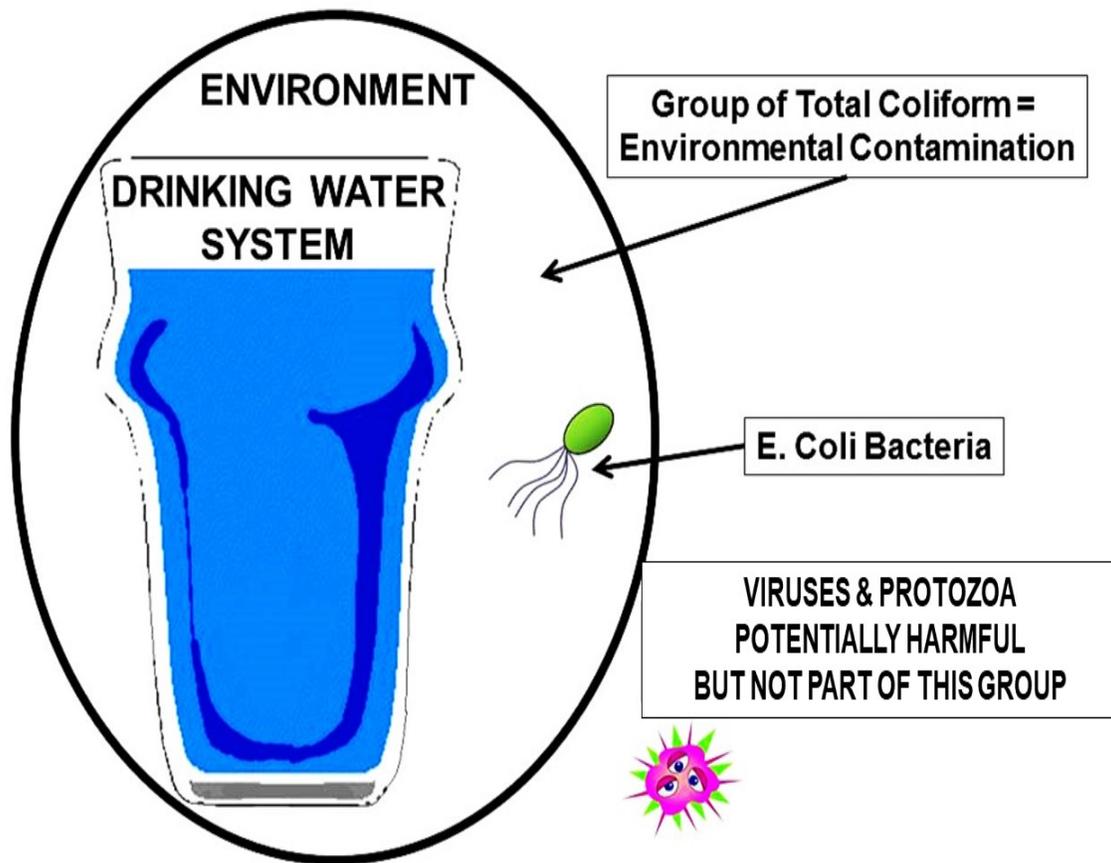


TOTAL COLIFORM RULE

CONTINUING EDUCATION COURSE



GROUP OF TOTAL COLIFORM BACTERIA



Printing and Saving Instructions

It is recommended that you download this pdf document and assignment to your computer desktop and open it with Adobe Acrobat DC reader.

Adobe Acrobat DC reader is a free computer software program and you can find it at Adobe Acrobat's website.

You can complete the course by viewing the course on your computer or you can print it out. This course booklet does not have the assignment (the test). Please visit our website and download the assignment (the test).

Printing Instructions: Once you have purchased the program, we will give you permission to print this document. If you are going to print this document, it was designed to be printed double-sided or duplexed but can be printed single-sided.

Hyperlink Assignment...

<https://www.abctlc.com/downloads/PDF/TCRASS.pdf>

State Approval Listing Link

<http://www.tlch2o.com/PDF/CEU%20State%20Approvals.pdf>

State Approval Listing Link, check to see if your State accepts or has pre-approved this course. Not all States are listed. Not all courses are listed. Do not solely trust our list for it may be outdated. It is your sole responsibility to ensure this course is accepted for credit. No refunds.

Hyperlink to the Glossary and Appendix

<http://www.abctlc.com/downloads/PDF/WTGlossary.pdf>

All downloads are electronically tracked and monitored for security purposes.

This course contains EPA's federal rule requirements. Please be aware that each state implements drinking water regulations that may be more stringent than EPA's regulations. Check with your state environmental agency for more information.



Some States and many employers require the final exam to be proctored.

Do not solely depend on TLC's Approval list for it may be outdated.

Most of our students prefer to do the assignment in Word and e-mail or fax the assignment back to us. We also teach this course in a conventional hands-on class. Call us and schedule a class today.

Contributing Editors

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Jack White, Environmental, Health, Safety expert, City of Phoenix. Art Credits.

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Technical Learning College's Scope and Function

Welcome to the Program,

Technical Learning College (TLC) offers affordable continuing education for today's working professionals who need to maintain licenses or certifications. TLC holds several different governmental agency approvals for granting of continuing education credit.

TLC's delivery method of continuing education can include traditional types of classroom lectures and distance-based courses or independent study. TLC's distance based or independent study courses are offered in a print - based distance educational format. We will beat any other training competitor's price for the same CEU material or classroom training.

Our courses are designed to be flexible and for you to finish the material at your convenience. Students can also receive course materials through the mail. The CEU course or e-manual will contain all your lessons, activities and instruction to obtain the assignments. All of TLC's CEU courses allow students to submit assignments using e-mail or fax, or by postal mail. (See the course description for more information.)

Students have direct contact with their instructor—primarily by e-mail or telephone. TLC's CEU courses may use such technologies as the World Wide Web, e-mail, CD-ROMs, videotapes and hard copies. (See the course description.) Make sure you have access to the necessary equipment before enrolling; i.e., printer, Microsoft Word and/or Adobe Acrobat Reader. Some courses may require proctored closed-book exams, depending upon your state or employer requirements.

Flexible Learning

At TLC, there are no scheduled online sessions or passwords you need contend with, nor are you required to participate in learning teams or groups designed for the "typical" younger campus based student. You will work at your own pace, completing assignments in time frames that work best for you. TLC's method of flexible individualized instruction is designed to provide each student the guidance and support needed for successful course completion.

Course Structure

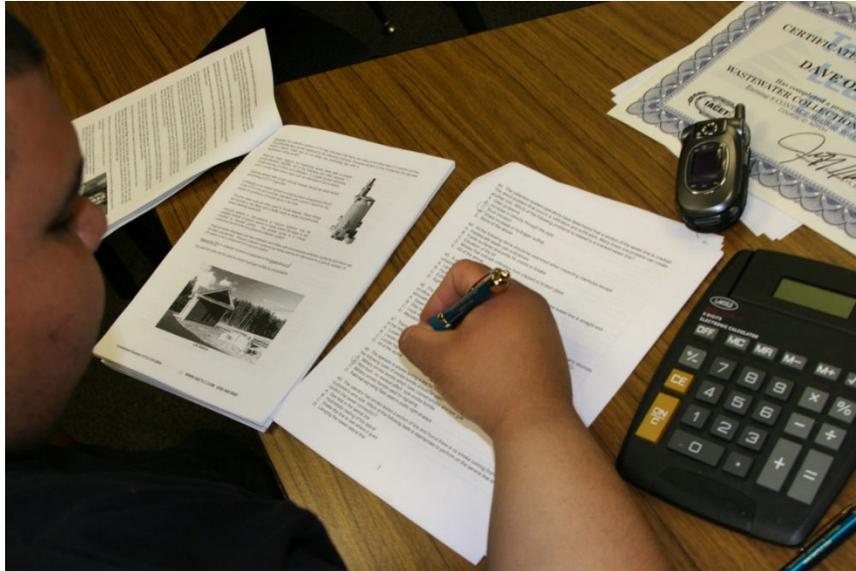
TLC's online courses combine the best of online delivery and traditional university textbooks. You can easily find the course syllabus, course content, assignments, and the post-exam (Assignment). This student-friendly course design allows you the most flexibility in choosing when and where you will study.

Classroom of One

TLC offers you the best of both worlds. You learn on your own terms, on your own time, but you are never on your own. Once enrolled, you will be assigned a personal Student Service Representative who works with you on an individualized basis throughout your program of study. Course specific faculty members (S.M.E.) are assigned at the beginning of each course providing the academic support you need to successfully complete each course. Please call or email us for assistance.

Satisfaction Guaranteed

We have many years of experience, dealing with thousands of students. We assure you, our customer satisfaction is second to none. This is one reason we have taught more than 20,000 students.



We welcome you to do the electronic version of the assignment and submit the answer key and registration to us either by fax or e-mail. If you need this assignment graded and a certificate of completion within a 48-hour turn around, prepare to pay an additional rush charge of \$50.

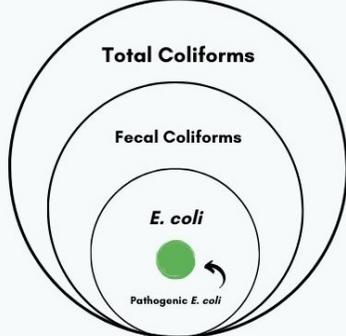
Contact Numbers
Fax (928) 468-0675
Email Info@tlch2o.com
Telephone (866) 557-1746

CEU COURSE DESCRIPTION

TOTAL COLIFORM RULE CEU TRAINING COURSE

This CEU course is a review of Environmental Protection Agency's Total Coliform Rule relating to proper biological water sampling, water sample preservation, reporting, and related sampling concerns. This course will cover the basic requirements of the federal rule concerning water sampling (TCR) and general bacteriological sampling procedures.

Attention Wastewater Treatment, Collections, Water Distribution, Well Drillers, Pump Installers, and Water Treatment Operators. The target audience for this course is the person interested in working in a water/wastewater treatment or distribution/collections facility and wishing to maintain CEUs for certification license or to learn how to do the job safely and effectively, and/or to meet education needs for promotion.

<p>TOTAL COLIFORM RULE (TCR) REVISIONS</p> <p>REVISED TOTAL COLIFORM RULE (RTCR) THIS REVISES THE 1989 TOTAL COLIFORM RULE (TCR) AND IS INTENDED TO IMPROVE PUBLIC HEALTH PROTECTION. THIS ESTABLISHED A "FIND-AND-FIX" APPROACH FOR INVESTIGATING AND CORRECTING CAUSES OF COLIFORM PROBLEMS WITHIN WATER DISTRIBUTION SYSTEMS.</p> <p>THE MAXIMUM CONTAMINANT LEVEL (MCL) FOR BACTERIA IN DRINKING WATER IS ZERO TOTAL COLIFORM COLONIES PER 100 MILLILITERS OF WATER.</p> <p>BEGINNING JULY 1st, 2021, ALL RESAMPLES SUBMITTED IN RESPONSE TO A PREVIOUS POSITIVE COLIFORM RESULT MUST BE ANALYZED TO DETERMINE COLIFORM AND E.coli DENSITY</p>	<p>Coliforms Explained</p> 
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TOTAL COLIFORM RULE (TCR) REVISIONS

What is the Total Coliform Rule (TCR)?

The Total Coliform Rule (TCR) requires all public water supplies to monitor for the presence of total coliforms in the distribution system. For drinking water, total coliforms are used to monitor the sanitary quality of the water, adequacy of water treatment, and the integrity of the distribution system. The absence of total coliforms in the distribution system minimizes the likelihood that fecal pathogens are present. Thus, total coliforms are used to determine the vulnerability of a system to fecal contamination.

Final Examination for Credit

Opportunity to pass the final comprehensive examination is limited to three attempts per course enrollment.

Course Procedures for Registration and Support

All of Technical Learning College's distance courses have complete registration and support services offered. Delivery of services will include, e-mail, web site, telephone, fax and mail support. TLC will attempt immediate and prompt service.

When a student registers for a distance or correspondence course, he/she is assigned a start date and an end date.

It is the student's responsibility to note dates for assignments and keep up with the course work. If a student falls behind, he/she must contact TLC and request an end date extension in order to complete the course.

It is the prerogative of TLC to decide whether to grant the request. All students will be tracked by a unique number assigned to the student.

Instructions for Written Assignments

The Total Coliform Rule CEU Training course uses a multiple-choice answer key.

Feedback Mechanism (Examination Procedures)

Each student will receive a feedback form as part of his or her study packet. You will be able to find this form in the front of the course assignment or lesson.

Security and Integrity

All students are required to do their own work. All lesson sheets and final exams are not returned to the student to discourage sharing of answers. Any fraud or deceit will result in forfeiture of all fees, and the appropriate agency will be notified.

Grading Criteria

TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice. For security purposes, please fax or e-mail a copy of your driver's license and always call us to confirm we've received your assignment and to confirm your identity. TLC offers students the option of either pass/fail or assignment of a standard letter grade. If a standard letter grade is not requested, a pass/fail notice will be issued. Final course grades are based on the total number of possible points. The grading scale is administered equally to all students in the course. Do not expect to receive a grade higher than that merited by your total points. No point adjustments will be made for class participation or other subjective factors. If TLC is not notified, you will only receive a pass/fail notice. In order to pass your final assignment, you are required to obtain a minimum score of 70% on your assignment.

Required Texts

The Total Coliform Rule CEU training course comes complete with a short summary of the EPA's Rules and Regulations (TCR Rule) and drinking water standards. If you need more information or a complete set of Rules, you can download them off the EPA's web page, www.epa.gov or contact your local state environmental agency. You may need to contact a laboratory or state agency for certain sampling information.

Recordkeeping and Reporting Practices

TLC will keep all student records for a minimum of seven years. It is the student's responsibility to give the completion certificate to the appropriate agencies. TLC will not release any records to any party, except to the student self. We will send the required information to required States for your certificate renewals.

ADA Compliance

TLC will make reasonable accommodations for persons with documented disabilities. Students should notify TLC and their instructors of any special needs. Course content may vary from this outline to meet the needs of this particular group.

Mission Statement

Our only product is educational service. Our goal is to provide you with the best possible education service possible. TLC will attempt to make your learning experience an enjoyable opportunity.

When the Student finishes this course...

At the conclusion of this course:

At the finish of this course, you (the student) should be able to explain and describe various the Total Coliform Rule, sampling techniques and biological monitoring. Describe reporting regulations, chain of custody and bacteriological sampling violations.

Educational Mission

The educational mission of TLC is:

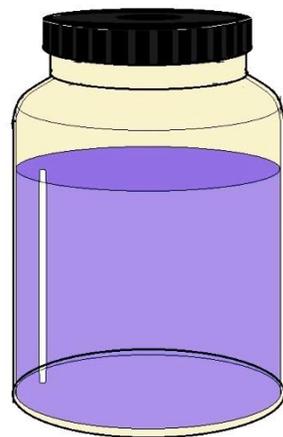
To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the environmental education field,

To provide TLC students with opportunities to apply and understand the theory and skills needed for operator certification,

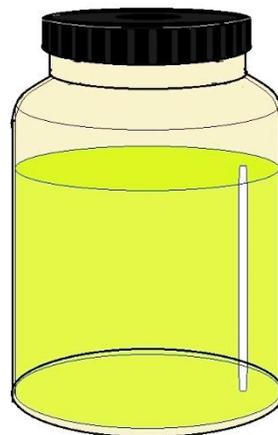
To provide opportunities for TLC students to learn and practice environmental educational skills with members of the community for the purpose of sharing diverse perspectives and experience,

To provide a forum in which students can exchange experiences and ideas related to environmental education,

To provide a forum for the collection and dissemination of current information related to environmental education, and to maintain an environment that nurtures academic and personal growth.



