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Environmental Quality Board  
P.O. Box 8477  
Harrisburg, PA 17105-8477

**Re: Philadelphia Water's Comments to the Proposed Revised Total Coliform Rule (RTCR)**

**Summary of Comments to the Environmental Quality Board (EQB)**

Dear Board Members:

Philadelphia Water (PW) hereby submits its comments to the proposed rulemaking and proposed changes to Chapter 109 relating to the implementation of the Federal Revised Total Coliform Rule (RTCR).

A brief summary of those comments are contained below. Please refer to the attached full formal comments for specific comment details and underlying support for PW's responses.

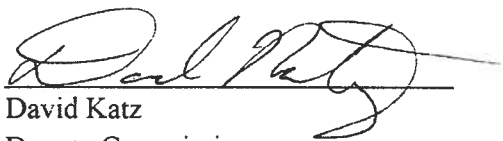
- **Remove all language that is inaccurate and inconsistent with the federal RTCR regulation language.** These inaccuracies and inconsistencies do not reflect the federal regulation and, if not removed, will foster confusion within the drinking water profession.
- **Allow flexibility in sample siting plans and incorporate the EPA's RTCR by allowing public water systems utilizing advanced technologies to develop better alternative repeat sampling plans than the 5 upstream/downstream requirement, which never had any demonstrated scientific background.** A Public Water Supplier (PWS) that can select, in real time, the most valid upstream and downstream sample locations, is better able to meet the intent of the rule and strengthen public health protection.
- **Prohibit overuse of public notification for issues that do not in themselves signify a public health threat.** This overuse will erode public trust in public water systems and could desensitize the public to the importance of notifications if they begin to hear them too often for issues that are not truly related to public health.
- **Prohibit the use of Level 1 and Level 2 Assessments outside of RTCR.** Federal regulation designed assessments to specifically respond to RTCR issues, not issues outside of RTCR.

- **Better clarify Level 1 and Level 2 Assessment Triggers through incorporating federal guidance.** There is language in the chapter 109 revisions regarding assessment triggers that does not incorporate the federal RTCR regulation.
- **Allow individuals designated by the public water system (and not necessarily “certified operators” or “professional engineers”) to be eligible to submit alternative repeat monitoring location plans and conduct RTCR assessments.** These designated individuals, such as water quality scientists and engineers, have vast experience in distribution system water quality and are well qualified to submit an alternative repeat monitoring location plan and conduct RTCR assessments.
- **Clarify which samples dictate how subsequent repeat samples under RTCR are collected.** Both EPA and PaDEP do not clearly communicate appropriate follow up requirements regarding repeat sampling under RTCR.

Philadelphia Water actively supports the EPA’s Federal Advisory Committee process, in which the federal RTCR was carefully developed. The Federal Advisory committee worked over many years and with the input of the nation’s experts on this topic, to move public water supply practice and regulatory oversight in a strong and positive direction. We strongly recommend that PaDEP’s RTCR follow as closely as possible the federal RTCR.

Thank you very much for the opportunity to comment.

Sincerely,



David Katz  
Deputy Commissioner  
Compliance  
Philadelphia Water

**Philadelphia Water**

regarding:

**Annex A**

**TITLE 25. ENVIRONMENTAL PROTECTION**

**PART I. DEPARTMENT OF ENVIRONMENTAL PROTECTION**

**Subpart C. PROTECTION OF NATURAL RESOURCES**

**ARTICLE II. WATER RESOURCES**

**CHAPTER 109. SAFE DRINKING WATER**

**Subchapter A. GENERAL PROVISIONS**

Dated 10/03/2015

**Philadelphia Water's**

**FINAL COMMENTS**

**11/30/2015**

Philadelphia Water hereby submits its comments to the Department of Environmental Protection's proposed regulatory changes to Chapter 109 to implement and address the Revised Total Coliform Rule:

1. PaDEP is incorrectly stating EPA guidance in the revised total coliform preamble "Background and Purpose" section by including language referencing that microbial contamination in the distribution system occurs when there are conditions that allow proliferation of the microorganisms, including "the lack of a disinfectant residual" or poor operation and maintenance practices. This is a misstatement of EPA guidance. In addition, the lack of a disinfectant residual is not a sanitary defect pursuant the Federal RTCR. Rather, it is simply an indication that a sanitary defect—a pathway to contamination—could exist.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109:**

PaDEP's Background and Purpose Section (Proposed Revised Total Coliform Rule Preamble):

According to the preamble to the Federal RTCR, the rule aims to increase public health protection through the reduction of sanitary defects that could provide potential pathways of entry for fecal contamination into the distribution system or could indicate a failure or imminent failure of a barrier that is already in place. See 78 FR 10269, 10276. EPA guidance states that microbial contamination in the distribution system occurs when there is a source of contamination, a pathway for microbial pathogens to enter the distribution system and conditions that allow proliferation of the microorganisms, including "the lack of a disinfectant residual" or poor operation and maintenance practices. See Revised Total Coliform Rule Assessments & Corrective Actions Guidance Manual, EPA 815-R-14-006, September 2014. Since fecal contamination may contain waterborne pathogens including bacteria, viruses and parasitic protozoa, a decrease in fecal contamination should reduce the risk from these contaminants.

EPA's Revised Total Coliform Rule Assessments & Corrective Actions Guidance Manual (Sept. 2014, pg. 2-1, 2-2) specifically states:

Coliform bacteria may be present in the distribution system if three conditions simultaneously occur:

1. A source of coliform bacteria;
2. A pathway into the distribution system or a breach in the system's physical integrity; and
3. A mechanism that allows coliform bacteria to be carried on this pathway into the distribution system or that allows bacteria within biofilms, corrosion tubercles or sediment to break free and enter the water.

**PaDEP is incorrectly stating that "the lack of disinfectant residual" is a sanitary defect in the revised total coliform preamble "Background and Purpose" section.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

PaDEP states that "the lack of disinfectant residual" is a sanitary defect and also references EPA's RTCR Assessment and Corrective Action Manual. EPA's guidance manual, despite PaDEP's reference to it,

does not identify disinfectant residual alone as being a pathway for contamination. PaDEP is suggesting that “the lack of a disinfectant residual” is a sanitary defect, i.e. a defect that could provide a pathway of entry for microbial contamination into the distribution system or that is indicative of a failure or imminent failure in a barrier that is already in place.

Pathways need to be clarified and thought of in terms of a route of exposure for contamination (See AWWA’s April 2011 Opflow Article *Preventing the Perfect Storm, Public Health Relies on Risk Management*). A cross connection, capable of causing backflow from back siphonage or backpressure, is a pathway for contamination. A finished water storage tank with any sort of opening, like an open defective hatch, vent or hole, is a pathway for contamination. A new water main that was exposed to the environment and not properly installed before connecting to the active distribution system, is a pathway for contamination.

The level of disinfectant residual may or may not indicate that contamination gained access to the distribution system. In other words, disinfectant residual is an indicator that a pathway may exist, but it is not *the pathway*. In fact, the real indicator is often a sudden loss in disinfectant residual that suggests an increase in demand, than a seasonal decline that is gradual. There is no scientifically based research showing a direct correlation between “lack” of a disinfectant residual and microbial contamination. This was noted during special TAC meetings with presentations from various utilities and experts, in which there were cases where samples were positive for total coliforms and *E. coli*, despite the presence of adequate disinfectant residuals.

EPA’s RTCR Assessments & Corrective Actions Guidance Manual, *Table 5-1: Common Causes of Total Coliforms and E. coli in the Distribution System & Possible Corrective Actions to Address Them*, (pg. 5-7 in the manual and shown below) under the Sanitary Defects/Cause(s) of TC+ & EC+ column lists inadequate disinfectant residual levels in the distribution system.

