DATE: February 6, 2007, **Revised April 19, 2011**

TO: Office of Drinking Water Technical Staff

FROM: J. Wesley Kleene, Ph.D., P.E., Director
Office of Drinking Water

SUBJECT: Sample Collection and Analysis- Compliance Sampling and Reporting

REFERENCE: Compliance Sampling and Reporting Guidance Manual (Sampling Manual)

DELETE: WM 907, WM 905, WM 831, WM 807

Project Leader: Gigi Meyer Reviewed by: Susan Douglas

Revision Highlights:
Procedures used to disseminate future revisions to the Sampling Manual have been added.
This revision of the Sampling Manual incorporates WM 907, WM 905, WM 831 and WM 807.
It also includes updates to other chapters.

The *Waterworks Regulations* require periodic monitoring of all public water supplies. It has been and will remain the responsibility of the waterworks owner to ensure that the proper number of samples (bacteriological, physical, chemical, and radiological) are collected, submitted for analysis, analyzed and results reported to the appropriate Field Office. However, the Health Department will assist the owner, on a regular frequency in obtaining the necessary services from State approved laboratories for the collection of bacteriological, chemical, physical and radiological samples.

The Sampling Manual provides instructions and clarifications to ODW staff regarding the compliance sampling and reporting requirements of the *Waterworks Regulations*. The Sampling Manual is not intended to replace the requirements of the Regulations. It identifies, describes and provides information related to: sample groups; sampling locations; monitoring plans; sample scheduling; monitoring waivers; chemical/physical/radionuclide compliance determinations; approved laboratories; DCLS sample request procedures; and reporting of results. The Sampling Manual does not cover groundwater source development samples.

The Compliance Sampling and Reporting Guidance Manual references a number of templates (forms and letters) which are intended to: standardize office procedures, improve office efficiency, and address regulatory requirements. They should only be modified to address specific circumstances or individual Field Office situations, or where noted as optional.

The Manual is intended for ODW staff use. It is not intended to be provided to the waterworks in lieu of technical assistance from ODW staff. Staff are responsible for reviewing the Sampling Manual revisions, and using the most current version of the Sampling Manual and reference templates available in electronic format on the "ODWSHARE" file server.

Field Directors shall send email confirmation to the author that all staff have been notified of the revisions, and the changes reviewed by the date given in the revision notification.

END OF MEMO

Compliance Sampling and Reporting Guidance Manual for ODW Staff

Version 3.4
October 10, 2012

VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

Office of Drinking Water
Safe Drinking Water for a Healthy Virginia

COMPLIANCE SAMPLING AND REPORTING GUIDANCE MANUAL

Version 3.4
October 10, 2012

FOREWARD

The *Waterworks Regulations* require routine monitoring of all public water supplies. It is the responsibility of the waterworks owner to ensure that the proper number of samples (bacteriological, physical, chemical, and radiological) are collected, submitted for analysis, analyzed and results reported to the appropriate Field Office. However, the Health Department will assist the owner, on a regular frequency in obtaining the necessary services from State approved laboratories for the collection of bacteriological, chemical, physical and radiological samples.

This manual provides guidance for ODW staff on the procedures required for compliance sampling and reporting. It identifies: sampling locations, monitoring plans, sample schedules, groundwater source sampling requirements and surface water influence determination, monitoring waiver procedures, chemical and radionuclides compliance decision flow charts, special procedures for ordering invoices from the Division of Consolidated Laboratories (DCLS); and reporting of results. The manual also includes copies of various standard monitoring plans, review/evaluation forms, and letters.

EXCLUSIONS

This manual does NOT cover well development sampling.

REVISIONS SUMMARY

DATE	DESCRIPTION OF CHANGES
February 6, 2007	Original issuance
Sept. 21, 2009 (Version 2.0)	1. Revised DCLS Table 2.1 with Sample Groups and Methods; 2. Revised Section 4 Bacteriological Sample Site Report to include TNC (section 4.1.5) and Triggered Source Water sample criteria (Section 4.2.); 3. Revised Section 6 Lead and Copper Monitoring Plan, to include LCR-STR changes; 4. Revised Section 7, Groundwater Sources Raw Water Sampling and GUDI Determination; 5. Included Section 8, Radiological Samples; 6. Revised Section 9, Monitoring Waivers; 7. Deleted Section V.III. New Sources; 8. Deleted Section V.IV. Groundwater Sources and Surface Influence Determination 9. Included note regarding TTHM / HAA5 Running Annual Average, Section 11.5; 10. Revised Section 12, Laboratories; 11. Revised Section 13 DCLS Sample Kit Request Procedures to include new Ad Hoc ordering procedures and Triggered Source Water Monitoring kit dispatch; 12. Revision to Section 14, Evaluation and Distribution of Sample Results; 13. Included Section 15, with revised Samples / Letters / Forms for Bacteriological Sample Site Report (to include Triggered Source Water Samples) and 14. Lead and Copper Monitoring Review Forms and Approval Letters updates to include LCR-STR changes.

April 19, 2011 (Version 3.0)	1. Revised section 2.1, DCLS Sample Groups. 2. Updated Section 5 – Disinfection and Disinfection Byproducts Regulatory Requirements and Monitoring Plans, for provisions of ST2 Rule, as incorporated into the revised *Waterworks Regulations*. 3. Updated Section 6 – Lead and Copper Monitoring Plan, to include LCR Short Term Revisions and Clarifications. This section incorporates WM 907, which has been deleted. Includes new flowchart for Corrosion Control Treatment and Examples section. 4. Revised Section 7- Groundwater Sources Raw Water Sampling and GUDI Determination. Revised GUDI Determination Review Sheet, and Raw Water Monitoring Decision Flow Chart, and notification letter. This section incorporates WM 905, which has been deleted, and deletes the original GUDI Determination Flow Chart. 5. Added new Section 9 – Contaminants of Concern. It includes emerging non-regulated contaminants such as MTBE, Chromium-6 and Percholate. The MTBE section replaces WM 807 and WM831, which have been deleted. 6. Section 12 "Laboratories" has been deleted, and Section 16 "Sample Letters and Forms" has been deleted.
August 22, 2011 (Version 3.1)	1. Revised Chapter 5, Disinfectants and Disinfection Byproducts: changes to sections 5.1, 5.4.1 and 5.4.2. Added DBP & OEL results letter and new OEL Report Review Sheet. 2. Revised Chapter 13, section 13.3 – Bacterial Repeat and triggered source water monitoring kit dispatch with staff procedure for ordering additional repeat bottle containers and labels. 3. Deleted section 14.3, Calculation form for Running Annual Average.
December 29, 2011 (Version 3.2)	1. Revise Chapter 11, section 11.8- Standard Monitoring Schedule to correct 1st, 2nd and 3rd period delimiters, clarify & correct radionuclides monitoring.
March 12, 2012 (Version 3.3)	1. Revise Chapter 5, section 5.4.2 – DBP Compliance & Operational Evaluation Level (OEL) Calculations, to include OEL forms, 2. Revise Chapter 5, section 5.4.3 - Stage 2 Reduced Monitoring, to clarify source running annual average TOC criteria. 3. Added sentence to first paragraph of section 11. Sample Scheduling noting when a thorough review of sampling requirements is needed.
October 10, 2012 (Version 3.4)	1. Chapter 2, Table 2.1 – DCLS Sample Groups, has been eliminated. Reference now made to ODW Website for information. 2. Chapter 5, Section 5.4.1. – DBP monitoring changes from ST1 to ST2 Rules have been clarified. 3. Chapter 9 – Section 9.3 Perchlorate has been updated. 4. Chapter 11, Table 11.6 – Location for TOC & Alkalinity sampling points has been corrected, footnote on alkalinity monitoring has been added, and the significant digits of the TOC removal ratio corrected. 5. Chapter 13 – Monitoring schedules posted to ODW Website and those submitted to DCLS have been clarified.

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1. List of Abbreviations

BSSR – Bacteriological Sample Siting Report

CCR – Consumer Confidence Report

CCT – Corrosion Control Treatment

CP – Copper Pipe

CR – Combined Radium Ra226 + Ra228

Cu - Copper

DBCP - Dibromochloropropane

DBP – Disinfection Byproducts

DBPR – Disinfection Byproducts Rule

DCLS – Division of Consolidated Laboratory Services

EDB – Ethylene dibromide

EP – Entry Point

GA – Gross Alpha Activity

GUDI – Groundwater Under the Direct Influence of Surface Water

GW - Groundwater

HAA5 – Haloacetic Acids (five)

IOC – Inorganic Chemicals

LSLR – Lead Service Line Replacement

LSR – Lead Service Lines

LUA – Land Use Activity

MCL – Maximum Contaminant Level

MCLG – Maximum Contaminant Level Goal

MFR – Multi-Family Residence

MPN – Most Probable Number bacteriological analysis method

MRDL – Maximum Residual Disinfection Level

NTNC – Nontransient Noncommunity water system

ODW – Office of Drinking Water

OWQP – Optimum Water Quality Parameters

Pb – Lead

PWS – Public Water System

RAA – Running Annual Average

SDWA – Safe Drinking Water Act

SFR – Single Family Residence

SOC – Synthetic Organic Chemicals

SUVA – Specific Ultraviolet Absorption at 254 nanometers

SW – Surface Water

TNC – Transient Noncommunity water system

TOC – Total Organic Carbon

TTHM – Total Trihalomethanes

U - Uranium

VOC – Volatile Organic Chemicals

WQP – Water Quality Parameters

2. Sample Groups

The *Waterworks Regulations* include a list of the required bacteriological, chemical, physical and radiological samples.

Required bacteriological analyses are based on whether the water sample is collected from the distribution system or directly from the water source.

Required Bacteriological Sampling Locations and Analysis Methods

Sample Location	Analysis Type
Source/Raw Water	Quantitative Analysis Methods
Approved Distribution System Sites	Presence / Absence Analysis Methods for total and fecal coliform or E. coli bacteria

Required chemical, physical and radiological analyses are listed in Tables 2.2 through 2.13 of the *Waterworks Regulations*. A current list of the various contaminants by analysis group is included in the monitoring schedules (MS Excel workbook) posted on the ODW Website under "Information for Laboratories" tab.

3. Sample Locations / Monitoring Plans

3.1. Compliance Sample Location Types

Water samples to be analyzed for compliance purposes must be collected from sample locations within a waterworks listed below:

Source Water (Raw Water) – Source water samples are water samples collected from the source prior to any treatment.

Combined Filter Effluent – Combined Filter Effluent samples are water samples collected where the effluent of multiple filters combine and must represent the treated water at a conventional surface water treatment plant.

Entry Point – Entry Point samples are water samples collected after application of any treatment as the water is entering the distribution system before the first customer.

Distribution System – Distribution System samples are water samples collected from approved locations within the distribution system of a waterworks.

Treatment Process Control - Treatment Process Control samples are water samples collected at various locations within a treatment plant and include but are not limited to source water samples, treated water samples, settled water samples, individual filter effluent water samples, combined filter effluent water samples and entry point samples. Treatment Process Control samples are not only used for compliance purposes but also for the purpose of identifying needed process changes at a treatment plant.

3.2. Monitoring Plans

The *Waterworks Regulations* require certain monitoring plans be submitted for review and approval. Listed below are the various monitoring plans needed by waterworks. The procedures for developing, reviewing and approving these monitoring plans are found in the sections listed below.

- Bacteriological Sample Site Report (Section 4)
- Bacteriological Sample Site Report / Triggered Source Water Monitoring Plan (Section 4)
- Disinfectants/Disinfection Byproducts Rule (Stage 1 and 2 DBPR) Regulatory Requirements and Monitoring Plans (Section 5)
- Lead and Copper Rule Materials Survey/Sampling Plan (Section 6)

4. Bacteriological Sample Site Report

Section 12 VAC 5-590-370 A1 of the *Waterworks Regulations* requires a written sample site report at all waterworks for the collection of water samples for total coliform analysis. We have renamed these Bacteriological Sample Site Reports (BSSR) to avoid confusion in our time accounting. The BSSRs must be reviewed and approved by our Field Offices.

4.1. Total Coliform Rule (TCR) Sample Site Plan

The following criteria should be used to evaluate the TCR sample site plan:

4.1.1. Waterworks < 3301 Population

- A minimum of 3 sample locations shall be identified for each sample required per month. These sample locations must be **representative** of conditions in the waterworks and must be assigned an identifying number.

- A distribution system map with each sample location identified shall be included. The map does not have to be to scale. It should accurately represent the distribution system and the sample locations.

- A statement the sample locations alternate from month to month or quarter to quarter should be included.

4.1.2. Waterworks > 3300 Population

- A minimum of 12 sample locations shall be identified on a distribution system map; however, each large waterworks shall be evaluated on a case by case basis to determine the number of sample locations needed to assure **representative** sampling.

- A statement the sample locations alternate from month to month or quarter to quarter should be included. It is acceptable to use a sample location more than once per month if that location otherwise meets the waterworks criteria for representative sampling.

4.1.3. Representative Sampling

- Sample locations shall be selected to be representative of all significant conditions that exist in a water distribution system. Consideration shall be given to such conditions as:

  - Water Main lines
  - Water Branch lines
  - Loops
  - Dead ends
  - Storage tanks
  - Pipe materials
  - Age and condition of pipe
  - Water use
  - Population Density

- Select accessible, well-used, conventional faucets.

- Select only those locations with readily identifiable repeat sample locations available. Repeat sample locations are sample site required to be sampled from after a routine sample indicates total coliform positive. Repeat sample locations include a site within 5 service connections upstream of the total coliform positive sample site, the total coliform positive sample site, a site within 5 service connection downstream of the total coliform positive sample site, and another routine sample location if the waterworks is only required to collect 1 routine sample per month. See 12 VAC 5-590-380D of the *Waterworks Regulations*.

4.1.4. Sample Location: NTNC and TNC Waterworks

- For waterworks with extremely limited distribution systems, an individual tap may be designated a sample location. Such waterworks may not have sufficient acceptable sample taps to meet all of the above requirements. Exceptions are appropriate if documented.

4.1.5. TNC Waterworks: Sample Scheduling and Exceptions

- Most TNCs continue to be eligible to collect one bacteriological sample for presence/absence analysis per calendar quarter. Except for this timing exception, all other compliance bacteriological sampling at TNCs must conform to requirements for community and NTNC waterworks. In the event of a positive result, TNCs must collect four repeat samples within 24 hours of notification, and *must collect five routine samples at evenly spaced intervals at approved locations during the following month***.** As is the case at other waterworks types, once triggered the increased monthly sampling at TNCs continues in subsequent months, until all five samples are negative for coliform bacteria.

- If results from all five monthly routine samples are satisfactory, the waterworks will resume collecting one routine bacteriological sample per calendar quarter during the next full calendar quarter.

EXAMPLE At Waterworks A an initial positive sample in January triggered four repeat samples within 24 hours of notification, and five routine samples in February. Because all five February samples were satisfactory, Waterworks A resumes collecting one sample per quarter between April 1 and June 30.

EXAMPLE Waterworks B delayed collection of its routine sample for the first calendar quarter until March. The March sample was positive, triggering the requirement to collect four repeat samples within 24 hours of notification, and five routine samples during April. Because all five April samples were satisfactory, the waterworks will resume collecting one routine sample per quarter between July 1 and September 30.

- Some TNCs operate with abbreviated annual operating periods, and may be exempted from the requirement to perform additional routine sampling after an initial positive sample under some circumstances. In these cases the systems do not incur monitoring violations, and should not be issued NOVs.

EXAMPLE A TNC campground collected a positive routine quarterly sample in October, and it must collect four repeat samples during October, within 24 hours of notification. It would normally be required to collect five routine samples in November, but the system ceases normal operation on October 31: its infrastructure is winterized, it produces no water, and its service population falls to zero effective November 1. This system would be exempt from the requirement to collect samples in November, though the system will still need to conduct bacteriological sampling prior to resuming service to consumers in April of the following year. If the system's annual operating period is shortened merely because it closes to customers, but it still produces water (for service to office staff, or resident caretakers, for example) it should proceed with collection of the additional routine samples during the following month.

4.2. Triggered Source Water Monitoring Plan

This section covers requirements of waterworks with groundwater sources to comply with the Ground Water Rule.

4.2.1. Triggered Source Water Monitoring Plan (TSWMP)

A triggered source water monitoring plan is required for all waterworks with groundwater sources not approved for 4-log inactivation of virus. The plan must include the applicable monitoring requirements of the GWR. Waterworks must submit triggered source water sampling plans to ODW for approval. This must be a **part of the BSSR** (in one combined BSSR/TSWMP) and must include the following items:

- Map of waterworks with sources and/or entry points and TCR BSSR monitoring locations indicated;
- For wholesale waterworks, identification of consecutive waterworks served and sources providing water to the consecutive waterworks;
- For consecutive waterworks, identification of wholesale waterworks and notification requirements;
- For waterworks rotating sources in and out of service based on seasonal operating practices, listing of typical begin and end dates of service. Waterworks with multiple sources that are not operated simultaneously for consecutive weeks or months shall provide clear statements that raw water samples are to be collected from the source(s) in service at the time the total coliform positive distribution system sample was collected;
- Public notification requirements in the event of a E. coli positive source water sampling;
- Number of raw water samples to be collected from sources in the event of a total coliform positive distribution system sample and *E. coli* positive raw water sample.

4.2.2. Representative Source Water Sampling

Waterworks with multiple sources may conduct *representative* raw water sampling in order to reduce the burden of triggered raw water monitoring. One of the following specific conditions must be met and listed in the approved triggered raw water monitoring plan:

- Hydraulic conditions dictate that a source provides water to an isolated area of the distribution system. Consequently, only source(s) identified as providing water to specific TCR monitoring locations must collect the triggered raw water samples based on sample results from the specified TCR sample point. The plan must clearly identify groundwater sources linked to each TCR monitoring site in the waterworks' BSSR.

- Documentation accepted by ODW exists that clearly demonstrates that the sources are chemically, physically and hydro-geologically similar. Consequently, one source may serve as the triggered raw water sample location representing two or more sources. The plan must clearly list representative triggered raw water monitoring procedures, based on the documentation. References to the documentation must be included in the plan.

For more information on groundwater triggered source water monitoring requirements, please refer to WM 910 - Groundwater Rule.

5. Disinfectants and Disinfection Byproducts Regulatory Requirements and Monitoring Plans

Sampling of disinfectant residuals, disinfection byproducts and disinfection byproduct precursors is covered in section 12VAC5-590-370-B.3 of the *Waterworks Regulations*. The *Waterworks Regulations* establish maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), and maximum residual disinfectant levels (MRDLs). The *Waterworks Regulations* also establish a treatment technique for disinfection byproduct precursors.

5.1. Monitoring Plans

All Community and NTNC waterworks using chlorine, chloramines, chlorine dioxide (as a disinfectant or oxidant) and/or ozone must develop and implement a plan for disinfectant residual monitoring and for disinfection byproduct monitoring.

Community and NTNC waterworks with surface water or GUDI sources using conventional filtration treatment and/or ozone must also develop and implement a plan for disinfection byproduct precursor monitoring. TNC waterworks using chlorine dioxide as a disinfectant or oxidant must develop a plan for disinfectant residual monitoring.

Each waterworks should have one monitoring plan that includes disinfectant residual, disinfection byproduct monitoring, and disinfection byproduct precursor monitoring, as required. In order to facilitate compliance, ODW will draft the initial monitoring plan for all waterworks regardless of water source or size. The plan must include monitoring location and dates for routine monitoring, increased monitoring, and calculation procedures for compliance and operational evaluation level. Templates have been created for this purpose, and are posted here: :\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898- Sampling Manual\Stage 2 - DDBP Rule

Reduced and increased monitoring requirements for TTHM/HAA5 are not included in the monitoring plans because the details are dependent on results of routine monitoring.

Stage 2 Monitoring Plans will replace Stage 1 Monitoring Plans. The table below lists monitoring start dates for Stage 2 monitoring as well as recommended dates for plan preparation and approval. These dates are earlier than the deadlines given to the waterworks in the template approval letter (Appendix D of WM909). Note also that while the number of sites and sampling frequency is based on current population and water source, the 'Schedule' is based on the 4/1/06 population.

PWS or CDS[1]: Population	Draft Plan Date	Approved Plan Date	Monitoring Start Date
Sch 1: ≥ 100,000	October 1, 2011	January 1, 2012	April 1, 2012
Sch 2: 50,000-99,999	April 1, 2012	July 1, 2012	October 1, 2012
Sch 3: 10,000-49,999	April 1, 2013	July 1, 2013	October 1, 2013
Sch 4: < 10,000 w/o crypto monitoring	April 1, 2013	July 1, 2013	October 1, 2013
Sch 4: <10,000 w/crypto monitoring	April 1, 2014	July 1, 2014	October 1, 2014

The plan must be approved by ODW no later than the date of the first required report, and must be made available for inspection by the ODW and the public.

[1] If a waterworks is included in a Combined Distribution system (CDS), their schedule is based on the population of the largest waterworks' service population in the CDS.

5.2. Disinfectant Residual Monitoring

5.2.1. Monitoring Frequency (12-VAC 5-590-370 B.3.h)

Community and NTNC waterworks using **chlorine or chloramines** for disinfection or oxidation must sample for the disinfectant residual at the same time and same locations as total coliform are sampled. NOTE: Separate locations may be approved for monitoring if the location is more representative of the treated water quality.

Community, NTNC and TNC waterworks using **chlorine dioxide** for disinfection or oxidation must sample daily for disinfectant residual at the entrance to the distribution system. Each day following a MRDL exceedance, three additional chlorine dioxide residual samples must be collected at intervals of at least 6 hours. These samples must be collected as close to the first customer as possible. If booster chlorination (re-chlorination) is provided, the three samples must be collected as follows: 1) close to the first customer as possible, 2) at a location representative of average residence time, and 3) as close to the end of the distribution system as possible reflecting maximum residence time. NOTE: Chlorine dioxide monitoring may not be reduced.

5.2.2. Reporting and Recordkeeping Requirements

DISINFECTANT RESIDUALS	
Parameter	Must Report
Chlorine or Chloramines 12 VAC 5-590-530 F.1.	• The number of samples taken during each month of the last quarter. • The monthly average of all samples taken in each month for the last 12 months. • The average of all monthly averages for the last 12 months. • Whether the MRDL was violated.
Chlorine Dioxide 12 VAC 5-590-530 F.2.	• The dates, results and locations of samples taken during the last quarter. • Whether the MRDL was violated. • Whether the MRDL was exceeded in any two consecutive daily samples and whether the resulting violation was acute or non-acute.

5.3. Disinfection Byproduct Precursors Monitoring

5.3.1. Monitoring Frequency (12 VAC 5-590-370 B.3.j)

Routine Monitoring – Community and NTNC surface water and GUDI sources using conventional treatment must collect one source water (prior to any treatment) TOC and alkalinity sample and one treated water (no later than the point of combined filter effluent turbidity monitoring representative of the treated water) TOC sample at each treatment plant per month. The source water and treated water samples must be collected at the same time (representing normal operating conditions and influent water quality) and are referred to as paired samples.

Reduced Monitoring – Waterworks which have an average treated water TOC of less than 2.0 mg/l for two consecutive years, or less than 1.0 mg/l for one year may reduce monitoring to one paired TOC and alkalinity source water sample~~s~~ quarterly from each treatment plant. The waterworks must revert to

routine monitoring in the month following the quarter when the annual average treated water TOC is equal to or is greater than 2.0 mg/l.

5.3.2. Reporting and Record Keeping Requirements

DISINFECTION BYPRODUCTS PRECURSORS	
Parameter	Must Report
Waterworks monitoring monthly or quarterly for TOC and required to meet the enhanced coagulation or enhanced softening requirements. 12 VAC 5-590-530 G.1.	1. The number of paired (source water and treated water) samples taken during the last quarter. 2. The location, date and results of each paired sample and associated alkalinity taken during the last quarter. 3. For each month in the reporting period that paired samples were taken, the average of the percent reduction of TOC for each paired sample and the required TOC percent removal. 4. Calculations for determining compliance with the TOC percent removal requirements. 5. Whether the waterworks is in compliance with the enhanced coagulation or enhanced softening percent removal requirements for the last four quarters.
Waterworks monitoring monthly or quarterly for TOC and meeting one or more of the alternative compliance criteria. 12 VAC 5-590-530 G.2.	1. The alternative compliance criterion that the system is using. 2. The number of paired samples taken during the last quarter. 3. The location, date and result of each paired sample and associated alkalinity taken during the last quarter. 4. The running annual average based on monthly averages (or quarterly samples) of source water TOC or of treated water TOC 5. The running annual average based on monthly averages (or quarterly samples) of source water SUVA or of treated water SUVA. 6. The running annual average of source water alkalinity and of treated water alkalinity. 7. The running annual average for both TTHM and HAA5. 8. The running annual average of the amount of magnesium hardness removal (as $CaCO_3$, in mg/L). 9. Whether the waterworks is in compliance with the particular alternative compliance criterion.

5.4. Disinfection Byproducts Monitoring

5.4.1. Monitoring Requirements

Routine, Increased and Reduced Monitoring requirements for the following parameters are specified in the Waterworks Regulations 12VAC5-590-370 B.3: e. TTHM/HAA5, f. Chlorite, and g. Bromate.

Routine monitoring frequency is established based on source water type and population served. The intent of the Stage 2 rule is that compliance samples be collected in evenly spaced intervals. For waterworks required to sample quarterly, this would mean sampling in the same week in equally spaced months.

Example: A waterworks has a peak historical month of August. The waterworks schedules sample collection for the 1st week of August. Then, to space evenly, sample collection is scheduled for the 1st weeks of November, February and May.

Chlorite monitoring will be required for waterworks that use chlorine dioxide. Bromate monitoring will be required for waterworks that use ozone. The reduced monitoring requirement for bromate has changed from Stage 1 Rule; as of April 1, 2009 it is based on bromate results. Sampling may be reduced to quarterly if the bromate RAA ≤ 0.0025 mg/l using methods 317.0 Rev. 2, 326.0 or 321.8.

Further information on Stage 2 compliance monitoring location selection is given in WM 909. Should there be a lab accident affecting any sample, only a replacement sample for the single sample is required (i.e. no paired sample or dual sample or full sets required.)

The number of sites and frequency of routine monitoring will be in accordance with the following table.

Service Population (a)	Routine Monitoring	
	Frequency	# Sites
Groundwater		
<500	annual	2 (b)
500-9,999	annual	2
10,000-99,999	quarter	4
Surface Water & GUDI		
<500	annual	2 (b)
500-3,300	quarter	2 (b)
3,301-9,999	quarter	2
10,000-49,999	quarter	4
50,000-249,999	quarter	8
250,000-999,999	quarter	12
1,000,000-4,999,999	quarter	16

(a) Refer to *Waterworks Regulations* for larger waterworks' monitoring requirements.
(b) 1 site for TTHM (only) and 1 site for HAA5 (only), or 1 site for both TTHM & HAA5.

For systems that submitted an IDSE report, site selection will be in accordance with the report. If systems have changed since the IDSE, sites may need to be revised. Changes should be made in accordance with the IDSE criteria and documented.

For systems that did not submit an IDSE report, an updated plan is still required (including month(s) of sampling, revised calculation, operational evaluation. Note that some systems that did not perform an IDSE will need additional sites. For these waterworks:

- The peak historic month of sampling should be selected using IDSE monitoring plan methodology (probably July or August).
- If the number of sites is the same, the Stage 1 site(s) becomes the Stage 2 site(s).
- If there is a decrease in sites, IDSE report methodology is used to pick between the existing sites (see WM 909).
- If there is an increase in sites, IDSE monitoring plan methodology is used to identify additional sites (see WM 895), specifically alternating between likely TTHM and HAA5 sites. ODW staff will determine the general location for the additional sample sites and contact the owner if specific addresses are needed. Many groundwater systems or consecutive surface water systems with 500-10,000 population will probably need 1 new site.

New waterworks, or newly-disinfecting waterworks, will require Stage 2 sampling sites. The waterworks may need to conduct an IDSE to determine these sites. This shall be determined on a case by case basis by the District Engineer, with concurrence of the Deputy Field Director or Field Director. The IDSE monitoring plan methodology may be appropriate.

A system that is conducting Stage 1 sampling at an increased or routine frequency will begin Stage 2 sampling at the same frequency. If a system is sampling at a reduced frequency, it may begin Stage 2 sampling at the next scheduled sampling period as identified under Stage 1 and continue with a reduced frequency only if it meets **all** of the following criteria (otherwise it must begin sampling at routine frequency):

- Received a VSS or 40/30 waiver (refer to WM 909 for these terms),
- Meets reduced monitoring criteria for Stage 2 for all sites, and
- Stage 2 and Stage 1 locations are the same (typically only met for SWTP<3,300 or GW<500.)