**COLIFORM POSITIVE
SAMPLE**

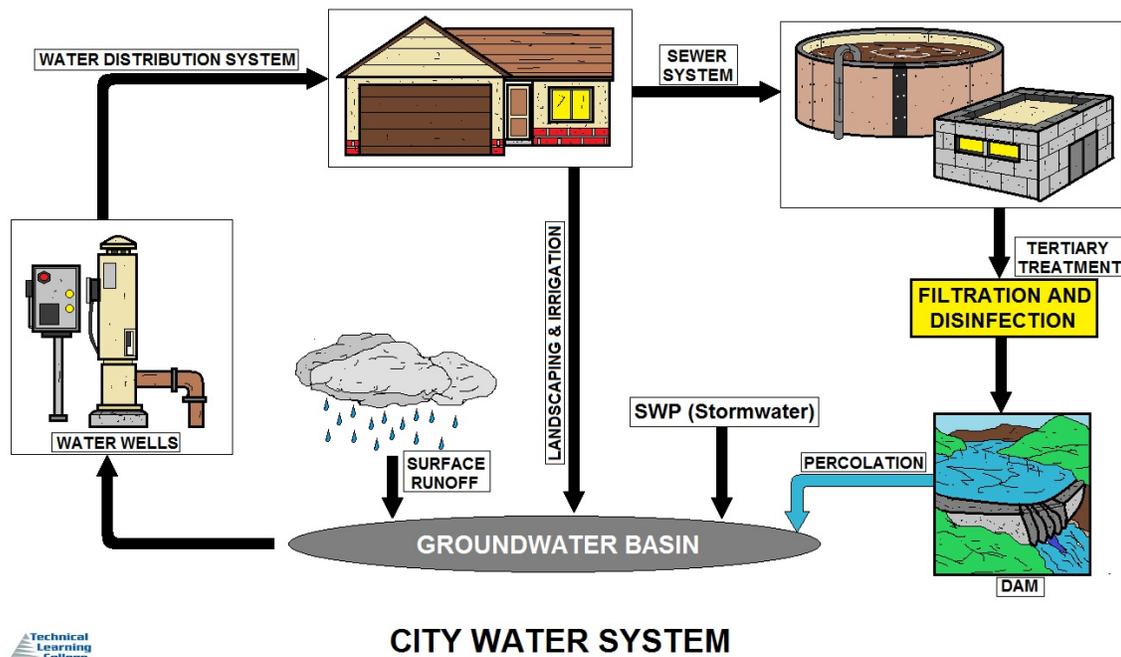


**COLIFORM NEGATIVE
SAMPLE**

COLIFORM BACTERIA COLOR TESTING

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This course contains EPA's federal rule requirements. Please be aware that each state implements drinking water regulations that may be more stringent than EPA's regulations. Check with your state environmental agency for more information.

Common Water Quality Definitions

Units of Measurement

mg/l = Milligrams per liter. One milligram per liter equals one packet of artificial sweetener sprinkled into 250 gallons of iced tea.

µg/l = Micrograms per liter. One microgram per liter is equal to one packet of artificial sweetener sprinkled into an Olympic-size swimming pool.

NTU = Nephelometric Turbidity Units. A measurement on the cloudiness of the water.

pCi/l = Picocuries per liter. A measure of radioactivity.

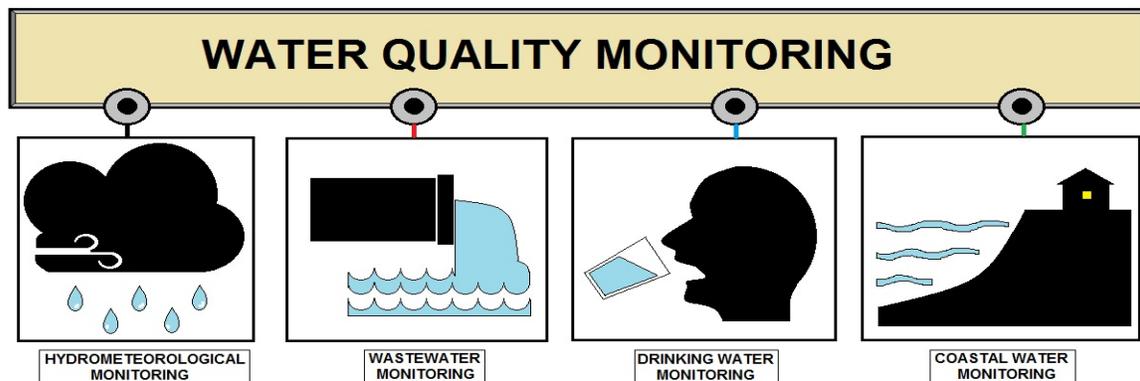
Acronyms

Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water.

Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health.

Treatment Technique (TT) - A required process intended to reduce the level of a contaminant in drinking water.

Action Level (AL) - The concentration of a contaminant that, if exceeded, triggers treatment or other requirements which a water system must follow.

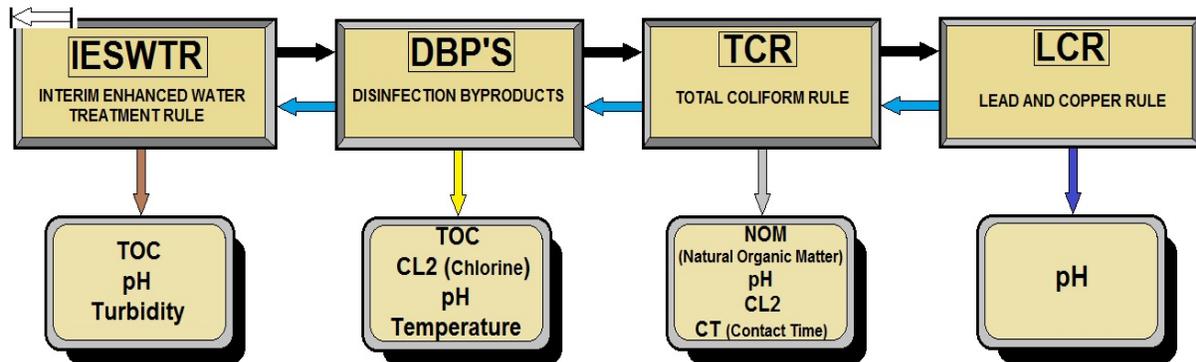


MAJOR WATER QUALITY MONITORING SYSTEMS

EPA's Total Coliform Rule

The Environmental Protection Agency (EPA) published the Revised Total Coliform Rule (RTCR) in the Federal Register (FR) on February 13, 2013 (78 FR 10269) and minor corrections on February 26, 2014 (79 FR 10665). The RTCR is the revision to the 1989 Total Coliform Rule (TCR) and is intended to improve public health protection.

Federal Water Drinking Water Quality Regulations Timeline



PARAMETERS THAT AFFECT SURFACE WATER TREATMENT RULES



National Interim Primary Drinking Water Regulations (NIPDWR) Promulgated 1975-1981
 Contained 7 contaminants Targeted: Trihalomethanes, Arsenic, and Radionuclides
 Established 22 drinking water standards.

Phase 1 Standards Promulgated 1987 Contained 8 contaminants Targeted: VOCs.

Phase 2 Standards Promulgated 1991 Contained 36 contaminants Targeted: VOCs, SOCs, and IOCs.

Phase 5 Standards Promulgated 1992 Contained 23 contaminants Targeted: VOCs, SOCs, and IOCs.

Surface Water Treatment Rule (SWTR) Promulgated 1989 Contained 5 contaminants Targeted: Microbiological and Turbidity.

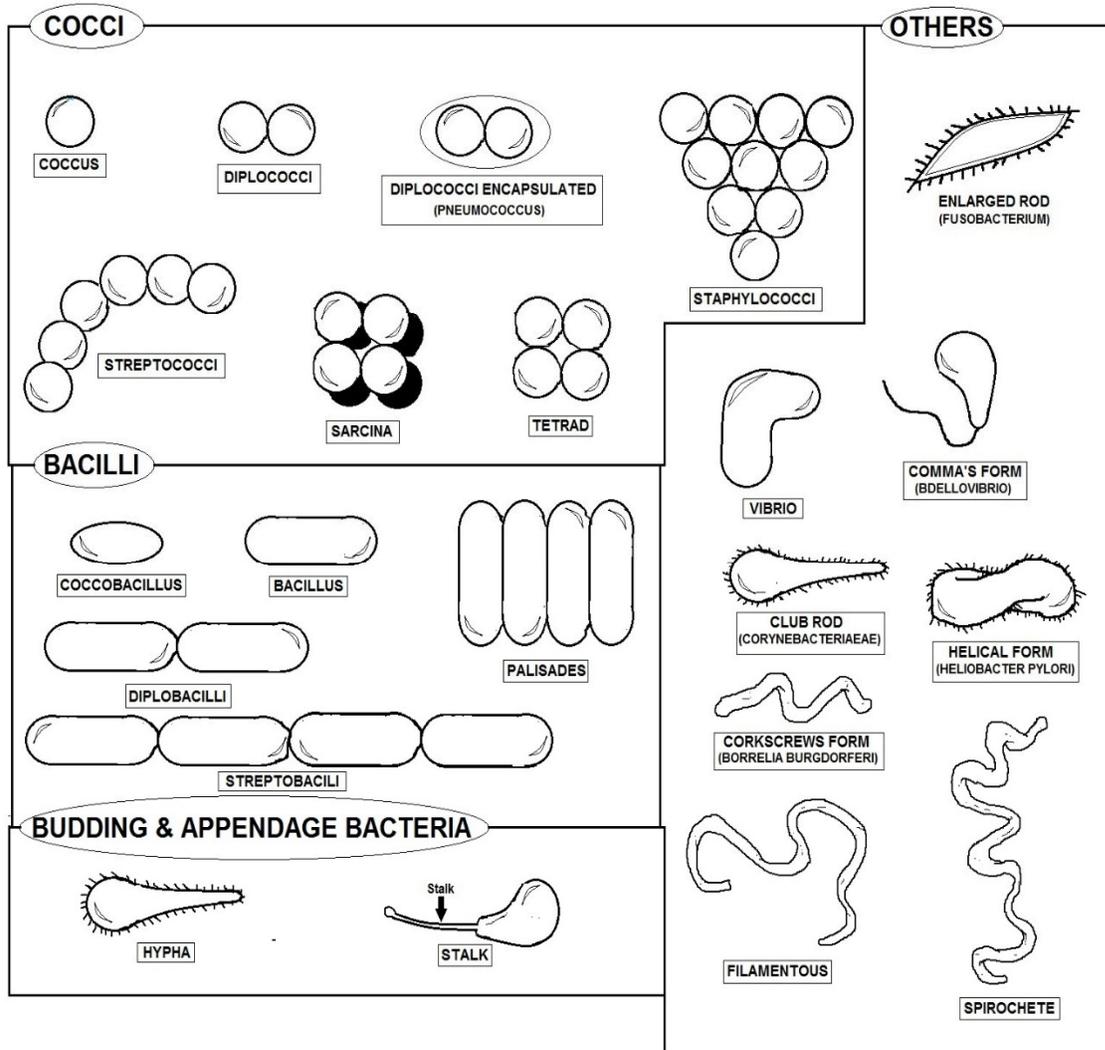
Stage 1 Disinfectant/Disinfection By-product (D/DBP) Rule Promulgated 1998 Contained 14 contaminants Targeted: DBPs and precursors.

Interim Enhanced Surface Water Treatment Rule (IESWTR) Promulgated 1998 Contained 2 contaminants Targeted: Microbiological and Turbidity.

Radionuclide Rule Promulgated 2000 Contained 4 contaminants Targeted: Radionuclides.

Arsenic Rule Promulgated 2001 Contained 1 contaminant Targeted: Arsenic.

Filter Backwash Recycling Rule Promulgated 2001 Contained - Targeted: Microbiological and Turbidity.



BACTERIA SHAPES

Organisms Descriptors and Meanings Chart

Description	Meaning
Aerobic	With air
Anaerobic	Without air
Auto	Self (Inorganic carbon)
Facultative	With air or without air
Hetero	Other (Organic carbon)
Troph	Feed or nourish
Photo	Light
Chemo	Chemical
Organo	Organic
Litho	Rock

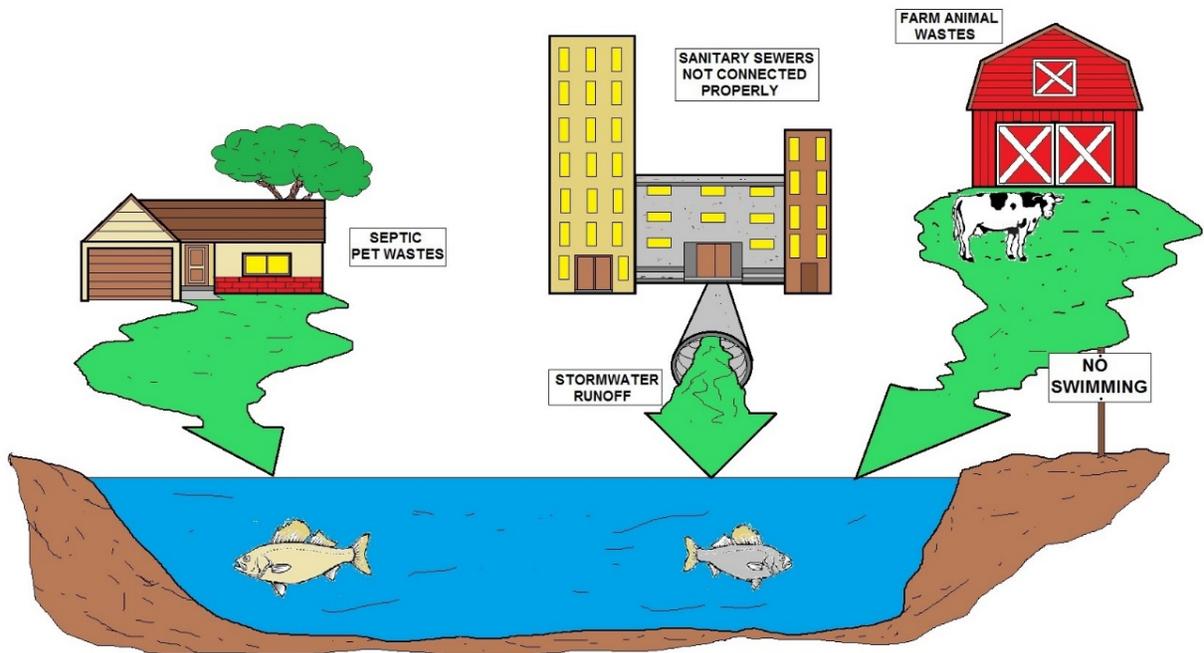
Revised Total Coliform Rule and Total Coliform Rule

Section Focus: You will learn the basics of the EPA's Total Coliform Rule and bacteriological sampling. At the end of this section, you will be able to understand and describe the Total Coliform Rule. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: The Environmental Protection Agency (EPA) published the Revised Total Coliform Rule (RTCR) in the Federal Register (FR) on February 13, 2013 (78 FR 10269) and minor corrections on February 26, 2014 (79 FR 10665). The RTCR is the revision to the 1989 Total Coliform Rule (TCR) and is intended to improve public health protection.

Introduction

Total coliforms are a group of related bacteria that are (with few exceptions) not harmful to humans. A variety of bacteria, parasites, and viruses, known as pathogens, can potentially cause health problems if humans ingest them. EPA considers total coliforms a useful indicator of other pathogens for drinking water.



SOURCES OF FECAL COLIFORM BACTERIA

Total coliforms are used to determine the adequacy of water treatment and the integrity of the distribution system. All bacteriological samples are analyzed for the coliform group; however, a positive reaction to these coliform analyses may be from sources other than fecal. In order to differentiate between these sources, all samples that are total coliform positive must be analyzed again to determine if fecal coliform or *E. coli* are present.

