

APPENDIX A¹
SAMPLING AND ANALYTICAL METHODOLOGY

401-A ALTERNATIVE ANALYTICAL TECHNIQUES

With written permission of the Director, concurred in by the Administrator of the EPA, an alternate analytical technique may be employed. An alternate technique shall be accepted if it is substantially equivalent to the prescribed test in both precision and accuracy as it relates to the determination of compliance with any MCL. The use of the alternate analytical technique shall not decrease the frequency of sampling required by these regulations.

402-A MICROBIOLOGICAL SAMPLING AND ANALYTICAL REQUIREMENTS

A. ANALYTICAL METHODOLOGY

1. The standard sample volume required for total coliform analysis, regardless of analytical method used, is 100 ml.
2. Public water systems need only determine the presence or absence of total coliforms; a determination of total coliform density is not required.
3. Public water systems must conduct total coliform analyses in accordance with one of the analytical methods in the following table or one of the alternative methods listed in Appendix A to subpart C of 40 CFR pt. 141:

Table 400-A-1 Analytical Methods for Total Coliform

Organism	Methodology ¹	Citation ²
Total coliforms ³	Total Coliform Fermentation Technique ^{4,5,6} Total Coliform Membrane Filter Technique ⁷ Presence-Absence (P-A) Coliform Test ^{6,8} ONPG-MUG Test ⁹ Colisure Test ¹⁰ E*Colite7 Test ¹¹ m-ColiBlue247 Test ¹²	9221 A, B 9222 A, B, C 9221 9223

The procedures shall be done in accordance with the documents listed below. Copies of the documents may be obtained from the sources listed below. Information regarding obtaining these documents can be obtained from the Safe Drinking Water Hotline at 800-426-4791. Documents may be inspected at EPA's Drinking Water Docket, 1200 North Capitol Street, NW, Suite 700, Washington D.C. 20460 (Telephone: 202-260-3027); or at the Office of the Federal Register, 800 North Capitol Street, NW, Suite 700, Washington D.C. 20408.

¹ EPA strongly recommends that laboratories evaluate the false-positive and negative rates for the method(s) they use for monitoring total coliforms. EPA also encourages laboratories to establish false-positive and false-negative rates within their own laboratory and sample matrix (drinking water or source water) with the intent that if the method they choose has an unacceptable false-positive or negative rate, another method can be used. The Agency suggests that laboratories perform these studies on a minimum of 5% of all total coliform-positive samples, except for those methods where verification/confirmation is already required, e.g., the M-Endo and LES Endo Membrane Filter Tests, Standard Total Coliform Fermentation Technique, and Presence-Absence Coliform Test. Methods for establishing false-positive and negative-rates may be based on lactose fermentation, the rapid test for β-galactosidase and cytochrome oxidase, multi-test identification systems, or equivalent confirmation tests. False-positive and false-negative information is often available in published studies and/or from the manufacturer(s).

² Methods 9221 A, B,; 9222 A, B, C; 9221 D and 9223 are contained in *Standard Methods for the Examination of Water and Wastewater*, 18th Edition (1992) and 19th Edition (1995) American Public Health Association, 1015 Fifteenth Street NW, Washington D.C. 20005; Either edition may be used.

¹ In addition to all methods specifically referenced in the Appendices A - G, NNEPA incorporates by reference the methods identified by USEPA on its website as approved analytical methods, for the purposes for which those methods are identified, as those methods may be updated from time to time. The USEPA website may be found at: www.epa.gov/safewater.

³ The time from sample collection to initiation of analysis may not exceed 30 hours. Systems are encouraged but not required to hold samples below 10EC during transit.

⁴ Lactose broth, as commercially available, may be used in lieu of lauryl tryptose broth, if the system conducts at least 25 parallel tests between this medium and lauryl tryptose broth using the water normally tested, and this comparison demonstrates that the false-positive rate for total coliforms, using lactose broth, is less than 10%.

⁵ If inverted tubes are used to detect gas production, the media should cover these tubes at least one-half to two-thirds after the sample is added.

⁶ No requirements exist to run the completed phase on 10% of all total coliform-positive confirmed tubes.

⁷ MI agar also may be used. Preparation and use of MI agar is set forth in the article, "New medium for the simultaneous detection of total coliform and *Escherichia coli* in water" by Brenner, K.P., et al., 1993, Appl. Environ. Microbiol. 59:3534-3544. Also available from the Office of Water Resource Center (RC-4100), 401 M. Street SW, Washington, DC 20460, EPA/600/J-99/225.

⁸ Six-times formulation strength may be used if the medium is filter-sterilized rather than autoclaved.

⁹ The ONPG-MUG Test is sometimes referred to as the Autoanalysis Colilert System.

¹⁰ A description of the Colisure Test, Feb 28, 1994, may be obtained from IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092. The Colisure Test may be read after an incubation time of 24 hours.

¹¹ A description of the E*Colite7 Test, "Presence/Absence for Coliforms and *E. Coli* in Water," Dec 21, 1997 is available from Charm Sciences, Inc., 36 Franklin Street, Malden, MA 02148-4120.

¹² A description of the m-ColiBlue247 Test, Aug 17, 1999, is available from the Hach Company, 100 Dayton Avenue, Ames, IA 50010.

B. Public water systems must conduct fecal coliform analysis in accordance with the following procedure.

1. When the MTF Technique or Presence-Absence (PA) Coliform Test is used to test for total coliforms, shake the lactose-positive presumptive tube or P-A vigorously and transfer the growth with a sterile 3-mm loop or sterile applicator stick into brilliant green lactose bile broth and EC medium to determine the presence of total and fecal coliforms, respectively.

2. For EPA-approved analytical methods which use a membrane filter, transfer the total coliform-positive culture by one of the following methods:

a. Remove the membrane containing the total coliform colonies from the substrate with a sterile forceps and carefully curl and insert the membrane into a tube of EC medium (the laboratory may first remove a small portion of selected colonies for verification), swab the entire membrane filter surface with a sterile cotton swab and transfer the inoculum to EC medium (do not leave the cotton swab in the EC medium), or inoculate individual total coliform-positive colonies into EC Medium. Gently shake the inoculated tubes of EC medium to insure adequate mixing and incubate in a waterbath at $44.5 \pm 0.2^\circ\text{C}$ for 24 ± 2 hours. Gas production of any amount in the inner fermentation tube of the EC medium indicates a positive fecal coliform test.

b. The preparation of EC medium is described in the 18th edition (1992) and 19th edition (1995) of *Standard Methods for the Examination of Water and Wastewater*, Method 9221E (paragraph 1a), either edition may be used.

c. Public water systems need only determine the presence or absence of fecal coliforms; a determination of fecal coliform density is not required.