Sanitary Defects <sup>10</sup> / Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)	For Additional Information
Inadequate disinfectant residual levels in the distribution system	<ul style="list-style-type: none"> <li>• Variable raw and/or treated water quality conditions</li> <li>• Inadequate disinfectant at entry point</li> <li>• Inadequate disinfectant at booster stations</li> <li>• Interruptions in disinfection processes</li> <li>• Increases in temperature that lead to accelerated disinfectant decay</li> </ul>	<ul style="list-style-type: none"> <li>• Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines.</li> <li>• Manage water age by looping dead ends, increasing volume turnover, and/or installing appropriate main sizes, automated flushing devices or mixing devices.</li> <li>• Install/upgrade on-line water quality monitoring and control.</li> <li>• Flush system (spot or routine).</li> </ul>	<ul style="list-style-type: none"> <li>• AWWA G200 (Standard for Distribution Systems Operation and Management)</li> </ul>

EPA guidance points more toward “inadequate disinfectant” being the result of disinfection practices that create a condition that may point to the presence of coliform or *E. coli*. In other words, EPA guidance is stating that inadequate disinfectant in the distribution system is more of a disinfection issue

(i.e. during the treatment phase) and needs to be addressed there rather than being reactionary to a low disinfectant residual result measured within the distribution system. Results within the distribution system shouldn't necessarily trigger corrective action; rather they should trigger investigation. Water with zero chlorine residual is not necessarily unsafe for drinking.

**Corrective Action:**

Philadelphia Water requests that PaDEP remove the inaccurate statement (microbial contamination in the distribution system occurs when there are conditions that allow proliferation of the microorganisms, including "the lack of a disinfectant residual" or poor operation and maintenance practices) because it incorrectly references specific EPA guidance. The intent of EPA's RTCR Assessment and Corrective Actions Guidance Manual is not about the proliferation of microorganisms, but about addressing failures to detect or mitigate the presence of coliforms and *E. coli*.

Philadelphia Water requests that PaDEP remove the inaccurate statement regarding the lack of disinfection residual as being a pathway for contamination because it misinterprets EPA's RTCR Assessment and Corrective Actions Manual.

Inaccurately referencing and misinterpreting EPA guidance in the preamble will lead to confusion among water systems because the language creates a regulatory framework that is inaccurate and that has not been proven. The language could expose public water systems to enforcement actions, public notifications and subsequent remedial action costs. A simple, accurate language reference could avoid misinterpretation and the previously mentioned risks as well as make PaDEP enforcement actions far less likely since background and purpose objectives would be clearly and accurately articulated.

2. PaDEP is using inaccurate and archaic language from the existing Total Coliform Rule (check sample terminology) that the EPA abandoned in revision to the Total Coliform Rule by changing all check sample language to repeat sample.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

EPA's *Total Coliform Rule – Distribution System Federal Advisory Committee (TCRDSAC)* carefully discussed changing the term “check sample” to repeat sample. There is no way to verify or discount an original positive sample by taking another grab sample at another time. The follow-up sample is not a “check” on the initial positive. The follow-up sample *repeats* the sampling process in order to determine if an active pathway for contamination could still be in place and to what extent. This error appears throughout the proposed regulation.

Additionally, PaDEP's current RTCR preamble contains language stating:

*“Section 109.301(3)(ii)(E) is proposed to be renumbered as § 109.301(3)(ii)(D). Proposed amendments clarify repeat monitoring requirements following a positive check sample. The clause is also proposed to be amended to clarify reporting requirements to the Department for when a system determines it has triggered an assessment. These proposed amendments reflect 40 CFR 141.858(a)(3).”*

PaDEP confuses the language, as they consider the follow-up process to refer to repeat monitoring requirements, however the follow-up samples collected are referred to as check samples. The “check sample” terminology is outdated, as EPA uses “repeat sample” terminology. The “check sample” terminology is confusing especially when going through EPA's RTCR references and publication reports.

**Corrective Action:**

The term “check sample” should be changed to “repeat sample” throughout Chapter 109 because the EPA RTCR abandoned “check sample” language. Along with the “check sample” terminology being inaccurate and inconsistent with the federal RTCR, its continued usage could create confusion among water systems when going through EPA's RTCR references and publication reports. The intent of revisions to TCR is to improve implementation while maintaining or improving public health protection and distribution system water quality, not to expose public water systems to enforcement actions, public notifications and subsequent remedial action costs. Abandoning language that is inconsistent with the EPA's RTCR could avoid these risks as well as make PaDEP enforcement actions far less likely since compliance standards and terminology are now clearly and consistently articulated.

3. PaDEP must clarify how a system must proceed after triggering another Level 1 assessment, as defined in subparagraph (i), within a rolling 12-month period if the Department has determined a likely reason that the samples that caused the first Level 1 assessment were total coliform-positive and has established that the system has corrected the problem.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.202. State MCLs, MRDLs and treatment technique requirements (Section (c)(4)(ii)(B))

*“(4) Public water systems shall conduct assessments in accordance with § 109.705(b) (relating to system evaluations and assessments) after meeting any of the triggers under subparagraph (i) or (ii). Failure to conduct an assessment or complete a corrective action in accordance with § 109.705(b) is a treatment technique violation requiring 1-hour reporting in accordance with § 109.701(a)(3) and public notification in accordance with § 109.409 (relating to Tier 2 public notice—categories, timing and delivery of notice).*

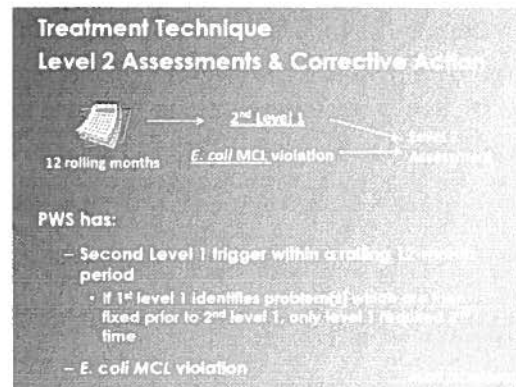
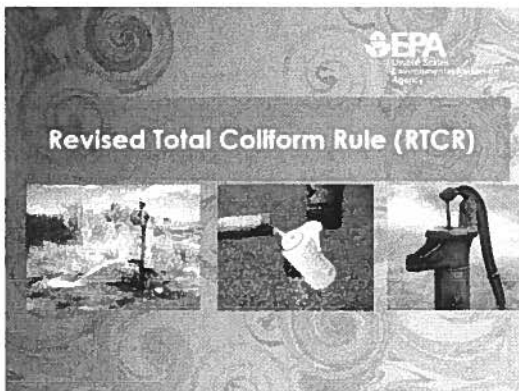
*(ii) A Level 2 assessment is triggered if any of the following conditions occur:*

*(A) A system fails to meet the E. coli MCL as specified under subsection (a)(2).*

*(B) A system triggers another Level 1 assessment, as defined in subparagraph (i), within a rolling 12-month period, unless the Department has determined a likely reason that the samples that caused the first Level 1 assessment were total coliform-positive and has established that the system has corrected the problem.*

According to EPA, if the first Level 1 Assessment identifies problem(s) and corrected them prior to the second Level 1 Assessment trigger, the only a Level 1 assessment is required the second time.

<http://archive.epa.gov/region9/tribal/web/pdf/rtrcr-presentation-2015-05.pdf>.





**Corrective Action:**

Philadelphia Water requests that PaDEP clarify that if during a rolling 12-month period, a second Level 1 assessment is triggered where the first Level 1 assessment identified and corrected the problem leading to the initial assessment, then only a Level 1 Assessment would be required the second time. If the problem leading to the initial assessment was not identified and corrected, then PaDEP must clarify that Level 2 assessment would be required.