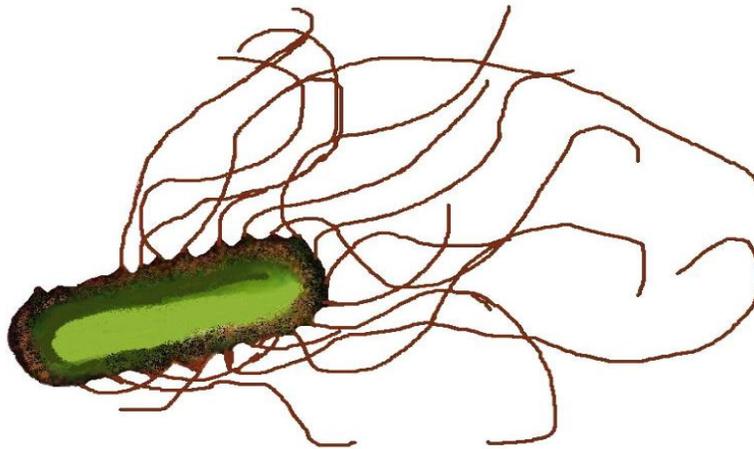
Dangerous Waterborne Microbes

Coliform Bacteria are common in the environment and are generally not harmful. However, the presence of these bacteria in drinking water are usually a result of a problem with the treatment system or the pipes which distribute water, and indicates that the water may be contaminated with germs that can cause disease.

Fecal Coliform and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes can cause short-term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms.

Cryptosporidium is a parasite that enters lakes and rivers through sewage and animal waste. It causes cryptosporidiosis, a mild gastrointestinal disease. However, the disease can be severe or fatal for people with severely weakened immune systems. The EPA and CDC have prepared advice for those with severely compromised immune systems who are concerned about **Cryptosporidium**.

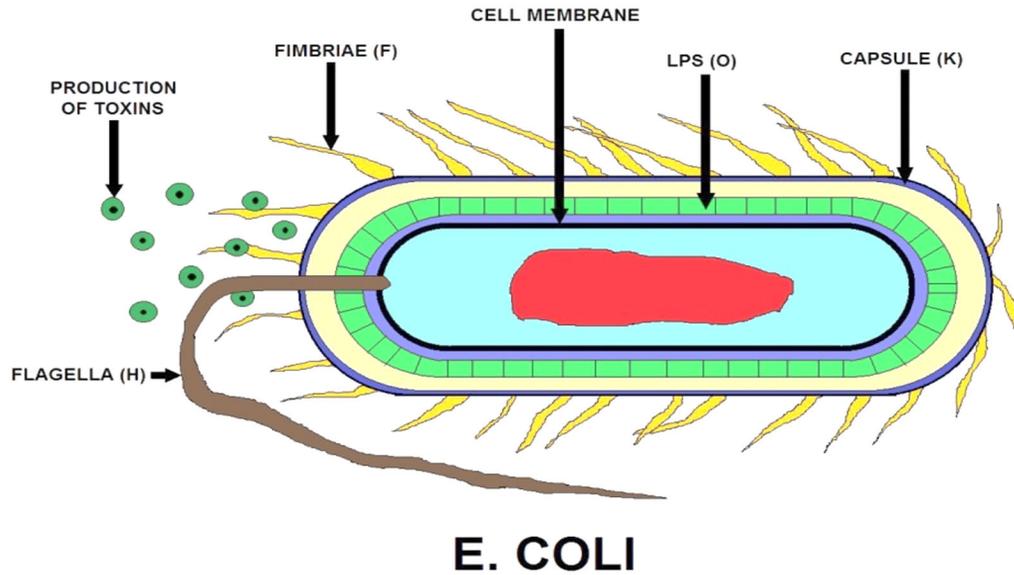
Giardia lamblia is a parasite that enters lakes and rivers through sewage and animal waste. It causes gastrointestinal illness (e.g. diarrhea, vomiting, and cramps).



PERITRICHOUS SHAPED BACTERIA EXAMPLE

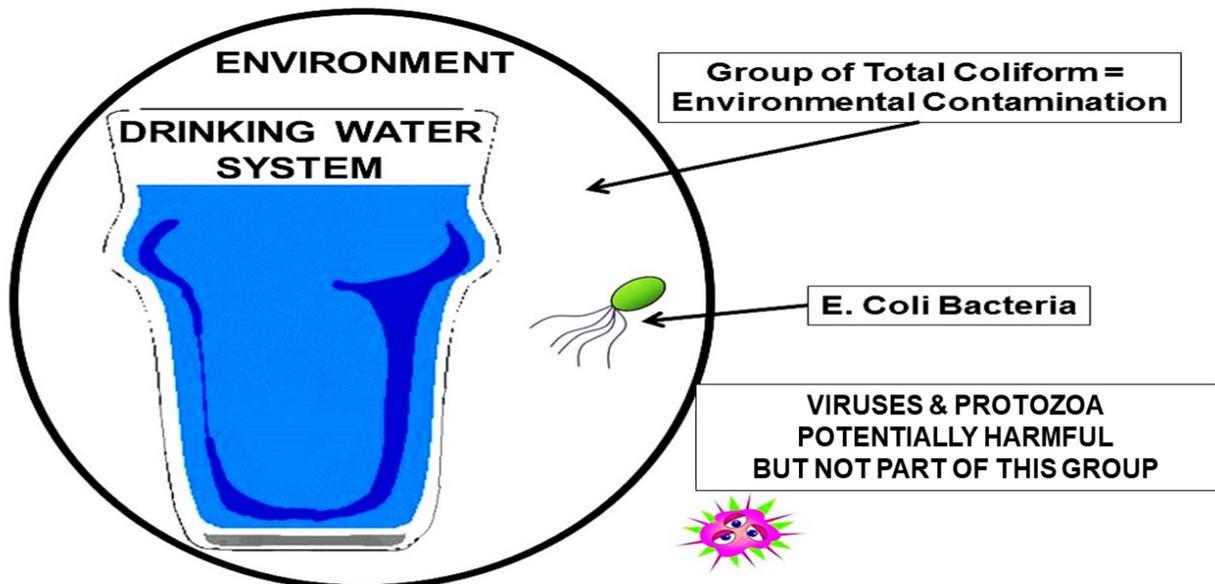
Microbiologists broadly classify bacteria according to their shape: spherical, rod-shaped, and spiral-shaped. Pleomorphic bacteria can assume a variety of shapes. Bacteria may be further classified according to whether they require oxygen (aerobic or anaerobic) and how they react to a test with Gram's stain.

Bacteria in which alcohol washes away Gram's stain are called gram-negative, while bacteria in which alcohol causes the bacteria's walls to absorb the stain are called gram-positive.

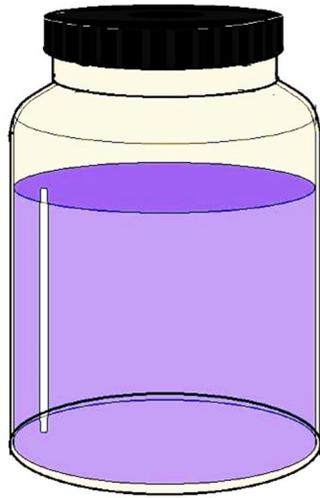


Fecal Coliform Bacteria

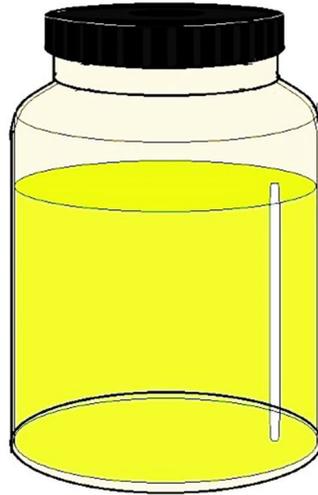
Fecal coliform bacteria are microscopic organisms that live in the intestines of warm-blooded animals. They also live in the waste material, or feces, excreted from the intestinal tract. When fecal coliform bacteria are present in high numbers in a water sample, it means that the water has received fecal matter from one source or another. Although not necessarily agents of disease, fecal coliform bacteria may indicate the presence of disease-carrying organisms, which live in the same environment as the fecal coliform bacteria.



GROUP OF TOTAL COLIFORM BACTERIA

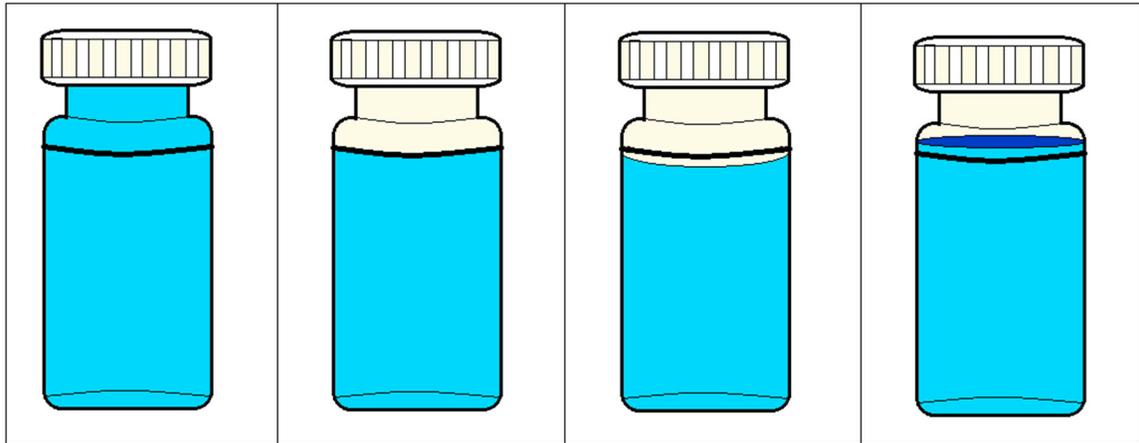


COLIFORM POSITIVE SAMPLE



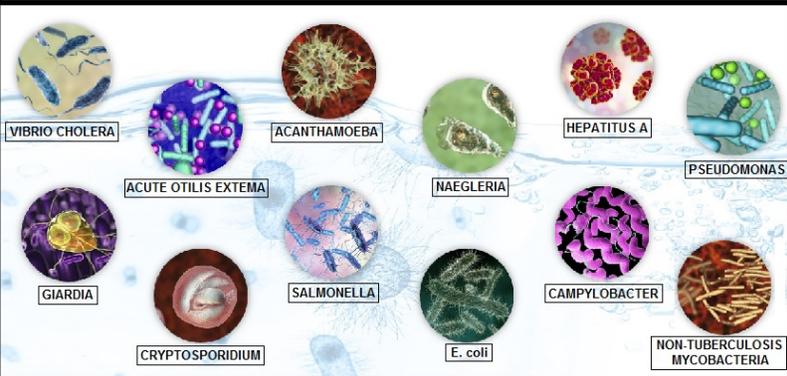
COLIFORM NEGATIVE SAMPLE

COLIFORM BACTERIA PRESENCE TEST EXAMPLE



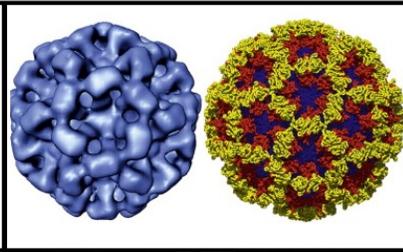
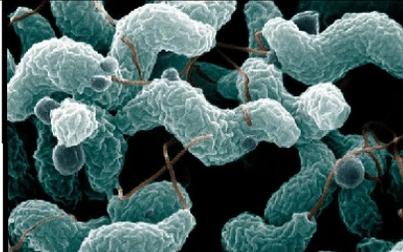
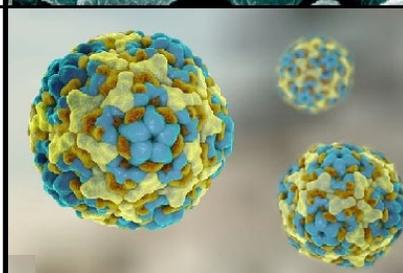
 OVER FILLED
  CORRECT (100mL)
  INCORRECT (97mL)
  CORRECT
 (Lab will pour off to 100mL)

BAC-T SAMPLE BOTTLE DIAGRAM

<p>PRESENCE OF PATHOGENS IN WATER</p>	<p style="text-align: center;">TYPES OF PATHOGENS FOUND IN WATER</p> 
<p>THE PRESENCE OF COLIFORM BACTERIA CAN INDICATE THERE MAY BE HARMFUL BACTERIA PATHOGENS IN THE WATER</p>	
<p>THE PRINCIPAL REMOVAL PROCESSES ARE THOSE LIKELY USED TO REMOVE THE MAJORITY OF THE MICROBES IN WATER BEING TREATED</p>	
<p>THE REMOVAL PROCESSES BEING UTILIZED ARE SEDIMENTATION, FLOTATION AND THE USE OF HIGH RATE GRANULAR MEDIA FILTRATION</p>	
<p>DISINFECTION WITH IODINE OR CHLORINE IS THE MOST EFFECTIVE AT KILLING VIRUSES FOUND IN WATER.</p>	

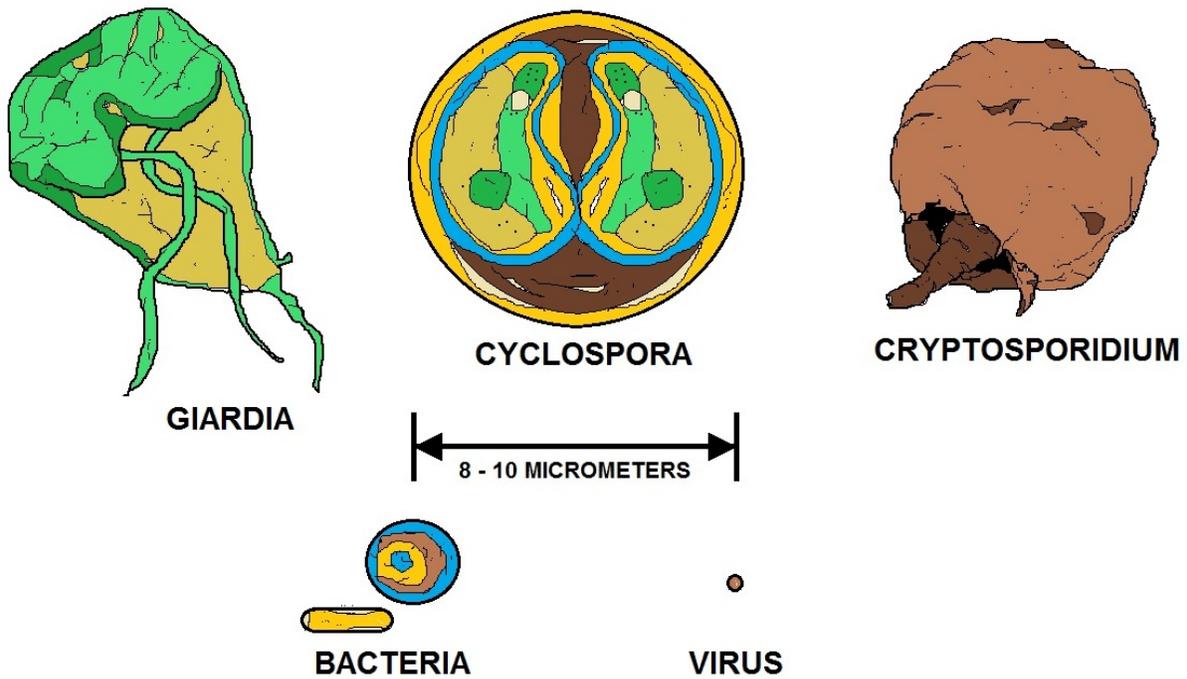
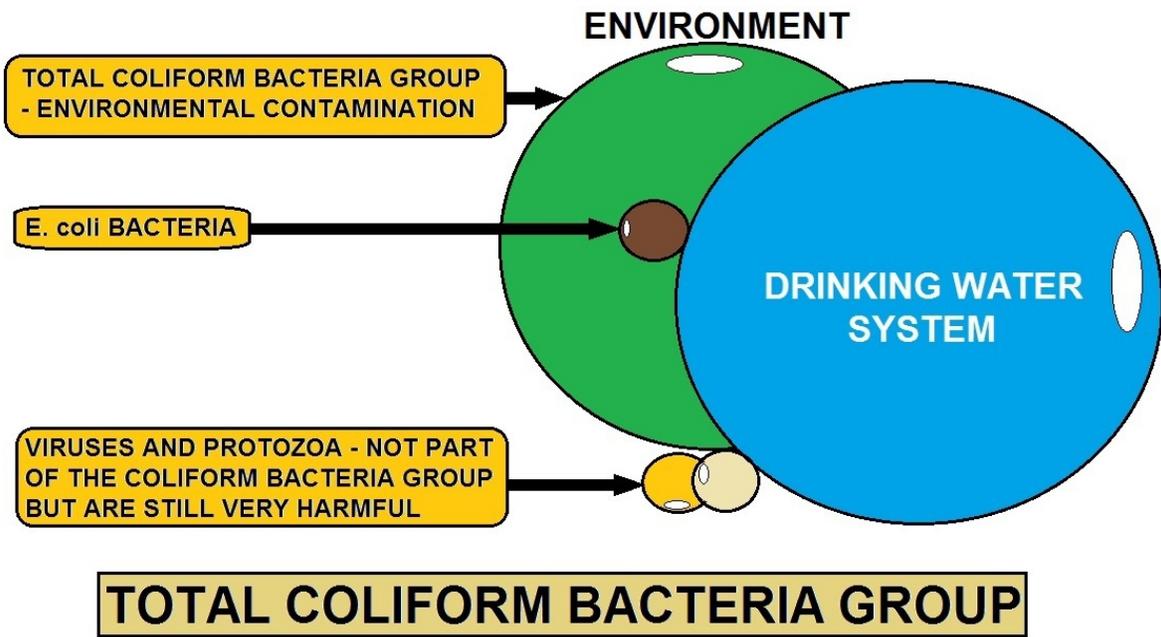