If the waterworks was required to either change the number of sites (increase or decrease) or change the location of their site(s), they are not eligible to remain on reduced monitoring. These waterworks must begin routine monitoring under Stage 2 and can qualify again for reduced monitoring once criteria under Stage 2 are met.

Locations for reduced monitoring are not identified in the monitoring plan. They will be selected from the routine sites at the time monitoring is reduced. Site selection will be documented in R&R Scheduler and a letter to the waterworks owner amending the Sampling Plan shall be issued. Refer to letter template provided.

5.4.2. DBP Compliance & Operational Evaluation Level (OEL) Calculations

At the end of each Stage 2 monitoring period, the Operational Evaluation Level (OEL) is calculated along with the compliance level at each location. R&R will automatically calculate the compliance and OEL levels for each location based on the following formulae:

Compliance = (A + B + C + D) / 4

OEL = [B + C + (2 * D)]/4

Where:

A = TTHM or HAA5 result for the 3rd previous quarter (mg/L)
B = TTHM or HAA5 result for the 2nd previous quarter (mg/L)
C = TTHM or HAA5 result for the previous quarter (mg/L)
D = TTHM or HAA5 result for the current quarter (mg/L)

The OEL weights more recent quarters and provides an indication of unusual things in the distribution system, or of rising DBP levels, either of which may require special attention. The OEL is exceeded if TTHM is >0.080 mg/l or if HAA5 is >0.060 mg/l. If the OEL is exceeded, the owner must produce a report to the ODW within 90 days of being notified by ODW.) The Operation Evaluation report shall cover:

- A review of the results (calculations and history of the site)
- An examination of possible causes of the exceedance(s) including: storage tank operations, excess storage capacity, distribution system flushing, sources of supply and source water quality, treatment processes and finished water quality. Further information is provided in ST2 Operational Evaluation Guidance Manual (EPA 815-R-08-018).). Operation Evaluation forms from the ST2 Operational Evaluation Guidance Manual have been reproduced on ODWSHARE, and may be provided to the owner for the evaluation. If the owner can clearly show the reason for the exceedance in writing, then a detailed examination of possible causes is not warranted.
- Actions that could minimize future exceedances or compliance level violations.

The OEL exceedance is not a violation, and does not need to be included in the CCR. Failure to submit the report is, and must be included in the CCR. ODW is *required* to review and approve the report, and must keep a copy in the system file. If the review shows the report to be incomplete (either a minor problem missing basic items or a significant problem missing additional details), then ODW shall require the owner to complete the report. If the owner fails to do so, then ODW shall issue a notice of violation for failure to comply with the regulations (submit a complete report). A form for review of the OEL report is provided with the other ST2 Rule templates on odwshare.

5.4.3. Stage 2 Reduced Monitoring

The following table summarizes reduced monitoring and the procedure to select the locations and frequencies. **Staff should document reduced monitoring in the R&R Scheduler comments.** To qualify for reduced monitoring:

- For all systems, each LRAA must have TTHM ≤ 40 ppb and HAA5 ≤ 30 ppb.
- For a SW or GUDI system, each source must also have a Running Annual Average raw water TOC ≤ 4.0.
- For consecutive waterworks serving more than 500 people, with SW or GUDI primary source(s), each SW or GUDI source must also have a Running Annual Average raw water TOC ≤ 4.0.[2]

[2] Memorandum dated Feb 2, 2012 from Mindy Eisenberg, Acting Chief Protection Branch,Drinking Water Protection Division, EPA, Washington, D.C.

A waterworks may be kept at routine monitoring by the FD or DFD if unusual circumstances dictate.

Service Population (a)	Reduced Monitoring		
	Frequency	# Sites	Comments
Groundwater			
<500	Triennial	2 (b)	1 individual TTHM at site and quarter of single highest TTHM, and 1 individual HAA5 at site and quarter of single highest HAA5.
500-9,999	Annual	2 (b).	1 individual TTHM at site and quarter of single highest TTHM, and 1 individual HAA5 at site and quarter of single highest HAA5.
10,000-99,999	Annual	2	1 dual sample (TTHM & HAA5) at site and quarter of single highest TTHM, and 1 dual sample (TTHM & HAA5) at site and quarter of single highest remaining HAA5.
Service Population (a)	Reduced Monitoring		
	Frequency	# Sites	Comments
Surface Water & GUDI			
<500			No reduced monitoring.
500-3,300	Annual	2 (b)	1 individual TTHM at site and quarter of single highest TTHM, and 1 individual HAA5 at site and quarter of single highest HAA5.
3,301-9,999	Annual	2	1 dual sample (TTHM & HAA5) at site and quarter of single highest TTHM, and 1 dual sample (TTHM & HAA5) at site and quarter of single highest remaining HAA5.
10,000-49,999	Quarter	2 (c)	Dual samples, with one site chosen using highest TTHM LRAA and another site using the highest HAA5 LRAA.
50,000-249,999	Quarter	4 (c)	Dual samples, as above for total of 2 TTHM and 2 HAA5.
250,000-999,999	Quarter	6 (c)	Dual samples, as above for total of 3 TTHM and 3 HAA5.
1,000,000-4,999,999	Quarter	8 (c)	Dual samples, as above for total of 4 TTHM and 4 HAA5.

(a) Refer to *Waterworks Regulations* for larger waterworks' monitoring requirements.
(b) 1 site for TTHM (only) and 1 site for HAA5 (only), or 1 site for both TTHM & HAA5
(c) Generally, sites will be selected alternating highest TTHM and HAA5. This may be modified slightly to optimize health protection, such as using historic problem sites or seeking geographic diversity.

Determining reduced sampling at most GW waterworks should be fairly simple. Some odd sampling schedules can occur at small SW/GUDI systems. Consider the following:

Example 1- SW/GUDI, population: 500-3300

Routine Results (individual quarterly)						Reduced Schedule (individual, annually)
	Jan	Apr	Jul	Oct		
TTHM	10	20	***30***	20		TTHM, one individual sample in Jul
HAA5	10	***30***	20	10		HAA5, one individual sample in Apr

Note that the site may be the same or different for TTHM and HAA5.

Example 2- SW/GUDI, population: 3301-9,999

Routine Results (2 dual, quarterly)						Reduced Schedule (2 dual, annually)
	Jan	Apr	Jul	Oct		
TTHM – Site 1	10	20	***50***	20		Site-1, one dual sample set in Jul (based on high THM)
TTHM – Site 2	10	10	40	10		
HAA5 – Site 1	10	20	***40***	10		
HAA5 - Site2	10	***30***	20	10		Site-2, one dual sample set in Apr (based on highest HAA5 at remaining sites)

Waterworks may remain on reduced monitoring as long as:

- Waterworks on quarterly monitoring have TTHM ≤ 40 ppb and HAA5 ≤ 30 ppb.
- Waterworks on annual or triennial monitoring have TTHM ≤ 60 ppb and HAA5 ≤ 45 ppb.
- SW or GUDI waterworks also have a Running Annual Average raw water TOC ≤ 4.0 mg/l.
- For consecutive waterworks serving more than 500 people, with SW or GUDI primary source(s), each SW or GUDI source must also have a Running Annual Average raw water TOC ≤ 4.0.[3]

A waterworks must return to routine or increased monitoring if these conditions are not met. The FD or DFD may also put a system on routine or increased monitoring if unusual circumstances dictate.

5.4.4. Stage 2 Increased Monitoring

Waterworks that use only groundwater and serve fewer than 10,000 people and waterworks that use SW or GUDI and serve fewer than 500 must proceed to increased monitoring if either the TTHM annual average is >0.080 mg/L or the HAA5 annual average is >0.060 mg/L. Increased monitoring must begin in the quarter immediately following the monitoring period where either of the above values was exceeded. A TTHM and HAA5 sample must be collected once a quarter at all locations under increased monitoring.

Waterworks may return to routine monitoring once increased monitoring has been conducted for at least four consecutive quarters and the LRAA for all monitoring locations is ≤0.060 mg/L for TTHM and ≤0.045 mg/L for HAA5. Otherwise, they must remain on increased monitoring.

[3] Memorandum dated Feb 2, 2012 from Mindy Eisenberg, Acting Chief Protection Branch, Drinking Water Protection Division, EPA, Washington, D.C.

5.4.5. Reporting and Recording Keeping Requirements

DISINFECTION BYPRODUCTS	
Parameter	**Must Report**
TTHM & HAA5	1. Number of samples taken during the last quarter. 2. Location, date and result of each sample taken during the last quarter. 3. Average of all samples taken in the last quarter for each monitoring location. 4. Locational Running Annual Average (LRAA) of the quarterly arithmetic averages for the last four quarters for each monitoring location. 5. Whether the PMCL was exceeded at any monitoring location. 6. Whether any Operational Evaluation Level (OEL) was exceeded. If yes, the location, date, and calculated TTHM and HAA5 Operational Evaluation Level. Subpart H systems qualifying for reduced monitoring must also report whether the raw water TOC RAA exceeded 4.0 mg/L.
Systems using Chlorine Dioxide: Chlorite 12-VAC5-590-530 B.3.f.	1. Number of entry point samples taken each month for the last 3 months. 2. Location, date, and result of each sample (both entry point and distribution system) taken during the last quarter. 3. For each month in the reporting period, the average of all samples taken in each three sample set taken in the distribution system. 4. Whether the PMCL was violated, in which month, and how many times it was violated each month.
Systems using Ozone: Bromate 12-VAC 5-590-530 B.3.g	1. Number of samples taken during the last quarter. 2. Location, date and result of each sample taken during the last quarter. 3. The average of the monthly averages of all samples taken in the last year. 4. Whether the PMCL was violated.

5.5. Stage 2 DBPR Monitoring & Compliance Decision Flowcharts

Charts for Surface Water Systems

5.5.1. Surface Water Systems Serving ≥ 10,000 People

5.5.2. Surface Water Systems Serving 500 – 9,999 People

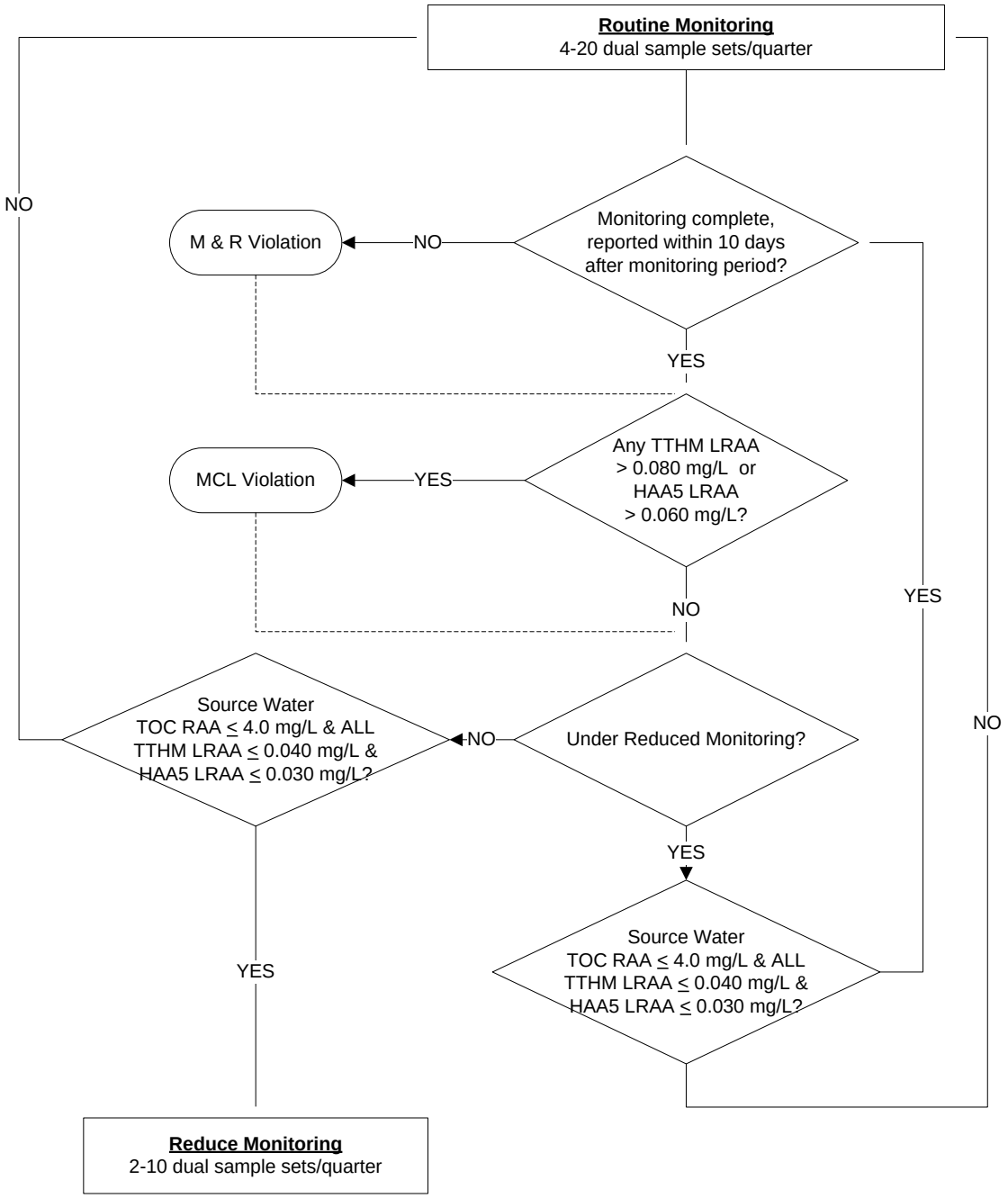
5.5.3 Surface Water Systems Serving < 500 People

Charts for Groundwater Systems

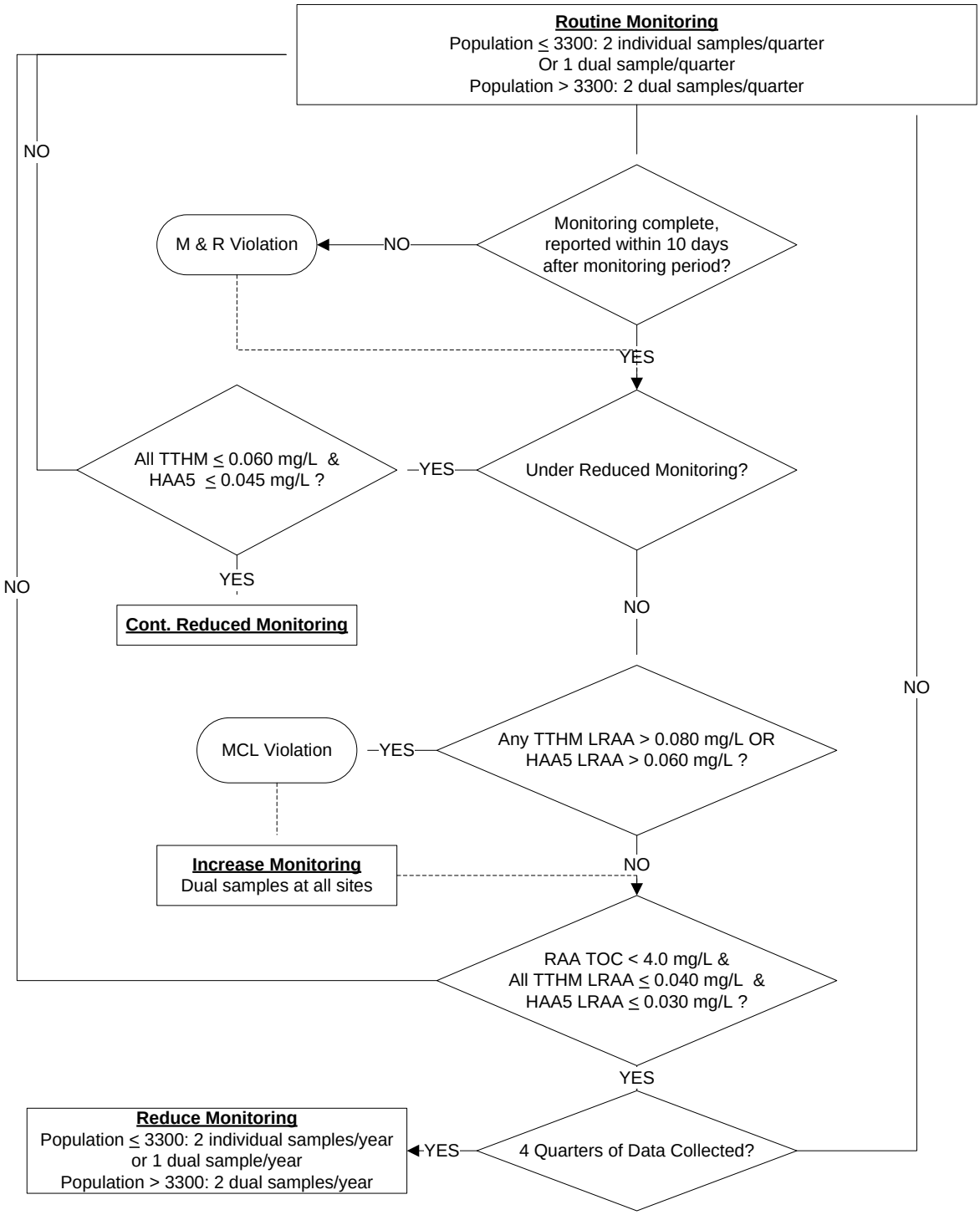
5.5.4. Groundwater Systems Serving 10,000 – 99,999 People

5.5.5 Groundwater Systems Serving < 10,000 People

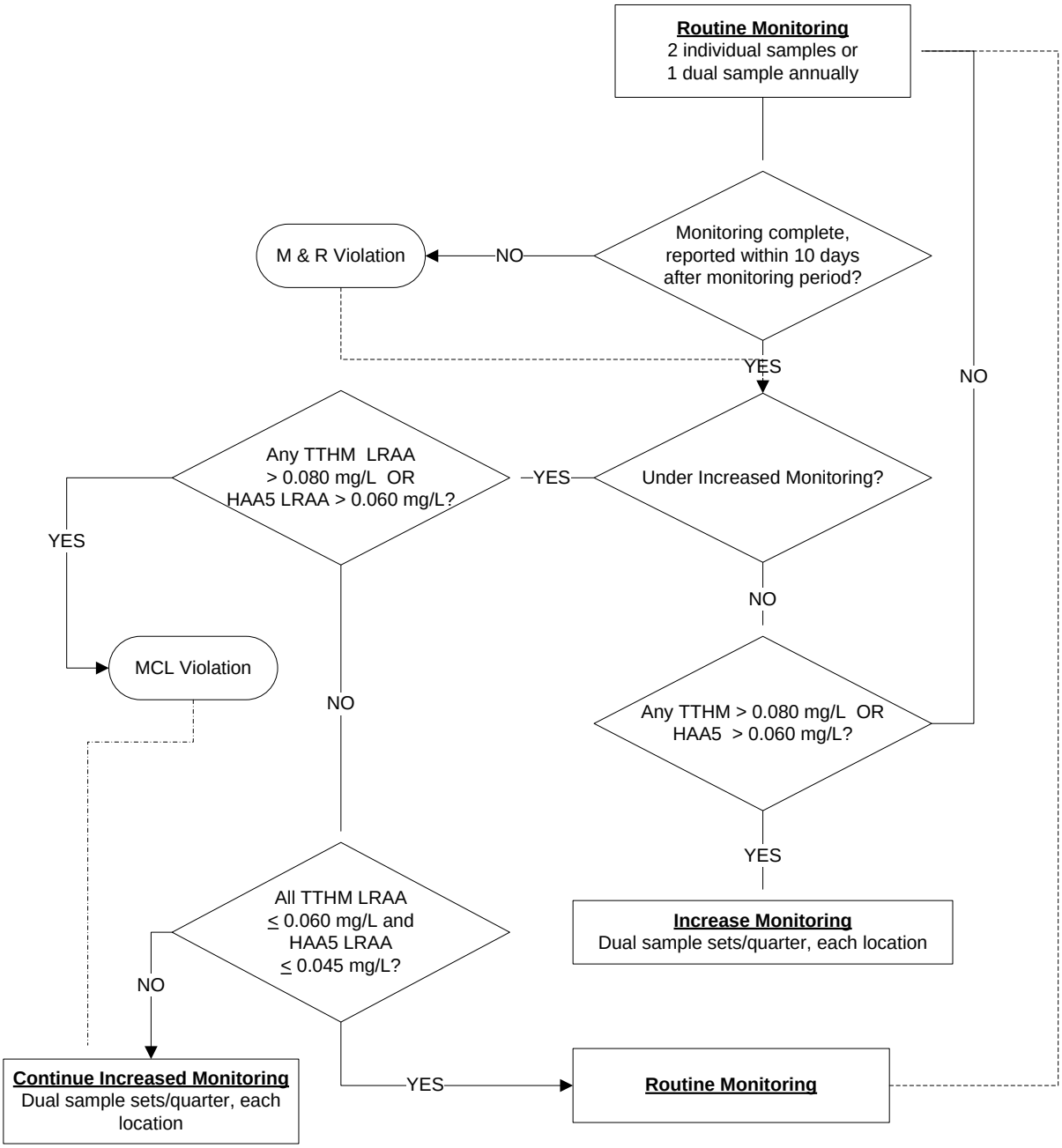
5.5.1. ST2: Surface Water Systems Serving ≥ 10,000 People



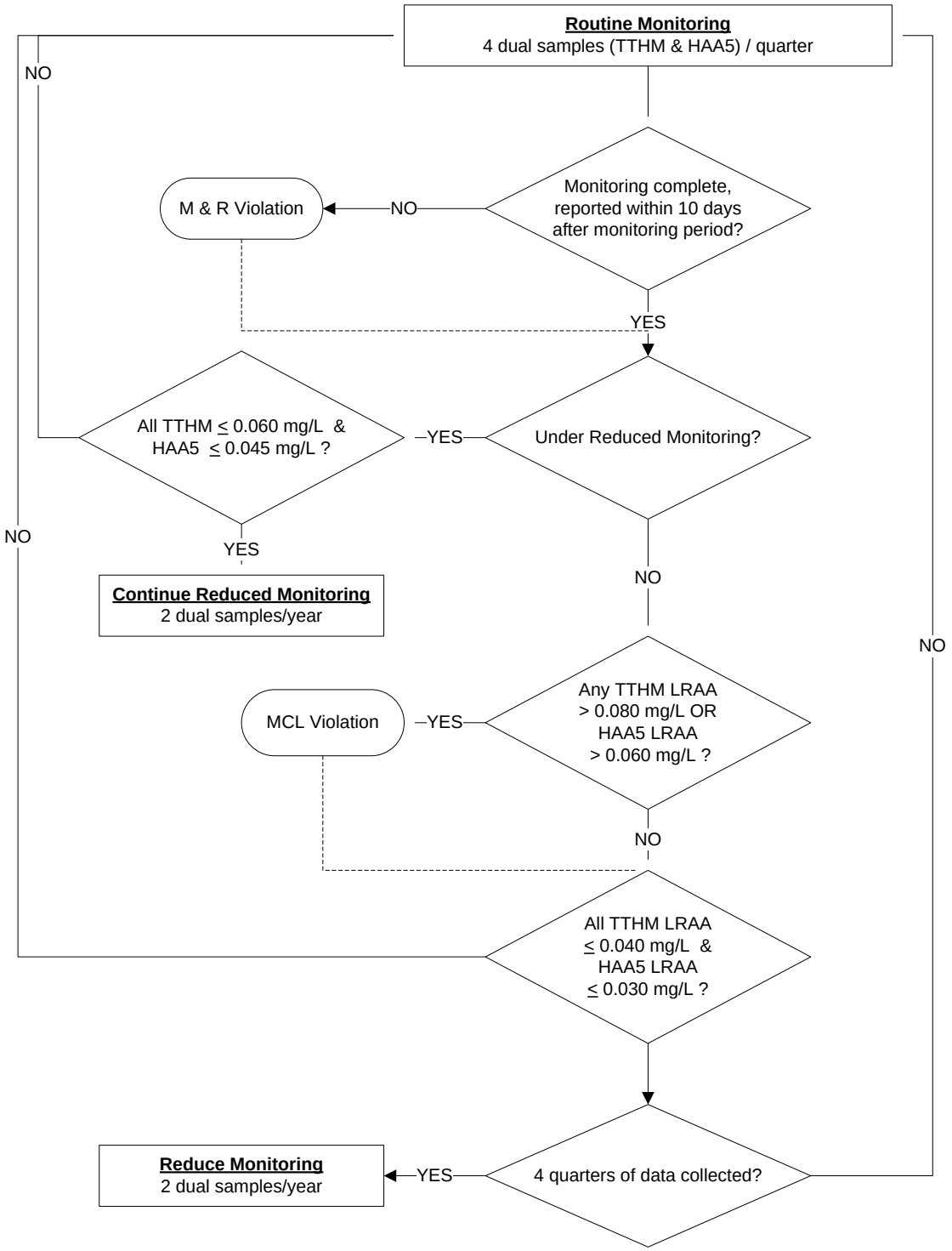
5.5.2. ST2: Surface Water Systems Serving 500 – 9,999 People



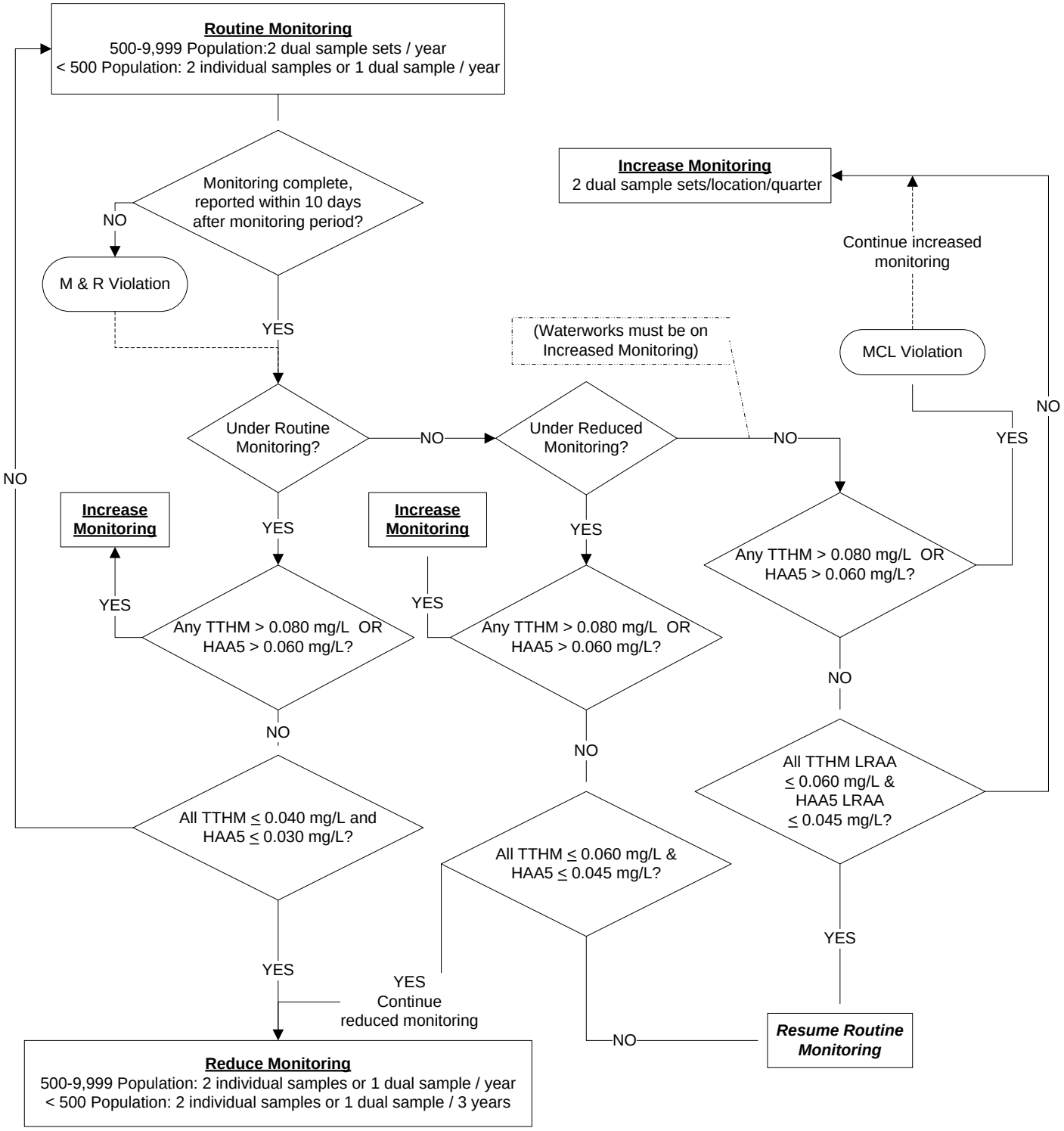
5.5.3. ST2: Surface Water Systems Serving < 500 People