4. PaDEP must not be able to broadly or vaguely direct a system to conduct an assessment if circumstances exist which may adversely affect drinking water quality.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.202. State MCLs, MRDLs and treatment technique requirements (Section (c)(4)(iii))

*“(4) Public water systems shall conduct assessments in accordance with § 109.705(b) (relating to system evaluations and assessments) after meeting any of the triggers under subparagraph (i) or (ii). Failure to conduct an assessment or complete a corrective action in accordance with § 109.705(b) is a treatment technique violation requiring 1-hour reporting in accordance with § 109.701(a)(3) and public notification in accordance with § 109.409 (relating to Tier 2 public notice—categories, timing and delivery of notice).*

*(i) A Level 1 assessment is triggered if any of the following conditions occur:*

*(A) For systems taking 40 samples or more per month under § 109.301(3), the system exceeds 5.0% total coliform-positive samples for the month.*

*(B) For systems taking fewer than 40 samples per month under § 109.301(3), the system has 2 or more total coliform-positive samples in the same month.*

*(C) The system fails to take every required check sample under § 109.301(3) after any single total coliform-positive sample.*

*(ii) A Level 2 assessment is triggered if any of the following conditions occur:*

*(A) A system fails to meet the E. coli MCL as specified under subsection (a)(2).*

*(B) A system triggers another Level 1 assessment, as defined in subparagraph (i), within a rolling 12-month period, unless the Department has determined a likely reason that the samples that caused the first Level 1 assessment were total coliform-positive and has established that the system has corrected the problem.*

*(iii) The Department may direct a system to conduct a Level 1 or Level 2 assessment if circumstances exist which may adversely affect drinking water quality including, but not limited to, the situations specified in § 109.701(a)(3)(iii).*”

**Corrective Action:**

Philadelphia Water requests that PaDEP within the revised TCR, tie the use of “assessments” to only RTCR triggers, because Level 1 and Level 2 Assessments are only intended in response to RTCR treatment technique or E. coli MCL violation. An “assessment” for situations outside of the RTCR is beyond the scope of the RTCR. Requiring assessments based on “water quality” is vague; not all water quality problems are threats to public health. As an example, bad taste and odor customer complaints will trigger an investigation by the water supplier but the proposed language here suggests that such an investigation could become a requirement under the RTCR.

5. PaDEP must not limit the use of advanced technology, if it is already available, for selecting repeat sampling locations rather than collecting at least one check sample at a tap within five service connections upstream of the original coliform-positive sample and at least one check sample within five service connections downstream of the original sampling site.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.301. General monitoring requirements – *Monitoring requirements for coliforms, Repeat monitoring Section* (Section 3(ii)(B))

*“(ii) Repeat monitoring. A public water system shall collect a set of check samples within 24 hours of being notified of a total coliform-positive routine sample, a total coliform-positive check sample or a total coliform-positive sample collected under subparagraph (i)(B). The Department may extend this 24-hour collection limit to a maximum of 72 hours if the system adequately demonstrates a logistical problem outside the system's control in having the check samples analyzed within 30 hours of collection. A logistical problem outside the system's control may include a coliform-positive sample result received over a holiday or weekend in which the services of a Department accredited laboratory are not available within the prescribed sample holding time.*

*(B) The system shall collect at least one check sample from the sampling tap where the original total coliform-positive sample was taken, at least one check sample at a tap within five service connections upstream of the original coliform-positive sample and at least one check sample within five service connections downstream of the original sampling site. If a total coliform-positive sample occurs at the end of the distribution system or one service connection away from the end of the distribution system, the water supplier shall collect an additional check sample upstream of the original sample site in lieu of a downstream check sample.”*

EPA §141.853(a)(5)(i) *General monitoring requirements for all public water systems* states :

(5) Systems must identify repeat monitoring locations in the sample siting plan. **Unless the provisions of paragraphs (a)(5)(i) or (a)(5)(ii) of this section are met, the system must collect at least one repeat sample from the sampling tap where the original total coliform-positive sample was taken, and at least one repeat sample at a tap within five service connections upstream and at least one repeat sample at a tap within five service connections downstream of the original sampling site.** If a total coliform-positive sample is at the end of the distribution system, or one service connection away from the end of the distribution system, the system must still take all required repeat samples. However, the State may allow an alternative sampling location in lieu of the requirement to collect at least one repeat sample upstream or downstream of the original sampling site. Except as provided for in paragraph (a)(5)(ii) of this section, systems required to conduct triggered source water monitoring under §141.402(a) must take ground water source sample(s) in addition to repeat samples required under this subpart.

(i) Systems may propose repeat monitoring locations to the State that the system believes to be representative of a pathway for contamination of the distribution system. A system may elect to specify either alternative fixed locations or criteria for selecting repeat sampling sites on a

situational basis in a standard operating procedure (SOP) in its sample siting plan. The system must design its SOP to focus the repeat samples at locations that best verify and determine the extent of potential contamination of the distribution system area based on specific situations. The State may modify the SOP or require alternative monitoring locations as needed.

EPA is suggesting methods like these to be used, when available, instead of the 5 upstream/downstream requirement which is not science-based. It has been demonstrated by hydraulic modeling (see the attached article featured in AWWA's May 2013 Issue of *OpFlow Hydraulic Model Improves Contamination Response*) that what was on one day an upstream sample location may be a downstream location on another day, or neither during different demands and valve operations. Issues associated with smaller system capabilities and PaDEP limitations should not become a disincentive to larger systems. For example, the application of online sensors, hydraulic models, event detection and customer complaint surveillance for water security is providing real benefits for routine system operations and helps utilities better understand water quality issues. Allowing a PWS to determine, in real time, the most likely upstream and downstream sample locations for repeat sampling improves the chances of identifying ongoing contamination and likely causes, and ultimately strengthens public health protection.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP adopt the EPA's RTCR suggestion by allowing public water systems utilizing advanced technologies to develop better alternative repeat sampling plans than the 5 upstream/downstream requirement, which never had any demonstrated scientific background. A PWS that can select, in real time, the most valid upstream and downstream sample location is better able to meet the intent of the rule and strengthen public health protection. Limiting systems from utilizing advanced technologies to better select repeat sampling locations will weaken public health protection.

6. **PaDEP must not limit the use of advanced technology, if it is already available, for selecting repeat sampling locations rather than collecting at least one check sample at a tap within five service connections upstream of the original coliform-positive sample and at least one check sample within five service connections downstream of the original sampling site.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

*The Board is interested in comments regarding the following:*

- *Why alternative repeat monitoring locations should be allowed.*

According to EPA's *Agreement in Principle (AIP), Total Coliform Rule – Distribution System Federal Advisory Committee (TCRDSAC)*, pg. 14, 15 the intent is that the RTCR should provide for a more flexible and more protective response. Larger, more complex systems can specify criteria for selecting repeat sampling sites on a situational basis in its standard operating procedures. This SOP should be designed to focus the repeat samples at locations that will best verify and determine the extent of potential contamination of the distribution system area based on specific situations.

Criteria using advanced methods - through an SOP – should be used, if available rather than the 5 upstream/downstream requirement (EPA §141.853(a)(5)(i) *General monitoring requirements for all public water systems*).

Additionally, in the *AIP (pg. 14, 15)* the intent of repeat sampling in RTCR is that flexibility in the selection of monitoring locations can provide a public health benefit through specific targeting for each incident to facilitate the identification of the source and extent of any problem. The intent by EPA and TCRDSAC during RTCR discussion, as described in the previously noted *AIP*, is for systems to use, if available, more advanced methods for selecting sites on a situational basis through an SOP. If those resources are not available, then collect the 5 upstream/downstream samples.

Alternative repeat monitoring locations are recommended by EPA, and allow a system to select, under certain conditions, the most valid upstream and downstream sample location to meet the intent of the RTCR. This is accomplished by reviewing variables that impact flow and direction of flow in the system such as valve positions, storage areas in service or out of service, and utilizing hydraulic modeling. It has been demonstrated by hydraulic modeling (see the attached article featured in AWWA's May 2013 Issue of *OpFlow Hydraulic Model Improves Contamination Response*) that what was on one day an upstream sample location may be a downstream location on another day, or neither during different demands and valve operations. Distribution systems are complex and by allowing a system to better determine repeat sample locations improves the chances of identifying any on-going contamination and, therefore, is better protective of public health than the 5 upstream/downstream requirement.