PATHOGENS FOUND IN WATER SUPPLIES

<p>MICROBIOLOGICAL CONTAMINANTS FOUND IN WATER</p>	
<p>THESE ARE OFTEN OF FECAL NATURE RELATED TO HUMANS, DOMESTIC ANIMALS OR WILDLIFE</p>	
<p><u>CALIVIVIRUS:</u></p> <p>SIGNS OF THIS VIRUS INCLUDE SNEEZING, NASAL DISCHARGE, OCULAR DISCHARGE, CONJUNCTIVITIS, ULCERATION OF THE TONGUE, LETHARGY, INAPPETENCE (Lack of Appetite) AND FEVER</p>	
<p><u>CAMPYLOBACTER JEJUNI:</u></p> <p>THIS IS ONE OF THE MOST COMMON CAUSES OF FOOD POISONING. IT IS CHARACTERIZED BY DIARRHEA, ABDOMINAL PAIN, FEVER, NAUSEA AND SOMETIMES VOMITING</p>	
<p><u>ENTEROVIRUS:</u></p> <p>SYMPTOMS OF THIS VIRUS INFECTION MAY INCLUDE FEVER, RUNNY NOSE, SNEEZING, COUGH, SKIN RASH, MOUTH BLISTERS, AND BODY AND MUSCLE ACHES</p>	
<p><u>ESCHERICHIA COLI:</u></p> <p>NORMALLY LIVES IN THE INTESTINES OF HEALTHY PEOPLE AND ANIMALS. MOST E.Coli ARE HARMLESS OR RELATIVELY BRIEF DIARRHEA. SOME E.Coli CAN CAUSE SEVERE STOMACH CRAMPS, BLOODY DIARRHEA AND VOMITING</p>	



MICROBIOLOGICAL CONTAMINANTS



COMPARATIVE SIZES OF PROTOZOAN PARASITES

Bacteriological Sampling Introduction



Bacteriological Monitoring Overview

Most waterborne diseases and illnesses have been related to the microbiological quality of drinking water. The routine microbiological analysis of your water is for coliform bacteria. The coliform bacteria group is used as an indicator organism to determine the biological quality of your water.

The presence of an indicator or pathogenic bacteria in your drinking water is an important health concern. Indicator bacteria signal possible fecal contamination, and therefore, the potential presence of pathogens. These are used to monitor for pathogens because of the difficulties in determining the presence of specific disease-causing microorganisms.

Indicator bacteria are usually harmless, occur in high densities in their natural environment and are easily cultured in relatively simple bacteriological media. Indicators in common use today for routine monitoring of drinking water include total coliforms, fecal coliforms, and *Escherichia coli* (*E. coli*).

What is Total Coliform Bacteria?

Total coliforms are a group of closely related bacteria that are (with few exceptions) not harmful to humans. They are an indicator of other pathogens that can be present in water. Coliform bacteria are present in the intestinal tract of warm-blooded animals. They are shed from the body in the feces. Because these organisms are shed from the body in large numbers and are relatively easy to detect in the laboratory, they have been accepted as an indicator of contamination.

All bacteriological samples are analyzed for the coliform group; however, a positive reaction to these coliform analyses may be from sources other than fecal. In order to differentiate between these sources, all samples that are total coliform positive must be analyzed again to determine if fecal coliform or *E. coli* are present.

What is the Total Coliform Rule (TCR)?

The Total Coliform Rule (TCR) requires all public water supplies to monitor for the presence of total coliforms in the distribution system. For drinking water, total coliforms are used to monitor the sanitary quality of the water, adequacy of water treatment, and the integrity of the distribution system.

The absence of total coliforms in the distribution system minimizes the likelihood that fecal pathogens are present. Thus, total coliforms are used to determine the vulnerability of a system to fecal contamination.

What is a coliform sample site plan?

A coliform sample site plan is a list of sites by street address, lot number, or other permanent description, that identifies all the approved locations where your routine (monthly) coliform samples may be collected. The list of sites must be plotted on a map of your service area. Larger water systems will divide their distribution system into specific sample areas.

Does the site plan have to be approved by the official State water or health agency?

Yes. The list of sites and the map is reviewed by the official State water or health agency Drinking Water Agency serving your facility to insure representative sites have been selected. A site number is then assigned to each sample location.

All reporting forms must be completed using the sample site number rather than the street address. Your approved site plan **MUST** be followed each time you collect routine samples. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

How can I find out the water system's sampling locations?

A copy of the WS or PWS's coliform site plan (and sample site numbers) is on file at your official State water or health agency

How often and when must I collect my routine samples?

Routine compliance samples must be collected every month. Each month is a sampling period.

Bacteria Sampling Key Terms



Bac-T Sample Bottle, often referred to as a Standard Sample, 100 mls, Notice the white powder inside the bottle. That is Sodium Thiosulfate, a de-chlorination agent. Be careful not to wash-out this chemical while sampling. Notice the custody seal on the bottle.

Coliform bacteria are common in the environment and are generally not harmful. However, the presence of these bacteria in drinking water is usually a result of a problem with the treatment system or the pipes that distribute water, and indicates that the water may be contaminated with germs that can cause disease.

Laboratory Procedures

The laboratory may perform the total coliform analysis in one of four methods approved by the U.S. EPA and your local environmental or health division.

What are Fecal Coliform and *E. coli*?

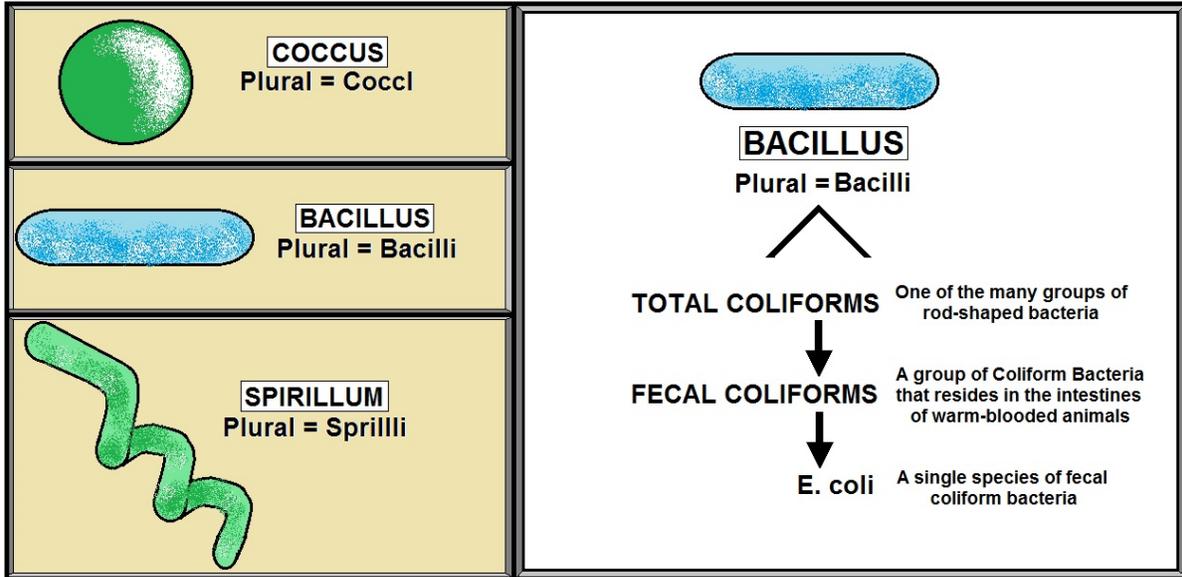
Fecal coliform is bacteria whose presence indicates that the water may be contaminated with human or animal wastes. *E. coli* is a member of the fecal coliform group. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.

The presence of fecal coliform or *E. coli* in drinking water sample indicate recent contamination and signals a greater possibility that pathogenic organisms are also in the water.

Why must a water system monitor for total coliform, fecal coliform, and *E. coli*?

Total coliforms serve as indicators of the efficiency of water treatment, of the integrity of the pipes in the distribution system, and as a screen for the presence of fecal contamination. Usually, coliforms are a sign that there could be a problem with the system's treatment or distribution system.

Fecal and/or *E. coli* indicates that pathogenic organisms may be present that can cause short-term health effects, such as diarrhea, cramps, nausea, headaches, fatigue and jaundice. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.



COLIFORM BACTERIA EXAMPLE



TOTAL COLIFORM RULE (TCR) REVISIONS	Coliforms Explained
<p>REVISED TOTAL COLIFORM RULE (RTCR) THIS REVISES THE 1989 TOTAL COLIFORM RULE (TCR) AND IS INTENDED TO IMPROVE PUBLIC HEALTH PROTECTION. THIS ESTABLISHED A "FIND-AND-FIX" APPROACH FOR INVESTIGATING AND CORRECTING CAUSES OF COLIFORM PROBLEMS WITHIN WATER DISTRIBUTION SYSTEMS.</p> <p>THE MAXIMUM CONTAMINANT LEVEL (MCL) FOR BACTERIA IN DRINKING WATER IS ZERO TOTAL COLIFORM COLONIES PER 100 MILLILITERS OF WATER.</p> <p>BEGINNING JULY 1st, 2021, ALL RESAMPLES SUBMITTED IN RESPONSE TO A PREVIOUS POSITIVE COLIFORM RESULT MUST BE ANALYZED TO DETERMINE COLIFORM AND E.coli DENSITY</p>	

TOTAL COLIFORM RULE (TCR) REVISIONS



Bacteriological Monitoring Introduction

Most waterborne diseases and illnesses have been related to the microbiological quality of drinking water. The routine microbiological analysis of your water is for coliform bacteria. The coliform bacteria group is used as an indicator organism to determine the biological quality of your water. The presence of an indicator or pathogenic bacteria in your drinking water is an important health concern. Indicator bacteria signal possible fecal contamination, and therefore, the potential presence of pathogens. They are used to monitor for pathogens because of the difficulties in determining the presence of specific disease-causing microorganisms.

Indicator bacteria are usually harmless, occur in high densities in their natural environment, and are easily cultured in relatively simple bacteriological media. Indicators in common use today for routine monitoring of drinking water include total coliforms, fecal coliforms, and *Escherichia coli* (*E. coli*).



Bacteria Sampling - 1 Example

Water samples for bacteria tests must always be collected in a sterile container. Take the sample from an outside faucet with the aerator removed. Sterilize by spraying a 5% Household bleach or alcohol solution or flaming the end of the tap with a propane torch. Run the water for five minutes to clear the water lines and bring in fresh water. Do not touch or contaminate the inside of the bottle or cap. Carefully open the sample container and hold the outside of the cap. Fill the container and replace the top. Refrigerate the sample and transport it to the testing laboratory within six hours (in an ice chest). Many labs will not accept bacteria samples on Friday so check the lab's schedule. Mailing bacteria samples is not recommended because laboratory analysis results are not as reliable. Iron bacteria forms an obvious slime on the inside of pipes and fixtures. A water test is not needed for identification. Check for a reddish-brown slime inside a toilet tank or where water stands for several days.

Bac-T Sample Bottle Often referred to as a Standard Sample, 100 mls, notice the white powder inside the bottle. That is Sodium Thiosulfate, a de-chlorination agent. Be careful not to wash-out this chemical while sampling. Notice the custody seal on the bottle.

Coliform bacteria are common in the environment and are generally not harmful. However, the presence of these bacteria in drinking water is usually a result of a problem with the treatment system or the pipes which distribute water, and indicates that the water may be contaminated with germs that can cause disease.

Laboratory Procedures

The laboratory may perform the total coliform analysis in one of four methods approved by the U.S. EPA and your local environmental or health division:

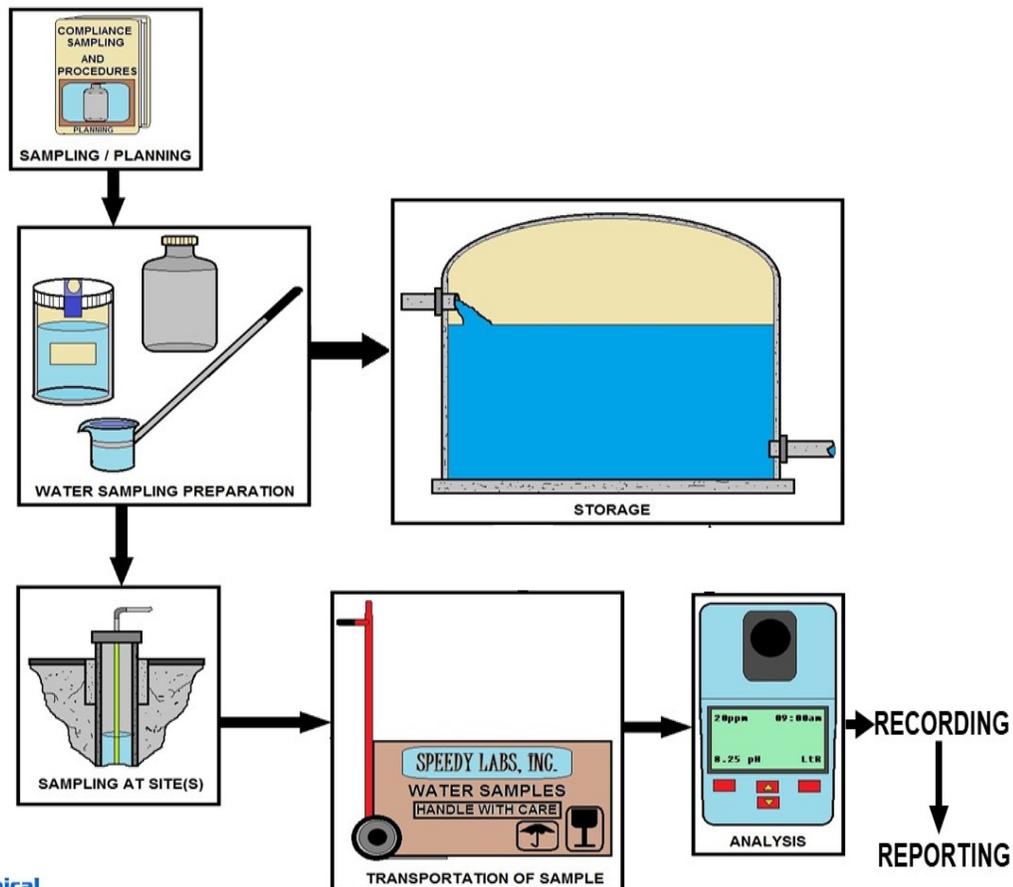
Methods

The MMO-MUG test, a product marketed as Colilert, is the most common. The sample results will be reported by the laboratories as simply coliforms present or absent. If coliforms are present, the laboratory will analyze the sample further to determine if these are fecal coliforms or *E. coli* and report their presence or absence.