5.5.4. ST2: Groundwater Systems Serving 10,000 – 99,999 People



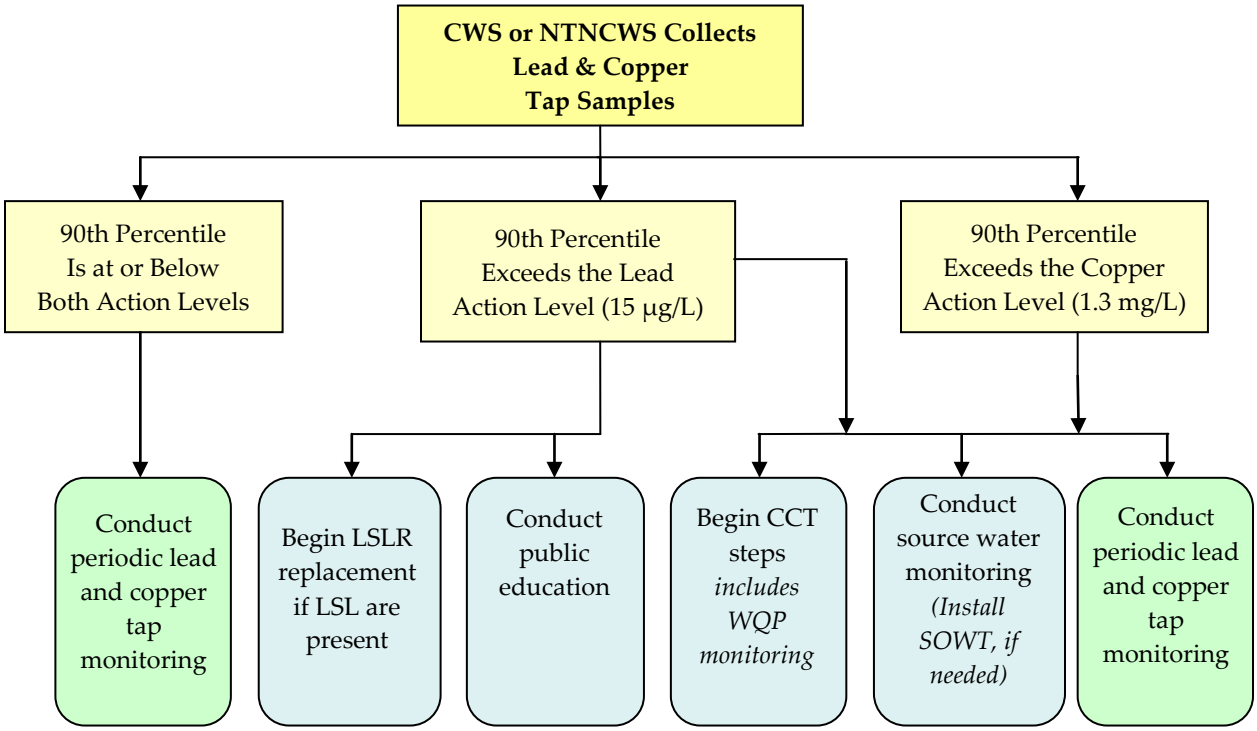
5.5.5. ST2: Groundwater Systems Serving < 10,000 People



6. Lead and Copper Sampling and Treatment Techniques

The Lead and Copper Rule (LCR), originally published on June 7, 1991; amended on January 12, 2000 with the Lead and Copper Rule Minor Revisions; amended October 10, 2008 with the Lead and Copper Rule - Short Term Revisions and Clarifications, stipulates lead and copper monitoring requirements and treatment techniques for all community (C) and nontransient noncommunity (NTNC) waterworks. The LCR monitoring requirements are contained in the *Waterworks Regulations* 12VAC5-590-375 and the LCR treatment technique requirements are contained in the *Waterworks Regulations* 12VAC5-590-405.

LCR Decision Flow Chart



6.1. Lead and Copper Monitoring at Consumers Taps

Lead and copper tap monitoring must be conducted at sample sites deemed to be the highest risk locations within the distribution system for leaching lead. This priority "Tier and Category" of sample sites is based on a survey of the plumbing materials found at residences and other buildings located within the distribution system. An acceptable sampling location should be a tap that is normally used for human consumption. This is typically a cold water kitchen or bathroom tap, or drinking fountains and water coolers located in schools or other buildings. Outside hose bibs or utility sinks are not acceptable sampling locations.

6.2 Materials Survey

Prior to collecting any lead and copper tap samples the waterworks will need to perform a survey of their water distribution system piping materials and the plumbing materials of all service connections including interior plumbing materials to develop a list of priority sample sites. Local plumbing codes, building officials, contractors and door to door visits with residents are sources and methods that can be used to complete the survey. A survey letter form is located at …:\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898- Sampling Manual\LCR

which the owner should use to report the results of the survey and their list of chosen sample sites. Note that all monitoring for lead and copper (initial monitoring and all future monitoring) must come from sites that are identified in the materials survey. As such we should encourage waterworks owners to identify more sites than the minimum number required. This will allow for a pool of replacement locations when the site may become unavailable in the future.

6.3. Preferred Sample Sites
(Defined in descending order)

Tier 1:

- Category A → Single family residences (SFRs) with 50% of the sample sites consisting of lead service lines (LSLs) and 50% consisting of either internal lead pipe or copper pipe with lead solder installed between 1983 and 1986. Since lead plumbing materials were banned in 1986 no newly developed waterworks with new homes will meet this category.
- Category B → All SFRs with all LSL sites included and the remainder consisting of homes with lead pipe or copper pipe with lead solder installed between 1983 and 1986. Again no newly developed waterworks with new homes will meet this category.
- Category C → If the waterworks can prove that there are no LSLs then 100% of the sample pool should be from tap samples collected from homes with lead pipe or copper pipe with lead solder installed between 1983 and 1986.
- Multiple-Family residences (MFRs) may be included in the Tier 1 sampling pool when they comprise at least 20 percent of the structures served.

Tier 2:

- Category D → If enough SFRs with LSLs , lead pipe and/or copper pipe with lead solder cannot be identified then the sample pool may be substituted from sites with MFRs and/or public and private buildings supplied by LSLs or containing lead pipe or copper pipe with lead solder installed between 1983 and 1986.

Tier 3:

- Category E → If the above categories cannot be fully met then the remainder of the sample sites must be filled with SFRs having copper pipe with lead solder installed prior to 1983.

Exceptions:

- Category F.1 → Those PWSs with only interior plastic plumbing that cannot demonstrate "lead free" conditions due to brass faucets and fittings. Monitoring should be at SFRs with brass faucets.

- Other Category F → SFRs with copper piping installed after 1986.

Additional information concerning preferred sample sites:

- Tier 3, Category E may still apply to many new and some existing waterworks that have older homes with lead soldered copper plumbing.

- Category F.1 appears to be the classification for many new waterworks with new homes due to only having brass that may contain some lead. The EPA has defined lead free brass materials as having up to 8 % lead. This has caused some problems in areas with very soft corrosive waters.

The general sample priority can be viewed in descending order as follows:

Lead service lines or lead pipe (LED) SFR → Copper pipe with lead solder (CP/LS) SFRs → CP/LS MFRs → CP/LS plumbed Public/Private buildings → Copper without lead solder SFRs → Copper MFRs → Copper plumbed Public/Private buildings → Plastic SFRs → Plastic MFRs → Plastic plumbed Public/Private buildings.

- The pool of sample sites should be made up entirely of the highest tier and category (priority) samples to the greatest extent possible.

- It is recommended that the waterworks owner identify more sites than the minimum number of samples required to ensure sufficient participation to obtain the minimum number of samples.

6.4. Tap Monitoring Sample Procedures

1. All lead and copper tap samples must be collected from approved locations identified in the approved materials survey.

2. Each sample must a "first draw" sample and be a volume of 1 liter. The tap to be sampled should be thoroughly flushed prior to a 6 hour period of no water use or holding time. The sample tap and other taps including the toilet are not to be operated for a period of at least 6-hours to insure that a standing undisturbed sample is collected (note that there is no regulatory maximum holding time and a high lead result can not be invalidated due to excessive standing times).

3. Faucet aerators (screens) should not be removed for sampling purposes. Consumers should periodically clean aeration screens to remove particles of copper, brass or solder that often accumulate and can increase the levels of lead and copper in their drinking water.

4. The sample tap should be operated at a moderate flow that does not splash when the sample is collected

5. The time of last water usage and sample collection time and date must be recorded

6. Residents can collect the lead and copper tap sample with proper instruction from the waterworks owner. Sample preservation requirements include the addition of nitric acid, however in order to eliminate any hazard with homeowners collecting the samples the LCR allows this preservation to be accomplished within 14 days of sample collection. This sample preservation is normally conducted by the testing laboratory so samples must be delivered to the lab within the 14 day time limit.

6.5. Initial Lead and Copper Tap Monitoring

After review and approval of the waterworks materials survey, the owner must begin initial monitoring. Initial monitoring consists of collecting two consecutive sets of samples in 6 month sampling periods (January – June and July - December) from the number of routine sample sites specified in the following table:

Minimum Number of Tap Samples		
System Population	No. of Routine Sample Sites	No. of Reduced Sample Sites
>100,000	100	50
10,001 to 100,000	60	30
3,301 to 10,000	40	20
501 to 3,300	20	10
101 to 500	10	5
≤ 100	5	5

For small systems with a population ≤ 100 and less than 5 acceptable sampling locations that are normally used for human consumption, the *Waterworks Regulations* allow that less than 5 samples may be collected if one sample is taken from each available tap.

If the 90 percentile results for both lead and copper do not exceed the 0.015 mg/L Action Level for lead or the 1.3 mg/L Action Level for copper during both consecutive initial monitoring periods, then the waterworks can proceed to reduced monitoring.

6.6. Reduced Lead and Copper Tap Monitoring

Reduced monitoring consists of collecting two additional consecutive sets of annual samples at the reduced number of sample sites indicated in the preceding table. These samples must be collected between June 1 and September 30.

Annual reduced lead and copper tap monitoring starts the next year after the 2nd 6-month period:

If 2nd 6-month sampling period is:	**Annual Monitoring Begins:**
January – June:	June 1 of the next year
July – December:	

If the 90th percentile lead and copper sample concentrations are still below the action levels for both sets of annual samples (a total of three years of monitoring) then the waterworks can proceed to ultimate reduced monitoring.

Ultimate reduced monitoring consists of collecting samples at the reduced number of sites at 3 year intervals. All samples must be collected between June 1 and Sept. 30 of the sampling year. The system can not exceed 3 years between sampling events and sampling can not be spread out over a 3 year period; samples must be collected within the same year, between June and September.

Accelerated ultimate reduced monitoring - Systems can proceed immediately to ultimate reduced monitoring (3 year intervals) if the monitoring results for two consecutive 6-month periods indicated a 90th lead concentration of ≤ 0.005 mg/L for lead and ≤ 0.65 mg/L for copper

6.7. Monitoring Waivers

There is a provision in the LCR and the *Waterworks Regulations* 12VAC5-590-375 B 7 for monitoring waivers. To date no waterworks has requested a monitoring waiver. Should a waterworks apply for a monitoring waive use the *Waterworks Regulations* as guidance.

6.8. Determining the 90th Percentile Concentrations

The LCR established Action Levels for both lead and copper. The lead Action Level is exceeded if the concentration of lead in more than 10% of tap water samples collected during any monitoring period than 0.015 mg/L (i.e., if the 90th percentile lead level is greater than 0.015 mg/L). The copper Action Level is exceeded if the concentration of copper in more than 10% of tap water samples collected during any monitoring period is greater than 1.3 mg/L (i.e., if the 90th percentile copper level is greater than 1.3 mg/L).

The District Engineer is responsible to ensure that the 90th percentile concentrations are determined for both lead and copper following receipt of all lead and copper sample results for each respective monitoring period. The procedure to determine the 90th percentile concentrations can be found the *Waterworks Regulations* 12VAC5-590-385.

- All valid sample results must be included in the 90th percentile calculation. A valid sample is a sample:

    1. Collected from a pre-approved sample location that was identified in the original or in a revised Lead and Copper Materials Survey and Sample Plan (Section 6.2)
    2. Collected from an approved alternate sample location that meets the same site tier and category as in the Sampling Plan
    3. Collected within the respective monitoring period – no exceptions - do not include any sample that was collected outside of the monitoring period

- Samples collected outside the compliance monitoring period (June 1 – September 30 for reduced monitoring) are not to be included in the 90th percentile calculation. However, samples collected outside the monitoring period containing elevated levels of lead must be addressed as a separate issue, and may require some type of public notice.
- If a waterworks collects fewer than the minimum number of samples, the lead and copper 90th percentile concentrations must be determined using the number of samples submitted. A monitoring violation must also be issued.

- Waterworks can collect samples or review the sample collection information before the sample is analyzed by the laboratory. If something is suspected to be incorrect, the sample should not be tested and another one collected. Once sample results are received, ODW can only invalidate the sample if one or more of the following occurs:

  - Improper sample analysis verified by the laboratory
  - Site selection criteria has not been met
  - Sample container was damaged in transit
  - Sample subjected to tampering

6.9. Monitoring for Water Quality Parameters (WQP's)

In addition to the lead and copper tap monitoring, the LCR also contains requirements for monitoring of WQP's. This monitoring is used to determine an appropriate optimum corrosion control treatment, if applicable, and to ensure that the corrosion control treatment at large systems is optimized. The WQP monitoring requirements are contained in the *Waterworks Regulations* 12VAC5-590-375.

All large waterworks (those serving >50,000 population) are required to conduct WQP monitoring. Small size (serving ≤ 3,300 population and medium size (serving 3,301 – 50,000 population) waterworks are required to monitor for WQP's only if either the lead or copper Action Level is exceeded.

WQP monitoring, when required, includes sampling from representative locations within the distribution system (such as sites used for routine total coliform monitoring) and from all entry points to the water distribution system. Distribution system monitoring includes two sets of samples collected from each site during each respective monitoring period. The number of distribution system sites to be sampled is based on population shown in the following table:

System Size – Number of Persons Served	Number of Sites for WQP Monitoring
> 100,000	25
10,001 to 100,000	10
3,301 to 10,000	3
501 to 3,300	2
101 to 500	1
Less than or equal to 100	1

Monitoring of WQP's at each entry point to the distribution system must include at least one sample at each entry point no less frequently than every two weeks (bi-weekly)

The following WQP's must be monitored: pH; alkalinity; orthophosphate, when an inhibitor containing a phosphate compound is used; silica, when an inhibitor containing a silicate compound is used; calcium; conductivity; and water temperature.

WQP's must be monitored during initial lead and copper tap monitoring; following the installation of corrosion control treatment; and after the State Health Commissioner (Commissioner) specifies optimal WQP's. See the *Waterworks Regulations* 12VAC5-590-375 for more specific requirements.

6.10. Reduced Monitoring for Water Quality Parameters (WQP's)

The LCR requires that states establish optimum water quality parameters (OWQP's) for all large size systems and for small and medium size systems that install corrosion control treatment and still fail to meet the established lead and/or copper Action Levels. The *Waterworks Regulations* state that the Commissioner shall designate:

- A minimum value or a range of values for pH measured at each entry point to the distribution system;
- A minimum pH value, measured in all tap samples. Such value shall be equal to or greater than 7.0, unless the Commissioner determines that meeting a pH level of 7.0 is not technologically feasible or is not necessary for the owner to optimize corrosion control;
- If a corrosion inhibitor is used, a minimum concentration or a range of concentrations for the inhibitor, measured at each entry point to the distribution system and in all tap samples, that the Commissioner determines is necessary to form a passivating film on the interior walls of the pipes of the distribution system;
- If alkalinity is adjusted as part of optimal corrosion control treatment, a minimum concentration or a range of concentrations for alkalinity, measured at each entry point to the distribution system and in all tap samples; or
- If calcium carbonate stabilization is used as part of corrosion control, a minimum concentration or a range of concentrations for calcium, measured in all tap samples.

The values for the applicable water quality control parameters listed above shall be those that the Commissioner determines to reflect optimal corrosion control treatment for the waterworks.

Once OWQP's are established, waterworks must operate within the established range or above the minimum established values. The owner of any waterworks that maintains the range of values for the water quality parameters reflecting optimal corrosion control treatment during each of two consecutive six-month monitoring periods must continue monitoring at the entry point and entry points to the distribution system. The waterworks must continue to collect two tap samples for applicable water quality parameters on the six-month frequency but at the following reduced number of sites.

System Size – Number of Persons Served	Number of Sites for WQP Monitoring
> 100,000	10
10,001 to 100,000	7
3,301 to 10,000	3
501 to 3,300	2
101 to 500	1
Less than or equal to 100	1

The owner of any waterworks that maintains the range of values for the water quality parameters reflecting optimal corrosion control treatment during three consecutive years of monitoring may reduce the frequency of tap samples from every six months to annually. The owner of any waterworks that maintains the range of values for the water quality parameters reflecting optimal corrosion control treatment during three consecutive years of annual monitoring may reduce the frequency from annually to every three years.
Note that WQP monitoring at the entry point locations continue to be on the every two weeks (bi-weekly) frequency.

6.11. WQP Treatment Technique Violations

Once the Commissioner has established WQP's, the waterworks must continue to operate within the established range of values or above the established minimum value. Failure to maintain the established WQP's is a treatment technique violation. Compliance is determined over a six month timeframe – January – June and July – December. Guidance on determining compliance with the WQP can be found in the *Waterworks Regulations* 12VAC5-590-405.

6.12. Consumer Notification

A revision by the LCR STR requires waterworks owners to provide a consumer notification following each lead and copper monitoring period. All systems, both community and NTNC, must provide notification of the lead and copper sampling results to the occupants at each site that was tested in the LCR tap monitoring program within 30 days of receipt of results. This consumer notice is required even if both lead and copper Action Levels are met. ODW will calculate this 30 day period from the date that the lead and copper results letter is sent to the waterworks. NTNC waterworks must post the results of tap monitoring. In addition to the consumer notification, the waterworks must provide ODW with a certification that the consumer notice requirements were met. This certification must be provided no later than three months from the end of the respective monitoring period.

Additional guidance and consumer notification templates for both community and NTNC waterworks is at: \\..\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898- Sampling Manual\LCR\

6.13. Consumer Confidence Report

A revision by the LCR STR regarding Consumer Confidence Reports (CCR's) will affect all community systems, even if results are not detected for lead and copper. All CCR's must contain mandatory language concerning lead in drinking water that includes Health effects on children and a flushing recommendation of 15 to 30 seconds prior to using the water. Waterworks can write their own educational statement to be approved by the ODW Field Office.

The CCRs must contain the following mandatory language, and any modifications must be approved by ODW:

"If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. *[Name of Utility]* is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 15 to 30 seconds or until it becomes cold or reaches a steady temperature before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead. "

6.14. Required Actions if an Action Level is Exceeded

The LCR contains four specific treatment techniques that must be implemented by the waterworks owner if the lead and/or copper Action Level is exceeded. These are summarized in the following table:

Action Level Exceeded	Required Treatment Technique
Lead	Corrosion Control Treatment
Copper	Corrosion Control Treatment
Lead	Source Water Monitoring and Treatment
Copper	Source Water Monitoring and Treatment
Lead	Public Education
Lead	Lead Service Line Replacement

6.15. Source Water Treatment

Whenever either the lead or copper Action Level is exceeded, the waterworks owner must collect source water samples for lead and/or copper to verify that the elevated levels at consumer's taps is the result of internal pipe corrosion and not from high source water concentrations. These samples must be collected from each entry point to the distribution system within six months from the end of the respective monitoring period in which the Action Level was exceeded. Additional guidance for the source water monitoring requirements can be found in the *Waterworks Regulations* 12VAC5-590-385 D.

The results of the routine metals monitoring from the waterworks may be substituted for this required source water monitoring if the results are less than one year old.

In the event that elevated lead or copper source water concentrations are found, the waterworks must install an appropriate source water treatment technology and conduct routine source water monitoring. To date no waterworks has been required to install source water treatment. Should this occur in the future additional guidance can be found in the *Waterworks Regulation* 12VAC5-590-405 B.

6.16. Corrosion Control Treatment

Any waterworks that exceeds either the lead or copper Action Level must install and continuously operate corrosion control treatment. Specific guidance and requirements are contained in the *Waterworks Regulation* 12VAC5-590-405 A.

- All large systems (>50,000 people) and, at the states discretion, small and medium systems (≤ 50,000 people) shall perform corrosion control treatment studies to investigate treatment options and determine which will provide optimum corrosion control treatment (OCCT is defined as treatment that minimizes lead and copper concentrations at the users' tap without violating any National Primary Drinking Water Standards). The following three types of treatment must be investigated:

    1. pH and alkalinity adjustment
    2. Calcium hardness adjustment
    3. Phosphate or silicate corrosion inhibitors

- For the large systems, the OCCT study must be completed within 18 months following the completion of initial monitoring. The District Engineer must review the submitted study and OCCT

recommendation and the Commissioner must approve the OCCT within 12 month of receiving the study.

- Small or medium size systems are considered to have optimized treatment (and are not required to complete the corrosion control treatment steps) after two consecutive 6-month monitoring periods of monitoring (Section 6.5) indicate both lead and copper are below their 90th percentile action levels.

- Any size system is considered to have optimized treatment if the results of two consecutive 6-month monitoring periods indicate the difference between the 90th percentile tap water lead concentration and the highest source water lead concentration is less than 0.005 mg/L.

- Small or medium size systems that exceed an Action Level are required to recommend an optimal CCT to the District Engineer within 6 months from the end of the monitoring period in which the AL was exceeded, unless the OCCT study is required.

- Assuming that the OCCT study is not required, the District Engineer must review the systems treatment recommendation and the Commissioner must either approve the treatment recommendation by the system or designate an alternate corrosion control treatment. This treatment designation must be made within 12 months from the end of the monitoring period in which the AL was exceeded.

- If the District Engineer requires the small or medium size system to conduct a corrosion study, the study must be completed within 18 months for medium size systems and within 24 months for small size systems. The District Engineer has the option of performing a "Desk top" evaluation for the waterworks (WM 740 provides detailed instructions, review forms and sample notification letters for performing the "Desk top" evaluation) in lieu of requiring the waterworks to perform the corrosion control treatment studies.

- If a corrosion control treatment study is required, the District Engineer must review the submitted study and OCCT recommendation and the Commissioner must approve the OCCT within 6 month of receiving the study.

- The waterworks owner must install the designated corrosion control treatment within 24 months following the Commissioner's decision.

- After the waterworks installed the corrosion control treatment follow-up monitoring shall be conducted. Follow-up monitoring consists of 2 consecutive 6-month rounds of lead and copper tap samples and WQP monitoring beginning immediately after installation of the CCT.

6.17. Public Education

Any waterworks that exceeds the lead Action Level is required to complete the prescribed Public Education requirements. Public Education is complicated in that there are different requirements depending upon the size and type of waterworks. The initial Public Education tasks must be completed within 60 days of the end of the monitoring period in which the lead Action Level is exceeded (for waterworks in reduced monitoring the end of the monitoring period is normally September 30 so any required Public Education must be completed no later than November 30). If the waterworks continues to exceed the lead Action Level or ceases to conduct lead and copper tap samples (until corrosion control

treatment is installed) then certain Public Education tasks must be repeated either on a 6 month or 12 month frequency.

Following any required Public Education task, the waterworks must submit a certification to the District Engineer indicating that the required task was satisfactorily completed. This certification must be submitted within 10 days after the end of each period in which the owner is required to perform a public education task.

Specific and detailed Public Education guidance including templates for both community and NTNC waterworks can be found at: ..\..\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898- Sampling Manual\LCR\

6.18. Lead Service Replacement

Any waterworks that continues to exceed the lead Action Level after installing corrosion control treatment is required to replace any existing lead service lines (LSL). To date there are no waterworks that have been required to replace lead service lines under the LCR. There are waterworks that are voluntarily replacing lead service lines when these lines are encountered.

Specific guidance regarding LSL replacement can be found in the *Waterworks Regulation* 12VAC5-590-405 C.

6.19. Advanced notification and approval of any change in water treatment or addition of a new water source

The LCR – Short Term Revisions requires waterworks owners to notify and gain approval from the States prior to making any changes in water treatment or adding a new water source. This is a direct result of the events where a change from free chlorine disinfection to chloramines resulted in increased distribution system lead levels. Additionally, the States, in granting approvals, must make an assessment as to whether the addition of a new water source or a change in water treatment will adversely affect optimal corrosion control treatment and result in an increase in distribution system lead or copper levels. Our assessment may result in requiring optimal corrosion control studies to be conducted prior to implementing a long term treatment change or adding a new source and/or requiring that additional lead and copper monitoring be conducted.

The Virginia *Waterworks Regulations* already require waterworks owners to obtain a Construction Permit for any changes in treatment or the addition of a new water source. As such we should be notified of significant treatment changes or new sources. The potential for a new water source or long-term changes in treatment to impact corrosion control treatment and distribution system lead levels should be addressed in the preliminary engineering conference and/or preliminary engineering report.

6.20. Long term treatment changes

Long-term treatment changes do not include chemical dose fluctuations associated with daily raw water quality changes or normal seasonal changes. The LCR STR guidance gives specific examples of long-term changes in treatment. These include:

- Changing disinfectants such as chlorine to chloramines
- Changing primary coagulants such as alum to ferric chloride

- Changing corrosion inhibitor chemicals such as orthophosphate to a blended phosphate
- Making a change in dose of an existing chemical if the system is planning long-term changes to its finished water pH or residual inhibitor concentration

Additional examples of long-term treatment changes include the installation of major unit processes such as membrane filtration, ozonation, enhanced coagulation/enhanced softening to reduce disinfectant by-product precursors, and other treatments or processes or combinations of processes that can greatly affect the pH, oxidation-reduction potential, alkalinity, or the major composition of the ionic background of the water.

The ODW's policy is to evaluate treatment changes on a case-by-case basis to determine if the waterworks must conduct optimum corrosion control studies and/or additional lead and copper tap monitoring. The District Engineer makes this evaluation and obtains concurrence of the Deputy Field Director in consultation with the Division of Technical Services staff in the Central Office. EPA has provided guidance to the states to evaluate the potential impact on corrosion and lead levels resulting from treatment changes. This guidance can be found in Chapter 4 of the Simultaneous Compliance Guidance Manual for the Stage 2 Rules, which is located on EPA's website : http://www.epa.gov/safewater/disinfection/stage2/pdfs/guide_st2_pws_simultaneous-compliance.pdf

ODW <u>will require</u> a waterworks to conduct lead and copper "follow-up monitoring" (monitoring for two consecutive 6 - month periods at the original number of tap sample sites) following proposed treatment changes that include:

1. Change in disinfection from free chlorine to chloramines
2. Any change in the method of optimum corrosion control treatment (i.e. changing from a corrosion inhibitor to pH and alkalinity adjustment, or from pH and alkalinity adjustment to a corrosion inhibitor or change in the type of corrosion inhibitor such as from a blended phosphate to a zinc orthophosphate)
3. Any other treatment change that results in a permanent change to the finished water pH and / or to the corrosion inhibitor concentration

Prior to implementing a treatment change, ODW <u>may require</u> a waterworks to conduct an optimum corrosion control study to assess the impact of the proposed treatment changes on distribution system lead concentrations. Such a study may benefit the waterworks to avoid making an expensive change in treatment that will result in an increase in distribution system lead concentrations. The need to conduct the optimum corrosion control study should be discussed during the preliminary engineering conference and/or the preliminary engineering report.