EPA's *Agreement in Principle (AIP), Total Coliform Rule – Distribution System Federal Advisory Committee (TCRDSAC)* can be found at:

[http://water.epa.gov/lawsregs/rulesregs/sdwa/tcr/upload/2009\\_05\\_01\\_disinfection\\_tcr\\_tcrdsac\\_agreement\\_in\\_principle\\_tcrdsac\\_2008-09-18.pdf](http://water.epa.gov/lawsregs/rulesregs/sdwa/tcr/upload/2009_05_01_disinfection_tcr_tcrdsac_agreement_in_principle_tcrdsac_2008-09-18.pdf)

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP adopt the EPA's RTCR suggestion by allowing public water systems utilizing advanced technologies to develop better alternative repeat sampling plans than the 5 upstream/downstream requirement, which never had any demonstrated scientific background. A PWS that can select, in real time, the most valid upstream and downstream sample location is better able to meet the intent of the rule and strengthen public health protection. Limiting systems from utilizing advanced technologies to better select repeat sampling locations will weaken public health protection.

7. PaDEP must not limit the use of advanced technology, if it is already available, for selecting repeat sampling locations rather than collecting at least one check sample at a tap within five service connections upstream of the original coliform-positive sample and at least one check sample within five service connections downstream of the original sampling site.

PaDEP is incorrectly stating that “the monitoring location represent the pathway for contamination”.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

*The Board is interested in comments regarding the following:*

- *How a PWS would demonstrate that an alternative repeat monitoring location represents the pathway for contamination that led to the original coliform-positive sample in the distribution system.*

Follow-up sampling can't, in and of itself, confirm or deny whether the initial sample was positive or not, or if it was representative of the distribution system because distribution systems are dynamic. Follow-up sampling is repeat sampling to see if coliform bacteria can still be detected at the sample tap and at two other sample taps. These other *alternative* sample taps are those that are chosen through advanced technology (i.e. hydraulic modeling) because they best represent the characteristics and direction of the flow that most likely occurred when the initial sample collected was positive.

Additionally, the “location” does not represent a *pathway* for contamination (see Comment #2); rather it represents the extent of contamination. This language is incorrectly written and is confusing and should be revised to include the extent of contamination, not pathways for contamination. Again, alternative repeat monitoring locations allow systems the ability to best select the most appropriate sample locations for follow-up sampling because they best represent the characteristics and direction of the flow that occurred when the initial sample collected was positive.

For additional information on how hydraulic modeling can improve total coliform response (and proof that it does), see the attached article featured in AWWA's May 2013 Issue of *OpFlow Hydraulic Model Improves Contamination Response*.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP adopt the EPA's RTCR suggestion by allowing public water systems utilizing advanced technologies to develop better alternative repeat sampling plans than the 5 upstream/downstream requirement, which never had any demonstrated scientific background. A PWS that can select, in real time, the most valid upstream and downstream sample location is better able to meet the intent of the rule and strength public health protection. Limiting systems from utilizing advanced technologies to better select repeat sampling locations will weaken public health protection.

Philadelphia Water requests that PaDEP remove the inaccurate statement regarding the monitoring location representing a pathway for contamination because the language is inaccurate and should be revised to include that the sampling location represents the *extent* of contamination.



8. PaDEP must not limit the use of advanced technology, if it is already available, for selecting repeat sampling locations rather than collecting at least one check sample at a tap within five service connections upstream of the original coliform-positive sample and at least one check sample within five service connections downstream of the original sampling site.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

*The Board is interested in comments regarding the following:*

- *Whether only fixed alternative repeat monitoring locations should be allowed or if a standard operating procedure for choosing locations may also be allowed and why.*

As noted in the *Agreement in Principle, Total Coliform Rule – Distribution System Federal Advisory Committee (TCRDSAC)*, pg.14, the intent of repeat sampling in RTCR is that flexibility in the selection of monitoring locations can provide a public health benefit through specific targeting for each incident to facilitate the identification of the source and extent of any problem.

Follow-up sampling can't, in and of itself, confirm or deny whether the initial sample was positive or not, or if it was representative of the distribution system because distribution systems are dynamic. Follow-up sampling is repeat sampling to see if coliform bacteria can still be detected at the sample tap and at two other sample taps. These other *alternative* sample taps are those that are chosen through advanced technology (i.e. hydraulic modeling) because they best represent the characteristics and direction of the flow that most likely occurred when the initial sample collected was positive.

Specification of criteria for selecting alternative repeat monitoring location on a situational basis through a standard operating procedure should be allowed.

For additional information on how hydraulic modeling can improve total coliform response (and proof that it does), see the attached article featured in AWWA's May 2013 Issue of OpFlow, *Hydraulic Model Improves Contamination Response*.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP adopt the EPA's RTCR suggestion by allowing public water systems utilizing advanced technologies to develop better alternative repeat sampling plans than the 5 upstream/downstream requirement, which never had any demonstrated scientific background. A PWS that can select, in real time, the most valid upstream and downstream sample location (and not be locked into fixed alternative repeat monitoring locations) is better able to meet the intent of the rule and strength public health protection. Limiting systems from utilizing advanced technologies to better select repeat sampling locations will weaken public health protection.

9. **PaDEP must not limit alternative repeat monitoring locations to only be submitted by a certified operator.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

*The Board is interested in comments regarding the following:*

- *Whether alternative repeat monitoring locations must be submitted under the signature of a certified operator.*

Larger water systems have numerous individuals (environmental scientists, chemists, biologists, engineers, laboratory director, water quality manager, etc.) who are not necessarily certified operators but who have vast experience in distribution system water quality. In many instances, a variety of personnel may be involved in the selection of the alternative repeat monitoring locations, none of whom are “certified operators”, but who are qualified to submit an alternative repeat monitoring location plan. Therefore, each system should designate these appropriate personnel and submit this list of qualified individuals to PaDEP, which can be reviewed and updated during sanitary surveys.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP allow individuals designated by the public water system (and not necessarily “certified operators”) be eligible to submit alternative repeat monitoring location plans because there may be numerous individuals who are not necessarily certified operators but who have vast experience in distribution system water quality and are qualified to submit an alternative repeat monitoring location plan.

**10. PaDEP must not limit alternative repeat monitoring locations to only be submitted under the seal of a professional engineer.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

*The Board is interested in comments regarding the following:*

*•Whether alternative repeat monitoring locations must be submitted under the seal of a professional engineer.*

Larger water systems have numerous individuals (environmental scientists, chemists, biologists, engineers, laboratory director, water quality manager, etc.) who are not necessarily professional engineers but who have vast experience in distribution system water quality. In many instances, a variety of personnel may be involved in the selection of the alternative repeat monitoring locations, none of whom are “professional engineers”, but who are qualified to submit an alternative repeat monitoring location plan. Therefore, each system should designate these appropriate personnel and submit this list of qualified individuals to PaDEP, which can be reviewed and updated during sanitary surveys.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP allow individuals designated by the public water system (and not necessarily “professional engineers”) be eligible to submit alternative repeat monitoring location plans because there may be numerous individuals who are not necessarily professional engineers but who have vast experience in distribution system water quality and are qualified to submit an alternative repeat monitoring location plan.

11. PaDEP must not limit the use of advanced technology, if it is already available, for selecting repeat sampling locations rather than collecting at least one check sample at a tap within five service connections upstream of the original coliform-positive sample and at least one check sample within five service connections downstream of the original sampling site.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

*The Board is interested in comments regarding the following:*

- *Whether alternative locations should only be allowed for systems serving greater than 9,999 people.*

As noted in the *Agreement in Principle, Total Coliform Rule – Distribution System Federal Advisory Committee (TCRDSAC)*, pg.14, the intent of repeat sampling in RTCR is that flexibility in the selection of monitoring locations can provide a public health benefit through specific targeting for each incident to facilitate the identification of the source and extent of any problem.