Microbial Regulations

One of the key regulations developed and implemented by the United States Environmental Protection Agency (USEPA) to counter pathogens in drinking water is the Surface Water Treatment Rule.

Among its provisions, the rule requires that a public water system, using surface water (or ground water under the direct influence of surface water) as its source, have sufficient treatment to reduce the source water concentration of *Giardia* and viruses by at least 99.9% and 99.99%, respectively. The Surface Water Treatment Rule specifies treatment criteria to assure that these performance requirements are met; they include turbidity limits, disinfectant residual and disinfectant contact time conditions.



WATER SAMPLING FLOW CHART

Basic Types of Water Samples

It is important to properly identify the type of sample you are collecting. Please indicate in the space provided on the laboratory form the type of sample.

The three (4) types of samples are:

1. **Routine:** Samples collected on a routine basis to monitor for contamination. Collection should be in accordance with an approved sampling plan.
2. **Repeat:** Samples collected following a '**coliform present**' routine sample. The number of repeat samples to be collected is based on the number of routine samples you normally collect.
3. **Special:** Samples collected for other reasons. Examples would be a sample collected after repairs to the system and before it is placed back into operation or a sample collected at a wellhead prior to a disinfection injection point.
4. **Trigger: Level 1 Assessment** is triggered if any one of the following occurs:
 - ▶ A PWS collecting fewer than 40 samples per month has 2 or more TC+ routine/repeat samples in the same month.
 - ▶ A PWS collecting at least 40 samples per month has greater than 5.0 percent of the routine/repeat samples in the same month that are TC+.
 - ▶ A PWS fails to take every required repeat sample after any single TC+ sample
5. **Trigger: Level 2 Assessment** is triggered if any one of the following occurs:
 - ▶ A PWS incurs an E. coli MCL violation.
 - ▶ A PWS has a second Level 1 Assessment within a rolling 12-month period.
 - ▶ A PWS on state-approved annual monitoring has a Level 1 Assessment trigger in 2 consecutive years.

Routine Coliform Sampling

The number of routine samples and frequency of collection for community public water systems is shown in Table 3-1 below.

Noncommunity and nontransient noncommunity public water systems will sample at the same frequency as a like sized community public water system if:

1. It has more than 1,000 daily population and has ground water as a source, or
2. It serves 25 or more daily population and utilizes surface water as a source or ground water under the direct influence of surface water as its source.

Noncommunity and nontransient, noncommunity water systems with less than 1,000 daily population and groundwater as a source will sample on a quarterly basis.

No. of Samples per System Population

Persons served - Samples per month

<u>up to 1,000</u>	<u>1</u>
<u>1,001-2,500</u>	<u>2</u>
<u>2,501-3,300</u>	<u>3</u>
<u>3,301 to 4,100</u>	<u>4</u>
<u>4,101 to 4,900</u>	<u>5</u>
<u>4,901 to 5,800</u>	<u>6</u>
<u>5,801 to 6,700</u>	<u>7</u>
<u>6,701 to 7,600</u>	<u>8</u>
<u>7,601 to 8,500</u>	<u>9</u>
<u>8,501 to 12,900</u>	<u>10</u>
<u>12,901 to 17,200</u>	<u>15</u>
<u>17,201 to 21,500</u>	<u>20</u>
<u>21,501 to 25,000</u>	<u>25</u>
<u>25,001 to 33,000</u>	<u>30</u>
<u>33,001 to 41,000</u>	<u>40</u>
<u>41,001 to 50,000</u>	<u>50</u>
<u>50,001 to 59,000</u>	<u>60</u>
<u>59,001 to 70,000</u>	<u>70</u>
<u>70,001 to 83,000</u>	<u>80</u>
<u>83,001 to 96,000</u>	<u>90</u>
<u>96,001 to 130,000</u>	<u>100</u>
<u>130,001 to 220,000</u>	<u>120</u>
<u>220,001 to 320,000</u>	<u>150</u>
<u>320,001 to 450,000</u>	<u>180</u>
<u>450,001 to 600,000</u>	<u>210</u>
<u>600,001 to 780,000</u>	<u>240</u>



Repeat Sampling Introduction

Repeat sampling replaces the old check sampling with a more comprehensive procedure to try to identify problem areas in the system. Whenever a routine sample has total coliform or fecal coliform present, a set of repeat samples must be collected within 24 hours after being notified by the laboratory. The follow-up for repeat sampling is:

1. If only one routine sample per month or quarter is required, four (4) repeat samples must be collected.
2. For systems collecting two (2) or more routine samples per month, three (3) repeat samples must be collected.
3. Repeat samples must be collected from:
 - a. The original sampling location of the coliform present sample.
 - b. Within five (5) service connections upstream from the original sampling location.
 - c. Within five (5) service connections downstream from the original sampling location.
 - d. Elsewhere in the distribution system or at the wellhead, if necessary.
4. If the system has only one service connection, the repeat samples must be collected from the same sampling location over a four-day period or on the same day.
5. All repeat samples are included in the MCL compliance calculation.
6. If a system which normally collects fewer than five (5) routine samples per month has a coliform present sample, it must collect five (5) routine samples the following month or quarter regardless of whether an MCL violation occurred or if repeat sampling was coliform absent.

Positive or Coliform Present Results

What do you do when your sample is positive or coliform present?

When you are notified of a positive test result you need to contact either the Drinking Water Program or your local county health department within 24 hours, or by the next business day after the results are reported to you. The Drinking Water Program contracts with many of the local health departments to provide assistance to water systems.

After you have contacted an agency for assistance, you will be instructed as to the proper repeat sampling procedures and possible corrective measures for solving the problem. It is very important to initiate the repeat sampling immediately as the corrective measures will be based on those results.



Some examples of typical corrective measures to coliform problems are:

1. Shock chlorination of a ground water well. The recommended dose of 5% household bleach is 2 cups per 100 gallons of water in the well. This should be done anytime the well is opened for repair (pump replacement, etc.). If you plan to shock the entire system, calculate the total gallonage of storage and distribution.
2. Conduct routine distribution line flushing. Install blowoffs on all dead end lines.
3. Conduct a cross connection program to identify all connections with non-potable water sources. Eliminate all of these connections or provide approved backflow prevention devices.
4. Upgrade the wellhead area to meet current construction standards as set by your state environmental or health agency.
5. If you continuously chlorinate, review your operation and be sure to maintain a detectable residual (0.2 mg/l free chlorine) at all times in the distribution system.
6. Perform routine cleaning of the storage system.

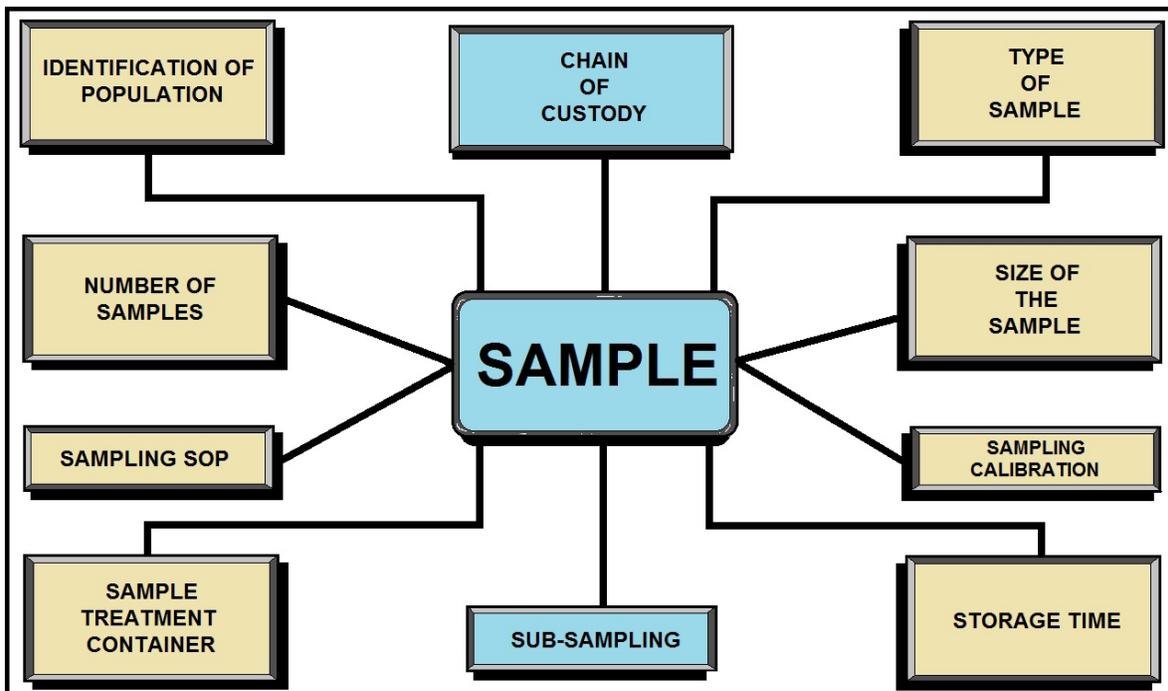
This list provides some basic operation and maintenance procedures that could help eliminate potential bacteriological problems, check with your state drinking water section or health department for further instructions.

Maximum Contaminant Levels (MCLs)

State and federal laws establish standards for drinking water quality. Under normal circumstances when these standards are being met, the water is safe to drink with no threat to human health. These standards are known as maximum contaminant levels (**MCL**). When a particular contaminant exceeds its MCL a potential health threat may occur.

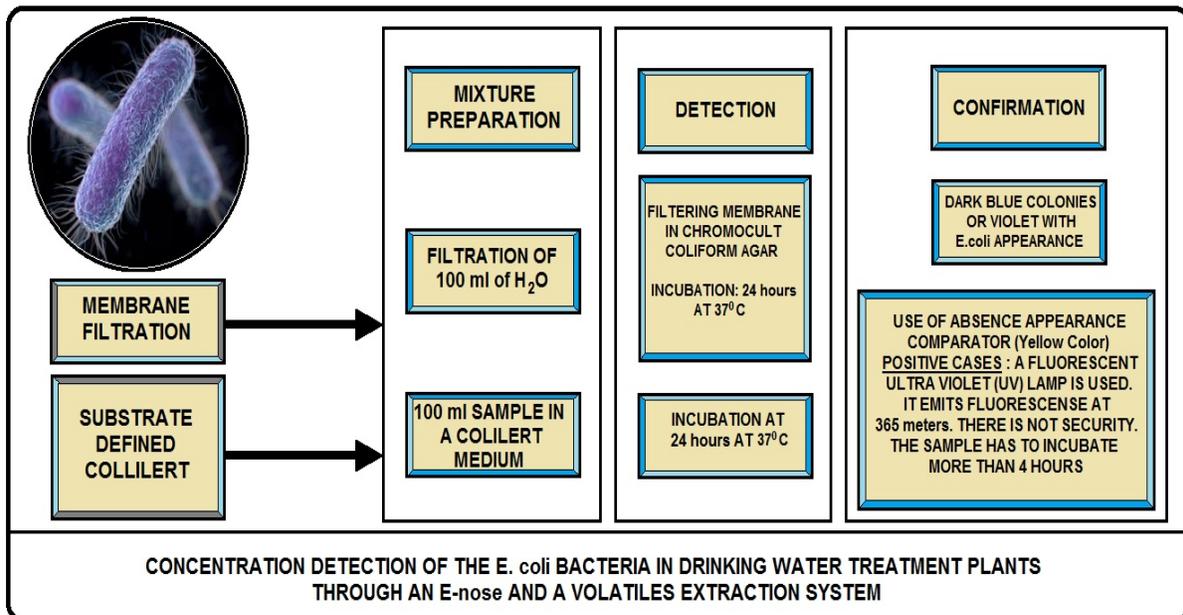
The MCLs are based on extensive research on toxicological properties of the contaminants, risk assessments and factors, short term (**acute**) exposure, and long term (**chronic**) exposure. You conduct the monitoring to make sure your water is in compliance with the MCL.

There are two types of MCL violations for coliform bacteria. The first is for total coliform; the second is an acute risk to health violation characterized by the confirmed presence of fecal coliform or *E. coli*.



- PROCEDURES FOR TAKING WATER SAMPLES ARE:**
- WEAR GLOVES AND EYE PROTECTION
 - ONLY USE 125 mL or 150 mL PLASTIC SAMPLE BOTTLES
 - RINSE THE BOTTLE AND CAP THREE TIMES WITH THE SAMPLE WATER AND FILL WITHIN ONE TO TWO INCHES FROM THE TOP
 - PLACE SAMPLE INTO A COOLER WITH ICE FOR IMMEDIATE DELIVERY TO THE LABORATORY

PROPER SAMPLING PROCEDURES (WATER)



CONCENTRATION DETECTION OF THE E. coli BACTERIA IN DRINKING WATER TREATMENT PLANTS THROUGH AN E-nose AND A VOLATILES EXTRACTION SYSTEM

CONVENTIONAL BACTERIOLOGICAL MONITORING



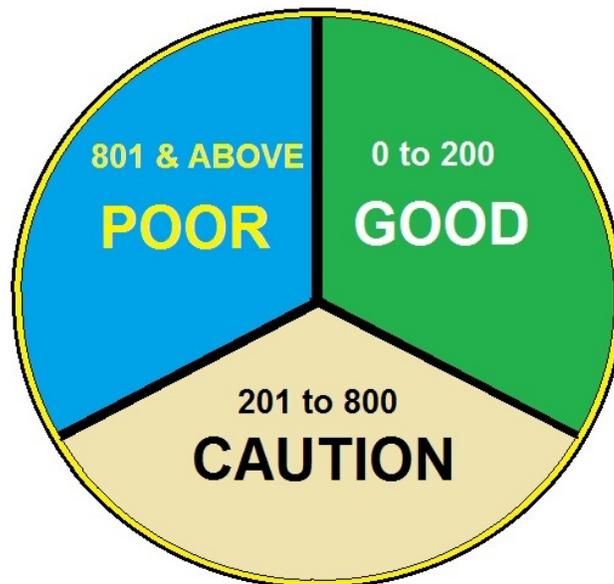
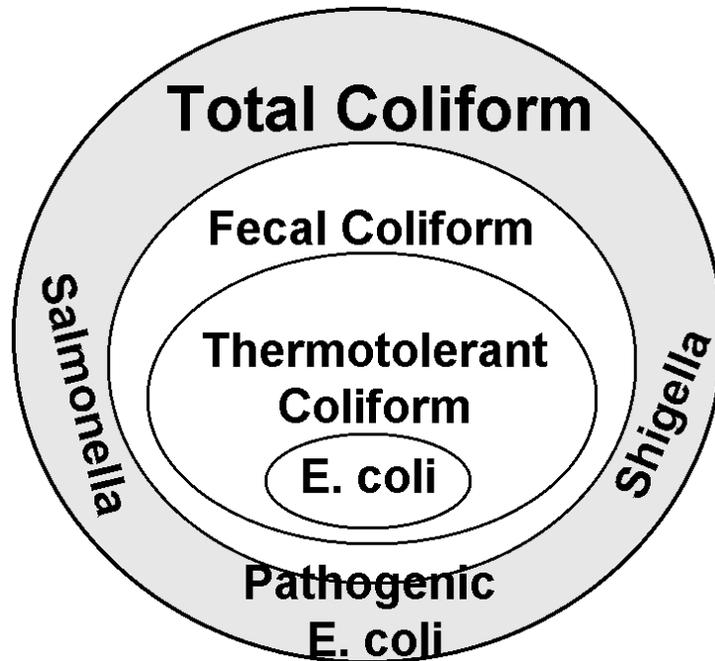


Looking under a black light to identify the presence of E. coli.