Other treatment changes (such as changing coagulants or installing new treatment processes) will be evaluated to assess the impact on corrosion related water quality parameters. If the evaluation indicates that the treatment change may result in increased distribution system lead or copper levels, the return to "follow-up monitoring" is required. If the evaluation indicates that the treatment change will not have an impact on distribution system lead or copper levels it is still advisable to require some additional lead and copper tap monitoring. This additional monitoring will provide data to demonstrate that the treatment change did not result in increased lead or copper levels. The number of samples to be collected will be determined by the District Engineer. Suggested additional monitoring would include 5 to 10 lead and copper tap samples to be collected from previously approved locations. This monitoring should be conducted 30 to 60 days after the treatment change has been initiated.

Several examples are posted at:…:\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898- Sampling Manual\LCR

6.21. Addition of a new water source

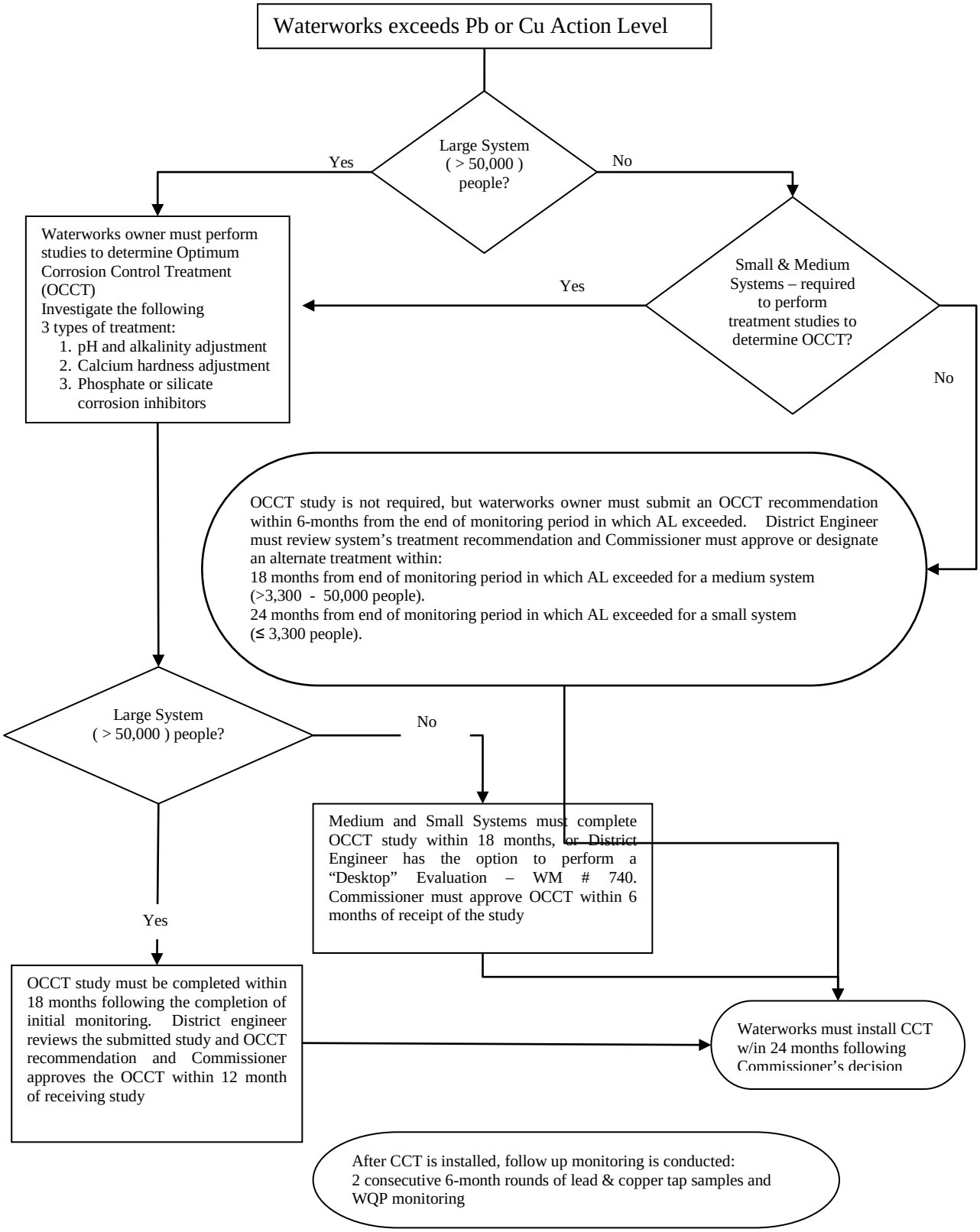
The LCR-STR requires states to approve the addition of new water sources and to make an assessment as to whether the new water source will adversely affect optimal corrosion control treatment and/or result in an increase in distribution system lead or copper levels. The ODW's policy is to evaluate the addition of new water sources on a case-by-case basis to determine if the waterworks must conduct optimum corrosion control studies and/or additional lead and copper tap monitoring. The District Engineer makes this evaluation and obtains the concurrence of the Deputy Field Director. The decision to require the waterworks to conduct a corrosion control study or additional monitoring must be made in consultation with the Division of Technical Services staff in the Central Office.

ODW requires the corrosion control study or additional monitoring when the new water source is significantly different in water quality characteristics that may impact corrosion. If a waterworks using wells decides to add an additional well source, and the new well has similar water quality to the existing wells, it would not be necessary to conduct a corrosion control study or additional monitoring. However, if the new well is significantly different in water quality then the OCCT or additional monitoring should be required. If a waterworks using wells decides to add a surface water source and abandon the wells, then the corrosion control study and/or additional monitoring (based upon both the different, new water source and the addition of new treatment for the surface water source), are required.

In situations where the new water source may adversely affect optimal corrosion control treatment and/or result in an increase in distribution system lead or copper levels, additional lead and copper tap monitoring as described for long-term treatment changes will be required.

EPA has developed guidance to assist States in making decisions related to the impact on lead corrosion resulting from the addition of a new water source or a long-term treatment change. See Appendix D of the "**Simultaneous Compliance Guidance Manual for the Long Term 2 and Stage 2 DBP Rules"** March 2007. This document can be accessed from the following EPA web site:
http://www.epa.gov/safewater/disinfection/stage2/pdfs/guide_st2_pws_simultaneous-compliance.pdf

6.22. Corrosion Control Treatment Flowchart



6.23. Examples

- **Example 1- Change in corrosion control treatment**

Anytown has a 3.0 MGD conventional WTP and is using a zinc orthophosphate inhibitor for corrosion control. Because of new and more stringent zinc limits contained in Anytown's VPDES Permit they are proposing to change from the zinc orthophosphate inhibitor to a blended phosphate inhibitor.

Because Anytown is changing to a new corrosion inhibitor they must return to lead and copper "follow-up" monitoring after changing to the blended phosphate inhibitor. Follow-up monitoring consists of lead and copper tap monitoring conducted during two consecutive 6-month monitoring periods (January – June and July – December) at the original, non-reduced number of sites based upon population.

- **Example 2 – Treatment change**

Anytown has a 3.0 MGD conventional WTP and is using liquid alum as the primary coagulant. Anytown wants to improve plant performance to meet the VOP sedimentation and filtration goals and has found that a poly- aluminum chloride (PACL) as the primary coagulant provide superior performance. The change to PACL will not result in any changes to the corrosion related water quality parameters. The finished water pH, alkalinity and blended phosphate inhibitor dosage will remain unchanged.

In this situation we can reasonably assume that this change from alum to PACL will not alter the finished water corrosion characteristics. As such no additional monitoring would be required.

- **Example 3 – Addition of a new water source**

Anytown is experiencing source water deficits during drought conditions and proposes to drill a new well to supplement the WTP. The well will be a new entry point to the distribution system. Anytown proposes to treat the well with chlorine, fluoride, and the same blended phosphate inhibitor used at the WTP.

Even though Anytown proposes to treat the well water with the same blended phosphate inhibitor, some additional lead and copper monitoring should be required to demonstrate that the new source does not result in increased lead concentrations at consumer's taps. In this situation a return to full "follow-up" monitoring is not appropriate as the well is a new entry point pumping directly into the distribution system and the entire system will not receive the well water. The District Engineer requires Anytown to collect 6 lead and copper tap samples from the portion of the service area that will receive water from the new well. These samples should be collected from locations that meet the same tier and category as the previously approved lead and copper sample sites for Anytown. Assuming that the results of the 6 special samples indicate lead and copper concentrations that are below the AL's no additional actions are necessary.

7. Groundwater Sources Raw Water Sampling

7.1. Introduction

Raw water monitoring is required as part of the ODW's continuing efforts in evaluating whether a groundwater source is directly under the influence of surface water, and whether disinfection treatment alone is sufficient to protect public health. This monitoring program is entirely different and separate from any raw water monitoring required by the Ground Water Rule (GWR).

12VAC 5-590-360.A allows ODW to ask for raw water monitoring of groundwater sources. It states: *"The water utility owner or owner of the property to be served, to the extent of their proper jurisdictions, shall provide and maintain conditions through the entirety of the water supply system in a manner that will assure a high degree of capability and reliability to effect compliance with these standards. ….this requirement shall include specific and continuing assessment of the capability, effectiveness, and reliability of the treatment process in relation to potential contaminants in the source of supply."*

This manual section includes detailed procedures for raw groundwater MPN sampling, and making a determination of groundwater under the direct influence of surface water (GUDI). The procedures to be used for existing sources and new sources are outlined as follows.

7.2. Existing Sources – Routine Monitoring

These raw water monitoring requirements only apply to sources that are provided with chlorine disinfection or some other treatment that may alter or affect bacteriological quality of the raw water. ODW staff must insure that an acceptable raw water sample tap is provided for all water sources. An acceptable location must be representative of the raw water prior to any treatment. The raw water monitoring location and sampling procedure shall be reviewed and evaluated during each sanitary survey.

The minimum raw water monitoring frequency for existing groundwater sources depends upon geology and whether the source is a well or a spring. Existing groundwater sources will be grouped as either a karst well, non-karst well, or spring. The *minimum* raw water monitoring frequency for these source types is contained in the following table:

Source Type	Minimum Raw Water Monitoring Frequency	Parameters
Well located in non-karst geology	One sample per year	Total Coliform and *E coli*
Well located in karst geology	One sample per quarter	Total Coliform and *E coli*
Spring	One sample per month	Total Coliform and *E coli*

The above table contains the minimum raw water monitoring frequency. The District Engineer may require more frequent monitoring for any source that is deemed to be "at risk" of being directly influenced by surface water or other sources of contamination. This determination may be made based upon geology, historical monitoring results, or any other evidence that the source is susceptible to surface water influence. District Engineers shall notify owners of these raw water monitoring requirements and use their judgment as to what systems provide treatment as described above.

Owners should be encouraged to conduct some of the sampling within 72 hours of a rainfall event to get the best information relative to potential surface water influence. District Engineers may use their discretion in determining what constitutes a rainfall event and whether to decrease the suggested time period for sampling after a rainfall event.

7.3. Microbiological Testing Methods

The required test method for raw groundwater source~~s~~ monitoring is a method yielding a Most Probable Number (MPN) result for both Total Coliform and *E. coli*. The laboratory analyses must conform to the most current edition available of *Standard Methods for the Examination of Water and Wastewater* published by the American Public Health Association, the American Water Works Association, and the Water Control Environment Federation, or analytical method approved by the Commissioner. All analyses must be performed by the DCLS or by laboratories certified by the DCLS for Total Coliform and *E. coli* MPN analysis. *E. coli* is a fecal indicator, and is used to demonstrate whether there is a pathway for pathogenic viruses and bacteria to enter a groundwater source.

7.4. Additional Monitoring and Evaluation of Results

The District Engineer shall ensure that all raw water monitoring results are reviewed and evaluated by the 21st of each month. Additional monitoring and other actions will be required depending upon the monitoring results and type of water source. Refer to the Raw Water Monitoring Decision Flowchart provided in section 7.8.

For any source with a raw water monitoring frequency less than monthly, the District Engineer must notify the owner to collect one confirmation sample within 10 calendar days of any single sample result indicating Total Coliform in excess of 50 colonies per 100 ml or any sample indicating the presence of *E. coli*.

Additional actions may be necessary, based upon an evaluation of the raw water monitoring results. The monitoring results to be evaluated will, in most cases, be either a series of 20 weekly samples for GUDI determination (explained in the following sections), or the results of the routine raw water monitoring required under this section. The additional actions may be a GUDI determination, a GUDI re-evaluation, or the need to impose the 4-log virus inactivation treatment technique, compliance monitoring and other requirements under the GWR.

7.5. GUDI Determination Background

The Surface Water Treatment Rule and the *Waterworks Regulations* define GUDI sources as any water beneath the surface of the ground with significant occurrence of insects, microorganisms, algae, or large-diameter pathogens such as *Giardia lamblia* (5 to 15 µm) or Cryptosporidium (2 to 7 µm). It also means significant and relatively rapid shifts in physical water quality characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to meteorological events or surface water conditions. Once a source is determined to be GUDI, it is a Subpart H source, subject to requirements of the Surface Water Treatment Rule.

The GWR is based on protecting against the presence of viruses (0.01 µm to 0.1 µm) and bacteria (0.2 µm to 20 µm), defined by the presence of a fecal indicator. ODW has determined that E. coli will be utilized as the indicator for triggered source water monitoring, required by the GWR. Triggered monitoring means that any routine distribution system "Total Coliform Rule (TCR)" sample that is total coliform positive (TC+) will automatically require source water monitoring for E. coli. If that triggered sample is E. coli positive, then five additional source water samples must be collected for E. coli analysis. If any one of the additional source water samples is found to be E. coli positive, then the source is declared to be fecal-indicator positive, and it must apply one of the GWR-prescribed treatment techniques that reliably achieves at least a 4-log inactivation of viruses. One purpose of ODW's GUDI determination policy is to ensure that this 4-log virus inactivation is sufficient public health protection for sources with positive fecal-indicator results. These groundwater sources must be further evaluated (or re-

evaluated) for GUDI, to determine if sufficient natural filtration exists to effectively block the transport of large diameter pathogens, and if the chosen treatment technique will provide adequate public health protection.

7.6. GUDI Determination Procedure

Use the GUDI Determination Review Sheet (Section 7.9) to document the evaluation of the source and all monitoring data used. The Review Sheet proceeds stepwise, following the procedures outlined in the following paragraphs. The corresponding steps in the Review Sheets are shown in boxes (Step 1a). Model letters for transmitting results of GUDI determinations to waterworks owners are listed in ..\..\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898- Sampling Manual\GUDI\

The GUDI determination procedure begins with evaluation of the source history and location. Has the source been associated with a disease outbreak Step 1a, a chemical contamination event from the surface Step 1b, evidence of direct surface water intrusion Step1c? *Note: Many of the compounds found in petroleum products are very soluble and can travel for long distances in groundwater. Use caution when applying the "chemical contamination event from the surface" criteria (Step 1b) in declaring a source GUDI based upon a petroleum contamination event.*

Most sources cannot be characterized on the basis of source history and location alone. Determinations will typically begin with a microbiological sampling series or can be based upon the results of routine raw water monitoring. The microbiological sampling series is usually a minimum of 20 samples analyzed by an approved laboratory, using an MPN test method for both total coliform and *E. coli*. A minimum of 20 weeks of monitoring, to include multiple significant rainfall events, is normally required. The number of samples, frequency, and the duration of sampling will be determined by the District Engineer.

7.6.1. Initiation of Microbial Sampling

A 20 sample MPN series can be triggered by three different circumstances. These include:

a. New source development – A new groundwater source that is being developed will require the MPN series. For new wells drilled in non-Karst geology, the 20 samples collected during the well development yield test can be used to make the GUDI determination. For new wells drilled in Karst geology or springs, the well development MPN series will provide a preliminary determination. A second MPN series will be used for final GUDI determination, which must consist of weekly samples collected over a minimum of 20 weeks. The monitoring period should include several (more than 3) significant (more than 0.5 inch) rainfall events. If significant rainfall events do not occur during the 20 week period, the monitoring shall continue for a period determined by the District Engineer.

b. Ground Water Rule – If the triggered and additional source water samples required under the Ground Water Rule are fecal-indicator positive, additional water quality monitoring is needed to determine if the disinfection treatment to achieve 4-log virus inactivation alone will provide adequate public health protection. A GUDI re-evaluation is required using a 20 sample MPN series.

   Note: the GWR requires that treatment be installed to achieve a 4-log inactivation of viruses within 120 days. This requirement must be met by the waterworks owner to comply with the GWR and is considered to be separate from the additional monitoring and GUDI re-evaluation. The purpose of the GUDI re-evaluation is to ensure that the GWR required disinfection treatment alone is sufficient.

c. Source Water Monitoring – Section 7.2 specifies that all groundwater sources with disinfection treatment shall collect periodic raw water samples for Total Coliform and *E. coli* MPN analysis. The results from this source water monitoring may indicate that the source is GUDI or that a GUDI re-evaluation is required. In addition, if the *E coli* results are fecal-indicator positive, the treatment technique requirements of the GWR will be necessary.

7.6.2. Review of Total Coliform Results

If the results of *routine* raw water monitoring Step 2a, and any additional samples as required in Section 7.4, indicate Total Coliform greater than 100 colonies per 100 ml in three or more samples collected during any running 6 calendar month review and evaluation period, the source is GUDI.

If results of the *routine* raw water monitoring (and any additional samples as required in Section 7.4) indicate Total Coliform greater than 50 colonies per 100 ml in two or more samples collected during any running 6 calendar month review and evaluation period, additional water quality monitoring is needed to determine if disinfection treatment alone is sufficient. A GUDI re-evaluation is required beginning with the 20 sample MPN series.

If the results of the Total Coliform MPN *series* indicate a Total Coliform geometric mean of greater than 100 colonies per 100 ml Step 2b or if more than 10% of the samples indicate Total Coliform greater than 100 colonies per 100 ml Step 2c, the source is determined to be GUDI.

7.6.3. Review of E.coli Results

If the results of the *routine* raw water monitoring, and any additional samples as required in Section 7.4, indicate the presence of *E coli* in two or more samples collected during any running 6 calendar month review and evaluation period, two separate actions are required:

a. Additional water quality monitoring is needed to determine if disinfection treatment alone is sufficient. A GUDI re-evaluation is required beginning with the 20 sample MPN *series*.

b. The 4-log virus inactivation treatment technique requirements (including the chlorine residual monitoring requirements) of the Ground Water Rule must apply. Refer to WM 910 for additional guidance and Public Notification requirements.

If a source is not declared GUDI based on the Total Coliform criteria above, evaluate the *E. coli* MPN series according to the following criteria:

a. If the results of the *E. coli* MPN series indicate ≥ 5 *E. coli* per 100 ml in three or more samples Step 2d, or if 5 or more of the *E. coli* MPN series shows *E. coli* to be present Step 2e, then the source must be assessed using the additional methodologies described as follows.

b. Conversely, if the *E. coli* MPN series shows < 5 *E. coli* per 100 ml in no more than three samples, and if fewer than 5 of the samples in the series show *E. coli* to be present, then the source is determined to be a groundwater source (NOT GUDI). If the source is not GUDI, raw water monitoring continues; the District Engineer may increase the frequency of this monitoring.

7.6.4. Additional Water Quality Assessment

If a source is not declared GUDI based upon Total Coliform MPN criteria (7.6.2.) and if the results of the E. coli MPN series indicate the presence of E. coli (7.6.3), then additional water quality assessment is required, or the owner may proceed directly with filtration treatment.

The additional water quality monitoring must include Microscopic Particulate Analysis (MPA) of the source and may also include raw water temperature, pH, turbidity, conductivity, etc. If surface water is located near the groundwater source, monitoring of the nearby surface water is recommended, using the same physical parameters and frequency as the groundwater source. In addition to the water quality parameter monitoring, records of rainfall and other meteorological events at the water source should be collected. The specific parameters to be monitored, monitoring frequency, and monitoring duration will be determined by the District Engineer. The waterworks owner must submit a written source water monitoring plan for approval (see section 7.10 for examples of parameters to include). The Monitoring Plan Worksheet (section 7.9) can be used to document the required testing.

The waterworks owner must provide the District Engineer with all of the monitoring results required in the approved monitoring plan. MPA results must be provided within 10 days of receipt by the owner if the laboratory does not provide the ODW with the results directly. Other long term monitoring (physical parameters) must be provided along with applicable rainfall / meteorological data to the District Engineer with a summary report. A final GUDI determination will be made based upon the results of the additional water quality monitoring. If the owner does not provide the requested data, ODW may designate the source a GUDI.

7.6.5. Physical Parameters

Physical Parameters such as water temperature, turbidity, pH, conductivity, etc. may be indicators of surface water influence. The best indicator using physical parameters is a direct correlation between groundwater monitoring results and monitoring results from a nearby surface water source, taking into account significant rainfall or other meteorological events Step 3a. Another indicator is water temperature fluctuations (± 15% in ^{o}F) in the groundwater following significant rainfall or other meteorological event Step 3b.

7.6.6. Microscopic Particulate Analysis (MPA)

Microscopic Particulate Analysis (MPA) is a method to identify organisms that occur only in surface waters, and whose significant occurrence in groundwater clearly indicates that at least some surface water is present. The parameters that are believed to be indicators of surface water contamination of groundwater include *Giardia lamblia* cysts, *Cryptosporidium*, *Coccidia*, diatoms, algae, insects/larvae, rotifers, and chlorophyll-containing plant debris.

a. All MPA testing and reporting of results must be in accordance with the USEPA *"Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)"* dated October 1992. This document is posted on "odwshare".

b. To optimize the detection of direct surface water influence, MPA samples are typically collected during both wet and dry periods. The purpose of collecting both wet-period and dry-period samples is to analyze water that is most likely to contain indicator organisms typical of surface water, if any exist, at times when conditions for transport to the potential GUDI source are optimal. ODW will require a minimum of two MPA tests to be conducted, one each during a wet and a dry period. Four MPA samples (collected one per calendar quarter and at least 60 days apart) is preferred.

c. MPA laboratory results must be reported in accordance with the above mentioned EPA consensus method. Application of this method results in relative risk factors (scores) that will be used to determine the degree of risk associated with influence by surface water. The following relative risk factors will be used to make the GUDI determination:

- High risk – A lab-provided MPA risk calculation $\geq$ 20
- Moderate risk – A MPA risk calculation equal to or greater than 10 and $\leq$ 19
- Low risk – A MPA risk calculation $\leq$ 9

EPA Relative Risk Tables are provided in section 7.11.

d. If any single MPA sample result indicates a score greater than or equal to 20, the source is determined to be GUDI Step 3c.

e. If any two MPA sample results indicate scores equal to or greater than 15, the source is determined to be GUDI Step 3d.

f. If all MPA sample results indicate scores of equal to or less than 9, the source is determined to be a groundwater source (NOT GUDI) Step 3e. Note that raw water monitoring continues. The District Engineer may increase the frequency of this monitoring or require additional monitoring parameters.

g. If the conditions stated in items d, e, and f do not apply, a decision on future action will have to be made. All of the available water quality data, geology, well construction, and any other relevant factors are to be reviewed and evaluated by the District Engineer. Proceed to one of the following actions with concurrence of the Field Director:

    - Consider the source to be "at risk" and continue to monitor. The District Engineer will establish the monitoring parameters and monitoring frequency.
    - Declare the source to be a groundwater source (NOT GUDI). Note that even with this action raw water monitoring continues.

7.7. Interim Action for GUDI Sources

Any waterworks with a source that has been determined to be GUDI must comply with the requirements of the Surface Water Treatment Rule and the *Waterworks Regulations* 12 VAC 5-590-420 B.2.f. by installing acceptable filtration and disinfection treatment within 18 months of the determination.

These requirements were developed and adopted prior to the LT2 Rule and do not take into account the possible occurrence of *Cryptosporidium* in GUDI sources. To address the public health concerns of *Cryptosporidium* in GUDI sources, a continuous boil water notice will be required for all waterworks using a GUDI source until filtration and disinfection treatment is installed and in operation.

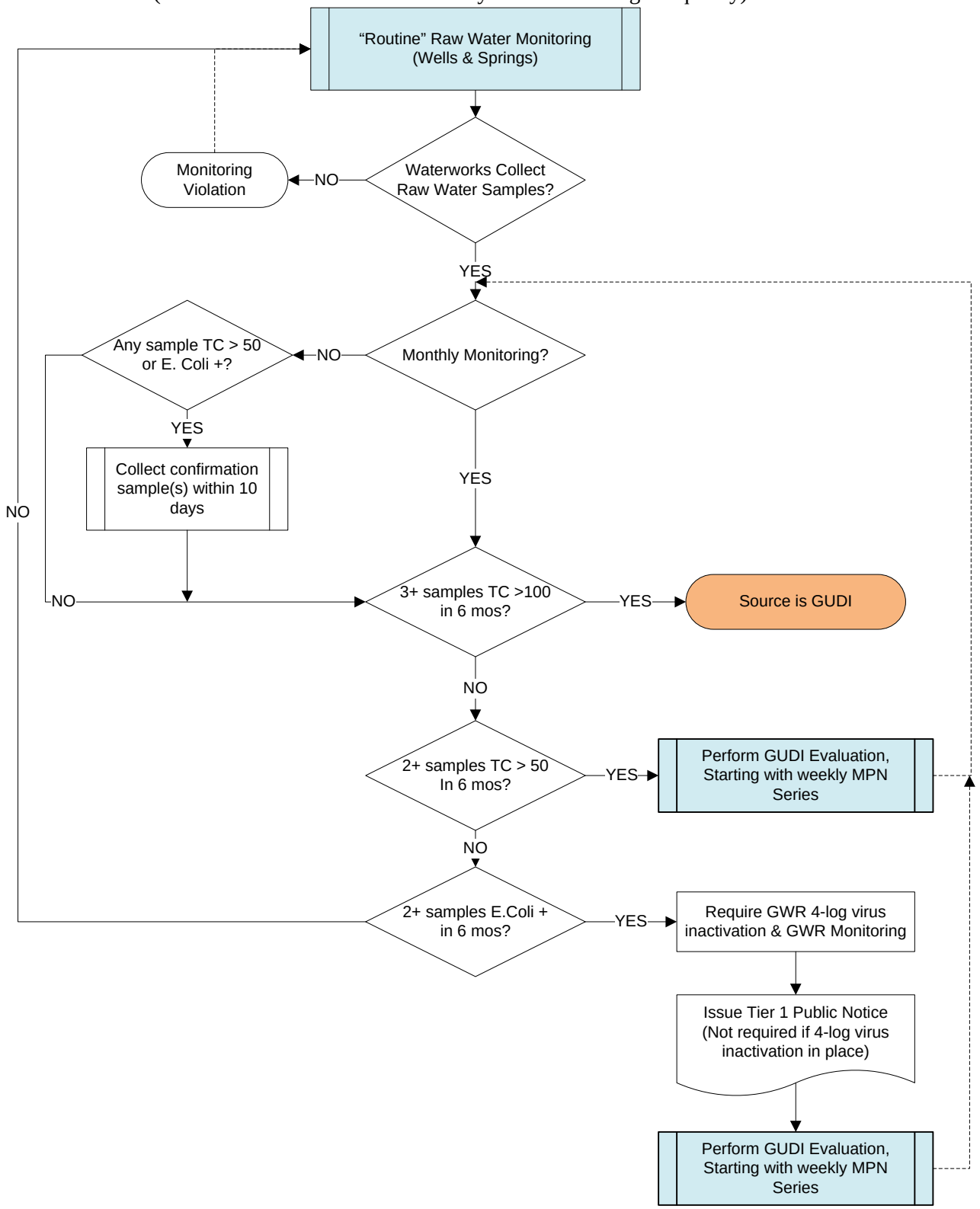
During the interim period until filtration and disinfection is installed and in operation, the waterworks owner shall discontinue use of the GUDI source. If the GUDI source must remain in service because discontinuing use of the source is not a viable option, the waterworks owner shall provide chlorine disinfection during the interim period before filtration is installed as follows:

- The free chlorine residual disinfectant concentration at the entry point to the distribution system shall not be less than 2.0 mg/L for more than four hours. Monitoring equipment must be installed that will ensure compliance with this requirement.
- The waterworks owner shall issue a boil water notice through the public notification procedure in 12 VAC 5-590-540 until such time as the required filtration and disinfection treatment is installed.

For waterworks that collect routine distribution system bacteriological samples at a monthly frequency, the waterworks shall collect twice the number of samples required for that population each month. For waterworks that collect routine bacteriological samples at a quarterly frequency, the waterworks shall increase the sampling frequency to monthly.