There are many progressive, small systems that know their systems well and use advanced technology (i.e. hydraulic modeling) to help better determine alternative repeat monitoring locations. Prohibiting smaller systems from using more advanced technology (compared to the 5 upstream/downstream requirement – which is non-science based) would weaken public health protection.

For additional information on how hydraulic modeling can improve total coliform response (and proof that it does), see the attached article featured in AWWA's May 2013 Issue of OpFlow, *Hydraulic Model Improves Contamination Response*.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP adopt the EPA's RTCR suggestion by allowing public water systems utilizing advanced technologies to develop better alternative repeat sampling plans than the 5 upstream/downstream requirement, which never had any demonstrated scientific background. A PWS that can select, in real time, the most valid upstream and downstream sample location (and not be locked into fixed alternative repeat monitoring locations) is better able to meet the intent of the rule and strengthen public health protection. Limiting systems from utilizing advanced technologies to better select repeat sampling locations will weaken public health protection

**12. PaDEP (and EPA) do not clearly communicate to water systems which sample(s) dictate where subsequent repeat samples need to be collected.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.301. General monitoring requirements – *Monitoring requirements for coliforms, Repeat monitoring Section* (Section 3(ii)(A))

*“(ii) Repeat monitoring. A public water system shall collect a set of check samples within 24 hours of being notified of a total coliform-positive routine sample, a total coliform-positive check sample or a total coliform-positive sample collected under subparagraph (i)(B). The Department may extend this 24-hour collection limit to a maximum of 72 hours if the system adequately demonstrates a logistical problem outside the system's control in having the check samples analyzed within 30 hours of collection. A logistical problem outside the system's control may include a coliform-positive sample result received over a holiday or weekend in which the services of a Department accredited laboratory are not available within the prescribed sample holding time.*

*(A) A public water system shall collect at least three check samples for each routine total coliform-positive sample found.”*

Consider the following scenario of total coliform results for an initial routine and repeat set that includes a repeat routine sample, and upstream and downstream samples (both collected within 5 service connections):

<b>Sample Location</b>	<b>Initial Sample</b>	<b>Repeat Sample</b>
<i>Upstream</i>	NA	TC-
<i>Routine</i>	TC+	TC-
<i>Downstream</i>	NA	TC+

Under the federal rule as stated in § 141.858(a)(3), water systems must continue collecting repeat samples until all samples within the repeat set are negative for the presence of coliforms. However, does every coliform positive require a set of repeat samples based on the latest positive’s location, or is it based on the routine repeat result? For example, when a repeat downstream is total coliform positive and all other repeats are total coliform negative, does the initial routine positive dictate where the repeats are collected or does the new repeat positive dictate where the new repeat samples are collected.

**Corrective Action:**

Philadelphia Water requests that PaDEP clarify which samples dictate where subsequent repeat samples are collected and address repeat sampling when the repeat routine may be negative for coliforms but one or both of the upstream or downstream samples in the repeat set are positive for coliforms. Both the federal and state RTCR do not clearly address this. The intent of revisions to TCR is to improve implementation while maintaining or *improving* public health protection and distribution system water quality. If the federal and state RTCR do not clearly address the situation when the repeat routine may

be negative for coliforms but one or both of the upstream or downstream samples in the repeat set are positive for coliforms, then public health protection will be weakened.

13. PaDEP is inconsistent within the federal RTCR and Chapter 109 revisions on the timeframe for collecting repeat samples.

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.301. General monitoring requirements – *Monitoring requirements for coliforms, Repeat monitoring Section* (Section 3(ii)(C))

*“(ii) Repeat monitoring. A public water system shall collect a set of check samples within 24 hours of being notified of a total coliform-positive routine sample, a total coliform-positive check sample or a total coliform-positive sample collected under subparagraph (i)(B). The Department may extend this 24-hour collection limit to a maximum of 72 hours if the system adequately demonstrates a logistical problem outside the system's control in having the check samples analyzed within 30 hours of collection. A logistical problem outside the system's control may include a coliform-positive sample result received over a holiday or weekend in which the services of a Department accredited laboratory are not available within the prescribed sample holding time.*

*(C) A system shall collect all check samples on the same day, except that a system with a single service connection may collect the required set of check samples all on the same day or consecutively over a 3-day period.”*

§ 109.301(3)(ii) and § 109.301(3)(ii)(C) do not match. The provision to collect “repeat samples” on the same day doesn’t allow much room for correction. For example, the system, due to various circumstances may be limited to collecting a routine sample later in the day and closer to the end of business. If results the following day shows the presence of coliform there is a very narrow window for collecting repeat samples on the same day. This could be especially challenging for smaller systems if they are limited on resources on a specific day (ex: sample bottles).

**Corrective Action:**

Philadelphia Water requests PaDEP to remain consistent with the federal RTCR (and throughout Chapter 109) by allowing repeat sampling to be completed within 24 hours, not on the same day. This will provide systems of all sizes enough time to address issues (like limited laboratory resources) for collecting the required set of repeat samples.

14. **Tier 2 public notification for a single positive *E. coli* result is inappropriate. Additionally, 1 hour notification to PaDEP of a single *E. coli* occurrence is inconsistent with the federal requirement of end of the day notification.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.409. Tier 2 public notice—categories, timing and delivery of notice (Section (a)(3))

*“(a) General violation categories and other situations requiring a Tier 2 public notice. A public water supplier shall provide Tier 2 public notice for the following circumstances:*

*(3) Failure to report an *E. coli* MCL violation or an *E. coli*-positive routine or check sample as required under § 109.701(a)(3)(iv) (relating to reporting and recordkeeping).”*

§ 109.701. Reporting and recordkeeping (Section (a)(3)(iv))

*“(a) Reporting requirements for public water systems. Public water systems shall comply with the following requirements:*

*(3) One-hour reporting requirements. A public water supplier shall report the circumstances to the Department within 1 hour of discovery for the following violations or situations:*

*(iv) Any sample result is *E. coli*-positive.”*

*E. coli* is an indicator of biological contamination, not an indicator of acute contamination. As an indicator species it is not perfect, therefore we can't overreact to a single positive *E. coli* sample. Years ago, Philadelphia Water experienced this as various samples delivered to the laboratory, at times, represented contamination that was not representative of water within the distribution system but was specific to other characteristics (ex: sample tap, sample collector) (See *Drinking Water E. coli Positive Samples during 2003-2006*).

After a single positive *E. coli* occurrence, a system is still investigating and collecting follow up samples and trying to determine if there is a possibility of contamination in the area of the distribution system where the positive has occurred. Within 1 hour of a single positive *E. coli* occurrence, there is little information to be communicated to PaDEP and therefore little to no action to be taken by PaDEP. How is 1 hour notification justified? A laboratory could report preliminary results to provide an advanced warning, but approved data release could come later. Reporting to PaDEP by the end of the working day or within the same day is fine. Reporting in 1 hour however, interferes with reaction to *E. coli* positive and provides no addition information on which to act.

Additionally, failure to report a single occurrence of *E. coli* within 1 hour does not in itself represent a threat to public health, especially since there have been documented cases of *E. coli* positive samples that did not signal water contamination. EPA in § 141.858(b)(1) *E.coli* testing, requires end of day notification to the state. Tier 3 public notification is appropriate for this type of reporting violation and is consistent with other reporting violations that fall under Chapter 109 related to reporting and recordkeeping requirements. Overuse of public notification for issues that do not in themselves signify a public health threat will unnecessarily erode public trust in the water system and could



desensitize the public to the importance of notifications if they begin to hear them often for issues that are not truly related to public health.

**Corrective Action:**

Philadelphia Water requests that a requirement to notify PaDEP of a single *E. coli* positive occur by the end of the day, not within 1 hour, because the system is still gathering information about the result after 1 hour.