Colilert tests simultaneously detect and confirms coliform and E. coli in water samples in 24 hours or less.

Simply add the Colilert reagent to the sample, incubate for 24 hours, and read results.

Colilert is easy to read, as positive coliform samples turn yellow or blue, and when E. coli is present, samples fluoresce under UV light.



**FECAL COLIFORM BACTERIA COLONIES
(Per 100 Milliliters)**

Heterotrophic Plate Count - Introduction

Heterotrophic organisms utilize organic compounds as their carbon source (food or substrate). In contrast, autotrophic organisms use inorganic carbon sources. The Heterotrophic Plate Count provides a technique to quantify the bacteriological activity of a sample. The R2A agar provides a medium that will support a large variety of heterotrophic bacteria. After an incubation period, a bacteriological colony count provides an estimate of the concentration of heterotrophs in the sample of interest.

Heterotrophic Plate Count (HPC) --- formerly known as the standard plate count, is a procedure for estimating the number of live heterotrophic bacteria and measuring changes during water treatment and distribution in water or in swimming pools. Colonies may arise from pairs, chains, clusters, or single cells, all of which are included in the term "*colony-forming units*" (CFU).

Method:

There are three methods for standard plate count:

1. Pour Plate Method

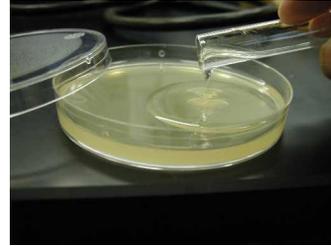
The colonies produced are relatively small and compact, showing less tendency to encroach on each other than those produced by surface growth. On the other hand, submerged colonies often are slower growing and are difficult to transfer.

2. Spread Plate Method

All colonies are on the agar surface where they can be distinguished readily from particles and bubbles. Colonies can be transferred quickly, and colony morphology can be easily discerned and compared to published descriptions. See next page

3. Membrane Filter Method

This method permits testing large volumes of low-turbidity water and is the method of choice for low-count waters.



Material

- i) Apparatus
 - Glass rod
 - Erlenmeyer flask
 - Graduated Cylinder
 - Pipette
 - Petri dish
 - Incubator
- ii) Reagent and sample
 - Reagent-grade water
 - Nutrient agar
 - Sample

Procedure*

1. Boil mixture of nutrient agar and nutrient broth for 15 minutes, then cool for about 20 minutes.
2. Pour approximately 15 ml of medium in each Petri dish, let medium solidify.
3. Pipette 0.1 ml of each dilution onto surface of pre-dried plate, starting with the highest dilution.

4. Distribute inoculum over surface of the medium using a sterile bent glass rod.
5. Incubate plates at 35°C for 48h.
6. Count all colonies on selected plates promptly after incubation, consider only plates having 30 to 300 colonies in determining the plate count.

*Duplicate samples

Computing and Reporting

Compute bacterial count per milliliter by the following equation:

CFU/ml = colonies counted / actual volume of sample in dish a) If there is no plate with 30 to 300 colonies, and one or more plates have more than 300 colonies, use the plate(s) having a count nearest 300 colonies.

b) If plates from all dilutions of any sample have no colony, report the count as less than 1/actual volume of sample in dish estimated CFU/ml.

c) Avoid creating fictitious precision and accuracy when computing CFU by recording only the first two left-hand digits.

Heterotrophic Plate Count (Spread Plate Method)

Laboratory Equipment Needed

100 x 15 Petri Dishes

Turntable

Glass Rods: Bend fire polished glass rod 45 degrees about 40 mm from one end. Sterilize before using.

Pipette: Glass, 1.1 mL. Sterilize before using.

Quebec Colony Counter

Hand Tally Counter



Reagents

1) R2A Agar: Dissolve and dilute 0.5 g of yeast extract, 0.5 g of proteose peptone No. 3, 0.5 g of casamino acids, 0.5 g of glucose, 0.5 g of soluble starch, 0.3 g of dipotassium hydrogen phosphate, 0.05 g of magnesium sulfate heptahydrate, 0.3 g of sodium pyruvate, 15.0 g of agar to 1 L. Adjust pH to 7.2 with dipotassium hydrogen phosphate **before adding agar**. Heat to dissolve agar and sterilize at 121 C for 15 minutes.

2) Ethanol: As needed for flame sterilization.

Preparation of Spread Plates

Immediately after agar sterilization, pour 15 mL of R2A agar into sterile 100 x 15 Petri dishes; let agar solidify. Pre-dry plates inverted so that there is a 2 to 3 g water loss overnight with the lids on. Use pre-dried plates immediately or store up to two weeks in sealed plastic bags at 4°C.

Sample Preparation

Mark each plate with sample type, dilution, date, and any other information before sample application.

Prepare at least duplicate plates for each volume of sample or dilution examined. Thoroughly mix all samples by rapidly making about 25 complete up-and-down movements.

Sample Application

Uncover pre-dried agar plate. Minimize time plate remains uncovered. Pipette 0.1 or 0.5 mL sample onto surface of pre-dried agar plate.

Record Volume of Sample Used.

Using a sterile bent glass rod, distribute the sample over surface of the medium by rotating the dish by hand on a turntable. Let the sample be absorbed completely into the medium before incubating. Put cover back on Petri dish and invert for duration of incubation time. Incubate at 28°C for 7 days. Remove Petri dishes from incubator for counting.



Counting and Recording

After incubation period, promptly count all colonies on the plates. To count, uncover plate and place on Quebec colony counter. Use a hand tally counter to maintain count. Count all colonies on the plate, regardless of size. Compute bacterial count per milliliter by the following equation:

$$\text{CFU/mL} = \frac{\text{colonies counted}}{\text{actual volume of sample in dish, mL}}$$

To report counts on a plate with no colonies, report the count as less than one (<1) divided by the sample volume put on that plate (remember to account for any dilution of that sample).

If plates of all dilutions for a sample have no colonies, report the count as less than one (<1) divided by the largest sample volume used. Example: if 0.1 mL of a 100:1 and 10000:1 dilution of a sample both turned up with no colonies formed, the reported result would be <1 divided by the largest sample volume 0.001 mL (0.1 mL divided by 100). The final reported result for the sample is <1000 CFU per mL.

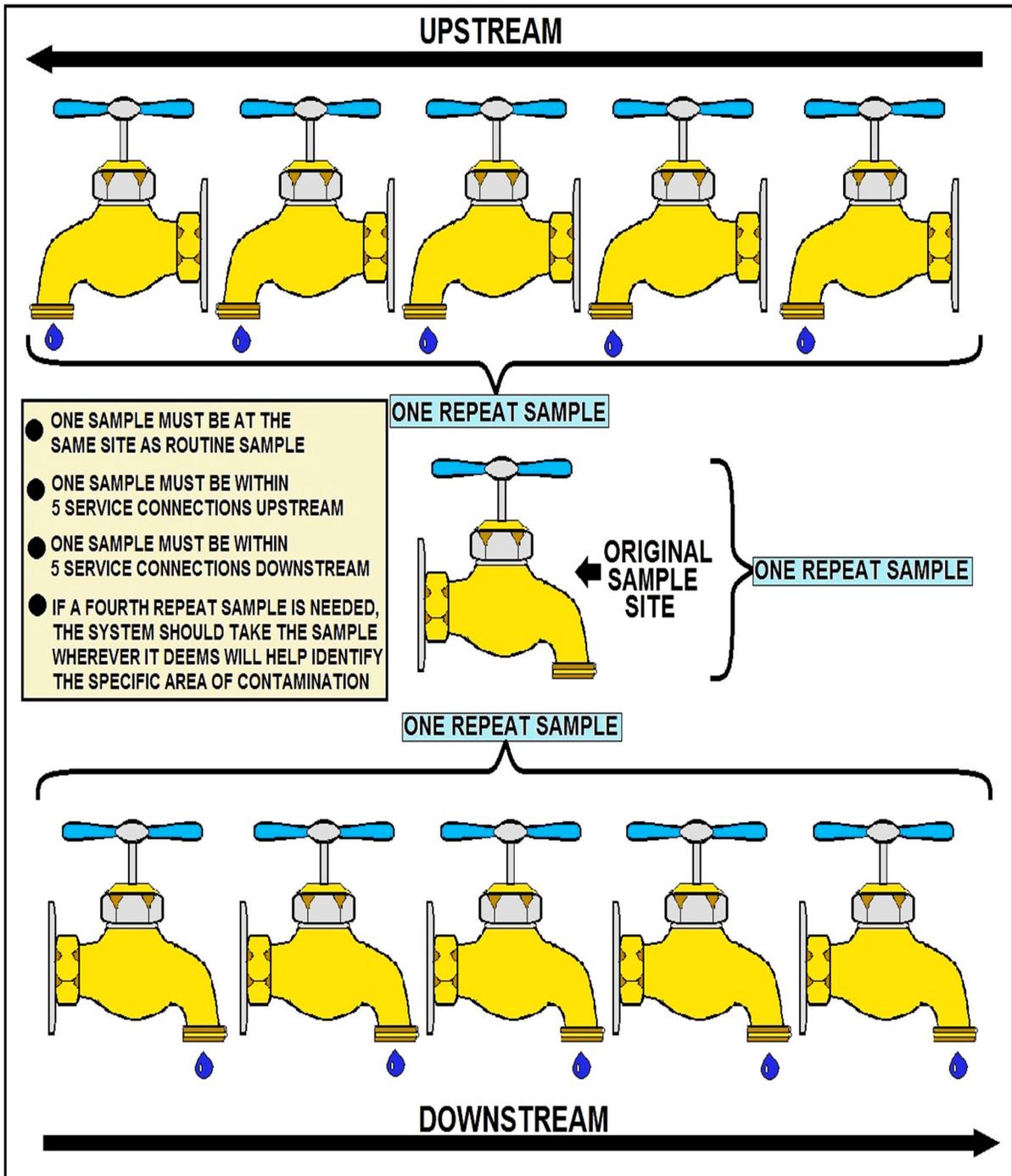
Assignment

1. Report the number of colony forming units (**CFU**) found on each plate.
2. Calculate the **CFU** per mL for each plate.
3. The aim of diluting samples is to produce a plate having 30 to 300 colonies, which plates meet these criteria. If no sample produces a plate with a count in this range, use the plate(s) with a count closest to 300. Based on these criteria, use your calculated results to report the CFU per mL for each sample.

In the conclusion of your lab report, comment on your final results for each sample type as well as the quality of your application of this analysis technique. Feel free to justify your comments using statistical analysis. Also, comment on the general accuracy of this analytical technique and the factors that affect its accuracy and or applicability.

Data Table for Samples

Sample ID	Volume of Sample, mL	Colonies Counted per plate



EXAMPLE OF WHAT HAS TO BE DONE IF A PRESENCE OF COLIFORMS ARE DETECTED WHEN CONDUCTING ROUTINE SAMPLES AT DESIGNATED SAMPLE SITES

Total Coliforms

This MCL is based on the presence of total coliforms, and compliance is on a monthly or quarterly basis, depending on your water system type and state rule. For systems which collect *fewer* than 40 samples per month, no more than one sample per month may be positive. In other words, the second positive result (repeat or routine) in a month or quarter results in an MCL violation.

For systems which collect 40 or more samples per month, no more than five (5) percent may be positive. Check with your state drinking water section or health department for further instructions.

Acute Risk to Health (Fecal Coliforms and E. coli)

An acute risk to human health violation occurs if either one of the following happen:

1. A routine analysis shows total coliform present and is followed by a repeat analysis which indicates fecal coliform or E. coli present.
2. A routine analysis shows total and fecal coliform or E. coli present and is followed by a repeat analysis which indicates total coliform present.

An acute health risk violation requires the water system to provide public notice via radio and television stations in the area. This type of contamination can pose an immediate threat to human health and notice must be given as soon as possible, but no later than 24 hours after notification from your laboratory of the test results.

Certain language may be mandatory for both these violations and is included in your state drinking water rule.

Public Notice

A public notice is required to be issued by a water system whenever it fails to comply with an applicable MCL or treatment technique, or fails to comply with the requirements of any scheduled variance or permit. This will inform users when there is a problem with the system and give them information.

A public notice is also required whenever a water system fails to comply with its monitoring and/or reporting requirements or testing procedure.

Each public notice must contain certain information, be issued properly and in a timely manner and contain certain mandatory language. The timing and place of posting of the public notice depends on whether an acute risk is present to users. Check with your state drinking water section or health department for further instructions.

The following are Acute Violations

1. Violation of the MCL for nitrate.
2. Any violation of the MCL for total coliforms, when fecal coliforms or E. coli are present in the distribution system.
3. Any outbreak of waterborne disease, as defined by the rules.

Sim Plate Method



IDEXX's SimPlate for HPC method is used for the quantification of heterotrophic plate count (HPC) in water.

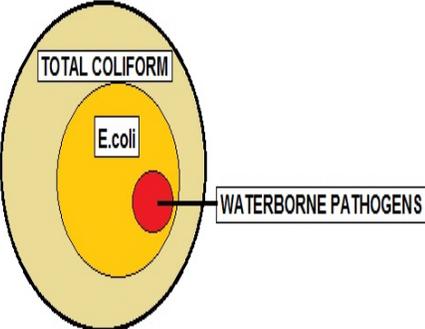
It is based on the Multiple Enzyme Technology which detects viable bacteria in water by testing for the presence of key enzymes known to be present in these little organisms.

This technique uses enzyme substrates that produce a blue fluorescence when metabolized by waterborne bacteria. The sample and media are added to a SimPlate Plate, incubated and then examined for fluorescing wells.

The number of wells corresponds to a Most Probable Number (MPN) of total bacteria in the original sample.

The MPN values generated by the SimPlate for HPC method correlate with the Pour Plate method using the Total Plate Count Agar, incubated at 35°C for 48 hours as described in *Standard Methods for the Examination of Water and Wastewater, 19th Edition*.

Revised Total Coliform Rule (RTCR) Sub-Section

REVISED RULE OVERVIEW		MAJOR RULE CHANGES	
TITLE:	REVISED TOTAL COLIFORM RULE (RTCR) 78 FR 10269, FEBRUARY 13th, 2013, Vol. 78, No. 30	CURRENT TCR Non-Accute MCL Violation	REVISED TCR Level 1 Assessment Trigger
PURPOSE:	INCREASE PUBLIC HEALTH PROTECTION THROUGH THE REDUCTION OF POTENTIAL PATHWAYS OF ENTRY FOR FECAL CONTAMINATION INTO DISTRIBUTION SYSTEM	FOR A SYSTEM COLLECTING AT LEAST 40 SAMPLES PER MONTH, MORE THAN 5.0% OF SAMPLES COLLECTED ARE TC POSITIVE	FOR A SYSTEM COLLECTING AT LEAST 40 SAMPLES PER MONTH, MORE THAN 5.0% OF SAMPLES COLLECTED ARE TC POSITIVE
GENERAL DESCRIPTION:	THE RTCR ESTABLISHES AN MCL FOR E.coli AND USES E.coli AND TOTAL COLIFORMS TO INITIATE AND "FIND A FIX" APPROACH TO ADDRESS FECAL CONTAMINATION THAT COULD ENTER DISTRIBUTION SYSTEM	FOR A SYSTEM COLLECTING FEWER THAN 40 SAMPLES PER MONTH, MORE THAN 1 SAMPLE TC POSITIVE	FOR A SYSTEM COLLECTING FEWER THAN 40 SAMPLES PER MONTH, MORE THAN 1 SAMPLE TC POSITIVE
UTILITIES COVERED:	THE REVISED TOTAL COLIFORM RULE APPLIES TO <u>ALL</u> PUBLIC WATER SYSTEMS	PUBLIC NOTICE IS REQUIRED	NO PUBLIC NOTICE MUST PERFORM LEVEL 1 ASSESSMENT
PUBLIC HEALTH BENEFITS			
IMPLEMENTATION OF THE REVISED TOTAL COLIFORM RULE <u>WILL</u> RESULT IN:			
<ul style="list-style-type: none"> ▶ A DECREASE IN THE PATHWAY BY WHICH FECAL CONTAMINATION CAN ENTER THE DRINKING WATER DISTRIBUTION SYSTEM ▶ REDUCTION IN FECAL CONTAMINATION <u>SHOULD</u> REDUCE THE POTENTIAL RISK FROM ALL WATERBORNE PATHOGENS INCLUDING BACTERIA, VIRUSES, PROTOZOA, AND ASSOCIATED ILLNESSES. 			