7.8. Raw Water Monitoring Decision Flowchart for Groundwater Sources

(Waterworks with treatment that may alter bacteriological quality)



7.9. GUDI Determination Review Sheet

Date: _____

Waterworks Name: _____

PWSID: _____

City / County: _____ Determined By: _____

Source Name: _____ Reviewed By: _____

STEP 1 of the evaluation procedure consists of reviewing the source history and location.

	Step 1: Source History	Yes / No
a.	Has this source been directly associated with a biological waterborne disease outbreak?	
b.	Has this source been directly impacted by a chemical contamination incident from the surface?	
c.	Do publications, surveys, reports or studies demonstrate a connection[1] between the source and surface water?	

This connection must be *DIRECT* and afford little or no natural filtration through a soil horizon, as determined by empirical data. These connections might include: sinkholes, sinking creeks, troughs, drainage features, high porosity soils (sands and gravels), fracture zones, or other geologic features that have a high transmissivity.

Step 1 Summary:

- If the answer to 1a, 1b, or 1c is **YES – STOP –** the source is GUDI.
- If the answers to 1a, 1b, and 1c are all **NO** proceed to Step 2

STEP 2 consists of evaluating the results of bacteriological monitoring – either the routine raw water monitoring or a minimum 20 sample series of raw water microbiological samples. Results must include both Total Coliform MPN's and *E. coli* MPN's.

	Step 2: Total Coliform and *E coli* Sampling	Yes / No
a.	Do results of the routine raw water monitoring indicate three or more samples in any running 6-month period with Total Coliform greater than 100 colonies per 100 mL?	
b.	If a 20 sample series is being evaluated - is the geometric mean of the Total Coliform MPN series greater than 100 colonies per 100 ml ?	
c.	If a 20 sample series is being evaluated - do more than 10% of the samples indicate a Total Coliform density of greater than 100 colonies per 100 ml ?	
d.	Does the *E. coli* MPN series indicate an *E. coli* density of greater than 5 per 100 ml in more than 3 samples?	
e.	Does the *E. coli* MPN series show *E. coli* to be present in 5 or more samples?	

Step Two Summary:

- If the answer to Step 2a, 2b, or 2c is **YES – STOP –** the source is GUDI
- If the answer to Step 2a, 2b, 2c, and 2d is **NO - STOP –** the source is a groundwater source, and is not GUDI.
- If the answer to Step 2e is **YES** proceed to Step 3e.

STEP 3 consists of evaluating the results of additional water quality monitoring conducted in accordance with an approved monitoring plan. The monitoring results must include Microscopic Particulate Analysis (MPA) results and may include physical parameters such as turbidity, water temperature, pH, conductivity, etc. A minimum of two MPA tests must be collected – one each during wet and dry conditions.

	Step 3: Additional Water Quality Monitoring	Yes / No
a.	Do the groundwater source physical parameter monitoring result(s) indicate a high correlation to a nearby surface water source monitoring parameter result(s) during, or after a rainfall or other meteorological event?	
b.	Does the groundwater temperature, turbidity, or pH fluctuate by ± 15% during, or after a rainfall or other meteorological event?	
c.	Does any single sample MPA result indicate a score of equal to or greater than 20?	
d.	Do any two MPA sample results indicate a score of equal to or greater than 15?	
e.	Do all MPA sample results indicate a score of equal to or less than 9?	

Step 3 Summary:

- If the answer to Step 3a, 3b, 3c, or 3d, is **YES - STOP** – the source is GUDI
- If the answer to Step 3e is **YES – STOP -** the source is a groundwater source, and is not GUDI.
- If the answer to Step 3e is **NO,** the District Engineer must evaluate all of the water quality monitoring data, well construction, geology, and any other relevant factors. Proceed to one of the following actions with concurrence of the Field Director:

    1) Consider the source to be "at risk" and continue to monitor. The District Engineer will establish the monitoring parameters and monitoring frequency.
    2) Declare the source to be a groundwater source (NOT GUDI). Note that even with this action raw water monitoring continues.

CONCLUSION:

☐ Based upon the criteria established in STEP _____, question _____ this source is determined to be GUDI. Filtration and disinfection treatment must be installed within 18 months and the waterworks owner must initiate the interim requirements.

☐ Based upon the criteria established in STEP _____, question _____ this source is determined to be a groundwater source and is NOT GUDI.

- ☐ Disinfection treatment alone is sufficient. Raw water monitoring must continue.
- ☐ Disinfection treatment is not required.

☐ This source is determined to be "at risk" for surface water influence. Raw water monitoring must continue as directed by the District Engineer.

_____
District Engineer

_____
Field Director

Attach all relevant water quality results

7.10. Water Quality Monitoring Plan for GUDI Determination

It is important to develop an appropriate, site-specific Water Quality Monitoring Plan. This plan, at a minimum, must include Microscopic Particulate Analysis (MPA) and may include additional parameters including turbidity, pH, temperature, and rainfall. Other parameters that may be considered for monitoring include dissolved oxygen, color, and conductivity. If the water source in question is located near a surface water source, the nearby surface water should be monitored for the same physical parameters as the groundwater source. Correlation data between the suspected GUDI source and the nearby surface water can be utilized to determine hydraulic connectivity.

Example Water Quality Parameter Monitoring: The following list includes parameters that may be included in the monitoring plan. Ideally, monitoring will last for one year to establish seasonal variations, but shorter periods may be allowed. Obviously, the monitoring period must include significant rainfall events.

Total Coliform and *E. coli*:
- Collect samples once per week.
- Collect samples from the raw water prior to any treatment.
- Use only laboratories State-certified to perform TC[1] and *E. coli* enumeration analysis[4].
- Report results as densities (MPN) rather than present or absent.

Temperature:
- Take measurements daily; minimum of 4 days per week.
- Monitor at the source being evaluated and the nearest surface water source (no more than 1,000 feet distant)
- An alcohol-filled thermometer or electric probe may be used.
- Use an instrument capable of reading ± 0.5° F increments.
- Use the same instrument for all readings.

Conductivity:
- Take measurements once per week minimum.
- Monitor the source being evaluated and the nearest surface water source (no more than 1,000 feet distant)
- Calibrate the instrument per manufacturer's recommendations, or submit to a State-certified laboratory.

Turbidity:
- Take measurements daily; minimum of 4 days per week.
- Monitor the source being evaluated and the nearest surface water source (no more than 1,000 feet distant)
- Use an instrument capable of reading 0.1 NTU increments.
- Standardize and calibrate instrument per manufacturer's recommendations.

[4] There is no explicit laboratory certification for MPNs. However, the statistical analyses used to calculate MPNs rely on Presence/Absence (PA) testing of the water, whether using Multiple Tube techniques on a series of dilutions, or ONPG-MUG techniques on a Quantitray array. In this sense, the lab reporting MPNs should be certified for the underlying PA methods used.

Specific Ions:
Any specific ions known to differ in concentration between the surface water and ground water. ODW will determine applicability of these analyses. Establish frequency, accuracy and calibration requirements on a case by case basis.

Rainfall:
- Identify source of rainfall gauging.
- May need to use more than one rainfall location if utilizing existing gauges not in close proximity to the groundwater source (i.e. compare rainfall data from two wastewater treatment plants, each located greater than 10 miles from the source)

Microscopic Particulate Analysis *(note that MPA testing is required):*
- A minimum of two MPA samples is required. Four samples collected one per quarter (and at least 60 days apart, is preferred.
- Collect samples during both dry periods and wet periods.
- Wet period sample shall be taken between 12-48 hours following a significant rainfall event.
- Collect samples from the source prior to any treatment.
- Sample shall be analyzed by an EPA certified lab per USEPA "Consensus Method for Determining Groundwater Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)"
- Lab shall submit results per the Consensus Method's risk rating protocol

7.11. EPA Relative Risk Tables

The following tables are excerpted from the USEPA "Consensus Method for Determining Groundwaters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)" dated October 1992.

Table A. Numerical range of each bio-indicator based on numbers counted per 100 gallons filtered water*

Indicators of Surface Water*	Extremely Heavy	Heavy	Moderate	Rare	None Found
Giardia**	>30	16-30	6-15	1-5	0
Coccidia**	>30	16-30	6-15	1-5	0
Diatoms	>150	41-149	11-40	1-10	0
Other Algae	>300	96-299	21-95	1-20	0
Insects/Larvae	>100	31-99	16-30	1-15	0
Rotifers	>150	61-149	21-60	1-20	0
Plant Debris	>200	71-200	26-70	1-25	0

Table B. Relative surface water risk factors associated with scoring of bio-indicators present during MPA of subsurface water sources.

Particulates Indicative of Surface Water*	Extremely Heavy***	Heavy	Moderate	Rare	None Found
Giardia	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

Table C. Risk of Groundwater Contamination by Surface Water Influence

≥20****	High Risk
10-19	Moderate Risk
≤ 9	Low Risk

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* According to EPA "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources," March, 1991 ed.

** If *Giardia* cysts, *Cryptosporidium*, or other coccidia are found in any sample, irrespective of volume, score as above.

*** Refer to Table A for range of indicators counted per 100 gallons under 100X.

**** Refer to Table B for numerical relative risk factor.

8. Radiological

The radionuclides regulation effective on December 8, 2003 requires routine monitoring of gross alpha activity, radium226, radium228 and uranium at each entry point to the distribution system for community waterworks. The initial sampling requirement for a new source is quarterly for four quarters. The next sampling period is determined based on the initial or most recent compliance period results and could be a quarterly, 3-year, 6-year, or 9-year frequency. The required sample periods and cycles fit into a standardized monitoring framework of three 3-year periods comprising a 9-year compliance cycle. The three 3-year sampling periods following the initial sampling period of 2004–2007 are 2008-2010, 2011-2013, and 2014-2016 comprising a 9-year cycle of 2008-2016.

8.1. Monitoring Substitutions and Calculated Values

The rule allows substitution of gross alpha activity for radium226 when the gross alpha activity is less than 5 pCi/L and substitution of gross alpha activity for uranium when the gross alpha activity is less than 15 pCi/L. Since the combined radium PMCL is based on the sum of radium226 + radium228, DCLS has agreed to analyze for radium226 when gross alpha activity is more than 3 pCi/L to minimize potential radium violation issues from gross alpha substitution. When a sample result exceeds the PMCL, both radium226 and radium228 analyses should be specifically required for the follow-up quarterly sampling.

Also, some laboratories measure uranium activity when uranium measurement is required. The uranium PMCL is based on mass rather than activity; however, uranium mass may be calculated from activity using a factor of 0.67pCi/ug (e.g. 20 pCi/L = 30 ug/L). Uranium mass should be analyzed when the value from the uranium activity calculation indicates a uranium exceedance (i.e. >30 ug/L) since the calculated value may be conservative and the actual mass value may be less.

8.2. Monitoring Groups

For simplicity, the intent of ODW is to maintain routine monitoring requirements for radionuclides as a group rather than individual analytes. Also, DCLS routinely analyzes radionuclide samples for gross alpha activity and radium228 with values for radium226 and uranium subsequently obtained by substitution and calculation by ODW. Of course, DCLS will perform the additional analyses required when the gross alpha triggers are exceeded. The exception to monitoring radionuclides as a group is when an MCL value is exceeded and quarterly monitoring is required. In this case, quarterly monitoring is only required for those radionuclides which exceeded the MCL. For practical purposes, these will be two subgroups, one being gross alpha and uranium and the second being radium226 and radium228.

8.3. Scheduling

For community waterworks, the radionuclides regulation requires initial quarterly sampling for four quarters for each entry point into the distribution system. Frequency for the next sampling event depends on the results for the current period. If the monitoring result is below detection limit for each contaminant, the next sampling frequency is 9 years. However, due to the routine testing arrangement in which gross alpha is substituted for radium226 and the detection limit for gross alpha is greater than the detection limit for radium226, a below-detection limit determination for radium226 cannot be made. In this case, the next sampling event frequency is 6 years. When the monitoring result is at or above detection limit but less than or equal to ½ the MCL, the next sampling event frequency is 6 years. When the monitoring result is greater than ½ the MCL but less than or equal to the MCL, the next sampling event frequency is 3 years. When the monitoring results exceed the MCL, quarterly sampling must continue until the results are at or below the MCL. A summary of the sampling frequencies is shown in the table below.

Next Radionuclides Monitoring Frequency Based on Current Period Result(s):

Sample Result(s)	Monitoring Frequency
Below Detection Limit	9 years
Above Detection Limit but <= ½ MCL	6 years
> ½ MCL but <= MCL	3 years
> MCL	Quarterly (4 Consecutive Quarters Minimum)

Except where quarterly sampling is required, the monitoring frequency for the radionuclides group will be governed by the highest frequency requirement of the component radionuclides. Also, when establishing the actual radionuclides sampling schedule, an effort should be made to integrate the radionuclides schedule to match the Phase II/V sampling schedule for the waterworks. Also, to the extent practical, the radionuclides schedules for each ODW field office should be evenly spread over time to even workload at the DCLS radiochemistry lab.

When reporting sample results to the owner, the writer may wish to provide an explanation about substitutions and the uranium conversion factor. A statement similar to the following may be used for this purpose:

> *Where applicable, radium226 and uranium activity values may be obtained by gross alpha substitutions as allowed by regulation. Combined radium is obtained by the addition of radium228 and radium226 activities. If gross alpha activity is less than 5 pCi/L, then radium226 may be obtained by substitution of the gross alpha activity. If the gross alpha activity is less than 15 pCi/L then uranium activity may be obtained by substitution of gross alpha activity. The uranium activity may be converted to uranium mass for compliance evaluation purposes using the relationship of 20 pCi/L $\approx$ 30 μg/L.*

8.4. CCR Reporting

The CCR Rule requires reporting of detections of all regulated contaminants including gross alpha and combined radium. There are no individual MCLs for radium226 or radium228; however, since radium228 is part of combined radium, anytime radium228 is detected combined radium must be reported, even if radium226 is not analyzed or not detected. To avoid confusion with application of the CCR Rule, we will require only contaminants measured and reported by the laboratory to be included. In the case where radium228 is analyzed but radium226 is not, combined radium is reported as the radium228 value. In cases where radium226 is detected and reported, but radium228 is absent or below detection levels, the radium226 result should be reported in the CCR as combined radium. Keep in mind that whenever a potential violation exists, additional analyses will be required by ODW for compliance determination and reporting.

For information on Gross Beta and Photon Emitters, refer to WM 872.

9. Contaminants of Concern

9.1. Methyl Tertiary Butyl Ether (MTBE)

MTBE is a synthetic volatile organic chemical with no natural sources. It is a blending component of gasoline that started replacing the use of lead in gasoline in the late 1970's. It is used in gasoline and reformulated gasoline (RFG) as an octane enhancer and to promote more complete burning, thereby reducing carbon monoxide and ozone levels in the air. The most common source of groundwater and surface water contamination by MTBE is leakage from storage tanks (both underground and above ground) and pipelines; spills at gasoline stations; disposal at landfill sites and dumps; emissions from marine engines into lakes and reservoirs; and to some extent from air deposition and storm water run-off.

MTBE moves rapidly into groundwater because of its solubility in water, relative mobility in soils, and resistance to decomposition. It generally migrates faster than other organic components of gasoline. As a result, MTBE can serve as an early indicator of potential gasoline contamination. MTBE has been detected in public and private drinking water wells. The reported concentrations of MTBE in wells can vary widely but generally are in the range of 1 to 10 parts per billion (ppb).

According to the Environmental Protection Agency (EPA), based on the limited sampling data available, most concentrations at which MTBE has been found in drinking water sources are unlikely to cause adverse health effects. However, there are no studies on the effects on humans of drinking MTBE-contaminated water.

There are significant uncertainties about the degree of risk associated with human exposure to low concentrations typically found in drinking water.

MTBE has a very unpleasant taste and odor that can make contaminated drinking water unacceptable to the public. Studies have shown that humans vary widely in the concentrations they are able to detect. The Environmental Protection Agency has issued a drinking water advisory of 20 to 40 ppb on the basis of odor and taste thresholds. Several states have set their action levels (or remediation trigger level) for MTBE in the 15 to 250 ppb range.

<u>ODW has adopted 15 ppb as a “trigger” level for MTBE in public drinking water.</u> The trigger level means the concentration at which MTBE should be more closely monitored, and increased technical assistance provided to the waterworks. ODW recommends that drinking water exhibiting taste and odor problems attributed to petroleum constituents, including MTBE, not be consumed. When this occurs, treatment or alternate sources of supply should be considered.

The Virginia General Assembly enacted a law in 2000 that requires every public water supply system to be tested for MTBE at least quarterly (15.2-2144 of the Code of Virginia.) The most pertinent excerpt of the law is as follows:

> B. *Every public water supply operator shall at least quarterly test the public water supply for the presence of methyl tertiary-butyl ether (MTBE). The locality shall maintain a record of testing conducted pursuant to this subsection. If the results of any test conducted pursuant to this subsection indicate the presence of MTBE in excess of fifteen parts per billion, the locality shall immediately notify the Department of Environmental Quality and the Department of Health. The Division of Consolidated Laboratory Services shall maintain and make available, upon the request of any person, a list of laboratories, accredited under the provisions of the federal Safe Drinking Water Act (42 U.S.C. § 300f et seq.) to analyze samples, located throughout the Commonwealth that possess the technical expertise to analyze water samples for the presence of MTBE. Any lab seeking accreditation under the Safe Drinking water Act may contact the Division of Consolidated Laboratory Services.*

This law does not supersede the Waterworks Regulations, nor does it invoke any action on the part of ODW except to receive the notification from the waterworks that the sample was in excess of 15 ppb.

While the law does not specify the exact location of the samples, ODW recommends that each entry point to the distribution system be sampled quarterly.

9.2. Hexavalent Chromium (Chromium-6)

Chromium is an odorless and tasteless metallic element found in rocks, soil, plants, and animals. Chromium is also used in steel making, metal plating, leather tanning, paints, dyes and wood preservatives. The most common forms of chromium in the environment are trivalent (chromium-3), hexavalent (chromium-6) and the metal form, chromium-0.

EPA has established a drinking water Maximum Contaminant Level (MCL) standard of 0.1 mg/L or 100 ppb for total chromium, which includes all forms of chromium. The Virginia Department of Health has adopted this total chromium standard in the *Waterworks Regulations*.

Community and NTNC waterworks currently take a minimum of one sample at each entry point to the distribution system. Samples are taken once every three years for waterworks having solely groundwater sources, and once annually for waterworks with surface water source(s).

States may set more stringent drinking water standards than EPA. California has a 50-µg/L MCL for total chromium. EPA plans to finalize the human health assessment, and after an external scientific peer review, it is likely that drinking water standards for chromium-6 will be established.

EPA recommends that systems voluntarily collect samples and test for chromium-6. Their guidelines are:

Locations to be sampled on the same day:
1) Samples of untreated water at the Intake/well locations,
2) Entry points to the distribution system,
3) Distribution System

Frequency:
1) Surface water sources: quarterly;
2) Ground water sources: semi-annually.

Sampling for Chromium-6 is voluntary in Virginia. However, ODW suggests that any waterworks that detects Total Chromium should test for chromium-6. Waterworks that test for Chromium-6 should request that the modified version of EPA Method 218.6, "Determination of Dissolved Hexavalent Chromium in Drinking Water, Groundwater and Industrial Wastewater Effluents by Ion Chromatography" be used. It is recommended that waterworks first look for total chromium using a more accessible method, then use the more complex EPA method to further refine any results requiring such testing.

9.3. Perchlorate

Perchlorate is both a naturally occurring and man-made chemical that is used to produce rocket fuel, fireworks, flares and explosives. Perchlorate can also be present in bleach and in some fertilizers. Scientific research indicates that this contaminant can disrupt the thyroid's ability to produce hormones needed for normal growth and development. EPA has included perchlorate on the first, second, and third Contaminant Candidate Lists (CCLs) published in the Federal Register on March 2, 1998, February 24, 2005, and October 8, 2009, respectively.

Perchlorate has been found in just over 4 % of public water systems nationally. Perchlorate was sampled in drinking water supplies as part of the Unregulated Contaminant Monitoring Regulation 1 (UCMR 1) program. EPA collected data on perchlorate from 3,865 public water supplies between 2001 and 2005. This included all large public water systems (serving more than 10,000 people), and a statistical sample of 800 small water systems, which together serve more than 80% of the population. In this (4.1%) of the systems reported a detection of perchlorate (in at least 1 entry/sampling point) at levels greater than or equal to 4 µg/L (the minimum reporting level of the test).

The EPA decision to propose a formal rule for perchloratewas published in the Federal Register on February 11, 2011. This action initiates a process to develop and establish a national primary drinking water regulation (NPDWR). The first public meeting was held September 20, 2012. The meeting focused on treatment technologies and analytical methods. The SDWA deadline for EPA's "notice of proposed rulemaking" is February 2013.

10. Monitoring Waivers

The *Waterworks Regulations* allow Community and Nontransient Noncommunity waterworks to apply for Monitoring Waivers for Volatile Organic Chemicals (VOC), Inorganic Chemicals (IOC), and Synthetic Organic Chemicals (SOC) contaminants. These contaminants can be waived by contaminant group, regional, or statewide grants. Waterworks which are not granted waivers must comply with the minimum sampling requirements defined in the 12 VAC 5-590, *Waterworks Regulations*. Waivers may be granted for a maximum of 3, 6, or 9 years, depending on the contaminant and waterworks' specific conditions.

The Commissioner, under the *Waterworks Regulations*, has allowed a statewide waiver for Dioxin, Endothall, Asbestos, and Glyphosate based on geographic vulnerability assessments. In addition, the Commissioner has granted contaminant specific waivers based on use and susceptibility determination, which includes three synthetic organic chemicals and one inorganic chemical: dibromochloropropane (DBCP), ethylene dibromide (EDB), diquat and the inorganic chemical, cyanide. Specific waiver requirements for these are as follows:

Cyanide: Cyanide monitoring may be waived after the initial monitoring requirements have been completed with no detection

Diquat: Diquat binds readily to clay particles, is absorbed by aquatic plants, is rapidly degraded by sunlight and is rendered biologically unavailable in clay soils. Most soils in the Commonwealth contain a high percentage of clay, except in the Tidewater region where sandy soils occur. Waterworks that are in sandy soil areas of the Tidewater region, where Diquat is used, will not be granted a waiver.

EDB: Studies have found concentrations of EDB associated with gasoline contamination, and EDB was added to some leaded gasolines. Therefore, well samples detecting any of the following VOCs; benzene, ethylbenzene, toluene, xylene, 1,2-dichloroethane, or MTBE must analyze for EDB at least once before granting of a waiver.

DBCP: DBCP may have been used as a soil fumigant.

The "Use Waiver" and "Susceptibility Waiver" are the two types of waivers that are available to all community and nontransient noncommunity waterworks. More information on the Use and Susceptibility Waiver can be found in the "Monitoring Procedures and Criteria" document, which serves as an application package that can be sent to waterworks requesting a waiver: This is located in the Monitoring Waivers folder at:
.\..\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898 – Sampling Manual\Monitoring Waivers

Procedures, Criteria, Applications, Reapplications and Form letters for applying for, reviewing and approving Use and Source Waivers are also found in the folder path above. A summary of these materials is as follows:

- Waiver application for Cyanide and SOC monitoring – Long Form: The waiver application form for Cyanide and SOCs.

- Waiver Application Due – Reminder Letter: A letter to be sent to waterworks owners to remind them to reapply for a chemical monitoring waiver at the end of the compliance period.

- Waiver Approval Letter – All Waivers Approved: A template letter stating that all SOC and Cyanide waivers have been granted for the subject waterworks.

- Waiver Approval – Denial Letter: A template letter stating that some SOC and/or Cyanide waivers have been denied to the subject waterworks.

- Waiver Evaluation Guide: The ODW waiver evaluation guidance packet for SOCs and Diquat with decision flow charts attached.

- Waiver Reapplication Form: A reapplication package for groundwater sources to be sent to waterworks owners that need reapply for SOCs and Cyanide waivers as they near the end of a compliance period.

11. Sample Scheduling

Compliance sampling at each waterworks is based on the type of waterworks (TNC, NTNC or Community); the type of sources (Groundwater, Groundwater Under the Direct Influence of Surface Water (GUDI), Surface Water, Purchased); population; and the type of treatment provided.

Tables 11.2 through 11.7 include a listing of initial and reduced compliance chemical and bacteriological sampling at the three types of waterworks using groundwater, groundwater under direct influence of surface water (GUDI), surface water or purchased water sources. These tables assume the waterworks have one type of source.

The Entry Point compliance schedule for waterworks with a combination of GUDI or surface water sources with groundwater, and/or purchased water sources must collect routine compliance chemical samples at a frequency listed for the GUDI/surface water sources. For example, a waterworks with a surface water source and a groundwater source will have to collect entry point samples annually for metals, and inorganic chemicals from the surface water source entry point and the groundwater source entry point.

11.1. Standardized Monitoring Framework

In order to standardize monitoring requirements across rules and contaminant groups, EPA established a nine-year (based on a calendar year) compliance cycle, with the first cycle beginning on January 1, 1993. The 3rd nine year compliance cycle contains three three-year compliance periods:

- 1st period: 2011 to 2013
- 2nd period: 2014 to 2016
- 3rd period: 2017 to 2019

The Standard Monitoring Framework encompasses both sampling and vulnerability assessment activities.

The Standardized Monitoring Framework only applies to entry point sampling for inorganic contaminants, synthetic and volatile organic contaminants, radionuclides, Nitrate + Nitrite (Combined), Nitrite, Cyanide and Asbestos. Table 11.8 is a table of the Standardized Monitoring Framework for the third cycle which began on January 1, 2011 and ends December 31, 2019. This section is provided as a tool to determine the appropriate sampling cycle or period the entry point is currently in and will aid in determining when a violation for failure to sample has occurred.

The *Waterworks Regulations* and the Standardized Monitoring Framework use the terms “Reliably and Consistently” when establishing sample schedules for entry points based on an initial sample result exceeding a trigger value, such as an MCL or ½ MCL or the detection of, various inorganic, synthetic organic, volatile organic, nitrate + nitrite (combined) and nitrite contaminants. Listed below are procedures for interpreting when “Reliably and Consistently” applies.

- <u>Initial Required Samples (Routine + any required Confirmation samples) > MCL</u>
  Quarterly water samples must be collected from the entry point for a minimum of 4 additional quarters. If the running annual average is less than the MCL and not trending toward the MCL, the District Engineer has the discretion to reduce sampling as indicated in the Standardized Monitoring Framework.

- <u>Detection of Synthetic Organic or Volatile Organic Contaminants < MCL</u>
  Quarterly water samples must be collected from the entry point. If the first two subsequent quarterly samples do not detect the organic contaminant, the District Engineer has the discretion of reducing the sampling to the previous routine frequency or to annually.

- If the SOC/VOC contaminant continues to be detected and is less than or equal to the MCL, sampling must continue for a minimum of 4 quarters. At the end of 4 quarters, the District Engineer has the discretion of reducing the sampling to annually during the quarter with the highest detection.

- <u>Nitrate + Nitrite (Combined) or Nitrite ≥ ½ MCL and ≤ MCL</u>
  Quarterly water samples must be collected from the entry point for a minimum of 4 quarters. If all samples are below the MCL and not trending toward the MCL, the District Engineer has the discretion of reducing sampling to annually during the quarter with the highest result detected.

11.2. Compliance Monitoring Requirements: TNC with a Groundwater Source

Parameter	Frequency	Locations	Sample schedule comments
Bacteria - distribution system	Quarterly[1]	Requires approved plan	The approved plan provides a repeat monitoring schedule should a positive result occur.
Bacteria (MPN), source	See (2) below	Source tap	Samples are collected at the source tap prior to treatment as indicated in (2) below.
Chlorine (for systems that use chlorine as a disinfectant or oxidant) – distribution system	Same as Bacteria – distribution system	Same as Bacteria Requires approved plan	A chlorine residual measurement shall be performed and recorded at the same time and location as each required bacteriological sample collection.
Chlorine Dioxide (for systems that use chlorine dioxide as a disinfectant or oxidant)	Daily	Entry points[3] Requires approved plan	If the chlorine dioxide residual exceeds MRDL of 0.8 mg/l, a minimum of three chlorine dioxide residual analysis will be performed at a sample site as close to the first customer as possible, at intervals of at least 6 hours.
Nitrates + Nitrites (Combined)	Once per year	Entry points[3]	If analysis result is > 5 ppm and ≤ 10 ppm, quarterly monitoring is required for at least 4 consecutive quarters. If all 4 quarterly samples are below 10 ppm and not trending toward 10 ppm, the District Engineer has the discretion of reducing sampling to annually during the quarter with the highest result detected. If analysis result is >10ppm, a confirmation sample must be collected within 24 hours and quarterly monitoring must begin and continue for the duration of the MCL exceedance
Nitrites	One sample	Entry points[3]	If the sample is < 0.5 ppm no further sampling is required; otherwise increase to quarterly for at least one year.