Philadelphia Water requests to classify failure to notify PaDEP about a single *E. coli* occurrence as a Tier 3 violation. Though Philadelphia Water agrees that the presence of *E. coli* requires investigation, Tier 2 public notification for a single positive *E. coli* sample is inappropriate. This would be overuse of public notification for issues that do not, in themselves, signify a public health threat and will unnecessarily erode public trust in the water system and could desensitize the public to the importance of notifications if they begin to hear them often for issues that are not truly related to public health.

**15. Repeat coliform monitoring locations must be included in sample siting plans**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.701. Reporting and recordkeeping (Section (a)(5))

*“(a) Reporting requirements for public water systems. Public water systems shall comply with the following requirements:*

*(5) Siting plan. The water supplier shall submit to the Department a written sample siting plan for routine and repeat coliform sampling as required under § 109.301(3) by \_\_\_\_ (Editor's Note: The blank refers to the effective date of adoption of this proposed rulemaking.). A public water system that begins operation after \_\_\_\_ (Editor's Note: The blank refers to the effective date of adoption of this proposed rulemaking.) shall submit the sample siting plan prior to serving water to the public.”*

§ 109.701. Reporting and recordkeeping (Section (a)(5)(i)(D))

*“(a) Reporting requirements for public water systems. Public water systems shall comply with the following requirements:*

*(5) Siting plan. The water supplier shall submit to the Department a written sample siting plan for routine and repeat coliform sampling as required under § 109.301(3) by \_\_\_\_ (Editor's Note: The blank refers to the effective date of adoption of this proposed rulemaking.). A public water system that begins operation after \_\_\_\_ (Editor's Note: The blank refers to the effective date of adoption of this proposed rulemaking.) shall submit the sample siting plan prior to serving water to the public.*

*(i) A sample siting plan shall include at a minimum the following:*

*(D) Available repeat monitoring locations for each routine monitoring location.”*

EPA's RTCR does not lay out specific sample siting plan details except that they should be representative of the water in the distribution system. As referenced in *Agreement in Principle, Total Coliform Rule – Distribution System Federal Advisory Committee (TCRDSAC) pg. 15, 16*, systems should have the flexibility to propose repeat monitoring locations that may be representative of a pathway for contamination (ex: storage tank) as opposed to the current requirement of 5 connections upstream and downstream. The RTCR is intended to be an incentive for systems to conduct more monitoring than is required, to investigate potential problems in the distribution system, and use monitoring as a tool to assist in uncovering problems where they exist. Nothing shall preclude a system from taking more than the minimum number of required routine samples and including them in calculating compliance with RTCR, if the samples are taken in accordance with the approved sample siting plan.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP allow flexibility in sample siting plans and follow the EPA's RTCR by allowing public water systems utilizing advanced technologies to develop better alternative repeat sampling plans than the non-science based 5 upstream/downstream requirement.

**16. PaDEP should not require a “certified operator” or “professional engineer” to complete Level 1 and Level 2 assessments.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.705. System Evaluations and Assessments (Section b(3),(4))

*“(3) A Level 1 assessment must be conducted by competent personnel qualified to operate and maintain the water system’s facilities.*

*(4) A Level 2 assessment must be conducted by one or more individuals meeting the following criteria:*

*(i) Hold a valid certificate issued under Chapter 302 (relating to administration of the water and wastewater operator’s certification program) to operate a water system.*

*(ii) Maintains certification in the appropriate class and subclassifications as defined in Chapter 302 for the size and treatment technologies for the water system being assessed.”*

Larger water systems have numerous individuals (environmental scientists, chemists, biologists, engineers, laboratory director, water quality manager, etc.) who are not necessarily certified operators or certified professional engineers, but who may have vast experience in distribution system water quality. In many instances, a variety of personnel may be well qualified to conduct an assessment, none of whom are “certified operators” or “professional engineers”, but are qualified to conduct an assessment. Therefore, each system should designate these appropriate personnel and submit this list of qualified individuals to PaDEP, and in the absence of a “certified operator” or “professional engineer”, these individuals can conduct an assessment. Additionally, personnel such as a laboratory director or water quality manager may not necessarily conduct an assessment, but may oversee and later submit the assessment.

**Corrective Action:**

Philadelphia Water strongly recommends that PaDEP allow individuals designated by the public water system and approved by PaDEP, but not necessarily “certified operators” or “professional engineers”, be eligible to conduct assessments. In many instances, a variety of personnel may be well qualified to conduct an assessment, none of whom are “certified operators” or “professional engineers”, but are qualified to conduct an assessment.

17. **Outside of RTCR treatment technique or *E. coli* MCL violation, PaDEP should not conduct a Level 1 or Level 2 assessment in addition to the assessment conducted by the public water system.**

**Location within Proposed Ch. 109/Support to Change Proposed Ch. 109::**

§ 109.705. System evaluations and assessment (Section (b)(5))

*“(b) A public water system shall conduct Level 1 and 2 assessments required under § 109.202(c)(4) (relating to State MCLs, MRDLs and treatment technique requirements). The public water system shall also comply with any expedited actions or additional actions required by the Department in the case of an *E. coli* MCL violation.*

*(5) The Department may conduct a Level 1 or Level 2 assessment in addition to the assessment conducted by the public water system.”*

Provided that PaDEP’s assessment is in the context of RTCR, otherwise if it is outside of that, it should be called something else other than Level 1 or Level 2 assessment to avoid confusion among water systems.

**Corrective Action:**

Philadelphia Water strongly recommends that if PaDEP conducts assessments outside of RTCR that those assessments are not referred to as Level 1 or Level 2 assessments. This will avoid exposing public water systems to unnecessary enforcement actions, public notifications and subsequent remedial action costs. A simple language clarification could avoid these risks as well as make PaDEP enforcement actions far less likely since compliance standards are now clearly articulated.

END OF COMMENTS

## Hydraulic Model Improves Contamination Response

With the Revised Total Coliform Rule set to go into effect in 2016, engineers in Philadelphia Water Department's water quality group decided it was a good time to see if the utility's repeat-sampling plan needed to be updated.

BY DAVID SPECHT

**T**HE 1989 TOTAL COLIFORM Rule (TCR) requires utilities to develop a repeat-sampling plan that details utility response to samples that test positive for coliforms or *E. coli*. To gear up for the Revised TCR (RTCR), effective in 2016, the Philadelphia Water Department (PWD) developed a

repeat-sampling plan that accounts for changes imposed by the revised rule and takes advantage of technologies that weren't available when the utility's current repeat-sampling plan was developed in the early 1990s. (For more information on the RTCR, see Assessments Are Coming—Are You Prepared? on page 8.)

### PWD'S CURRENT TCR PROGRAM

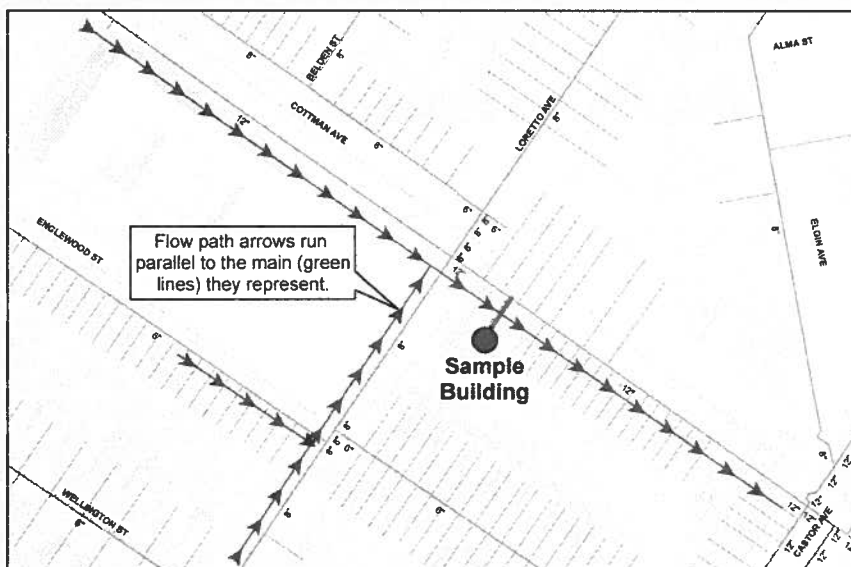
PWD operates and maintains a distribution system that serves an average of nearly 225 mgd of water to about 1.6 million people. The distribution system contains more than 3,100 miles of water main in 13 pressure districts. Overall system water quality is tracked using 87 grab-sampling stations throughout the city. An average of 480 samples is collected per month from 74 total coliform compliance-monitoring locations.