C. Public water systems must conduct analysis of *Escherichia coli* in accordance with one of the following analytical methods or one of the alternative methods listed in Appendix A to subpart C of 40 C.F.R. pt. 141:

1. EC medium supplemented with 50 µg/ml of 4-methylumbelliferyl-beta-D-glucuronide (MUG) (final concentration). EC medium is described in as referenced in subsection (B)(2)(b) of this section. MUG may be added to EC medium before autoclaving. EC medium supplemented with 50 µg/ml of MUG is commercially available. At least 10 ml of EC medium supplemented with MUG must be used. The inner inverted fermentation tube may be omitted. The procedure for transferring a total coliform-positive culture to EC medium supplemented with MUG shall be as specified in subsection (B)(2) of this section for transferring a total coliform-positive culture to EC medium. Observe fluorescence with an ultraviolet light (366 nm) in the dark after incubating tube at $44.5 \pm 0.2^\circ\text{C}$ for 24 ± 2 hours; or

2. Nutrient agar supplemented with 100 µg/ml 4-methylumbelliferyl-beta-D-glucuronide (MUG) (final concentration). Nutrient Agar is described in Method 9221B (paragraph 3) in *Standard*

Methods for the Examination of Water and Wastewater, 18th edition, 1992 and in the 19th edition, 1995; either edition may be used. This test is used to determine if a total coliform-positive sample, as determined by the Membrane Filter technique or any other method in which a membrane filter is used, contains *E. coli*. Transfer the membrane filter containing a total coliform colony(ies) to nutrient agar supplemented with 100µg/ml (final concentration) of MUG. After incubating the agar plate at 35°C for 4 hours, observe the colony(ies) under ultraviolet light (366 nm) in the dark for fluorescence. If fluorescence is visible, *E. coli* are present.

3. Minimal Medium ONPG-MUG (MMO-MUG) Test, as set forth in the article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Detection of Total Coliforms and *Escherichia coli* from Drinking Water: Comparison with Presence-Absence Techniques" (Edberg et al.), *Applied and Environmental Microbiology*, Volume 55, pp. 1003-1008, April 1989. (Note: The Autoanalysis Colilert System is an MMO-MUG test). If the MMO-MUG test is total coliform-positive after a 24-hour incubation, test the medium for fluorescence with a 366 nm ultraviolet light (preferably with a 6 watt lamp) in the dark. If fluorescence is observed, the sample is *E. coli*-positive. If fluorescence is questionable (cannot be definitively read) after 24 hours incubation, incubate the culture for an additional four hours (but not to exceed 28 hours total), and again test the medium for fluorescence. The MMO-MUG Test with hepes buffer in lieu of phosphate buffer is the only approved formulation for the detection of *E. coli*.
 4. The Colisure Test. A description of the Colisure Test may be obtained from the Millipore Corporation, Technical Services Department, 80 Ashby Road, Bedford MA, 01730.
 5. The membrane filter method with MI agar.
 6. E*Colite® Test, a description of which is cited in footnote 10 to Table 400-A-1 in subsection (A)(3) of this section.
 7. m-ColiBlue24® Test, a description of which is cited in footnote 11 to Table 400-A-1 in subsection (A)(3) of this section.
- D. As an option to subsection(C)(iii) of this section, a system with a total coliform-positive, MUG-negative, MMO-MUG test may further analyze the culture for the presence of *E. coli* by transferring a 0.1 ml, 28-hour MMO-MUG culture to EC Medium + MUG with a pipet. The formulation and incubation conditions of EC Medium + MUG, and observation of the results are described in subsection (C)(1) of this section.
- E. The following materials are incorporated by reference in this section with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of the analytical methods cited in *Standard Methods for the Examination of Water and Wastewater* (18th and 19th editions) may be obtained from the American Public Health Association et al.; 1015 Fifteenth Street, NW.; Washington, DC 20005. Copies of the methods set forth in *Microbiological Methods for Monitoring the Environment, Water and Wastes* may be obtained from ORD Publications, U.S. EPA, 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. Copies of the MMO-MUG Test as set forth in the article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and *Escherichia coli* from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method" (Edberg et al.) may be obtained from the American Water Works Association Research Foundation, 6666 West Quincy Avenue, Denver, CO 80235. A description of the Colisure Test may be obtained from the Millipore Corp., Technical Services Department, 80 Ashby Road, Bedford, MA 01730. Copies may be inspected at EPA's Drinking Water Docket; 401 M Street, SW.; Washington, DC 20460, or at the Office of the Federal Register; 800 North Capitol Street, NW.; Suite 700; Washington, DC 20408.

403-A INORGANIC CHEMICAL SAMPLING AND ANALYTICAL REQUIREMENTS

TABLE 400-A-2 DETECTION LIMITS FOR INORGANIC CHEMICALS

CONTAMINANT	MCL (mg/l)	METHODOLOGY	DETECTION LIMIT (mg/l)
ANTIMONY	0.006	Atomic Absorption: Furnace Atomic Absorption: Platform ICP-Mass Spectrometry Hydride-Atomic Absorption	0.003 0.0008 ⁵ 0.0004 0.001

ARSENIC	⁶ 0.010	Atomic Absorption; Furnace Atomic Absorption; Platform--Stabilized Temperature. Atomic Absorption; Gaseous Hydride ICP-Mass Spectrometry	0.001 ⁷ 0.0005 0.001 ⁸ 0.0014
ASBESTOS	7 MFL ¹	Transmission Electron Microscopy	0.01 MFL
BARIUM	2	Atomic Absorption: furnace technique Atomic Absorption: direct aspiration Inductively Coupled Plasma	0.002 0.1 0.002 (0.001)
BERYLLIUM	0.004	Atomic Absorption: Furnace Atomic Absorption: Platform Inductively Coupled Plasma ² ICP-Mass Spectrometry.	0.0002 0.00002 ⁵ 0.0003 0.0003
CADMIUM	0.005	Atomic Absorption: furnace technique Inductively Coupled Plasma	0.0001 0.001
CHROMIUM	0.1	Atomic Absorption: furnace technique Inductively Coupled Plasma	0.001 0.007 (0.001)
CYANIDE	0.2	Distillation, Spectrophotometric ³ Distillation: Automated, Spectrophotometric ³ Distillation, Selective Electrode ³ Distillation, Amenable, Spectrophotometric ⁴	0.02 0.005 0.05 0.02
MERCURY	0.002	Manual Cold Vapor Technique Automated Cold Vapor Technique	0.0002 0.0002
NICKEL	x1	Atomic Absorption: Furnace Atomic Absorption: Platform Inductively Coupled Plasma ² ICP-Mass Spectrometry	0.001 0.0006 ⁵ 0.005 0.0005
NITRATE	10 (as N)	Manual Cadmium Reduction Automated Hydrazine Reduction Automated Cadmium Reduction Ion Selective Electrode Ion Chromatography	0.01 0.01 0.05 1 0.01
NITRITE	1 (as N)	Spectrophotometric Automated Cadmium Reduction Manual Cadmium Reduction Ion Chromatography	0.01 0.05 0.01 0.004
SELENIUM	0.05	Atomic Absorption: furnace Atomic Absorption: gaseous hydride	0.002 0.002

¹ MFL = million fibers per liter > 10 micrometers

² Using a 2X preconcentration step as noted in Method 200.7. Lower MDLs may be achieved when using a 4X preconcentration.