REVISED TOTAL COLIFORM RULE (RTCR)

The following are EPA's federal rule requirements. Please be aware that each state implements drinking water regulations that may be more stringent than EPA's regulations. Check with your state environmental agency for more information.

EPA published the Revised Total Coliform Rule (RTCR) in the Federal Register (FR) on February 13, 2013 (78 FR 10269). It is the revision to the 1989 Total Coliform Rule (TCR).

Why revise the 1989 TCR?

The 1996 amendments to the Safe Drinking Water Act [Section 1412(b) (9)] require the Administrator to review and revise, as appropriate, each national primary drinking water regulation not less often than every six years. EPA published its decision to revise the TCR in July 2003 as part of its National Primary Drinking Water Regulation (NPDWR) review.

The RTCR:

- Upholds the purpose of the 1989 TCR to protect public health by ensuring the integrity of the drinking water distribution system and monitoring for the presence of microbial contamination.
- Requires public water systems (PWSs) to meet a legal limit for E. coli, as demonstrated by required monitoring.

- Specifies the frequency and timing of required microbial testing based on population served, public water system type and source water type: ground water or surface water.

When must PWSs comply with the RTCR requirements?

Unless a State determines an earlier effective date, all PWSs must comply with the RTCR requirements starting April 1, 2016. All PWSs include:

- Community Water Systems (CWSs),
- Non-Transient Non-Community Water Systems (NTNCWSs), and
- Transient Non-Community Water Systems (TNCWSs).

Minor Corrections to the Revised Total Coliform Rule (RTCR)

Minor corrections to the final RTCR became effective on April 28, 2014. No comments were received on the Direct Final Rule published on February 26, 2014 and the corrections therefore became effective without further notice. See the **Direct Final Rule** Federal Register Notice.

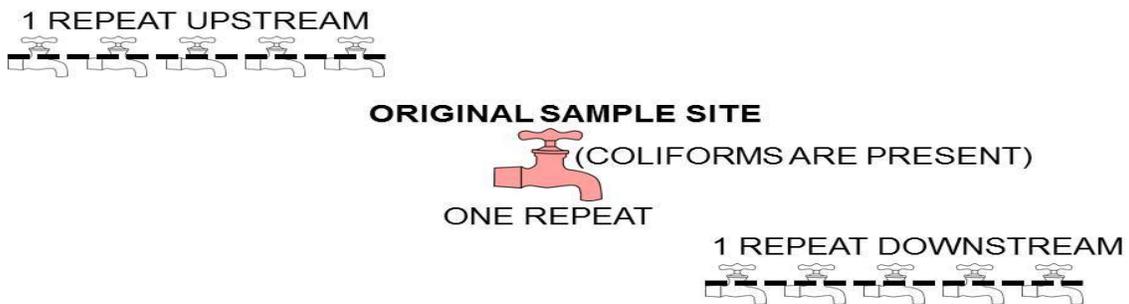
Revised Total Coliform Rule (RTCR) – Final Rule

On February 13, 2013, EPA published in the Federal Register the revisions to the 1989 TCR. EPA anticipates greater public health protection under the Revised Total Coliform Rule (RTCR) requirements.

The RTCR:

- Requires public water systems that are vulnerable to microbial contamination to identify and fix problems; and
- Establishes criteria for systems to qualify for and stay on reduced monitoring, which could reduce water system burden and provide incentives for better system operation.

Public water systems (PWSs) and primacy agencies must comply with the revised requirements by April 2016. Until then, PWSs and primacy agencies must continue complying with the 1989 TCR.



ONE AT THE SAME SITE AS THE ROUTINE SAMPLE.
 ONE WITHIN 5 SERVICE CONNECTIONS UPSTREAM.
 ONE WITHIN 5 SERVICE CONNECTIONS DOWNSTREAM.

IF A FOURTH REPEAT SAMPLE IS REQUIRED THE SYSTEM SHOULD TAKE THE SAMPLE WHEREVER IT FEELS IT WILL HELP IDENTIFY THE AREA OF CONTAMINATION.

REPEAT SAMPLING PROCEDURES

RTCR Key Provisions *Most of this section comes from the USEPA.*

Provision Category	Key Provisions
Contaminant Level	<ul style="list-style-type: none"> • Addresses the presence of total coliforms and E. coli in drinking water. • • For E. coli (EC), the Maximum Contaminant Level Goal (MCLG) is set at zero. The Maximum Contaminant Level (MCL) is based on the occurrence of a condition that includes routine and repeat samples. • • For total coliforms (TC), PWSs must conduct a Level 1 or Level 2 assessment of their system when they exceed a specified frequency of total coliform occurrences. • • An MCL violation or failure to take repeat samples following a routine total coliform-positive sample will trigger a Level 1 or Level 2 assessment. • • Any sanitary defect identified during a Level 1 or Level 2 assessment must be corrected by the PWS. These are the treatment technique requirements of the RTCR.
Monitoring	<ul style="list-style-type: none"> • Develop and follow a sample-siting plan that designates the PWS's collection schedule. This includes location of routine and repeat water samples. • • Collect routine water samples on a regular basis (monthly, quarterly, annually). Have samples tested for the presence of total coliforms by a state certified laboratory. • • Analyze all routine or repeat samples that are total coliform positive (TC+) for E. coli. • • Collect repeat samples (at least 3) for each TC+ positive routine sample. • • For PWSs on quarterly or annual routine sampling, collect additional routine samples (at least 3) in the month after a TC+ routine or repeat sample.

RTCR Key Provisions <i>Most of this section comes from the USEPA.</i>	
	<ul style="list-style-type: none"> Seasonal systems must monitor and certify the completion of a state-approved start-up procedures.
Level 1 and Level 2 Assessments and Corrective Actions	<ul style="list-style-type: none"> PWSs are required to conduct a Level 1 or Level 2 assessment if conditions indicate they might be vulnerable to contamination. PWSs must fix any sanitary defects within a required timeframe.
Reporting and Recordkeeping	<ul style="list-style-type: none"> PWSs are required to report certain items to their states. These reporting and recordkeeping requirements are essentially the same as under TCR. The addition to the Requirements is the Level 1 and Level 2 requirements.
Violations, Public Notification (PN) and Consumer Confidence Report (CCR)	<ul style="list-style-type: none"> PWSs incur violations if they do not comply with the requirements of the RTCR. The violation types are essentially the same as under the TCR with few changes. The biggest change is no acute or monthly MCL violation for total coliform positive samples only. PN is required for violations incurred. Within required timeframes, the PWS must use the required health effects language and notify the public if they did not comply with certain requirements of the RTCR. The type of PN depends on the severity of the violation. Community water systems (CWSs) must use specific language in their CCRs when they must conduct an assessment or if they incur an E. coli MCL violation.

Disinfection Key

- ▶ Contact time is required
 - ▶ 99% or 2 log inactivation of crypto
 - ▶ 99.9% or 3 log inactivation of giardia lamblia cysts
 - ▶ 99.99% or 4 log inactivation of enteric viruses
- ▶ CT = Concentration of disinfectant x contact time

The chlorine residual leaving the plant must be = or > 0.2 mg/L and measurable throughout the system

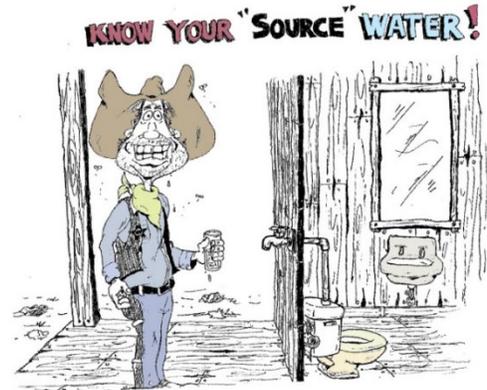
Troubleshooting Table for Bacteriological Monitoring

Problems

1. Positive Total Coliform.
2. Chlorine taste and odor.
3. Inability to maintain an adequately free chlorine residual at the furthest points of the distribution system or at dead end lines.

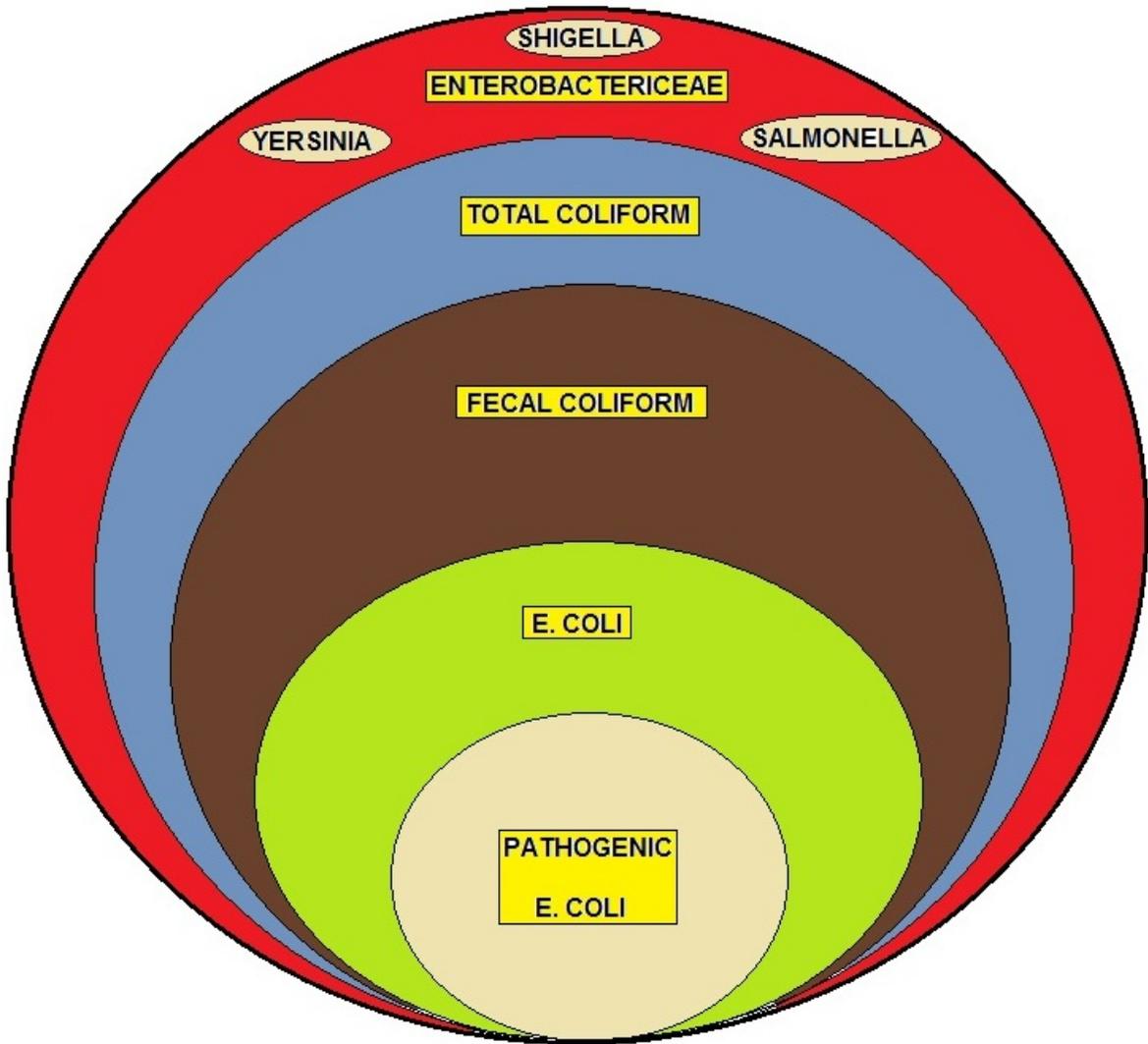
Possible Causes

- 1A. Improper sampling technique.
- 1B. Contamination entering distribution system.
- 1C. Inadequate chlorine residual at the sampling site.
- 1D. Growth of biofilm in the distribution system.
- 2A. High total chlorine residual and low free residual.
- 3A. Inadequate chlorine dose at treatment plant.
- 3B. Problems with chlorine feed equipment.
- 3C. Ineffective distribution system flushing program.
- 3D. Growth of biofilm in the distribution system.



Possible Solutions

- 1A/ Check distribution system for low-pressure conditions, possibly due to line breaks or excessive flows that may result in a backflow problem.
- 1B. Insure that all staff are properly trained in sampling and transport procedures as described in the TCR.
- 1C. Check the operation of the chlorination feed system. Refer to issues described in the sections on pumps and hypochlorination systems. Insure that residual test is being performed properly.
- 1D. Thoroughly flush effected areas of the distribution system. Superchlorination may be necessary in severe cases.
- 2A. The free residual should be at least 85% of the total residual. Increase the chlorine dose rate to get past the breakpoint in order to destroy some of the combined residual that causes taste and odor problems. Additional system flushing may also be required.
- 3A. Increase chlorine feed rate at point of application.
- 3B. Check operation of chlorination equipment.
- 3C. Review distribution system flushing program and implement improvements to address areas of inadequate chlorine residual.
- 3D. Increase flushing in area of biofilm problem.



**COLIFORM BACTERIA SUB-SET #1
INDICATOR ORGANISMS**

Sampling Questions

Sample Collection/Repeat Samples / Follow-up to Coliform Positive Samples

Do we need to use any special reporting forms when submitting samples to the laboratory?

Yes. These forms can be obtained by calling your **certified laboratory**. The reporting forms should be included with the bottles. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

How do I complete the reporting/collection form?

For the most part, the form is self-explanatory. A few reminders:

1. Always use your official State water or health agency assigned sample site numbers (not sample address). If a site number does not exist for a location, please add it to your site plan by calling your **official Drinking Water Agency**. Simply record the address if it's a "one-time" sample location.
2. Be-sure you include all "Contact Person" information including telephone number and cellular number. This information is very important in case there is a positive sample.
3. Clearly mark sample purpose.
4. If the WS or PWS is chlorinated, you must include the chlorine residual on the form. Failure to do so will result in a violation.

After I collect the sample, how long does it have to reach the laboratory?

Always check with your Agency to ensure this rule is correct, for this rule is different in some States. In order for the laboratory to analyze the sample(s), it must be received within 24 or 30 hours of collection. If not, a replacement must be collected. It is strongly recommended that the monthly routine samples be collected within the first few days of each month. This will allow ample time for the collection of replacement sample(s) if they are required.

What days of the week should I collect my samples?

It is preferred that routine samples be collected and shipped to the laboratory on Mondays or Tuesdays. If routine samples are hand delivered to the laboratory, they should be delivered no later than Thursday. However, emergency or repeat samples may be submitted at any time. If you anticipate the samples will arrive on a weekend or holiday, you should contact your certified laboratory and make the necessary arrangements. It is recommended that you call your certified laboratory for a contact person, business hours, and any special delivery instructions. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

Do all coliform samples collected during the month count towards meeting our compliance monitoring requirements?