Notes:
(1) Most systems are required to collect only one routine sample per quarter. However, if the population served is > or = 1001 the sample frequency increases to monthly in accordance with 12 VAC5-590-370 A. of the Waterworks Regulations.
(2) Groundwater sources with treatment which could alter bacteriological quality are required to collect MPN raw source water samples as follows :
- Springs, collect one sample per month prior to treatment.
- Karstian wells, collect one sample per quarter prior to treatment.
- Non-karstian well, one sample per year prior to treatment.

(3) Entry points are either at water source downstream of treatment or at a point where more than one water source is mixed before entering system.

11.3. Compliance Monitoring Requirements: TNC with a Surface Water or GUDI Source

Parameter	Initial Frequencies	Locations	Sample schedule comments
Bacteria[1] – distribution system	Monthly	Requires approved plan	The approved plan provides a repeat monitoring schedule should a positive result occur
Chlorine (for systems that use chlorine as a disinfectant or oxidant) – distribution system	Same as Bacteria	Same as Bacteria Requires approved plan	A chlorine residual measurement shall be performed and recorded at the same time and location as each required bacteriological sample collection.
Nitrates + Nitrites (Combined)	Yearly	Entry point tap[2]	If analysis result is > 5 ppm and≤ 10 ppm, quarterly monitoring is required for at least 4 consecutive quarters. If all 4 quarterly samples are below 10 ppm and not trending toward 10 ppm, the District Engineer has the discretion of reducing sampling to annually during the quarter with the highest result detected. If analysis result is >10ppm, a confirmation sample must be collected within 24 hours and quarterly monitoring must begin and continue for the duration of the MCL exceedance
Nitrites	One sample	Entry point tap[2]	If the sample is < 0.5 mg/l no further sampling is required; otherwise increase to quarterly for at least one year.
Chlorine Dioxide (for systems that use chlorine dioxide as a disinfectant or oxidant)	Daily	Entry point tap[2]	If the chlorine dioxide residual is exceeds MRDL of 0.8 mg/l, a minimum of three chlorine dioxide residual analysis will be performed at a sample site as close to the first customer as possible, at intervals of at least 6 hours.

Notes:
(1) The number of samples required per quarter or per month is dependent on the population served. See 12 VAC5-590-370 A. of the *Waterworks Regulations*.
(2) Entry points are either at water source downstream of treatment or at a point where more than one water source is mixed before entering system.

11.4. Compliance Monitoring Requirements: TNC Consecutive Waterworks

Parameter	Frequency	Locations	Sample schedule comments
Bacteria - distribution system	Quarterly[1]	Requires approved plan	The approved plan provides a repeat monitoring schedule should a positive result occur.
Chlorine (for systems that receive chlorine as a disinfectant or oxidant) – distribution system	Same as Bacteria	Same as Bacteria Requires approved plan	A chlorine residual measurement shall be performed and recorded at the same time and location as each required bacteriological sample collection.

Notes:
(1)Systems are required to collect routine samples based on population served in accordance with 12 VAC5-590-370 A. of the *Waterworks Regulations*.

11.5. Compliance Monitoring Requirements: Community or NTNC with a Groundwater Source

Parameter	Initial Frequency	Locations	Sample schedule comments
Bacteria - distribution system[1]	Monthly	Requires approved plan	The approved monitoring plan requires additional monitoring should a positive result occur.
Bacteria (MPN), source water	See (2) below	Source tap	Samples are collected at the source tap prior to treatment as indicated in (2) below.
Chlorine (for systems that use chlorine as a disinfectant or oxidant) – distribution system	Same as Bacteria	Same as Bacteria Requires approved plan	A chlorine residual measurement shall be performed and recorded at the same time and location as each required bacteriological sample collection.
Chlorine Dioxide (for systems that use chlorine dioxide as a disinfectant or oxidant)	Daily	Entry points Requires approved plan	If the chlorine dioxide residual exceeds MRDL of 0.8 mg/l, a minimum of three chlorine dioxide residual analysis will be performed. These samples must be collected as close to the first customer as possible at 6 hour intervals. If booster chlorination (re-chlorination) is provided, the samples must be collected as close to the first customer as possible, at a location representative of average residence time and as close to the end of the distribution system as possible reflecting maximum residence time.
Nitrates + Nitrites (Combined)	Once per year	Entry points	If analysis result is > 5 ppm and ≥ 10 ppm , quarterly monitoring is required for at least 4 consecutive quarters. If all 4 quarterly samples are below 10 ppm and not trending toward 10 ppm, the District Engineer has the discretion of reducing sampling to annually during the quarter with the highest result detected. If analysis result is >10ppm, a confirmation sample must be collected within 24 hours and quarterly monitoring must begin and continue for the duration of the MCL exceedance
Nitrites	One sample	Entry points	If the sample is < 0.5 mg/l no further sampling is required; otherwise increase to quarterly for at least one year.
Metals	Once per 3 year compliance period	Entry points	Increase to quarterly if a PMCL is exceeded. Samples must be collected in a 3 year window.
Inorganics	Once per 3 year compliance period	Entry points	Increase to quarterly if a PMCL is exceeded. Samples must be collected in a 3 year window.
VOCs	Quarterly	Entry points	If no detects after the initial 4 quarters, reduce to yearly at highest previous quarter; after an additional 2 annual samples with no detects, reduce to once per 3 year compliance period. If detected, see (5) below.
Radionuclides[3] -Community only (includes Gross Alpha, Combined Radium-226/228 and Uranium, also see (3*) below)	Quarterly[2]	Entry point tap	If the initial 4 consecutive quarterly average exceeds the MCL the system shall continue to sample quarterly until the average is equal to or below the MCL then see (3) below.
SOCs[4]	Quarterly[4]	Entry points	If not detected after the initial 4 quarters see (4) below; if detected, see (5) below.
Cyanide	Once every 3 years	Entry points	After 3 samples with no detects a waiver is granted where only one sample per 9 year cycle is required.
Disinfection Byproducts[6]	Population dependent	Requires approved plan	See (6) below if chlorine, Chloramination, Chlorine Dioxide or Ozone is used.
Lead & Copper[7]	See (7) below	Requires approved plan	Sampling locations are based on the population and plumbing materials survey.

11.5 Compliance Monitoring Requirements: Community or NTNC with a Groundwater Source (continued)

Parameter	Initial Frequency	Locations	Sample schedule comments

Notes:

(1) The number of samples required per month is dependent on the population served. See 12 VAC5-590-370 A. of the *Waterworks Regulations*.

(2) Groundwater sources with treatment which could alter bacteriological quality are required to collect MPN raw source water samples as follows :
- Springs, collect one sample per month prior to treatment.
- Karstian wells, collect one sample per quarter prior to treatment.
- Non-karstian well, one sample per year prior to treatment.

(3) The running average of 4 consecutive quarterly samples determines compliance and sampling frequency for each contaminant.
a) If the average of initial monitoring results is below detection limits, the sampling frequency will reduce to one sample every 9 years (because of substitutions a 9 year schedule will not normally apply).
b) If the average of initial monitoring results is greater than or equal to the detection limit but less than or equal to one half the MCL, the sampling frequency will reduce to one sample every 6 years.
c) If the average of initial monitoring results is greater than one half the MCL but less than or equal to the MCL , the sampling frequency will reduce to one sample every 3 years.

* Systems determined to have vulnerable or contaminated source water from manmade Radionuclides shall sample on a frequency established by the *Waterworks Regulations.*

(4) Waterworks may request a waiver to SOC monitoring requirements for each water source. Waivers must be renewed by submission of an application for each source every 3 years. Waterworks denied a monitoring waiver may reduce the monitoring frequency if SOCs are not detected in the initial 4 quarters as follows:
a) For populations > 3300, two quarterly samples within a one year window during the 3 year compliance period, or
b) For populations < or = 3300, one sample per 3 year compliance period.

(5) Waterworks which detect a VOC or SOC must continue to collect quarterly samples for a minimum of four consecutive quarters. If the concentration of the detected contaminant is reliably and consistently below the MCL, sampling may be reduced to annually during the quarter with the highest analytical result. Waterworks which previously detected SOC's but have collected 3 annual samples with no detection of contaminants may apply for SOC Waivers as indicated in (4) above. Waterworks which previously detected VOC's but have collected 3 annual samples with no detection of contaminants may be reduced to once every 3 year compliance period.

(6) Please refer to Section 5 for information on Disinfection Byproducts Monitoring, and to ..\..\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898-Sampling Manual\

(7) Lead & Copper monitoring is required for 2 successive 6 month periods. If the 90th percentile lead & copper levels do not exceed the action levels, then at least two sets of subsequent satisfactory annual samples are required before reducing the monitoring to every 3 years. Also, samples collected annually and every three years can be reduced to half (but not< 5) of the number required during the initial sampling, but must be collected between June and September. If the initial results exceed action levels, then source treatment or lead containing service line replacement are potential required solutions.

11.6. Compliance Monitoring Requirements: Community or NTNC with a Surface Water or GUDI Source

Parameter	Initial Frequencies	Locations	Sample schedule comments
Bacteria – distribution system	Monthly[1]	Requires approved plan	The approved plan provides a repeat monitoring schedule should a positive result occur
Chlorine (for systems that use chlorine as a disinfectant or oxidant) – distribution system	Same as Bacteria	Same as Bacteria Requires approved plan	A chlorine residual measurement shall be performed and recorded at the same time and location as each required bacteriological sample collection.
Nitrates + Nitrites (Combined)	Quarterly	Entry point tap	If analysis result is > 5 ppm and≤ 10 ppm, quarterly monitoring is required for at least 4 consecutive quarters. If all 4 quarterly samples are below 10 ppm and not trending toward 10 ppm, the District Engineer has the discretion of reducing sampling to annually during the quarter with the highest result detected. If analysis result is >10ppm, a confirmation sample must be collected within 24 hours and quarterly monitoring must begin and continue for the duration of the MCL exceedance
Nitrites	One sample	Entry point tap	If the sample is < 0.5 mg/l no further sampling is required; otherwise increase to quarterly for at least one year.
Metals	Yearly	Entry point tap	Increase to quarterly if a PMCL is exceeded
Inorganics	Yearly	Entry point tap	Increase to quarterly if a PMCL is exceeded
VOCs	Quarterly	Entry point tap	If not detected in the initial 4 quarters, reduce to yearly; if detected , see (4) below.
Radionuclides[2] -Community only (includes Gross Alpha, Combined Radium-226/228 and Uranium, also see (2*) below)	Quarterly[2]	Entry point tap	If the initial 4 consecutive quarterly average exceeds the MCL the system shall continue to sample quarterly until the average is equal to or below the MCL then see (2) below.
SOCs[3]	Quarterly[3]	Entry point tap	If not detected after the initial 4 quarters see (3) below; if detected see (4) below.
Cyanide	Once every year	Entry point tap	After 3 years with no detects a waiver is granted where only one sample per 9 year cycle is required.
Disinfection Byproducts[5]	Population dependent	Requires approved plan	See (5) below.
TOC & Alkalinity[6]	Monthly	Raw & combined filter effluent taps Requires approved plan	A paired set of samples shall be collected each month demonstrating the removal ratio for TOCs . A removal ratio of 1.00 or greater is required on a running quarterly average to be in compliance. The % removal requirements are based on the source water alkalinity and TOC concentrations as listed in the *Waterworks Regulations.*
Bromate (only if using Ozone)	Monthly	Entry point	Compliance is based on a running annual average
Bromide (if using Ozone)	Monthly	Source water	Collection required to reduce the required Bromate samples to that noted above

11.6 Compliance Monitoring Requirements: Community or NTNC with a Surface Water or GUDI Source (continued)

Parameter	Initial Frequencies	Location	Sample Schedule Comments
Chlorine Dioxide (for systems that use chlorine dioxide as a disinfectant or oxidant)	Daily	Entry points Requires approved plan	If the chlorine dioxide residual exceeds MRDL of 0.8 mg/l, a minimum of three chlorine dioxide residual analysis will be performed. These samples must be collected as close to the first customer as possible at 6 hour intervals. If booster chlorination (re-chlorination) is provided, the samples must be collected as close to the first customer as possible, at a location representative of average residence time and as close to the end of the distribution system as possible reflecting maximum residence time.
Lead & Copper[7]	See (6) below	Requires approved plan	Sampling locations are based on the population and plumbing materials survey.

Notes:

(1) The number of samples required per month is dependent on the population served. See 12 VAC5-590-370 A. of the *Waterworks Regulations*.

(2) The running average of 4 consecutive quarterly samples determines compliance for each contaminant.

a) If the average of initial monitoring results is below detection limits, the sampling frequency will reduce to one sample every 9 years (because of substitutions a 9 year schedule will not normally apply).

b) If the average of initial monitoring results is greater than or equal to the detection limit but less than or equal to one half the MCL, the sampling frequency will reduce to one sample every 6 years.

c) If the average of initial monitoring results is greater than one half the MCL but less than or equal to the MCL , the sampling frequency will reduce to one sample every3 years.

* Systems determined to have vulnerable or contaminated source water from manmade Radionuclides shall sample on a frequency established by the *Waterworks Regulations.*

(3) Waterworks may request a waiver to SOC monitoring requirements for each water source. Waivers must be renewed by submission of an application for each source every 3 years. Waterworks denied a monitoring waiver may reduce the monitoring frequency if SOCs are not detected in the initial 4 quarters as follows:

a) For populations > 3300, two quarterly samples within a one year window during the 3 year compliance period, or

b) For populations < or = 3300, one sample per 3 year compliance period.

(4) Waterworks which detect a VOC or SOC must continue to collect quarterly samples for a minimum of four consecutive quarters. If the concentration of the detected contaminant is reliably and consistently below the MCL, sampling may be reduced to annually during the quarter with the highest analytical result. Waterworks which previously detected SOC's but have collected 3 annual samples with no detection of contaminants may apply for SOC Waivers as indicated in (3) above.

(5) Please refer to Y:\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM898- Sampling Manual for Disinfection Byproducts Monitoring Plans, Review forms and Approval Letters

(6)Alkalinity monitoring is only required at the raw water tap.

(7) Lead & Copper monitoring is required for 2 successive 6 month periods. If the 90th percentile lead & copper levels do not exceed the action levels, then at least two sets of subsequent satisfactory annual samples are required before reducing the monitoring to every 3 years. Also, samples collected annually and every three years can be reduced to half of the number required during the initial sampling but must be collected between June and September. If the initial results exceed action levels, then source treatment or lead containing service line replacement are potential required solutions.

11.7 Compliance Monitoring Requirements: Community or NTNC Consecutive Waterworks

Parameter	Frequency	Locations	Sample schedule comments
Bacteria, distribution system	Monthly[1]	Requires approved plan	The approved plan provides a repeat monitoring schedule should a positive result occur.
Chlorine (for systems that receive chlorine as a disinfectant or oxidant) – distribution system	Same as Bacteria	Same as Bacteria Requires approved plan	A chlorine residual measurement shall be performed and recorded at the same time and location as each required bacteriological sample collection.
Disinfection Byproducts (for systems receiving disinfected water from their supplier or providing disinfection)[3]	Population dependent	Requires approved plan	See Chapter 5 for Disinfection Byproducts Monitoring Plans, Review Forms and Approval Letters.
Chlorine Dioxide (for systems that use chlorine dioxide as a disinfectant or oxidant)	Daily	Entry points Requires approved plan	If the chlorine dioxide residual exceeds MRDL of 0.8 mg/l, a minimum of three chlorine dioxide residual analysis will be performed. These samples must be collected as close to the first customer as possible at 6 hour intervals. If booster chlorination (re-chlorination) is provided, the samples must be collected as close to the first customer as possible, at a location representative of average residence time and as close to the end of the distribution system as possible reflecting maximum residence time.
Chlorite (only if using Chlorine dioxide)	Daily	Entry point - Requires approved plan	If daily samples exceed MRDL, then must collect 3 samples from distribution system
Lead & Copper[2]	See (2) below	Requires approved plan	Sampling locations are based on the population and plumbing materials survey.

Notes:
(1) Systems are required to collect routine samples based on population served in accordance with 12 VAC5-590-370 A. of the *Waterworks Regulations*.

(2) Lead & Copper monitoring is required for 2 successive 6 month periods. If the 90th percentile lead & copper levels do not exceed the action levels, then at least two sets of subsequent satisfactory annual samples are required before reducing the monitoring to every 3 years. Also both annual and samples collected every three years can be reduced to half (but not< 5) of the number required during the initial sampling, but must be collected between June and September. If the initial results exceed action levels, then source treatment or lead containing service line replacement are potential required solutions.

11.8 Standard Monitoring Schedule

		THIRD CYCLE									FOURTH CYCLE								
		1ST Period			2nd Period			3rd Period			1ST Period			2nd Period			3rd Period		
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Inorganic IOCs	Groundwater < MCL	*			*			*			*			*			*		
	Surface Water < MCL	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Groundwater & Surface Water > MCL[1]																		
	Groundwater Reliably and Consistently ≤ MCL	*			*			*			*			*			*		
	Surface Water Reliably and Consistently ≤ MCL	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Groundwater & Surface Water > MCL	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****
Synthetic Organic SOCs	Population > 3,300 – No Waivers < Detection Limit	**			**			**			**			**			**		
	Population ≤ 3,300 – No Waivers < Detection Limit	*			*			*			*			*			*		
	≥ Detection Limit[1] and																		
	Reliably and Consistently ≤ MCL[2]	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Not Reliably and Consistently ≤ MCL	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****
Volatile Organic VOC's	< Detection Limit and																		
	Groundwater (after collection of 4 initial quarterly samples)[3]	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Surface Water (after collection of 4 initial quarterly samples)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	≥ Detection Limit[1] and																		
	Reliably and Consistently < MCL[2]	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Not Reliably and Consistently ≤ MCL	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****
Nitrate + Nitrite (Combined)	Community/NTNC Waterworks																		
	Surface Water with 4 Quarters of Results < ½ MCL[4]	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Groundwater Reliably and Consistently < MCL[4]	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	≥ ½ MCL or not Reliably and Consistently < MCL	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****
	Transient Noncommunity Waterworks																		
	Standard Monitoring	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

**** See Legend on next page

11.8 Standard Monitoring Schedule (continued)

		THIRD CYCLE									FOURTH CYCLE								
		1ST Period			2nd Period			3rd Period			1ST Period			2nd Period			3rd Period		
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Nitrite	< ½ MCL	Established by Commissioner									Established by Commissioner								
	Reliably and Consistently < MCL[4]	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	≥ ½ MCL or not Reliably and Consistently < MCL	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****
Radionuclides[5]	Community Waterworks																		
	< Detection Limit [6] ***(9-yr schedule)***	*									*								
	≥ Detection Limit and ≤ ½ MCL ***(6-yr schedule)***	*						*						*					
	> ½ MCL and ≤ MCL ***(3-yr schedule)***	*			*			*			*			*			*		
	> MCL [7]	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****

Legend		
* 1 sample at each entry point to distribution system	** 2 quarterly samples at distribution system entry points. Samples must be taken during 1 calendar year during each 3-year compliance period.	**** 4 quarterly samples at each distribution system entry point within time frame.

Notes

[1] A system with a sampling point result above the MCL (IOC) or Detection Level (SOC, VOC) must collect quarterly samples, at that sampling point, until the system is determined to be reliably and consistently below the MCL.

[2] Samples must be taken during the quarter which previously resulted in the highest analytical result. Systems can apply for a waiver after 3 consecutive annual sampling results are below the detection limit.

[3] If all monitoring results during initial quarterly monitoring are less than the detection limit, the system can take annual samples. If after a minimum of 3 years of annual sampling with all analytical results less than the detection limit, the system may be allowed to take 1 sample during each compliance period.

[4] Samples must be taken during the quarter which previously resulted in the highest analytical result.

[5] Radionuclides – Gross Alpha, Combined Radium and Uranium.

[6] To obtain a nine-year reduced monitoring schedule, all required radionuclides (gross alpha, radium-226, radium-228 and uranium) must be below detection level from direct testing, not obtained by substitution. Where substitutions are used and measured results (typically gross alpha and radium-228) are below detection limit, the resulting reduced monitoring schedule would be a six-year schedule.

[7] When a radionuclide MCL is exceeded, quarterly sampling must be conducted at that entry point until four consecutive quarterly results are below the MCL. The result of the four-quarter average is used to determine the new monitoring schedule.

12. Entry Point Monitoring Decision Flow Charts

Provided in the following pages are various chemical and radiological monitoring flow charts for assisting staff in determining compliance with the various rules, and for assisting staff in determining if and/or when reduced monitoring is allowed.

This section should be used as follows:

1. Use the Section contents to locate the flow chart, description, or form that best describes your need. For instance, the waterworks has completed their first quarter or their 4 consecutive quarterly (baseline) monitoring for a SOC that had been denied a waiver - one would go to the SOC Baseline flow chart, or a waterworks detected a VOC - one would go to the VOC Detected flow chart. Note that the charts are divided as the rules for each contaminant require.

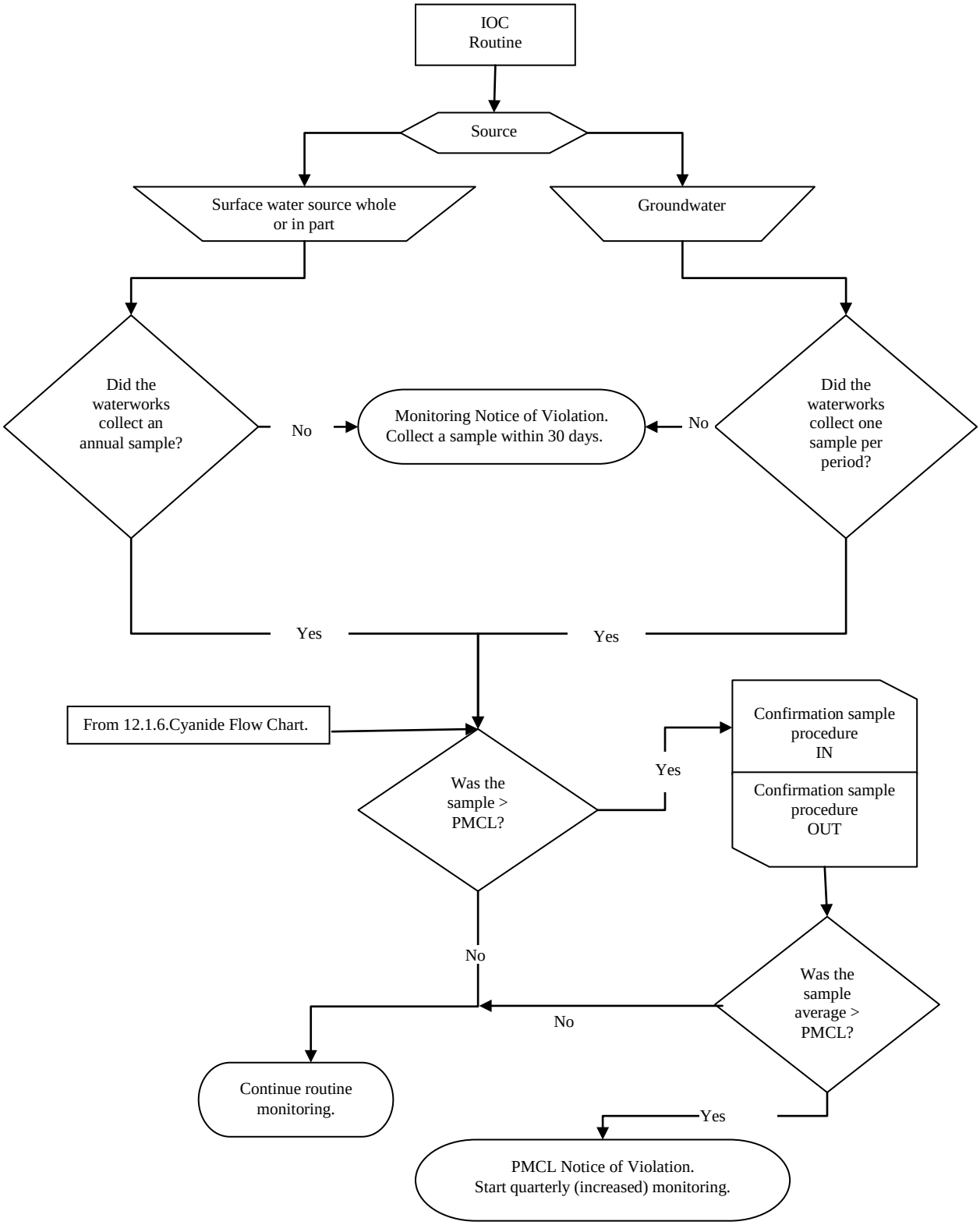
2. Follow the logical flow of the flow chart by answering the questions in the decision diamonds and perform the process (example, Confirmation Procedure or procedure). The flow charts are an aid for you to determine the next action that needs to be taken that applies to that particular waterworks for that particular circumstance. In most cases the sampling is to be done quarterly. The quarterly chart will then lead to an annual flow chart or other reduced monitoring frequency.
   Note that Ttere are also provisions in the reduced monitoring charts to increase the frequency of monitoring.

EPA has also published “NPDWR Violations and RTC Definitions” that provide this information in a tabular format. The latest release is dated March 9, 2012. Please consult with the SDWIS Administrator for status and availability of this resource.