³ Screening method for total cyanides.

⁴ Measures "free" cyanides.

⁵ Lower MDLs are reported using stabilized temperature graphite furnace atomic absorption.

⁶ The value for arsenic is effective January 23, 2006. Until then, the MCL is 0.05 mg/L.

⁷ The MDL reported for EPA Method 200.9 (Atomic Absorption; Platform - Stabilized Temperature) was determined using a 2x concentration step during sample digestion. The MDL determined for samples analyzed using direct analyses (i.e. no sample digestion) will be higher. Using multiple depositions, EPA 200.9 is capable of obtaining MDL of 0.0001 mg/L.

⁸ Using selective ion monitoring, EPA method 200.8 (ICP-MS) is capable of obtaining a MDL of 0.0001 mg/L.

A. Inorganic Analysis:

1. Analysis for the following contaminants shall be conducted in accordance with the methods in the Table 400-A-3, or their equivalent as determined by EPA. Criteria for analyzing arsenic, barium, beryllium, cadmium, calcium, chromium, copper, lead, selenium, sodium, and thallium with digestion or directly without digestion, and other analytical test procedures are contained in *Technical Notes on Drinking Water Methods*, EPA-600/R-94-173, October 1994. This document also contains approved analytical test methods which remain available for compliance monitoring until July, 1996. These methods will not be available for use after July 1, 1996. This document is available from the National Technical Information Service, NTIS PB95-104766, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161 (1-800-553-6847).

TABLE 400-A-3 INORGANIC CONTAMINANTS ANALYTICAL METHODS

CONTAMINANT	METHODOLOGY	EPA	ASTM ³	SM ⁴	SM online ²²	OTHER
Antimony	Atomic Absorption; Furnace			3113 B		
	Atomic Absorption; Platform	² 200.9				
	ICP-Mass Spectrometry	² 200.8				
	Hydride-Atomic Absorption		D-3697-92			
Arsenic	Inductively Coupled Plasma	² 200.7		¹⁵ 3120 B		
	ICP-Mass Spectrometry	² 200.8				
	Atomic Absorption; Platform	² 200.9				
	Atomic Absorption; Furnace		D-2972-97,03 C	3113 B	3113B-99	
	Hydride Atomic Absorption		D-2972-97,03 B	3114 B	3114B-97	
Asbestos	Transmission Electron Microscopy	⁹ 100.1				
	Transmission Electron Microscopy	¹⁰ 100.2				
Barium	Inductively coupled plasma	² 200.7		3120 B		
	ICP Mass Spectrometry	² 200.8				
	Atomic Absorption; Direct			3111 D		
	Atomic Absorption; Furnace			3113 B		
Beryllium	Atomic Absorption; furnace		D-3645-93B	3113 B		
	Atomic Absorption; platform	² 200.9				
	Inductively Coupled Plasma	² 200.7		3120 B		
	ICP-Mass Spectrometry	² 200.8				
Cadmium	Inductively Coupled plasma	² 200.7				
	ICP Mass Spectrometry	² 200.8				
	Atomic Absorption; Platform	² 200.9				
	Atomic Absorption; Furnace			3113 B		
Chromium	Inductively Coupled Plasma	² 200.7		3120 B		
	ICP-Mass Spectrometry	² 200.8				
	Atomic Absorption; Platform	² 200.9				
	Atomic absorption; Furnace			3113 B		
Cyanide	Manual Distillation followed by		D2036-98A	4500-CN-C		
	Spectrophotometric, Amenable		D-2036-98B	4500-CN-G		
	Spectrophotometric Manual		D-2036-98A	4500-CN-E		I-3300-85 ⁵
	Spectrophotometric Semi-Automated Selective Electrode	⁶ 335.4			4500-CN-F	
Fluoride	Ion Chromatography	⁶ 300.0	D4327-91	4110B		

	Manual Distill; color. SPADNS			4500F-B, D	
	Manual Electrode		D1179-93B	4500F-C	
	Automated Electrode				380-75 WE ¹¹
	Automated Alizarin			4500F-E	129-71 W ¹¹
	Capillary Ion Electrophoresis				D6508, Rev. 2 ²³
Mercury	Manual cold vapor	² 245.1	D3223-97, 02	3112 B	
	Automated cold vapor	¹ 245.2			
	ICP-Mass Spectrometry	² 200.8			
Nickel	Inductively Coupled Plasma	² 200.7		3120B	
	ICP-Mass Spectrometry	² 200.8			
	Atomic Absorption; Platform	² 200.9			
	Atomic Absorption; Direct			3111B	
	Atomic Absorption; Furnace			3113B	
Nitrate	Ion chromatography	⁶ 300.0	D4327-97, 03	4110B	B-1011 ⁸
	Automated cadmium reduction	⁶ 353.2	D3867-90A	4500-NO ₃ -F	
	Ion selective electrode			4500-NO ₃ -D	601 ⁷
	Manual cadmium reduction		D3867-90B	4500-NO ₃ -E	
	Capillary Ion Electrophoresis				D6508, Rev. 2 ²³
Nitrite	Ion chromatography	⁶ 300.0	D4327-97, 03	4110B	B-1011 ⁸
	Automated cadmium reduction	⁶ 353.2	D3867-90A	4500-NO ₃ -F	
	Manual cadmium reduction		D3867-90B	4500-NO ₃ -E	
	Spectrophotometric			4500-NO ₂ -B	
	Capillary Ion Electrophoresis				D6508, Rev. 2 ²³
Selenium	Hydride-Atomic Absorption		D3859-93A	3114B	
	ICP Mass Spectrometry	² 200.8			
	Atomic Absorption; Platform	² 200.9			
	Atomic absorption; Furnace		D3859-98B, 03	3113B	
Thallium	Atomic Absorption; Platform	² 200.9			
	ICP-Mass Spectrometry	² 200.8			
Lead	Atomic Absorption; furnace		D3559-95D	3113B	
	ICP Mass Spectrometry	² 200.8			
	Atomic Absorption; platform	² 200.9			
	Differential Pulse Anodic Stripping Voltametry				Method 1001 ¹⁵
Copper	Atomic absorption; furnace		D1688-95C	3113B	
	Atomic absorption; direct aspiration		D1688-95A	3111B	
	ICP	² 200.7		3120B	
	ICP-Mass Spectrometry	² 200.8			
	Atomic absorption; platform	² 200.9			
Conductivity	Conductance		D1125-95A	2510B	
Alkalinity	Trisrimetric		D1067-92B	2320B	
	Electrometric titration				I-1030 -85 ⁵
Calcium	EDTA titrimetric		D511-93 A	3500-Ca- D	
	Atomic Absorption; direct aspiration		D511-93 B	3111B	
	Inductively-coupled plasma	² 200.7		3120B	
	Ion Chromatography		D6919-03		
Magnesium	Atomic Absorption		D 511-93, 03B	3111 B	
	ICP	² 200.7		3120 B	
	Complexation Titrimetric Methods		D 511-93, 03A	3500-Mg E	
	Ion Chromatography		D6919-03		
Orthophos-ph ate ¹²	Colorimetric, automated, ascorbic acid	⁶ 365.1		4500-P F	
	Colorimetric, ascorbic acid, single reagent		D515-88A	4500-P E	
	Colorimetric, phosphomolybdate				I-1602 -85 ⁵

