanitary survey reports;
 - c. Raw water quality data (i.e., bacteria) for past three years if available;
 - d. Geologic features of the aquifer; and
 - e. Historic records of a known or suspected disease outbreak due to a pathogenic organism.

The DWS determination of groundwater under the direct influence of surface water, based on the findings of the demonstration study, will be made on a case-by-case basis.

Well Use During GWUDI Demonstration Study

The DWS may issue a well use approval for an existing, new, or replacement well while a GWUDI demonstration study is underway if the public water systems installs an approved interim disinfection system and meets the criteria listed below under items 1-3. Samples for a new or replacement well must be taken at the conclusion of the required well yield test.

1. Initial MPA test results indicate that the total relative risk factors for the well are low (i.e., ≤ 9);
2. No *Giardia* or *Cryptosporidium* or Coccidia are present in the initial MPA sample; and
3. Results of an initial water quality test are negative for *E. coli* bacteria.

A well use approval will not be issued for new or replacement wells until the interim disinfection system has been installed and approved by the DWS, and all initial water quality and MPA test results are submitted to the DWS for review, and determined by the DWS to be in compliance with Section 19-13-B102 of the RCSA.

Conditions for the continued use of an existing, new, or replacement well during a GWUDI demonstration study shall include:

4. Interim disinfection, as approved by the DWS, must remain on-line throughout the entire demonstration study period. (*Note*: If the PWS elects to chlorinate the groundwater to satisfy its requirement for interim disinfection, chlorination must be provided pursuant to Section 19-13-B102(e)(7)(M) of the RCSA);
5. Daily turbidity test shall be performed at the entry point to the system as required in Section 19-13-B102(e)(7)(H)(ii) of the RCSA. When the turbidity of any such test exceeds one (1) nephelometric turbidity unit (NTU) then the system's certified operator shall collect at least one

- (1) total coliform sample near the first service connection within twenty-four (24) hours of the turbidity exceedance, as required in Section 19-13-B102(e)(7)(H)(i) of the RCSA;
6. Quarterly MPA test results must continue to indicate that the total relative risk factors for the well remain low (i.e., ≤ 9) with no more than 1 quarterly sample indicating a moderate relative risk factor for the duration of the GWUDI demonstration study;
7. *Giardia* or *Cryptosporidium* or Coccidia are not present in any of the subsequent MPA samples;
8. There are no occurrences of a known or suspected waterborne disease outbreak due to *Giardia* or other pathogenic organisms while the well is in use;
9. Weekly tests of untreated groundwater for *E. coli* bacteria must continue to be negative for the duration of the GWUDI demonstration study; and
10. A preliminary analysis of weekly temperature and conductivity tests taken over the first quarter that the well is in operation, and quarterly thereafter, does not indicate a correlation with surface water test results.

The DWS may order that use of the well be suspended immediately or that treatment be installed pursuant to Section 19-13-B102(j) of the RCSA prior to completion of the full 12-month GWUDI demonstration study if:

1. Test results from any MPA sample indicate that the well is under the direct influence of surface water;
2. A known or suspected waterborne disease outbreak occurs due to *Giardia* or other pathogenic organisms; or
3. *E. coli* bacteria are detected in the untreated groundwater.

The system shall notify the department by the end of the day on which the system is notified of a positive test result for *E. coli* bacteria but no later than ninety-six (96) hours from the time of sample collection. If the department office is closed, notification shall be made before the end of the next business day. The system shall notify the department whenever a quarterly MPA sample result indicates a high total relative risk factor based on Table 5. Such results must be reported by the end of the day on which the system is notified of the result. If the department office is closed, notification shall be made before the end of the next business day. Test results for weekly physical samples need not be submitted to the DWS until the entire 12-month GWUDI demonstration study is completed.

Pursuant to Section 19-13-B46 of the RCSA, the department must also be notified by the system whenever there are interruptions in treatment or other water supply emergencies occur while the demonstration study is underway.

Note: If any quarterly MPA sample result indicates a high relative risk factor, the PWS is not allowed to re-test in order to possibly obtain results indicating a lower relative risk factor. If additional MPA samples are taken in addition to the four quarterly samples required by the demonstration study, all MPA test results must be reported to the DWS.