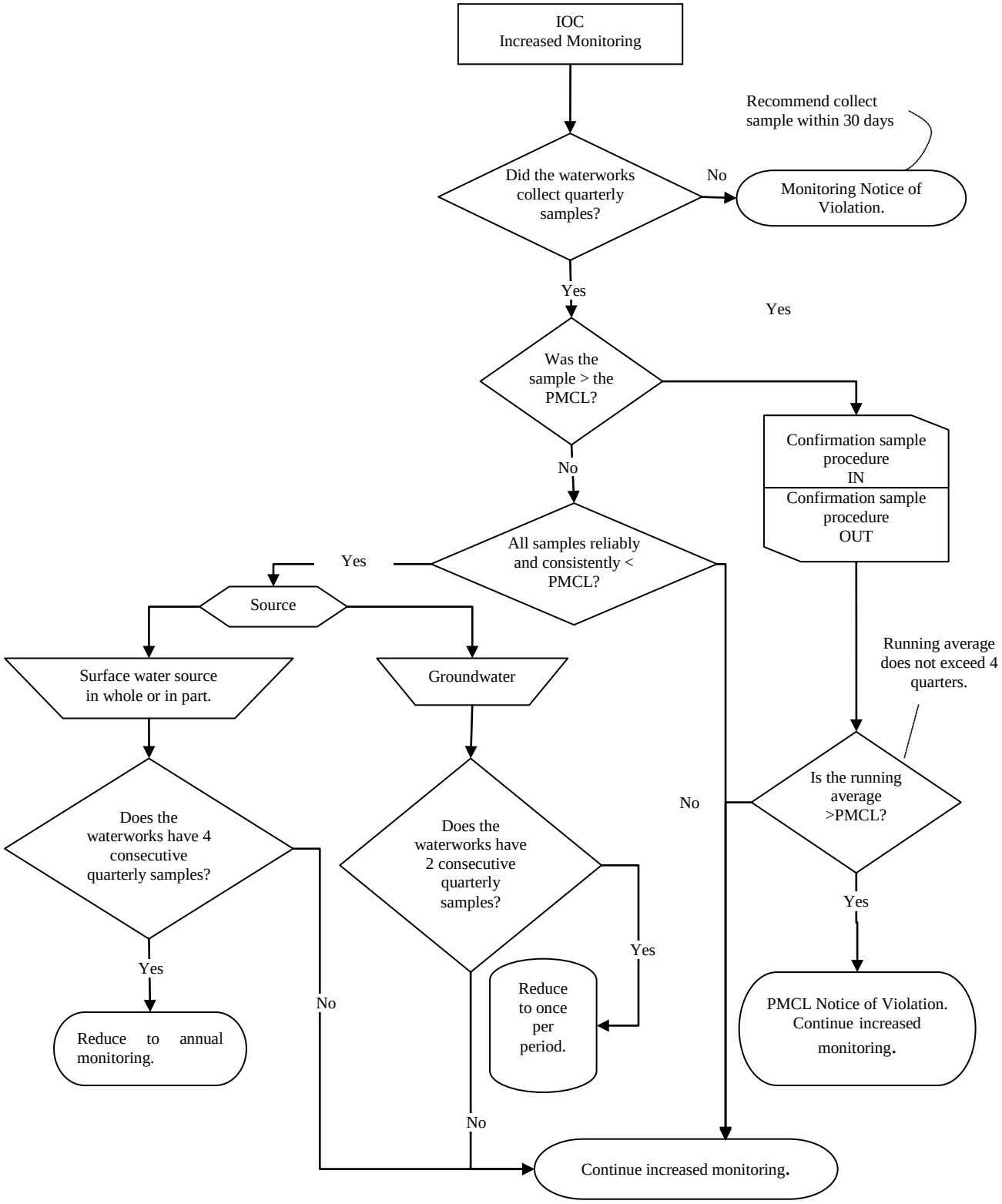
13. IOCs (Inorganic Chemicals) Metals & Nonmetals

13.1.1. **IOC Routine**
13.1.2. **IOC Increased Monitoring**
13.1.3. **Nitrates + Nitrites (Combined) – Quarterly**
13.1.4. **Nitrates + Nitrites (Combined) – Annual**
13.1.5. **Nitrite**
13.1.6. **Cyanide**

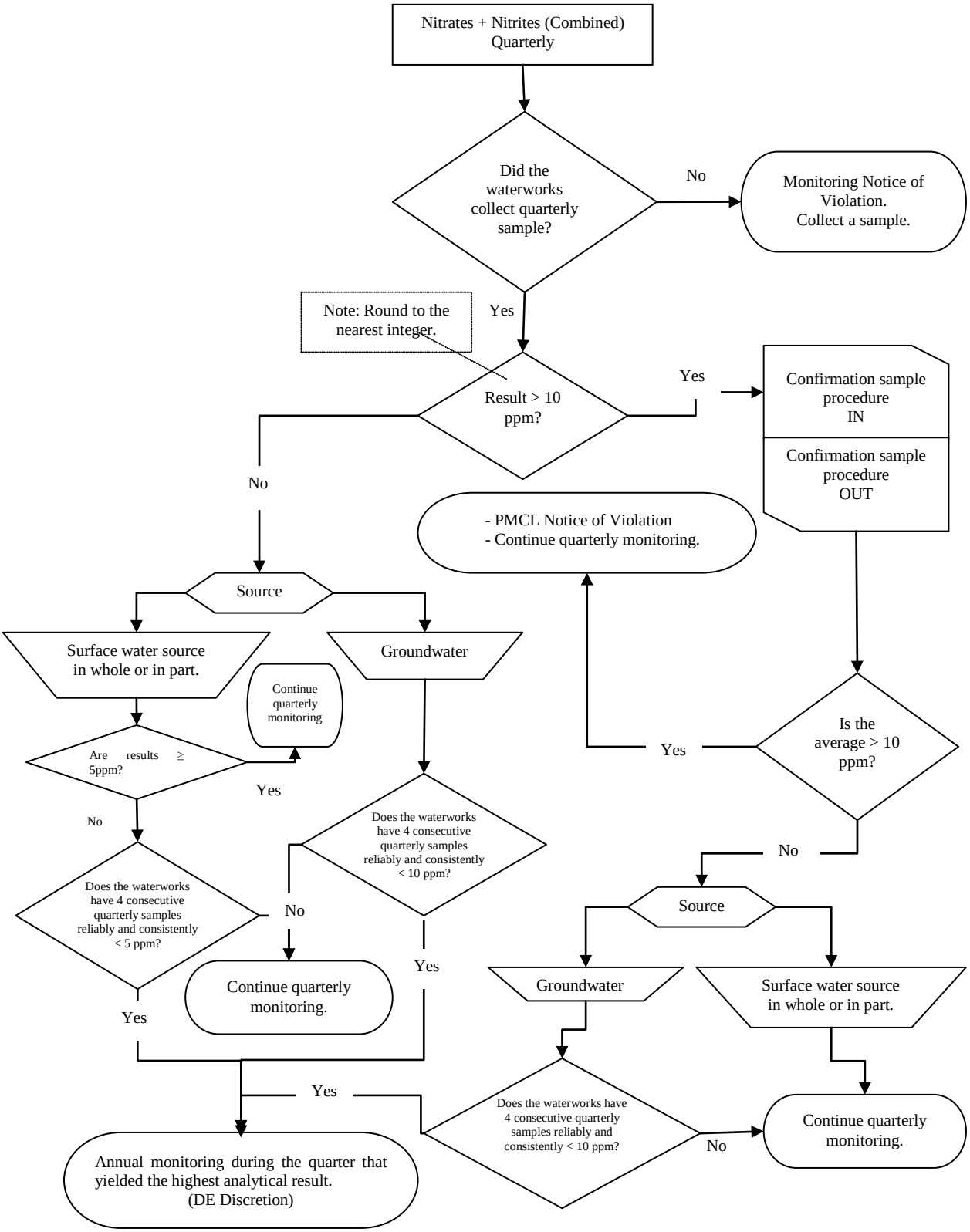
12.1.1. **IOC Routine Flow Chart**



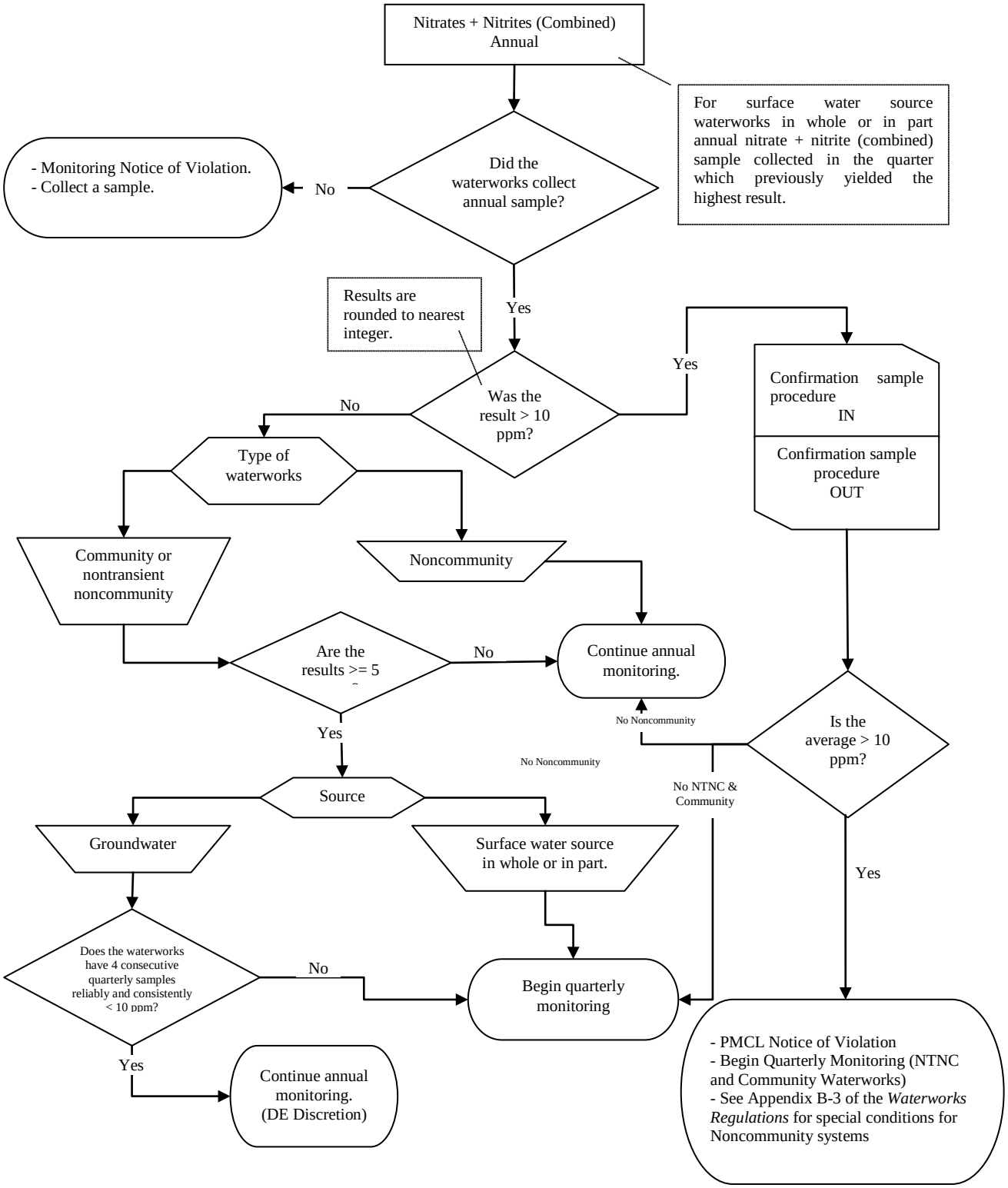
12.1.2. **IOC Increased Monitoring Flow Chart**



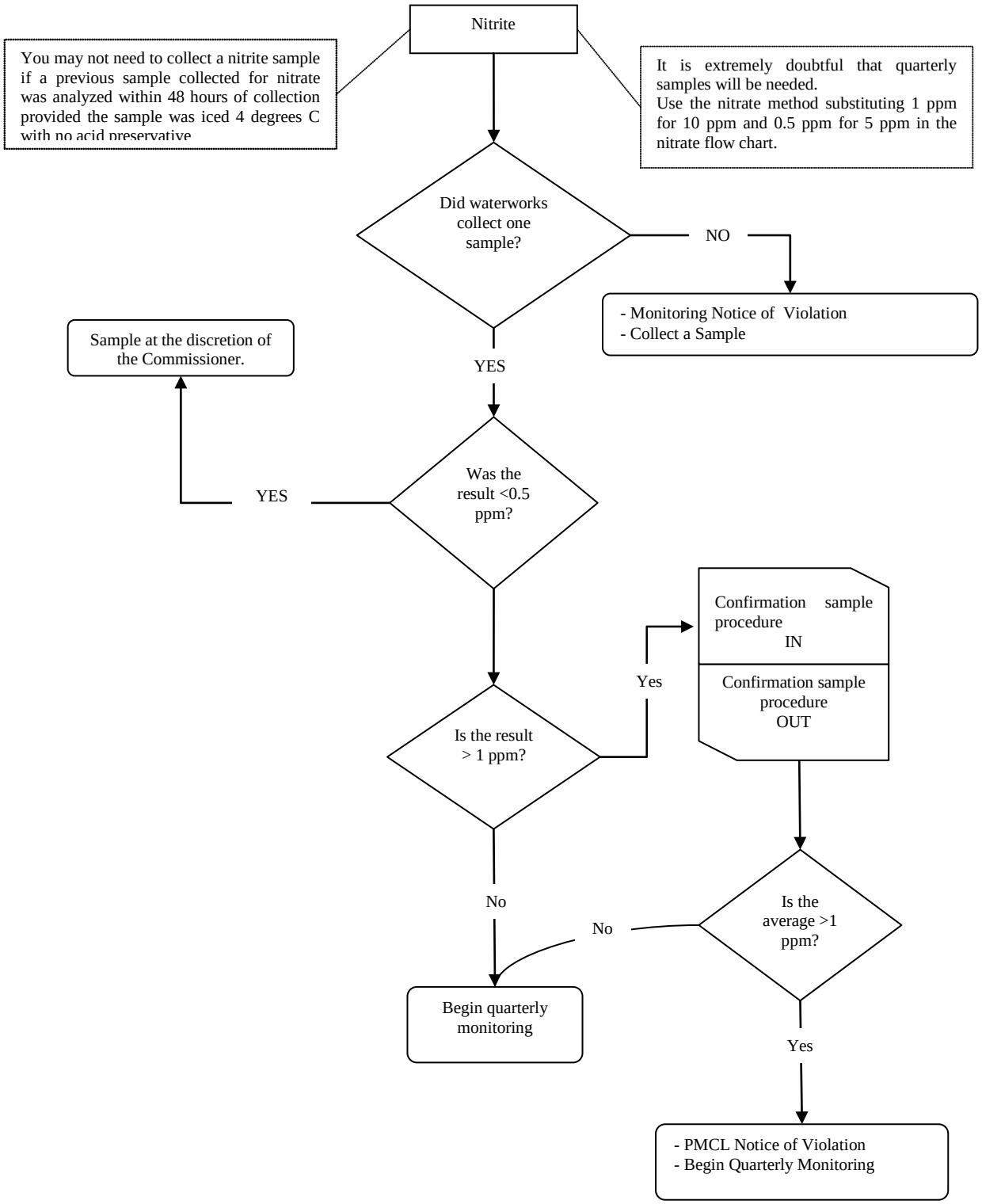
12.1.3. **Nitrates + Nitrites (Combined) – Quarterly Flow Chart**



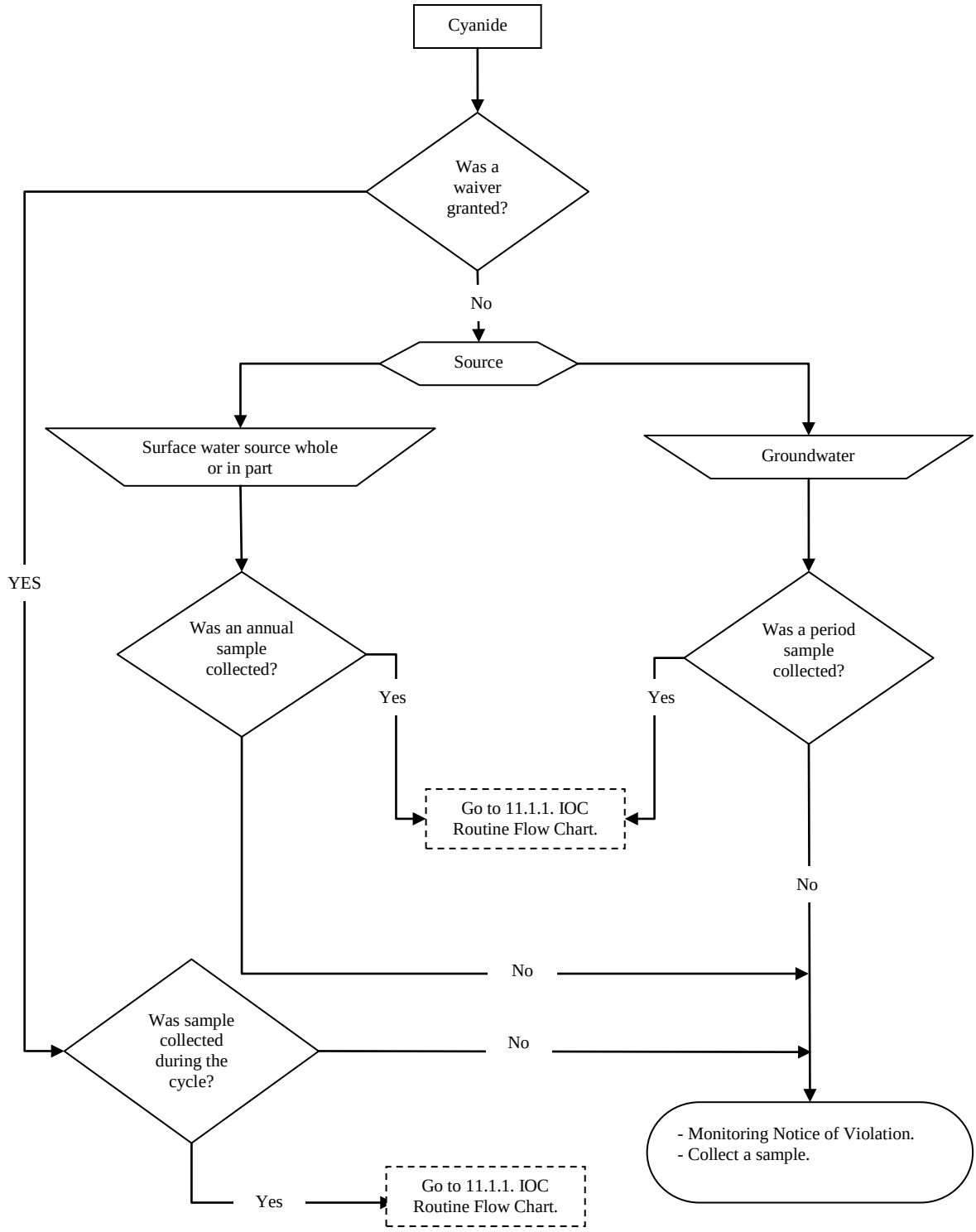
12.1.4. **Nitrates + Nitrites (Combined) – Annual Flow Chart**



12.1.5. **Nitrite Flow Chart**



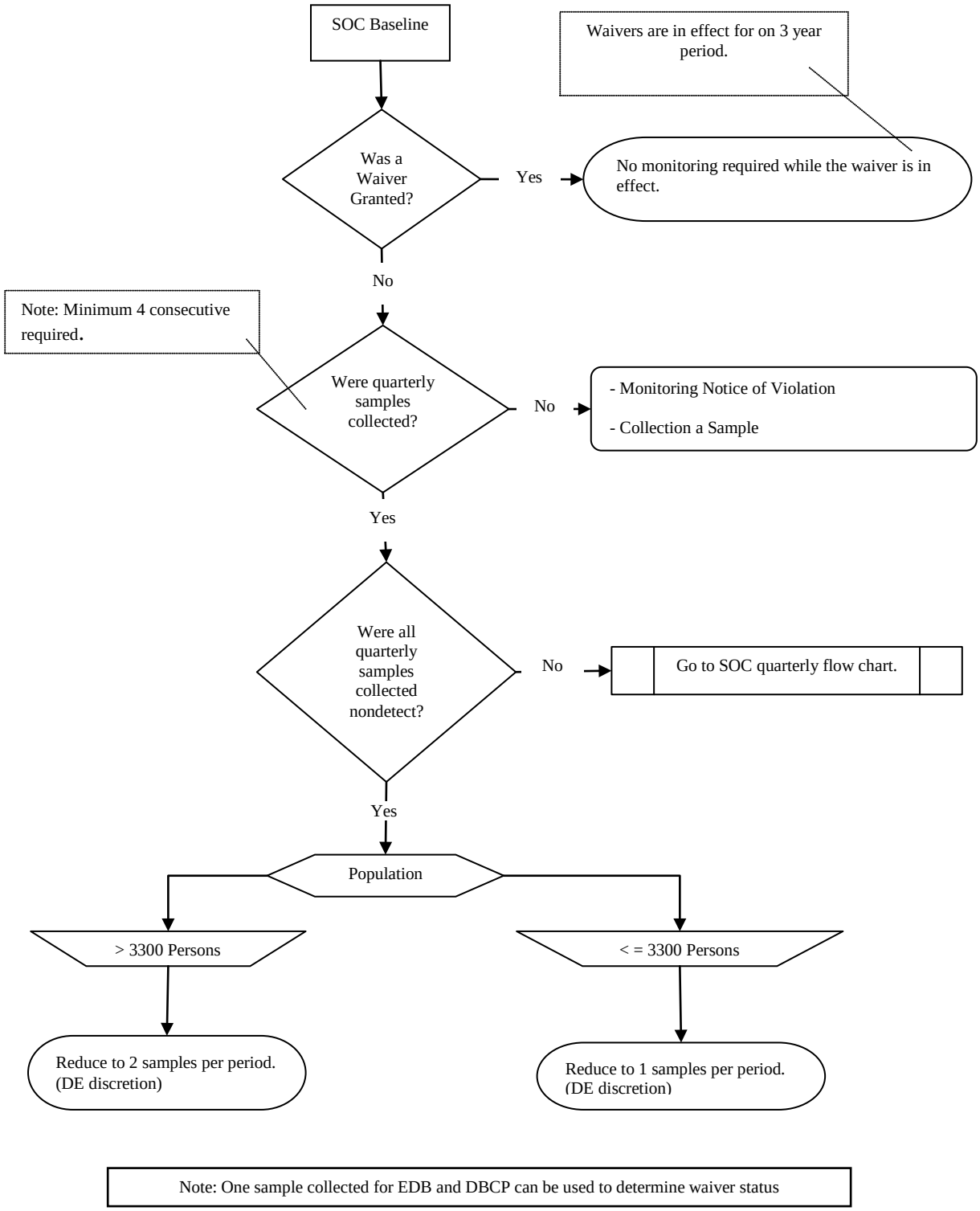
12.1.6. **Cyanide Flow Chart**



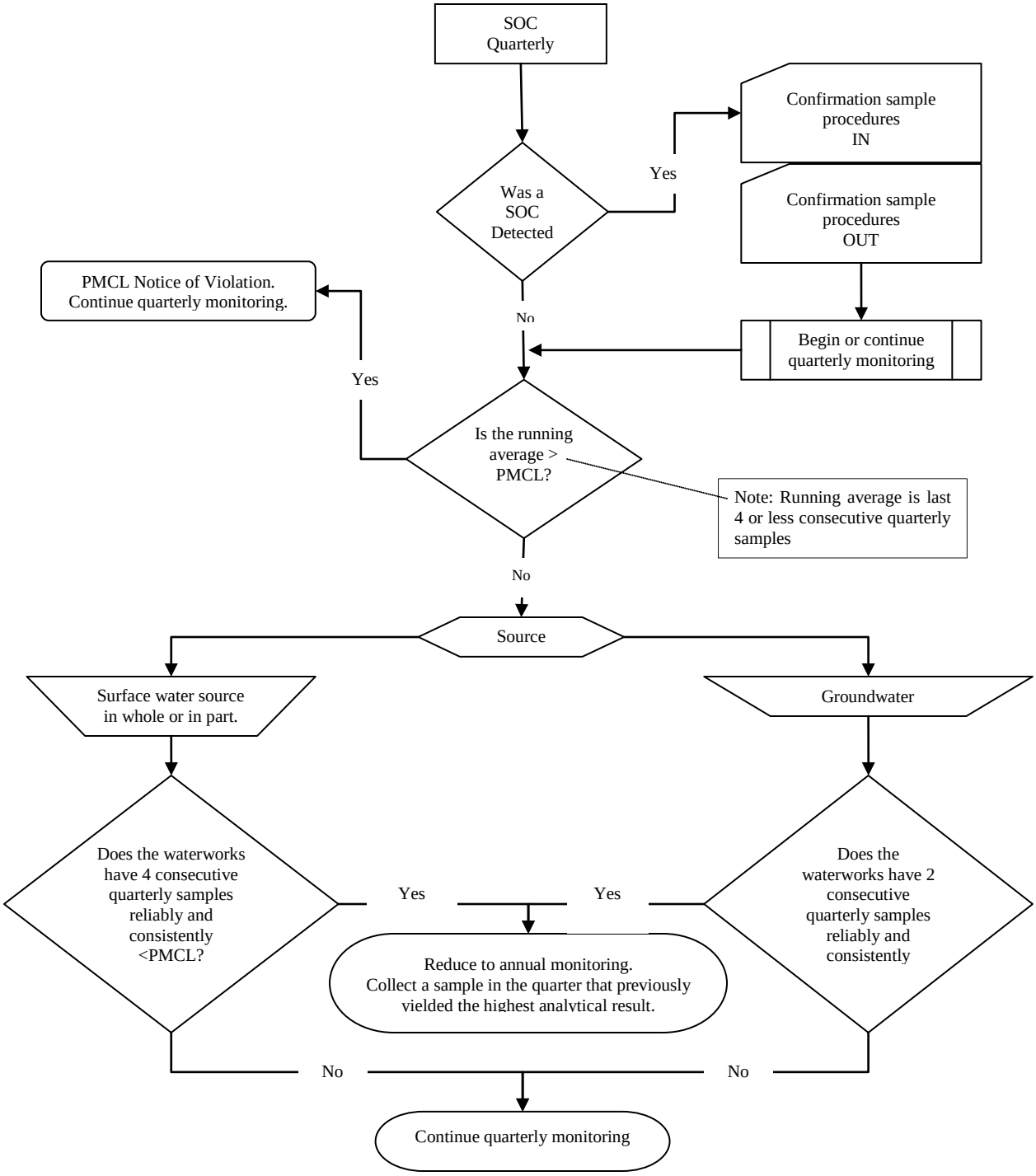
12.2. SOCs (Synthetic Organic Chemicals)