	automated-segmented flow;				I-2601-90 ⁵
	automated discrete				I-2598-85 ⁵
	Ion chromatography	⁶ 300.0	D4327-97, 03	4110 B	
	Capillary Ion Electrophoresis				D6508, Rev. 2 ²³
pH	Electrometric	¹ 150.1 ¹ 150.2	D1293-95	4500-H+-B	
Silica	Colorimetric, molybdate blue;				I-1700-85 ⁵
	automated-segmented flow				I-2700-85 ⁵
	Colorimetric		D859-94, 00		
	Molybdosilicate			4500-Si-D	
	Heteropoly blue			4500-Si-E	
	Automated method for molybdate-reactive silica			4500-Si-F	
	Inductively-couple plasma	³ 200.7		3120B	
Sodium	Inductively-coupled plasma	² 200.7			
	Atomic Absorption; direct aspiration			3111B	
	Ion chromatography		D6919-03		
Temperature	Thermometric			2500B	

The procedures shall be done in accordance with the documents listed below. Copies of the documents may be obtained from the sources listed below. Information regarding obtaining these documents can be obtained from the Safe Drinking Water Hotline 800-426-4791. Documents may be inspected at EPA's Drinking Water Docket, EPA West, 1301 Constitution Avenue, NW, Room B135, Washington, D.C. (Telephone: 202-566-2426); or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, Call 202-741-6030, or go to: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.

¹ "Method for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, March 1983. Available at NTIS, PB84-128677.

² "Methods for the Determination of Metals in Environmental Samples-Supplement I", EPA-600/R-94-111, May 1994. Available at NTIS, PB 95-125472.

³ Annual Book of ASTM Standards, 1994, 1996, 1999 or 2003, Vols. 11.01 and 11.02, ASTM International; any year containing the cited version of the method may be used. The previous versions of D1688-95A, D1688-95C (copper), D3559-95D (lead), D1293-95 (pH), D1125-91A (conductivity) and D859-94 (silica) are also approved. These previous versions D1688-90A, C; D3559-90D, D1293-84, D1125-91A and D859-88, respectively are located in the Annual Book of ASTM Standards, 1994, Vol. 11.01. Copies may be obtained from the ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

⁴ Standard Methods for the Examination of Water and Wastewater, 18th edition (1992), 19th edition (1995), or 20th edition (1998). American Public Health Association 1015 Fifteenth Street NW, Washington, DC 20005. The cited methods published in any of these three editions may be used, except that the versions of 3111B, 3111D, 3113B and 3114B in the 20th edition may not be used.

⁵ Method I-2601-90, Methods for Analysis by the U.S. Geological Survey National Water Quality Laboratory - Determination of Inorganic and Organic Constituents in Water and Fluvial Sediments, Open File Report 93-125, 1993; For Methods I-1030-85; I-1601-85; I-1700-85; I-2598-85; I-2700-85; and I-3300-85 see Techniques of Water Resources Investigation of the U.S. Geological Survey, Book 5 Chapter A-1, 3rd ed., 1989; Available from Information Services, U.S. Geological Survey, Federal Center, Box 25286, Denver, CO 80225-0425.

⁶ "Methods for the Determination of Inorganic Substances in Environmental Samples", EPA 600/R-93-100, August 1993, Available at NTIS, PB94-120821.

⁷ The procedure shall be done in accordance with the Technical Bulletin 601 "Standard Method of Test for Nitrate in Drinking Water", July, 1994, PN 221890-001, Analytical Technology, Inc. Copies may be obtained from ATI Orion, 529 Main Street, Boston, MA 02129.

⁸ Method B-1011, "Waters Test Method for Determination of Nitrite/Nitrate in Water Using Single Column Ion Chromatography" August 1987. Copies may be obtained from Waters Corporation, Technical Services Division, 34 Maple Street, Milford, MA 01757, Telephone 508/482-2131, Fax 508/482-3625.

⁹ Method 100.1 "Analytical Method for Determination of Asbestos Fibers in Water," EPA-600/4-83/043, September 1983, Available at NTIS, PB83-260471.

¹⁰ Method 100.2, "Determination of Asbestos Structure Over 10-µm in Length in Drinking Water", EPA-600/R-94-134, June 1994, Available at NTIS, PB94-201902.

¹¹ Industrial Method No. 129-71W, "Fluoride in Water and Wastewater," December 1972 and Method No. 380-75WE, "Fluoride in Water and Wastewater," February 1976, Technicon Industrial Systems. Copies may be obtained from Bran & Leubbe, 1025 Busch Parkway, Buffalo Grove, IL 60089.

¹² Unfiltered, no digestion or hydrolysis.

¹³ Because MDLs reported in EPA Methods 200.7 and 200.9 were determined using a 2X preconcentration step during sample digestion, MDLs determined when samples are analyzed by direct analysis (i.e., no sample digestion) will be higher. For direct analysis of cadmium by Method 200.7, sample preconcentration using pneumatic nebulization may be required to achieve lower detection limits. Preconcentration may also be required for direct analysis of antimony, lead, and thallium by Method 200.9; antimony and lead by Method 3113 B; and lead by Method D3559-90D unless multiple in-furnace depositions are made.