Review of GWUDI Demonstration Study Results

A well/spring is considered to be groundwater under the direct influence of surface water if either item 1 or 2, as stated below, is determined:

1. The total of the relative risk factors, as determined by Appendix A for one or more quarterly MPA analyses, is ≥ 20 (i.e., high risk) and the sample cannot be invalidated;
2. The total of the relative risk factors, as determined by Appendix A for two or more quarterly MPA analyses, is 10-19 (i.e., moderate risk), and the temperature of the well/spring water correlates with that of the surface water and/or has seasonal variations (in °C) of 15-20% over the course of the year, and/or the conductivity of the well/spring water correlates with that of the surface water; and

Additional monitoring may be required before a final GWUDI determination can be made when the relative risk factors specified in items 1 and 2 are not exceeded but physical monitoring and MPA data indicate that:

- a) water temperature of the well/spring correlates with that of the surface water and/or has a seasonal variation (in °C) of 15-20% over the course of the year, or
- b) conductivity of the well/spring water correlates with that of the surface water; or
- c) at least one quarterly MPA sample from the demonstration study indicates a moderate relative risk factor

Note: The conclusion rendered by the PWS, based on the outcome of the demonstration study, is subject to the DWS's discretion. Therefore, the DWS may consider additional monitoring as a step to undertake prior to requiring the installation of filtration and disinfection for removal and inactivation.

The GWUDI demonstration study final study report must be submitted to the DWS within 18 months after being notified by the DWS that a source has been determined to be groundwater potentially under the direct influence of surface water. Therefore, if the study report is not submitted to the DWS within this timeframe, the PWS may be required to replace the source or install treatment pursuant to the Section 19-13-B102(j) of the RCSA within 18 months after the report's due date.

If the DWS concurs with the findings of the demonstration study that the well is under the direct influence of surface water, the public water system will have 18 months from the date of determination by the DWS to install filtration and disinfection pursuant to Section 19-13-B102(j) of the RCSA or replace or abandon the source.

References

U.S. Environmental Protection Agency. 1991. *Guidance Manual For Compliance With The Filtration and Disinfection Requirements For Public Water Systems Using Surface Water Sources*. Washington, D.C.

Vasconcelos, J.T. and S. Harris. 1992. *Consensus Method For Determining Groundwater Under The Direct Influence of Surface Water Using Microscopic Particulate Analysis*. Port Orchard, Washington: U.S. Environmental Protection Agency.

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Appendix A - Interpretation of MPA Test Results

Table 4. Numerical Range Of Each Primary Bio-Indicator (Particulates) Counted Per 100 Gallons Water (see key)

Indicators of surface water ¹	EH	H	M	R	NS
<i>Giardia</i> or <i>Cryptosporidium</i> ²	>30	16-30	6-15	1-5	<1
Coccidia ²	>30	16-30	6-15	1-5	<1
Diatoms ³	>150	41-149	11-40	1-10	<1
Other Algae ³	>300	96-299	21-95	1-20	<1
Insects/Larvae	>100	31-99	16-30	1-15	<1
Rotifers	>150	61-149	21-60	1-20	<1
Plant Debris ³	>200	71-200	26-70	1-25	<1

1. According to EPA “Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources”, March, 1991 ed.
2. If *Giardia*, *Cryptosporidium* cysts or coccidia are found in any sample, irrespective of volume, score as above.
3. Chlorophyll containing

Table 5. Relative surface water risk factors associated with scoring of primary bio-indicators (particulates) present during MPA of subsurface water sources (see key)

Indicators of surface water ¹	Relative Risk Factor ³				
	EH ²	H	M	R	NS
<i>Giardia</i> or <i>Cryptosporidium</i>	40	30	25	20	0
Coccidia	35	30	25	20	0
Diatoms	16	13	11	6	0
Other Algae	14	12	9	4	0
Insects/Larvae	9	7	5	3	0
Rotifers	4	3	2	1	0
Plant Debris	3	2	1	0	0

1. According to EPA “Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources”, March 1991 ed.
2. Refer to Table 1 for range of indicators counted per 100 gallons.
3. Scoring for risk of surface water contamination:

≥20 - high risk 10-19 - moderate risk ≤9 - low risk

Key	EH = extremely heavy	H = Heavy	M = Moderate
	R = Rare	NS = not significant	

Figure 1-

EXAMPLE OF WELLS NEEDING EVALUATION UNDER THE SURFACE WATER TREATMENT RULE

Regulations of Connecticut State Agencies Section 19-13-B102(j)
(Groundwater Under the Direct Influence of Surface Water)