11.2.1 SOC – Baseline
11.2.2 SOC – Quarterly
11.2.3 SOC Annual

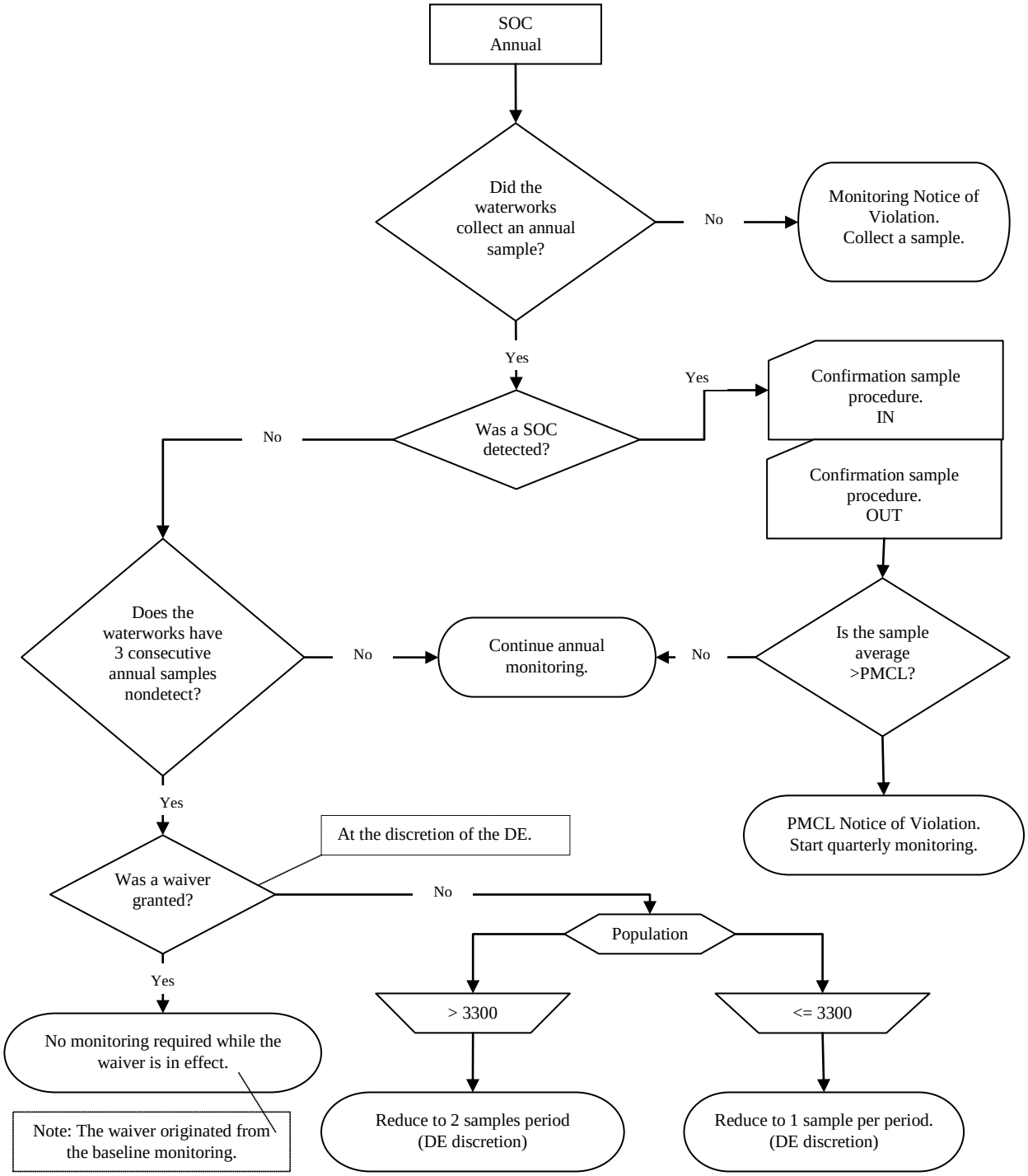
12.2.1. **SOC – Baseline Flow Chart**



12.2.2. **SOC – Quarterly Flow Chart**



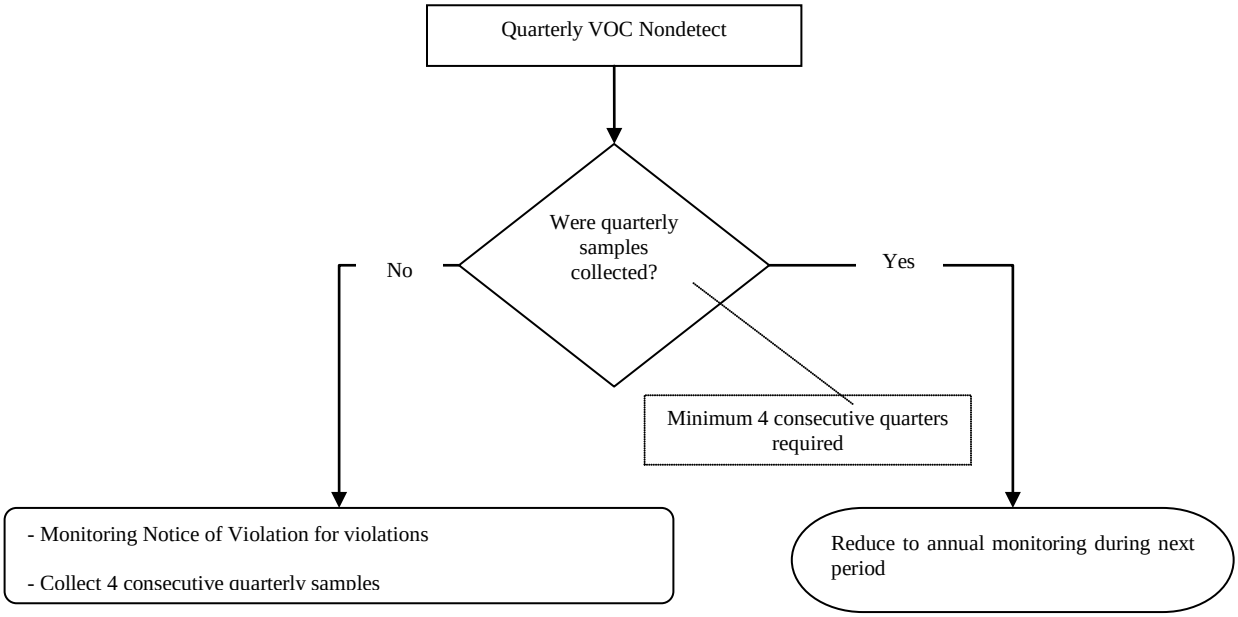
12.2.3. **SOC Annual Flow Chart**



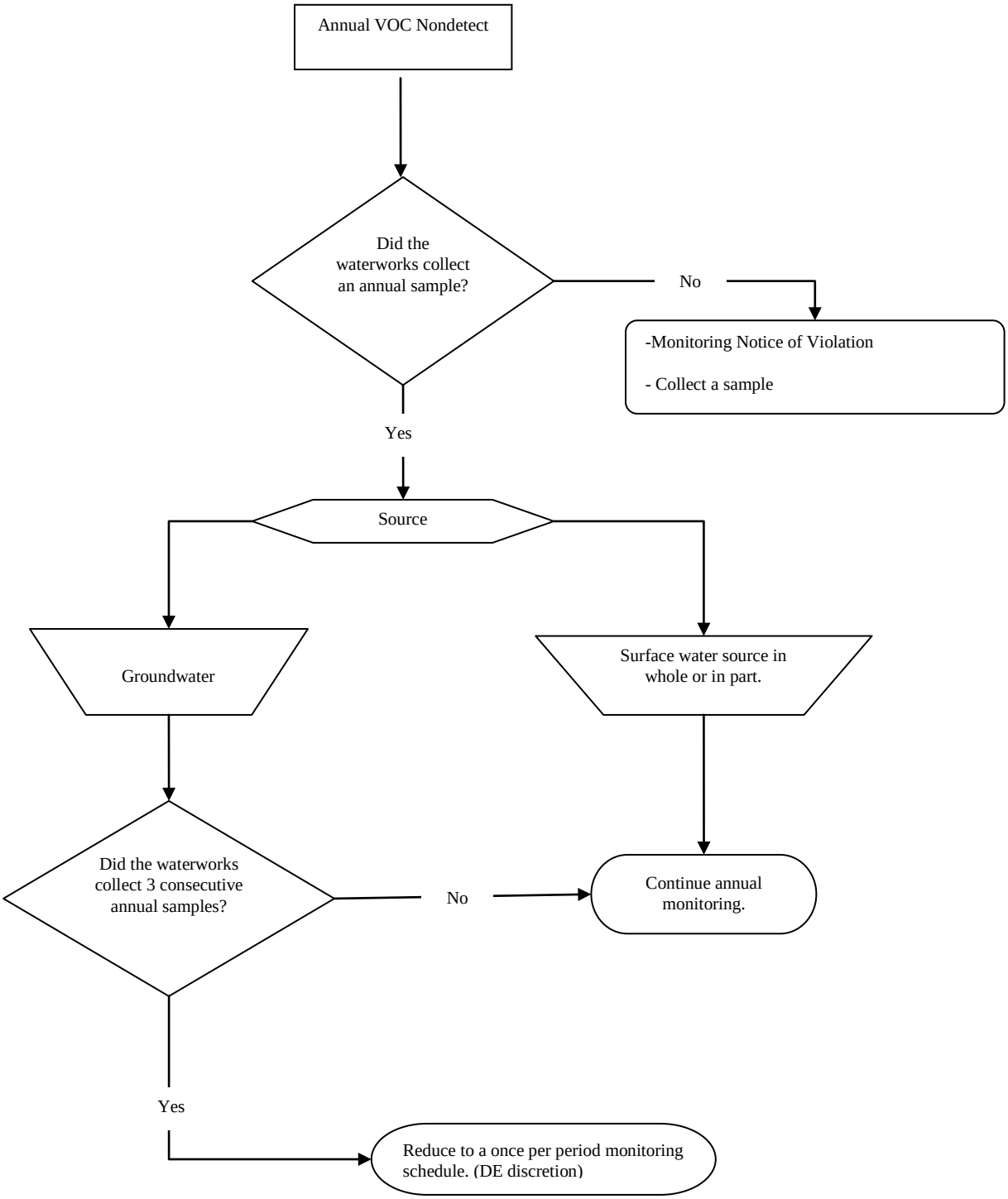
12.3. VOCs (Volatile Organic Chemicals)

11.3.1 VOC - Quarterly, Nondetect
11.3.2 VOC - Annual, Nondetect
11.3.3 VOC Detected
11.3.4 Check for Vinyl Chloride
11.3.5 Confirmation Sample Procedure

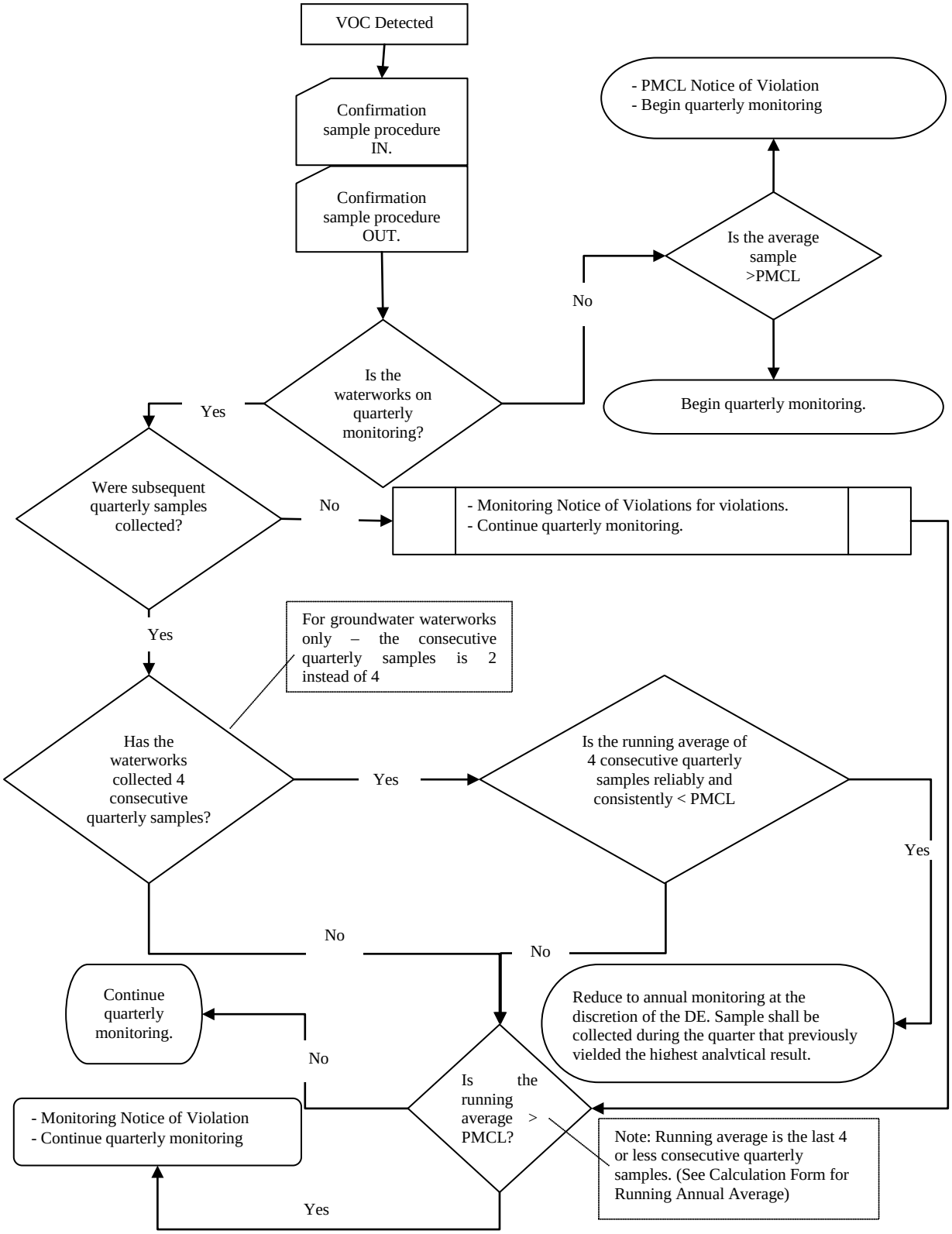
12.3.1. **VOC - Quarterly, Non-detect Flow Chart**



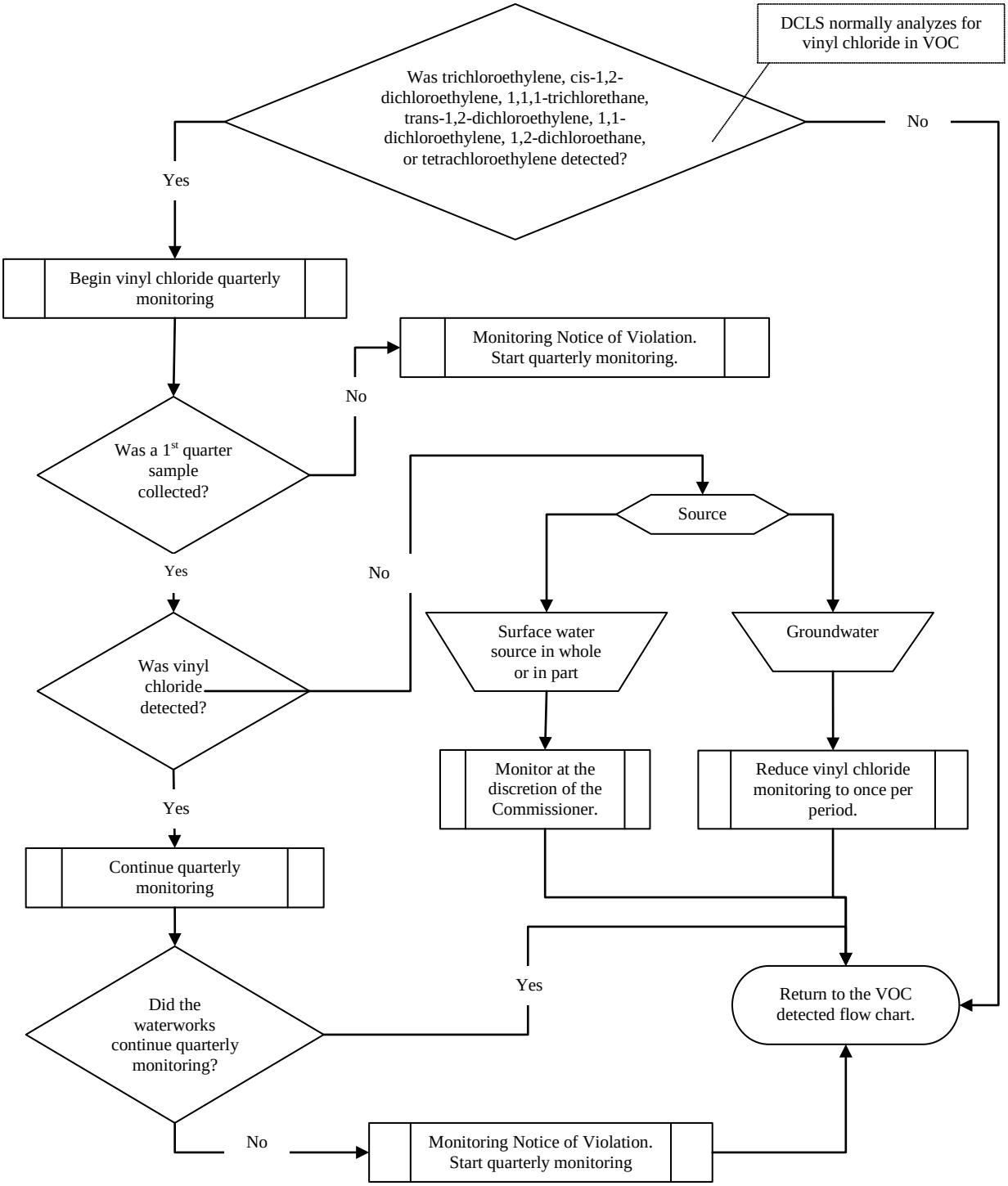
12.3.2. **VOC - Annual, Non-detect Flow Chart**



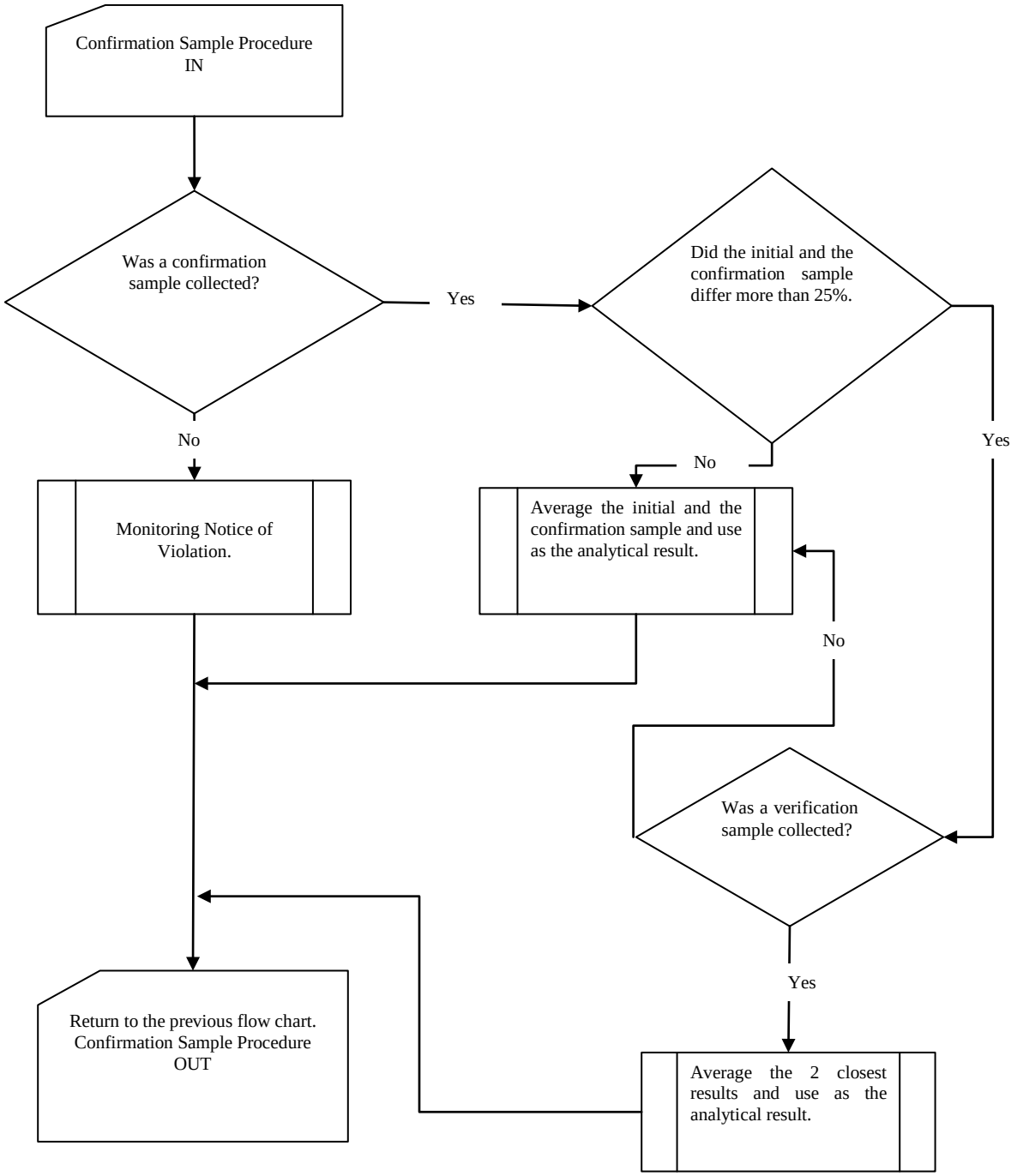
12.3.3. **VOC Detected Flow Chart**



12.3.4. **Check for Vinyl Chloride Flow Chart**



12.3.5. **Confirmation Sample Procedure Flow Chart**

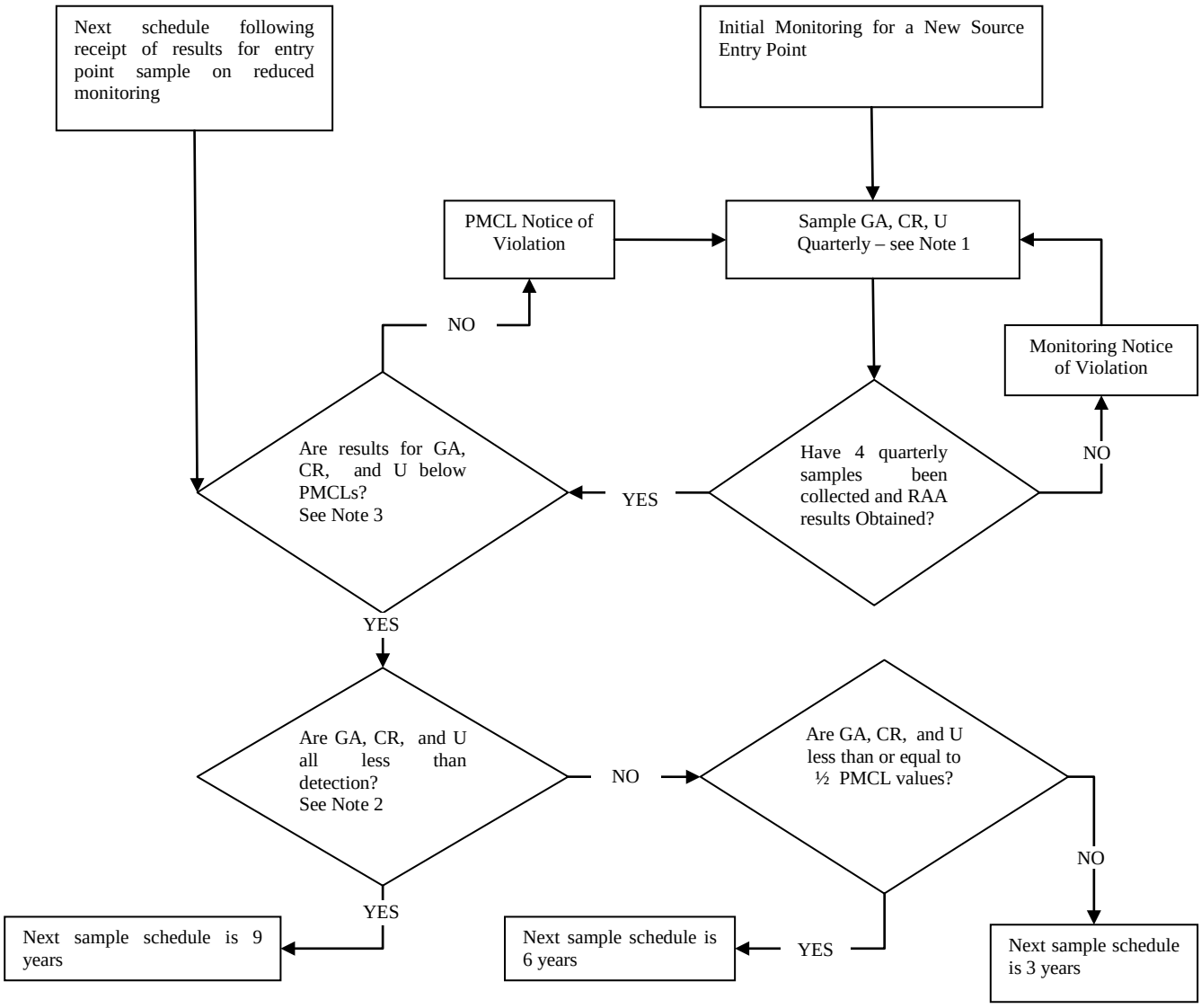


12.4. Radionuclides

12.4.1. Radionuclides Rule Routine Monitoring Requirements: Community Waterworks Only / Entry Point Sampling

11.4.2 New Source Startup Chemical and Radionuclides Entry Point Monitoring Requirements

12.4.1. **Radionuclides Rule Routine Monitoring Requirements Community Waterworks Only - Entry Point Sampling Flowchart**



Abbreviations: GA (Gross Alpha Activity) CR (Combined Radium Ra226 + Ra228) U (Uranium)
RAA (Running Annual Average)

1. When GA is ≤ 15 pCi/L, GA may be substituted for U. Divide uranium activity (pCi/L) by 0.67 to obtain Uranium mass (µg/L). When GA is ≤ 5 pCi/L, GA may be substituted for Ra226. DCLS has agreed to analyze for Ra226 when GA is ≥ 3 pCi/L.
2. Unless Ra226 and Uranium were measured directly and not obtained by GA substitution, "less than detection" for CR and U cannot be established. Detection limits are: Gross alpha particle activity (3 pCi/L), Radium 226 (1 pCi/L), Radium 228 (1 pCi/L), and Uranium (1µg/L).
3. If an individual radionuclide contaminant exceeds the PMCL for an entry point following initial four-quarter monitoring, only that contaminant must be placed on or continue with quarterly monitoring. When using DCLS, quarterly monitoring options are uranium or the radionuclides panel, since these are the service options available at this time. Otherwise, VDH has chosen to maintain schedules (3, 6, or 9 year) based on the most restrictive schedule for the group of radionuclide contaminants in order to reduce sample schedule complexity. The owner has the option to monitor each parameter on a schedule based on requirements established by the Waterworks Regulations. The ODW database is not set up to track such individual parameter schedules.

12.4.2. **New Source Start Up Entry Point Monitoring Requirements**

It is recommended that these samples be collected within 30 days of the startup of the new source.

Groundwater – Community:

IOCs:	One sample per period (3 years)
Nitrates + Nitrites (Combined):	Begin annual monitoring
Nitrites:	Collect period sample
VOCs:	Begin quarterly monitoring
SOCs:	If required, begin quarterly monitoring (based on waiver status)
Cyanide:	One sample per period (3 years)
Radionuclides:	Begin quarterly monitoring (4 qtrs)

Groundwater – Nontransient Noncommunity (NTNC):

IOCs:	One sample per period (3 years)
Nitrates + Nitrites (Combined):	Begin annual monitoring
Nitrites:	Collect period sample
VOCs:	Begin quarterly monitoring
SOCs:	If required, begin quarterly monitoring (based on waiver status)
Cyanide:	One sample per period (3 years)

Groundwater – Transient Noncommunity (TNC):

Nitrates + Nitrites:	Begin annual monitoring

Surface Water Sources - Community:

IOCs:	Begin annual sampling
Nitrates + Nitrites (Combined):	Begin quarterly monitoring (4 qtrs)
Nitrites:	Collect period sample
VOCs:	Begin quarterly monitoring (4 qtrs)
SOCs:	If required, begin quarterly monitoring (based on waiver status)
Cyanide:	Begin annual sampling
Radionuclides:	Begin quarterly monitoring (4 qtrs)

Surface Water Sources – Nontransient Noncommunity (NTNC):

IOCs:	Begin annual sampling
Nitrates + Nitrites (Combined):	Begin quarterly monitoring (4 qtrs)
Nitrites:	Collect period sample
VOCs:	Begin quarterly monitoring (4 qtrs)
SOCs:	If required, begin quarterly monitoring (based on waiver status)
Cyanide:	Begin annual sampling

Surface Water Sources – Transient Noncommunity (TNC):

Nitrates + Nitrites (Combined):	Begin quarterly monitoring (4 qtrs)

NOTE: These sampling requirements do not include the daily testing at the waterworks

13. DCLS Sample Kit Request Procedures

Requesting Bacteriological / Chemical / Radiological Sample Kits from DCLS:

13.1. Routine Kit Requests

Routine sample kit orders are prepared quarterly for every waterworks, approximately 45 days prior to the start of a calendar quarter. The data gathered only includes samples that are required to be taken in the upcoming quarter. Field Office electronically transmit this order to the Central Office. These orders are based on the monitoring schedules maintained in SDWIS (TCR & Raw Water MPN) and R&R (Chemical/Radiological). ODW Staff is expected to maintain these schedules with guidance from the corresponding manuals:

- ODW SDWIS Manual referenced in WM 823
- R&R Program User's Guide referenced in WM 824

The monitoring schedules for all waterworks are posted on the ODW Website under the "Information for Laboratories" tab.

An electronic data file is also submitted to DCLS that only includes monitoring schedules that meet one or more of the following criteria:

- DCLS analytical services were used in the past 40 months
- Waterworks activated or reactivated in the past 12 months
- Waterworks has radiological monitoring schedules

13.2. Ad Hoc Kit Requests

Kits needed outside of the quarterly order event are ordered through the Ad Hoc Order feature of R&R. The most common example of an Ad-Hoc order is the required additional temporary routine water samples for the monitoring period following a coliform present analysis result of a distribution system sample. Ad Hoc Orders may also be submitted for other non-routine sample kits. In all cases, these requests result in DCLS generating an invoice sent to the waterworks. The invoice must be paid prior to DCLS sending the kits.

13.3. Bacteriological repeat and triggered source water monitoring kit dispatch

Time sensitive repeat and triggered source water monitoring bacteriological sample containers are dispatched to waterworks by the Field Office staff. Sample collection input forms generated from the R&R Ad Hoc module, and DCLS-provided sample containers and labels are given to the waterworks representative. Because of the time sensitivity of these samples, DCLS will perform the analysis prior to payment and submit an invoice to the waterworks afterwards. Field Office staff should routinely take inventory of DCLS labels and sample container supplies. To replenish stock, staff should send a request to "LabAdmin" with the quantity of labels and bottles needed.

14. Evaluation and Distribution of Sample Results

ODW staff are required to review and evaluate all bacteriological, chemical, physical, and radiological analysis results. Where necessary, staff must inform waterworks when repeat and/or special samples will be required as well as providing required notices of violations for any exceedance of maximum contaminant levels.

14.1. Distribution of Bacteriological Analysis Results

It is not normally necessary for ODW to inform waterworks of bacteriological results unless a problem has been found and/or the laboratory has failed to provide a copy of the results to the owner.

14.2. Distribution of Chemical / Physical / Radiological Analysis Results

It is the policy of the ODW to inform waterworks in writing of the receipt and evaluation of all chemical, physical and radionuclides analysis results by generating and signing the Owner's Report generated by R&R.

Please refer to the various enforcement and public notification working memos when issuing a Notice of Violation for failure to collect samples and/or for issuing a Notice of Violation for exceeding maximum contaminant levels.