¹⁴ If ultrasonic nebulization is used in the determination of arsenic by Method 200.8, or SM 3120 B, the arsenic must be in the pentavalent state to provide uniform signal response. For direct analysis of arsenic with method 200.8 using ultrasonic nebulization, samples and standards must contain one mg/L of sodium hypochlorite.

¹⁵ Reserved.

¹⁶ The description for Method Number 1001 for lead is available from Palintest, LTD, 21 Kenton Lands Road, P.O. Box 18395, Erlanger, KY 41018 or from the Hach Company, P.O. Box 389, Loveland, CO 80539.

¹⁷ The description for the Kelada 01 Method, "Kelada Automated Test Methods for Total Cyanide, Acid Dissociable Cyanide, and Thiocyanate," Revision 1.2, August 2001, EPA #821-B-01-009 for cyanide is available from the National Technical Information Service (NTIS), PB 2001-108275, 5282 Port Royal Road, Springfield, VA 22161. The toll free telephone number is 800-553-6847. Note: A 450-W UB lamp may be used in this method instead of the 550-W lamp specified if it provides performance within the quality control (QC) acceptance criteria of the method in a given instrument. Similarly, modified flow cell configurations and flow conditions may be used in the method, provided that the QC acceptance criteria are met.

¹⁸ The description for the QuikChem Method 10-204-001-X, "Digestion and distillation of total cyanide in drinking and wastewaters using MICRO DIST and determination of cyanide by flow injection analysis," Revision 2.1, November 30, 2000 for cyanide is available from Lachat Instruments, 6645 W. Mill Rd, Milwaukee, WI 53218, USA. Phone 414-358-4200.

¹⁹ "Methods for the Determination of Organic and Inorganic Compounds in Drinking Water," Vol. 1, EPA 815-R-00-014, August 2000. Available at NTIS, PB2000-106981.

²⁰ Method OIA-1677, DW "Available Cyanide by Flow Injection, Ligand Exchange, and Amperometry," January 2004. EPA-821-R-04-001, Available from ALPKEM, A Division of OI Analytical, P.O. Box 9010, College Station, TX 77842-9010.

²¹ Sulfide levels below those detected using lead acetate paper may produce positive method interferences. Test samples using a more sensitive sulfide method to determine if a sulfide interference is present, and treat samples accordingly.

²² Standards Methods Online are available at <http://www.standardmethods.org>. The year in which each method was approved by the Standard Methods Committee is designated by the last two digits in the method number. The methods listed are the only online versions that may be used.

²³ Method D6508, Rev. 2, "Test Method for Determination of Dissolved Inorganic Anions in Aqueous Matrices Using Capillary ion Electrophoresis and Chromate Electrolyte," Available from Waters Corp, 34 Maple St. Milford, MA, 07157, Telephone: 508/482-2131, Fax: 508/482-3625.

B. Sample collection for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, nitrate, nitrite, selenium and thallium under this section shall be conducted using the sample preservation, container, and maximum holding time procedures specified in the table below:

TABLE 400-A-4 SAMPLE COLLECTION PROCEDURE

CONTAMINANT	PRESERVATIVE ¹	CONTAINER ²	TIME ³
Antimony	HNO ₃	P or G	6 months
Arsenic	Conc HNO ₃ to pH < 2	P or G	6 months
Asbestos	4°C	P or G	48 hours ⁴
Barium	HNO ₃	P or G	6 months
Beryllium	HNO ₃	P or G	6 months
Cadmium	HNO ₃	P or G	6 months
Chromium	HNO ₃	P or G	6 months
Cyanide	4°C, NaOH	P or G	14 days
Fluoride	NONE	P or G	1 month

Mercury	HNO ₃	P or G	28 days
Nickel	HNO ₃	P or G	6 months
Nitrate	4°C	P or G	48 hours ⁵
Nitrate-Nitrite ⁶	H ₂ SO ₄	P or G	28 days
Nitrite	4°C	P or G	48 hours
Selenium	HNO ₃	P or G	6 months
Thallium	HNO ₃	P or G	6 months

¹ For cyanide determinations samples must be adjusted with sodium hydroxide to pH 12 at the time of collection. When chilling is indicated the sample must be shipped and stored at 4 °C or less. Acidification of nitrate or metals samples may be with a concentrated acid or a dilute (50% by volume) solution of the applicable concentrated acid. Acidification of samples for metals analysis is encouraged and allowed at the laboratory rather than at the time of sampling provided the shipping time and other instructions in Section 8.3 of EPA Methods 200.7 or 200.8 or 200.9 are followed.

² P = plastic, hard or soft; G = glass, hard or soft.

³ In all cases, samples should be analyzed as soon after collection as possible. Follow additional (if any) information on preservation, containers, or holding times that is specified in method.

⁴ Instruction for containers, preservation procedures and holding times as specified in Method 100.2 must be adhered to for all compliance analyses including those conducted with Method 100.1.

⁵ If the sample is chlorinated, the holding time for an un-acidified sample kept at 4°C is extended to 14 days.

⁶ Nitrate-Nitrite refers to a measurement of total nitrate.

C. Analysis under this section shall only be conducted by laboratories that have been certified by EPA. Laboratories may conduct sample analysis under provisional certification until January 1, 1996. To receive certification to conduct analyses for antimony, arsenic, asbestos, barium, beryllium, cadmium, chromium, cyanide, fluoride, mercury, nickel, nitrate, nitrite, selenium and thallium, the laboratory must:

1. Analyze Performance Evaluation (PE) provided by EPA, at least once a year.
2. For each contaminant that has been included in the PE sample and for each method for which the laboratory desires certification achieve quantitative results on the analyses that are within the following acceptance limits:

TABLE 400-A-5 CONTAMINANT ACCEPTANCE LIMIT

CONTAMINANT	ACCEPTANCE LIMIT
Antimony	± 30 at ≥ 0.006 mg/l
Arsenic	± 30 at ≥ 0.003 mg/L
Asbestos	2 standard deviations based on study statistics
Barium	± 15% at ≥ 0.15 mg/l
Beryllium	± 15% at ≥ 0.001 mg/l
Cadmium	± 20% at ≥ 0.002 mg/l
Chromium	± 15% at ≥ 0.01 mg/l
Cyanide	± 25% at ≥ 0.1 mg/l
Fluoride	± 10% at ≥ 1 to 10 mg/l
Mercury	± 30% at ≥ 0.0005 mg/l
Nitrate	± 10% at ≥ 0.4 mg/l
Nitrite	± 15% at ≥ 0.4 mg/l

Selenium	± 20% at ≥ 0.01 mg/l
Thallium	± 30% at ≥ 0.002 mg/l

404-A ORGANIC CHEMICALS SAMPLING AND ANALYTICAL REQUIREMENTS

A. Analyses for the contaminants listed in § 204, Table 200.3 (1) through (21), shall be conducted using the following EPA methods or their equivalent as approved by EPA or the alternative methods listed in Appendix A to Subpart C of 40 C.F.R. pt. 141, or their equivalent as determined by EPA.