No. Special purpose samples, such as those taken to lift a boil order, or new construction samples to determine whether disinfection practices are sufficient following pipe placement, replacement or repair, will not be used to determine compliance with the Maximum Contaminant Level (MCL) or towards the routine number of samples required each month.

Routine raw and/or finished water entry point samples do not count towards meeting the total number of distribution samples required each month.

However, finished water entry point samples will be used to determine compliance with the MCL. Thus, if you have a positive finished water entry point sample, you must follow-up with the collection of repeat samples.

Our water system is chlorine exempt. Are there any special monitoring requirements?

Yes. In past years, some very small systems have been granted an exemption from chlorination by State water or health agencies.

New exemptions are no longer granted. Official State water or health agency may still honors past chlorine exemptions, but recognizes that the water lacks the protection of the residual chlorine.

Consequently, it is especially important that the bacterial quality of the water be monitored at frequent intervals. One of the conditions of the exemption is that samples be collected and analyzed at twice the frequency required of a chlorinated WS or PWS (two times a month). Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

How am I notified of positive coliform samples?

If a routine or replacement sample is total coliform positive, the certified laboratory and the Drinking Water Agency will try to contact the WS or PWS by telephone using the contact name and number provided on the reporting form. All Water Systems should keep a small number of extra coliform bottles/reporting forms in case of required repeat sampling. If for some unforeseen reason, the WS or PWS does not have extra coliform bottles on hand, the laboratory will overnight coliform bottles to the facility. However, this is not a preferred situation. Remember, responsibility for timely sampling ultimately falls on the WS or PWS. Therefore, waiting for bottles to arrive in the mail incurs risk on the WS or PWS. Obviously, to receive “repeat” sample bottles in the mail is an indication that there is a positive sample and immediate action is needed.

What is a repeat sample?

Any sample that is analyzed as a follow-up to an initial positive result is referred to as “repeat” sample. After a routine coliform sample is found to be total coliform positive, repeat samples are required to confirm the initial positive result(s), to determine if the contamination is ongoing, and to evaluate the extent of the contamination within the distribution system.

How many repeat samples must I collect?

The number of repeats samples is dependent on the number of routine samples collected for the month. **Three** repeat samples are required for each distribution sample that is coliform positive; **however**, if the WS or PWS sends in only one routine distribution sample per month, **four** repeat samples are required for each sample that is coliform positive. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

Where must repeat samples be collected?

If **three** repeat samples are required, one repeat sample must be collected from a tap within five

(5) service connections upstream from the original sample, another repeat sample must be collected within five (5) service connections downstream from the original sampling site, and the last must be collected at the original site.

If **four** repeat samples are required, one repeat sample must be collected from a tap within five (5) service connections upstream from the original sample, another repeat sample must be collected within five (5) service connections downstream from the original sampling site, another must be collected at the original site, and the fourth may be collected anywhere within the distribution system (this may aid in identifying the possible source of contamination).

All repeat samples (or sample set) must be collected on the same day. Exceptions to this rule are WS or PWS with a single service connection. In this case the official State water or health agency may allow the WS or PWS to collect the repeat samples over a four-day period or to collect a single sample of at least 400 ml (300 ml if the system collects more than one sample per month). Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

Where should the repeat samples be collected if the positive sample was collected at the end of the distribution system?

The WS or PWS is still required to collect three (or four when applicable) repeat samples. If the original sampling site is at the end of the distribution system (or one tap away from the end) the State Drinking Water agency may waive the requirement to collect one of the repeat samples downstream. An additional sample will be required upstream or from the same building. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

How many repeats are required if a finished water entry point sample or raw well sample is positive?

One. Only one repeat sample should be collected from the positive finished water entry point location or raw positive location. Raw or finished entry point samples (or raw/entry point repeat samples) are not used when determining compliance. Prior to August 2007, a routine coliform positive finished water (entry point) sample required three or four repeats. This has changed. Only one repeat is now required and it is to be collected from the same entry point location as the positive (downstream repeat samples are no longer required). Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

How much time do I have to collect repeat sample(s)?

24 Hours. If a routine or replacement sample is total coliform positive, the WS or PWS must collect a set of repeat samples within 24 hours of being notified of the positive result. Again, **all WS or PWS should keep a small number of extra coliform bottles/reporting forms in case of required repeat sampling.** If the WS or PWS is waiting for bottles to be shipped from the laboratory, repeat samples must be collected on the day of bottle receipt.

All repeat samples (or sample set) must be collected on the same day. Exceptions to this rule are WS or PWS with a single service connection.

In this case the official State water or health agency may allow the WS or PWS to collect the repeat samples over a four-day period or to collect a single sample of at least 400 ml (300 ml if the system collects more than one sample per month). Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

When does the repeat sample collection “start clock” begin?

The 24-hour clock starts when the laboratory (or State) notifies the water system of the initial positive coliform result. You have 24 hours from the time of notification to collect your repeat samples and return them to a laboratory for analysis. If you fail to meet this window, a violation will be issued, provided that no extension had been granted.

If the WS or PWS cannot be reached via phone, the official State water or health agency has defined “notified” as the date that the laboratory initiates shipment of repeat sample bottles.

The laboratory records this date on the coliform reporting form. The repeat samples must be collected on the on the day that the bottles are received at the WS or PWS. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

What if I cannot meet the 24-hour repeat collection requirement?

your official State water or health agency acknowledges that some circumstances may arise, totally beyond the control of the WS or PWS, which prevent repeat samples from being collected within the 24-hour period. Therefore, extensions may be granted by your **Drinking Water Agency**. A valid reason for the extension must be provided. Extensions cannot be granted after the fact. Therefore, requests for extensions **MUST** be made prior to or at the same time the repeat samples are being collected. Extensions will always specify exactly how much time the WS or PWS has to collect and return the repeat samples. Failure to obtain the extension or failure to meet the terms of the extension will result in a monitoring violation. Please remember that an extension on the 24-hour repeat collection requirement is **NOT** a waiver for actually collecting the repeat samples. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

What happens if I am notified on a Friday of positive routine results (or receive repeat bottles on a Friday or Holiday)?

The 24-hour collection requirement must still be met. You should contact your **certified laboratory** to arrange a time on Saturday to collect the repeat samples and drive them to the laboratory. If this is not possible, the WS or PWS must request an extension the first business day following the weekend or holiday. Please call the official State water or health agency at the earliest possible time to request an extension on the 24-hour requirement.

It is strongly recommended that all routine coliform samples be collected and mailed on a Monday or Tuesday to avoid this situation.

What happens if any of the repeats are positive or invalid?

If one or more repeat samples in the set are total coliform positive or invalid, the whole repeat monitoring process must start over. A new “set” of three or four (if only one routine sample is collected per month) repeats must be collected within 24 hours of being notified of the positive or invalid repeat.

If a repeat sample location is positive and is not from the same location as the original positive sample (and/or the original site is negative), the next repeat collection should be based on the original positive site location and NOT the positive repeat location. Every consecutive set of repeat samples must be collected at the same locations as the 1st set of repeat samples.

The WS or PWS must repeat this process until either total coliform are not detected in one complete “set” of repeat samples or the WS or PWS determines that the total coliform Maximum Contaminant Level(MCL) has been exceeded and notifies your official State water or health agency. It is highly recommended that sampling be repeated until a “set” is satisfactory. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

Does one (or more) positive routine or repeat sample change the following month’s monitoring requirements?

Yes. If you collect less than 5 routine distribution samples per month and have at least one positive routine, repeat or replacement sample, 5 routine distribution samples MUST be collected the following month. The samples can be collected from other approved coliform sites or from other locations in the distribution system. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

Who is responsible for notifying the official State water or health agency if results are positive?

The WS or PWS is responsible for notifying your official State water or health agency when a total coliform positive sample is found and for having the appropriate repeat samples analyzed. In most cases, an agreement has been made between the certified laboratory and the WS or PWS that the laboratory will notify the State Agency; however, even in this case, the WS or PWS is held accountable for this notification requirement.

Invalidating Sample Results

Can a sample result be invalidated?

A coliform positive can be invalidated when there is a significant reason to believe the test results are not accurate or not representative of the water quality. These samples are not used in compliance calculations and a replacement must be collected within the same monitoring period (same month) at the same location to avoid a possible monitoring violation.

There are three conditions in which a total coliform positive sample result may be invalidated:

1. The laboratory establishes that an error in its analytical procedure caused the total coliform positive result.
2. The State water or health agency, on the basis of the results of repeat samples collected determines that the total coliform positive sample resulted from a domestic or other non-distribution system-plumbing problem.
3. The State water or health agency determines that there are substantial grounds to believe that a total coliform positive result is due to a circumstance or condition that does not reflect water quality in the distribution system.

The laboratory will invalidate the results if they are unable to obtain a true result according to the test method used to analyze the sample. If a laboratory invalidates a routine sample due to interference, the WS or PWS must collect another sample from the same location as the original sample within 24 hours of being notified of the interference problem.

How can I have a positive coliform result invalidated?

Always check with your Agency to ensure this rule is correct, for this rule is different in some States. The invalidation process involves 3 steps:

1. All repeat samples must have been collected in accordance with the repeat sampling requirements.
2. As soon as you feel a sample should be invalidated, the **Drinking Water Agency** should be contacted by telephone and the situation discussed. If the Drinking Water Agency verbally agrees that the sample is not representative of the water quality, they will direct you as to what certain steps need to be taken (e.g., proof, additional samples, etc.). Ultimately, the Drinking Water Agency will recommend to the Compliance or Regulatory division whether or not a sample should be invalidated. Failure to get the Drinking Water Agency's concurrence will result in your request being rejected by the Compliance or Regulatory division.
3. A formal written request must be mailed to the **Drinking Water Agency** and Compliance or Regulatory division within four weeks of the original routine sample collection date. The written documentation must state the specific cause of the total coliform positive sample and what action the supplier has taken, or will take, to correct this problem. The official State water or health agency will provide a written notification to the WS or PWS as to whether or not the request for invalidation was granted.

The State water or health agency will not invalidate a total coliform positive sample solely on the grounds that all repeat samples are total coliform negative.

How soon do I have to initiate the invalidation process?

At the time of receiving notice of positive results, the WS or PWS should immediately begin an investigation and collect repeat samples. At that time, any reason to question validity of a result should be acted on promptly while the situation is fresh at hand.

If a sample is invalidated by the State water or health agency or the certified laboratory does it still count towards meeting the monthly monitoring requirements?

No. You **MUST** collect another routine sample to replace any invalidated routine sample. To confirm the sample purpose look at the reporting form.

Remember that all routine samples are marked with a sample purpose of "Routine" on the reporting form. The replacement sample(s) **MUST** be collected within the same monitoring period (same month). Repeat samples cannot be used to meet this requirement. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

My repeat sample is invalid. Now what?

If one or more repeat samples in a set are invalid, the whole repeat monitoring process must begin over starting with the collection of a new "set" (3 or 4) of repeat samples within 24 hours. Every consecutive set of repeat samples should be collected at the same locations as the 1st set of repeats.

Interpretation of Results

How do I know if the sample is satisfactory?

The laboratory will determine if any bacteria are present in your sample(s). If no bacteria are present the sample is considered satisfactory with a (S) recorded on the reporting form.

If bacteria are detected in the sample, the laboratory will record the number of colonies (if using the membrane filter technique) and analyze the sample to see if the bacteria are coliform. If the bacteria are determined to be coliform the laboratory will use the designation of "P" (positive). If no coliform is detected, the designation will be given as "N" (negative). *Any sample with a non-coliform bacteria count of 200 colonies or less is considered a satisfactory (S) sample.*

If any coliform bacteria are found, the sample is positive and requires collection of repeat samples as described in – **Repeat Samples / Follow-up to Coliform Positive Samples**. Additional tests are performed on the original total coliform positive sample to determine if fecal coliform or *E. coli* is present. This result is also recorded on the reporting form with a P or N.

A sample analyzed by the membrane filter technique is deemed invalid (I) in the following scenarios:

1. Samples are negative for coliform but exhibit confluent growth. Confluent growth is continuous bacterial growth covering all or part of a membrane filter.
2. Samples are negative for coliform but bacteria colonies are too numerous to count (reported as G- or TNTC by the laboratory). Submission of replacement sample(s) is required. When using the multiple fermentation tube procedure or the presence-absence procedure, if the media is turbid with no production of gas or acid, the sample also is invalidated with replacement sample(s) required.

How long must I keep coliform results and other related paperwork?

5 years. Records of total coliform analyses must be kept for no less than five (5) years. The actual laboratory reports may be kept or the data may be transferred to tabular summaries. Local procedures may contain requirements concerning the retention of records. The most stringent requirement should be followed. Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

Laboratory Related Questions

Can we have our coliform samples analyzed anywhere?

No. A laboratory certified by your State Drinking Water Agency or Health Department must analyze samples. A sample analyzed at a laboratory that is not certified cannot be used for compliance.

What laboratory methods are used for analyzing coliform samples?

WS or PWS must conduct total coliform analyses in accordance with one of the analytical methods in the following table:

Organism Methodology

Total Coliforms Total Coliform Fermentation Technique
Total Coliform Membrane Filter Technique
Presence-Absence (P-A) Coliform Test
ONPG-MUG Test (Colilert)
Colisure Test
E*Colite® Test
m-ColiBlue24® Test
Readycult coliform 100 Presence/Absence
Colitag® Test

Always check with your Agency to ensure this rule is correct, for this rule is different in some States.

Do we need to use any special reporting forms when submitting samples to the laboratory?

Yes. These forms can be obtained by calling your **certified laboratory**. The reporting forms should be included with the bottles.

Is the water system or the laboratory responsible for getting results to the State water or health agency?

The water system. Regardless of whether a State or private laboratory is used, the WS or PWS is ultimately held accountable. It is very important that the WS or PWS is in frequent contact with the laboratory to confirm: the samples reach the laboratory, the status of results (positive vs. negative), and the results are sent to the official State water or health agency in a timely manner (within 10 days of the sampling period).

Post Quiz

Answers are found at the end of the References, near the last page

This is not your final assignment.

The final Assignment is found at <https://www.abctlc.com/downloads/PDF/TCRASS.pdf>

True or False

1. Total coliforms are a group of closely related viruses that are (with few exceptions) not harmful to humans. They are an indicator of other pathogens that can be present in water.
2. Coliform bacteria are present in the blood stream of warm-blooded animals. They are shed from the body in the feces. Because these organisms are shed from the body in large numbers and are relatively easy to detect in the laboratory, they have been accepted as a guideline of contamination.
3. All bacteriological samples are analyzed for the coliform group; however, a positive reaction to these coliform analyses may be from sources other than fecal. In order to differentiate between these sources, all samples that are total coliform positive must be analyzed again to determine if fecal coliform or *E. coli* are present.
4. To comply with the monthly MCL for total coliforms (TC), PWSs must not find coliforms in more than fifty percent of the samples they take each month to meet EPA's standards. If more than twenty percent of the samples contain coliforms, PWS operators must report this violation to the state and the public.
5. If a sample tests positive for TC, the system must collect a set of repeat samples located within 10 or fewer sampling sites adjacent to the location of the routine positive sample within 48 hours.
6. When a routine or repeat sample tests positive for total coliforms, it must also be analyzed for fecal coliforms or *E. coli*, which are types of coliform bacteria that are directly associated with fresh feces.
7. A positive result for fecal coliforms or *E. coli* can signify an acute MCL violation, which necessitates rapid state and public notification because it represents a direct health risk.
8. At times, an acute violation due to the presence of fecal coliform or *E. coli* may result in a "boil water" notice. The system must also take at least 5 routine samples the next month of operation if any sample tests positive for total coliforms.

9. A coliform sample site plan is a list of sites by street address, lot number, or other permanent description, that identifies all the approved locations where your routine (monthly) coliform samples may be collected. The list of sites must be plotted on a map of your service area.

10. Small water systems shall divide their distribution system into specific sample areas.

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Post Quiz

Answers are found...

1. False, 2. False, 3. True, 4. False, 5. False, 6. True, 7. True, 8. True, 9. True, 10. False



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