From 2003 through 2012, an annual average of 5,800 samples was tested for the presence of coliforms and *E. coli*. Of those samples, an average of 14 tested positive for coliforms (0.24 percent of all tested samples). The positive samples came from different sampling locations and weren't the result of recurring positive samples at a small number of unique locations. These results illustrate that PWD uses its repeat-sampling plan an average of 14 times during a typical year in response to total coliform-positive samples.

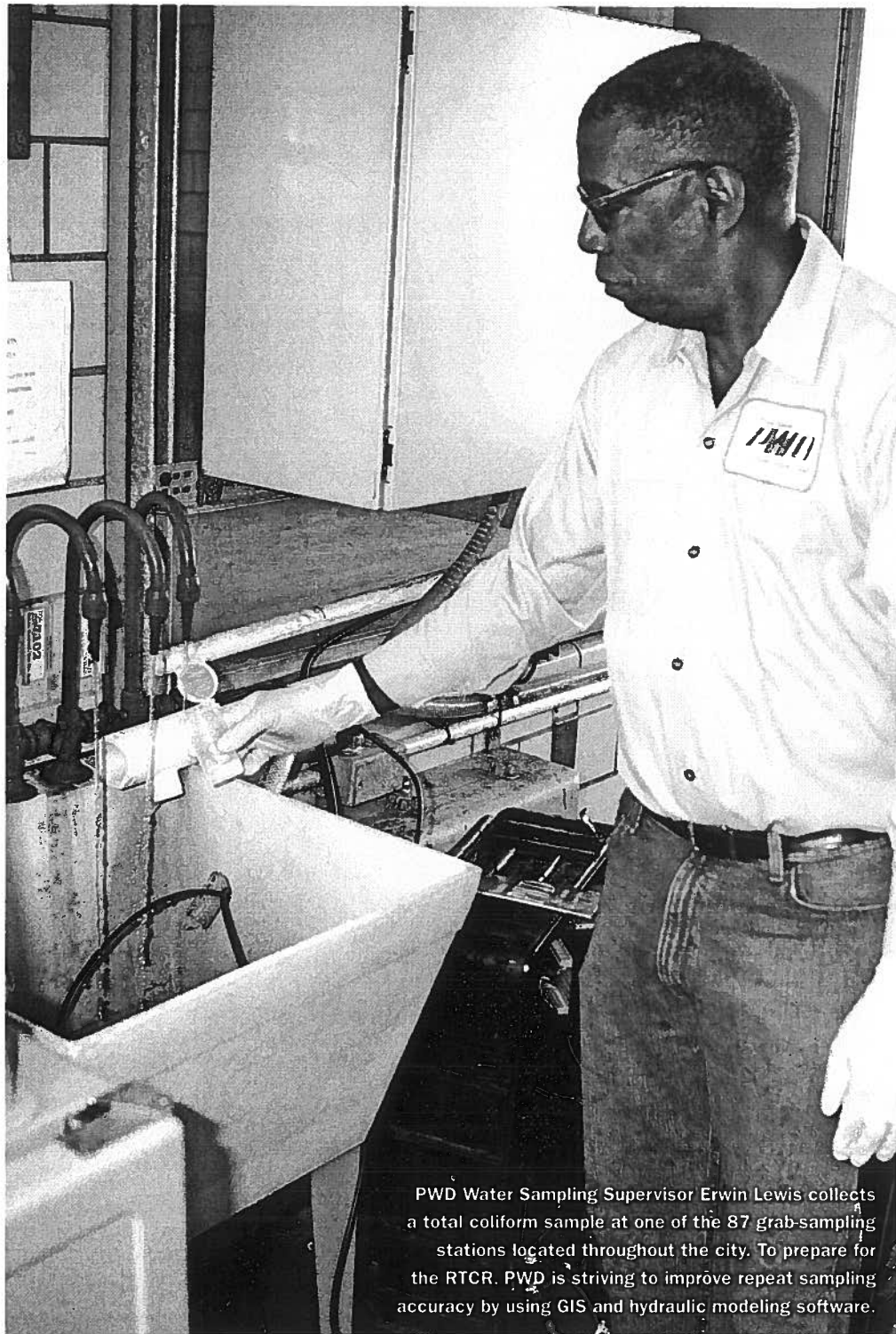
In the event of a total coliform- or *E. coli*-positive sample, the 1989 TCR requires utilities to collect repeat samples within 24 hours of initial lab notification. Subsequent samples include a repeat sample from the location that

### Figure 1. Unidirectional Flow

Blue flow-path arrows represent the category "Unidirectional Flow." The red line indicates the sample building's service connection.



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PWD Water Sampling Supervisor Erwin Lewis collects a total coliform sample at one of the 87 grab-sampling stations located throughout the city. To prepare for the RTCR, PWD is striving to improve repeat sampling accuracy by using GIS and hydraulic modeling software.

geographic information system (GIS) and hydraulic modeling software. Buildings previously identified (without use of hydraulic modeling) as being located upstream or downstream of each compliance sampling location would be confirmed or refuted through a comparison with the utility's all-pipe hydraulic model. New repeat sampling locations would be identified if necessary.

#### UNDERSTANDING UPSTREAM AND DOWNSTREAM

PWD previously used its all-pipe hydraulic model to model pressure fluctuations caused by valve closures and main breaks, determine whether pump replacements are adequate, and identify specific valves to close to achieve certain water velocities for leak-detection inspections. In addition, the utility has used the model to trace water to improve storage tank chlorine residual and determine the area of impact of contamination from a deteriorating reservoir cover.

Before the hydraulic model could be used for this project, PWD needed an accurate GIS layer identifying all buildings that house grab-sampling locations. In addition, site visits were necessary to determine which main fed each building by physically locating the service connection and its curb valve. After every service connection was identified, hydraulic modeling results were analyzed for flow direction in the mains around each sampling location.

The hydraulic model is set up to represent the distribution system's average weekday operating conditions. Typical hydraulic operations are assigned to all pumps, tanks, reservoirs, and control valves. A 24-hour extended period simulation (EPS) was run on the entire city model. Hydraulic values were calculated every 15 minutes, and a report time step of 1 hour was used.

Results of this 24-hour average-day simulation were used to identify flow directions in the mains around each total

originally tested positive, a sample from a tap within five service connections upstream, and a sample from a tap within five service connections downstream. Sampling must be conducted until the contamination source is identified or until all repeat samples are negative for coliforms.