- The following documents are incorporated by reference. Copies may be inspected at EPA's Drinking Water Docket, 401 M Street, SW., Washington, DC 20460; at the Office of the Federal Register, 800 North Capitol Street, NW., Suite 700, Washington, DC. Method 508A and 515.1 are in *Methods for the Determination of Organic Compounds in Drinking Water*, EPA-600/R-88-039, December 1988, revised July 1991. Methods 547, 550 and 550.1 are in *Methods for the Determination of Organic Compounds in Drinking Water-Supplement I*, EPA-600-4-90-020, July 1990. Methods 548.1, 549.1, 552.1 and 555 are in *Methods for the Determination of Organic Compounds in Drinking Water-Supplement II*, EPA-600/R-92-129, August 1992. Methods 502.2, 504.1, 505, 506, 507, 508, 508.1, 515.2, 524.2, 525.2, 531.1, 551.1, and 552.2 are in *Methods for the Determination of Organic Compounds in Drinking Water-Supplement III*, EPA/600/R-95-131, August 1995. Method 1613 is titled "Tetra-through Octa-Chlorinated Dioxins and Furans by Isotope-Dilution HRGC/HRMS," EPA -821-B-94-005, October 1994. These documents are available from the NTIS PB91-231480, PB91-146027, PB92-207703, PB95-261616 and PB95-104774, US Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161 (1-800-553-6847). Method 6651 shall be followed in accordance with *Standard Methods for the Examination of Water and Wastewater*, 18th edition, 1992 and 19th edition, 1995, American Public Health Association (APHA); either edition may be used. Method 6610 shall be followed in accordance with the *Supplement to the 18th edition of Standard Methods for the Examination of Water and Wastewater*, 1994, or with the 19th edition of *Standard Methods for the Examination of Water and Wastewater*, 1995, APHA; either publication may be used. The APHA documents are available from APHA 1015, Fifteenth Street NW., Washington, D.C. 20005. Other required analytical test procedures germane to the conduct of these analyses are contained in *Technical Notes on Drinking Water Methods*, EPA 600/R-94-173, October 1994, NTIS PB95-104766. EPA Methods 515.3 and 549.2 are available from U.S. Environmental Protection Agency, National Exposure Research Laboratory (NERL)-Cincinnati, 26 West Martin Luther King Drive, Cincinnati, OH 45268. ASTM Method D 5317-93 is available in the *Annual Book of ASTM Standards*, 1996, Vol. 11.02, American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, or in any edition published after 1993.

TABLE: 400-A-6 ORGANIC CHEMICALS OTHER THAN TOTAL TRIHALOMETHANES SAMPLING AND ANALYTICAL METHODS

Contaminant	Method	Standard Methods	ASTM	Other
Benzene	502.2, 524.2			
Carbon Tetrachloride	502.2, 524.2, 551.1			
Chlorobenzene	502.2, 524.2			
1,2-Dichlorobenzene	502.2, 524.2			
1,4-Dichlorobenzene	502.2, 524.2			
1,2-Dichloroethane	502.2, 524.2			
cis-Dichloroethylene	502.2, 524.2			
trans-Dichloroethylene	502.2, 524.2			
1,2-Dichloropropane	502.2, 524.2			
Ethylbenzene	502.2, 524.2			

Styrene	502.2, 524.2			
Tetrachloroethylene	502.2, 524.2, 551.1			
1,1,1-Trichloroethane	502.2, 524.2, 551.1			
Trichloroethylene	502.2, 524.2, 551.1			
Toluene	502.2, 524.2			
1,2,4-Trichlorobenzene	502.2, 524.2			
1,1-Dichloroethylene	502.2, 524.2			
1,1,2-Trichloroethane	502.2, 524.2, 551.1			
Vinyl Chloride	502.2, 524.2			
Xylenes (total)	502.2, 524.2			
2,3,7,8-TCDD (dioxin)	1613			
2,4-D ⁴ (as acids, salts, and esters)	515.2, 555, 515.1, 515.3, 515.4		D5317-93, 98 (Reapproved 2003).	
2,4,5-TP ⁴ (Silvex)	515.2, 555, 515.1, 515.3, 515.4		D5317-93, 98 (Reapproved 2003).	
Alachlor ²	507, 525.2, 508.1, 505, 551.1			
Atrazine ²	507, 525.2, 508.1, 505, 551.1			Syngenta ⁵ AG-625
Benzo(a)pyrene	525.2, 550, 550.1			
Carbofuran	531.1, 531.2	6610		
Chlordane	508, 525.2, 508.1, 505			
Dalapon	552.1, 515.1, 552.2, 515.3, 515.4, 552.3			
Di(2-ethylhexyl)adipate	506, 525.2			
Di(2-ethylhexyl)phthalate	506, 525.2			
Dibromochloropropane (DBCP)	504.1, 551.1			
Dinoseb ⁴	515.2, 555, 515.1, 515.3, 515.4			
Diquat	549.2			
Endothall	548.1			
Endrin	505, 508, 525.2, 508.1, 551.1			
Ethylene dibromide (EDB)	504.1, 551.1			
Glyphosate	547	6651		
Heptachlor	505, 508, 525.2, 508.1, 551.1			
Heptachlor epoxide	505, 508, 525.2,			

	508.1, 551.1			
Hexachlorobenzene	505, 508, 525.2, 508.1, 551.1			
Hexachlorocyclopentadiene	505, 508, 525.2, 508.1, 551.1			
Lindane	505, 508, 525.2, 508.1, 551.1			
Methoxychlor	505, 508, 525.2, 508.1, 551.1			
Oxamyl	531.1, 531.2	6610		
PCBs ³ (as decachlorobiphenyl)	508A			
PCBs ³ (as Aroclors)	508A 505, 508, 508.1, 525.2			
Pentachlorophenol	515.2, 525.2, 555, 515.1, 515.3, 515.4		D5317-93, 98 (Reapproved 2003).	
Picloram ⁴	515.2, 555, 515.1, 515.3, 515.4		D5317-93, 98 (Reapproved 2003).	
Simazine ²	507, 525.2, 508.1, 505, 551.1			
Toxaphene	508, 508.1, 525.2, 505			
Total Trihalomethanes	502.2, 524.2, 551.1			

¹ Reserved.