In the early 1990s, the rule required PWD to submit to its primacy agency a repeat-sampling plan for all total coliform compliance locations. Scientists and other water quality specialists analyzed

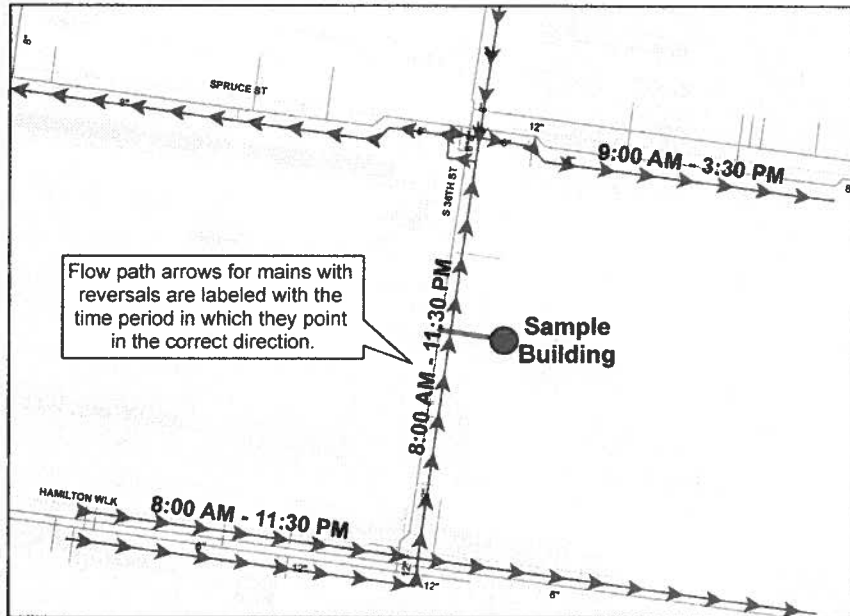
maps to best determine the direction of water flow in the mains around each location. Then they went door to door and established contacts in buildings they believed to be upstream and downstream of each compliance sampling location. These contacts and their addresses were compiled and submitted as the utility's repeat-sampling plan, which is still used today.

To prepare for the RTCR, PWD is striving to improve repeat sampling accuracy by using current technology, primarily

# Regulatory Compliance

**Figure 2. Day Flow Reversal**

Red flow-path arrows represent the category "Flow Reversal During the Day."



coliform compliance-sampling location within the distribution system. The focus was to identify a typical flow path around each sampling location to show all nearby upstream and downstream locations that could be used for repeat sampling.

For each site, visualization tools—primarily flow-direction arrows placed over each pipe and basic graphs showing flow rate—were used to analyze the model-run results. The tools allowed PWD engineers to draw their own flow paths around each sampling location.

### FLOW PATH TYPES

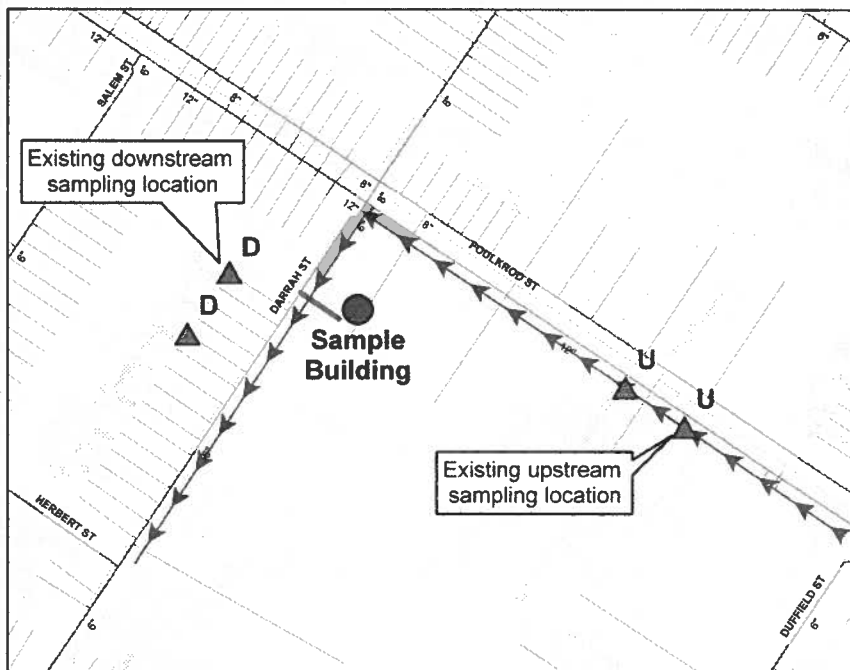
The flow path for each sampling location was categorized depending on whether the main feeding that location reversed flow direction at some point during the simulated average 24-hour day and, if so, during what part of the day the reversal occurred.

**Unidirectional Flow.** Accounting for 80 percent of the locations, the first category identifies locations with flow paths that don't reverse direction during an average day. Sampling locations with these flow paths always have the same upstream and downstream locations regardless of time of day.

**Flow Reversal at Night.** For the second category, flow direction for the main feeding these locations reversed at some point during off hours. This means the upstream and downstream locations of the original sampling location switch positions at night. Regardless, the upstream and downstream locations are the same when the original sample was collected (typically 4–7 a.m.) and the next day when repeat samples are collected (usually 9 a.m. to 1 p.m.) after notification from the lab. This complicates the identification of possible contamination sources, because an upstream repeat sample that tests positive for coliforms or *E. coli* doesn't necessarily indicate the direction the potential contamination is coming from.

**Figure 3. Existing Locations Match**

Existing repeat sampling locations match the model flow path.



Half the locations for the existing plan didn't represent water that was upstream or downstream of the sampling locations, although previously they were believed to be.

**Flow Reversal During the Day.** Locations in the third category reversed flow direction during the day, between the time of original sampling and that of next-day repeat samples collected later in the day (after lab notification). This further complicates the identification of local contamination sources, because the upstream and downstream locations aren't the same for the original sample and repeat samples.

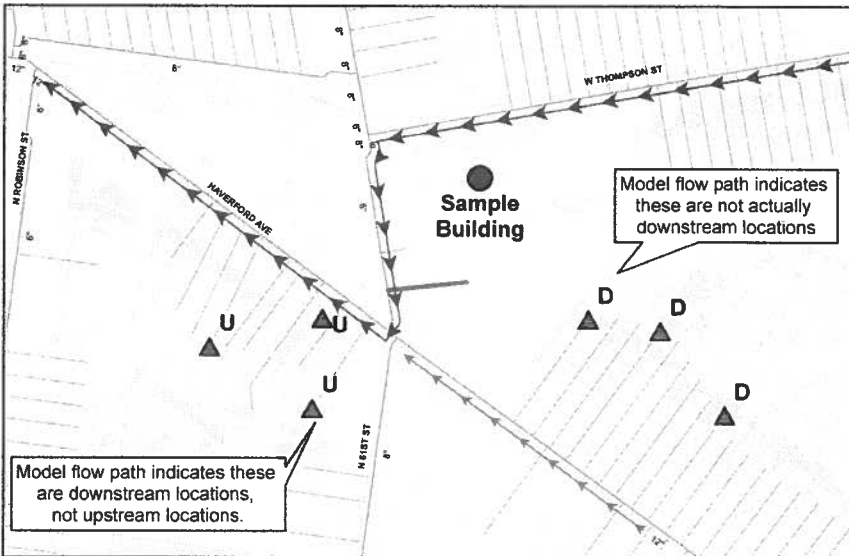
#### A BETTER PLAN

After average-day flow-path arrows were drawn around each compliance sampling location, PWD engineers compared upstream and downstream areas identified by the model with the upstream and downstream locations identified in the utility's existing repeat-sampling plan. An address locator was used to geocode the addresses of the existing plan to a GIS layer, which was viewed along with the flow-path layer. Next, each address of the existing repeat-sampling plan was categorized as matching or not matching the model-predicted flow path. Once the process was complete, it was determined that about half of the existing upstream and downstream locations for all total coliform compliance-testing locations didn't lie on the flow path predicted by the model. In other words, half the locations for the existing plan didn't represent water that was upstream or downstream of the sampling locations, although previously they were believed to be.

When the RTCR goes into effect, PWD will submit to its primacy agency a new repeat-sampling plan that focuses more on identifying groups of buildings in the areas located by the model as being suitable for repeat sampling. This is because PWD engineers believe that hydraulic modeling is the most accurate method the utility has for locating suitable repeat sampling locations. Through the use of hydraulic modeling, the engineers are confident their response to possible contamination events has improved.

**Figure 4. Existing Locations Reversed**

Existing repeat sampling locations don't match the model flow path.



**Figure 5. Sample Collector Map**

A sample collector map includes hundred-block street labels and local business locations, which make it easier for a sample collector to physically find suitable sampling locations.