² Substitution of the detector specified in Method 505, 507, 508, or 508.1 for the purpose of achieving lower detection limits is allowed as follows. Either an electron capture or nitrogen phosphorous detector may be used provided all regulatory requirements and quality control criteria are met.

³ PCBs are qualitatively identified as Aroclors and measured for compliance purposes as decachlorobiphenyl. Users of Method 505 may have more difficulty in achieving the required detection limits than users of Methods 508.1, 525.2 or 508.

⁴ Accurate determination of the chlorinated esters requires hydrolysis of the sample as described in EPA methods 515.1, 515.2, 515.3, and 555, and ASTM Method D 5317-93.

⁵ This method may not be used for the analyses of atrazine in any system where chlorine dioxide is used for drinking water treatment. In samples from all other systems, any result for atrazine generated by Method AG-625 that is greater than one-half the maximum contaminant level (MCL) (in other words, greater than 0.0015 mg/L or 1.5 µg/L) must be confirmed using another approved method for this contaminant and should use additional volume of the original sample collected for compliance monitoring. In instances where a result from Method AG-625 triggers such confirmatory testing, the confirmatory result is to be used to determine compliance.

B. Compositing samples prior to GC analysis.

1. Add 5 ml or equal larger amounts of each sample (up to 5 samples are allowed) to a 25 ml glass syringe. Special precautions must be made to maintain zero head-space in the syringe.
2. The samples must be cooled at 4° Celsius during this step to minimize volatilization losses.
3. Mix well and draw out a 5-ml aliquot for analysis.
4. Follow sample introduction, purging, and desorption steps described in the method.
5. If less than five samples are used for compositing, proportionately small syringe may be used.

C. Compositing samples prior to GC/MS analysis.

1. Inject 5-ml or equal larger amounts of each aqueous sample (up to 5 samples are allowed) into a 25-ml purging device using the sample introduction technique described in the method.
 2. The total volume of the sample in the purging device must be 25 ml.
 3. Purge and desorb as described in the method.
- D. Analysis under this section shall only be conducted by laboratories that are certified by EPA according to the following conditions (laboratories may conduct sample analysis under provisional certification until January 1, 1996):
1. To receive certification to conduct analyses for the contaminants in § 204 (A)(1) Table 200.3 (2) through (21) the laboratory must:
 - a. Analyze Performance Evaluation (PE) samples provided by EPA at least once a year by each method for which the laboratory desires certification.
 - b. Achieve the quantitative acceptance limits under subsection (E)(1)(c) and (d) of this section for at least 80% of the regulated organic chemicals listed in Table 200.3 (2) through (21).
 - c. Achieve quantitative results on the analyses performed under subsection (E)(1)(a) of this section that are within $\pm 20\%$ of the actual amount of the substances in the Performance Evaluation sample when the actual amount is greater than or equal to 0.010 mg/l.
 - d. Achieve quantitative results on the analyses performed under subsection (E)(1)(a) of this section that are within $\pm 40\%$ of the actual amount of the substances in the Performance Evaluation sample when the actual amount is less than 0.010 mg/l.
 - e. Achieve a method detection limit of 0.0005 mg/l, according to the procedures in Appendix B of 40 CFR Part 136.
 2. To receive certification for vinyl chloride, the laboratory must:
 - a. Analyze Performance Evaluation (PE) samples provided by EPA at least once a year by each method for which the laboratory desires certification.
 - b. Achieve quantitative results on the analyses performed under subsection (E)(2)(a) of this section that are within $\pm 40\%$ of the actual amount of vinyl chloride in the Performance Evaluation sample.
 - c. Achieve a method detection limit of 0.0005 mg/l, according to the procedures in Appendix B of 40 CFR Part 136.
 - d. Obtain certification for the contaminants listed in Table 200.3 (2) through (21).
 3. Each certified laboratory must determine the method detection limit (MDL), as defined in Appendix B to 40 CFR Part 136, at which it is capable of detecting VOCs. The acceptable MDL is 0.0005 mg/l. This concentration is the detection concentration for purposes of this section.
 4. Analysis for PCBs shall be conducted as follows using the methods in subsection A of this section:
 - a. Each system which samples for PCBs shall analyze each sample using either Method 508.1, 525.2, 508 or 505. Users of method 505 may have more difficulty in achieving the required Aroclor detection limits than users of Methods 508.1, 525.2, or 508.
 - b. If PCBs (as one of seven Arochlors) are detected (as designated in this subsection) in any sample analyzed using Methods 505 or 508, the system shall reanalyze the sample using Method 508A to quantitate PCBs (as decachlorobiphenyl).

TABLE 400-A-7 DETECTION LIMIT OF PCB

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AROCHLOR	DETECTION LIMIT mg/l)
1016	0.00008
1221	0.02
1232	0.0005
1242	0.0003
1248	0.0001
1254	0.0001
1260	0.0002

c. Compliance with the PCB MCL shall be determined based upon the quantitative results of analyses using Method 508A.

5. Detection, as used in this subsection, shall be defined as greater than or equal to the following concentrations for each contaminant.

TABLE 400-A-8 DETECTION LIMIT

CONTAMINANT	LIMIT (mg/l)
Alachlor	0.0002
Aldicarb	0.0005
Aldicarb sulfoxide	0.0005
Aldicarb sulfone	0.0008
Atrazine	0.0001
Benzo(a)pyrene	0.00002
Carbofuran	0.0009
Chlordane	0.0002
Dalapon	0.001
Dibromochloropropane (DBCP)	0.00002
Di(2-ethylhexyl) adipate	0.0006
Di(2-ethylhexyl) phthalate	0.0006
Dinoseb	0.0002
Diquat	0.0004
2,4-D	0.0001
Endothall	0.009
Endrin	0.00001
Ethylene dibromide (EDB)	0.00001
Glyphosate	0.006
Heptachlor	0.00004
Heptachlor epoxide	0.00002

Hexachlorobenzene	0.0001
Hexachlorocyclopentadiene	0.0001
Lindane	0.00002
Methoxychlor	0.0001
Oxamyl	0.002
Picloram	0.0001
Polychlorinated biphenyls (PCBs) (as decachlorobiphenyl)	0.0001
Pentachlorophenol	0.00004
Simazine	0.00007
Toxaphene	0.001
2,3,7,8-TCDD(Dioxin)	0.000000005
2,4,5-TP (Silvex)	0.0002

6. Analysis under this section shall only be conducted by laboratories that have received certification by EPA and have met the following conditions:
- a. To receive certification to conduct analyses for the contaminants in § 204 (A)(2) the laboratory must:
 1. Analyze Performance Evaluation (PE) samples provided by EPA at least once a year by each method for which the laboratory desires certification.
 2. For each contaminant that has been included in the PE sample achieve quantitative results on the analyses that are within the following acceptance limits:

TABLE 400-A-9 ACCEPTANCE LIMITS

CONTAMINANT	ACCEPTANCE LIMITS(%)
Dibromochloropropane (DBCP)	± 40
Ethylidibromide (EDB)	± 40
Alachlor	± 45
Atrazine	± 45
Benzo(a)pyrene	2 Standard deviations
Carbofuran	± 45
Chlordane	± 45
Dalapon	2 Standard deviations
Di(2-ethylhexyl)adipate	2 Standard deviations
Di(2-ethylhexyl)phthalate	2 Standard deviations
Dinoseb	2 Standard deviations
Diquat	2 Standard deviations

Endothall	2 Standard deviations
Endrin	± 30
Glyphosate	2 Standard deviations
Heptachlor	± 45
Heptachlor Epoxide	± 45
Hexachlorobenzene	2 Standard deviations
Hexachloro-cyclopentadiene	2 Standard deviations
Lindane	± 45
Methoxychlor	± 45
Oxamyl	2 Standard deviations
PCBs (as Decachlorobiphenyl)	0-200
Picloram	2 Standard deviations
Simazine	2 Standard deviations
Toxaphene	± 45
Aldicarb	2 Standard deviations
Aldicarb sulfoxide	2 Standard deviations
Aldicarb sulfone	2 Standard deviations
Pentachlorophenol	± 50
2,3,7,8-TCDD (Dioxin)	2 Standard deviations
2,4-D	± 50
2,4-TP (Silvex)	± 50

405-A ANALYTICAL METHODS FOR RADIOACTIVITY

A. Analysis for the following contaminants shall be conducted to determine compliance with §209 (radioactivity) in accordance with the methods in the following table, or the alternative methods listed in Appendix A to subpart C of 40 C.F.R. pt. 141, or their equivalent determined by EPA in accordance with § 415.

TABLE 400-A-10 RADIOACTIVITY METHODS

Contaminant	Methodology	Reference (method or page number)								
		EPA ¹	EPA ²	EPA ³	EPA ⁴	SM ⁵	ASTM ⁶	USGS ⁷	DOE ⁸	Other
Naturally occurring: Gross alpha ¹¹ and beta	Evaporation	900.0	p 1	00-0 1	p 1	302, 7110 B		R-1120-7 6		
Gross Alpha ¹¹	Co-precipitation			00-0 2		7110 C				
Radium 226	Radon emanation	903.1	p 16	Ra-0 4	p 19	305,7500-R a C	D 3454-97	R-1141-7 6	Ra-04	N.Y. ⁹
		903.0	p 13	Ra-0		304 7500-Ra	D 2460-97	R-1140-7		

	Radio chemical			3		B		6		
Radium 228	Radio chemical	904.0	p 24	Ra-05	p 19	7500-Ra D		R-1142-76		N.Y. ⁹ N.J. ¹⁰
Uranium ¹²	Radio Chemical	908.0				7500-U B				
	Fluorometric	908.1				7500-U C (17th Ed)	D2907-97	R-1180-76 R-1181-76	U-04	
	ICP-MS	200.8 ¹ ₃				3125	D5673-03			
	Alpha spectrometry			00-07	p 33	7500-U C (18 th 19 th or 20 th Ed)	D3972-97	R-1182-76	U-02	
	Laser Phosphorimetry						D5174-97			
Man-made:										
Radioactive cesium	Radio chemical	901.0	p 4			7500-Cs B	D 2459-72	R-1111-76		
	gamma ray spectrometry	901.1			p 92	7120	D 3649-91	R-1110-76	4.5.2 .3	
Radioactive iodine	Radio chemical	902.0	p 6 p.9			7500-I B 7500-I C 7500-I D	D 3649-91			
	Gamma ray spectrometry	901.1			p 92	7120	D 4785-93		4.5.2 .3	
Radioactive Strontium 89, 90	Radio chemical	905.0	p 29	Sr-04	p 65	303, 7500-Sr B		R-1160-76	Sr-01 Sr-02	
Tritium	Liquid scintillation	906.0	p 34	H-02	p 87	306, 7500- ³ H B, 306, 7500- ³ H B-00	D 4107-91	R-1171-76		
Gamma emitters	gamma ray	901.1			p 92	7120	D 3649-91	R-1110-76	Ga-01 -R	
	spectrometry	902.0				7500-Cs B, 7500-I B	D4785 93			
		901.0								

The procedures shall be done in accordance with the documents listed below. Copies of the documents may be obtained from the sources listed below. Information regarding obtaining these documents can be obtained from the Safe Drinking Water hotline at 800-426-4791. Documents may be inspected at EPA's Drinking Water Docket, EPA West, 1301 Constitution Avenue, NW, Room B135, Washington, D.C., 20460 (telephone: 202- 566-2426); or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.

¹ "Prescribed Procedure for Measurement of Radioactivity in Drinking Water", EPA 600/4-80-032, August 1980. Available at U.S. Department of Commerce, National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161 (Telephone 800-553-6847), PB 80-224744, except Method 200.8, "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry," Revision 5.4, which is published in "Methods for the Determination of Metals in Environmental Samples-Supplement I," EPA 600-R-94-111, May 1994. Available at NTIS, PB95-125472.

² "Interim Radiochemical Methodology for Drinking Water", EPA 600/4-75-008 (revised), March 1976, Available at NTIS, *ibid.* PB 253258.

³ "Radiochemistry Procedures Manual", EPA 520/8-84-006, December 1987, Available at NTIS ibid, PB 84-215581.

⁴ "Radiochemical Analytical Procedures for Analysis of Environmental Samples", March 1979, Available at NTIS, ibid. EMSL LV 053917

⁵ "Standard Methods for the Examination of Water and Wastewater", 13th, 17th, 18th, 19th Editions, or 20th edition, 1971, 1989, 1992, 1995, 1998. Available at American Public Health Association, 1015 Fifteenth Street, N.W., Washington, D.C., 20005. Methods 302, 303, 304, 305 and 306 are only in the 13th edition. Methods 711B, 7500-Ra B, 7500-Ra C, 7500-Ra D, 7500-U B, 7500-Cs B, 7500-I B, 7500-I C, 7500-I D, 7500-Sr B, 7500-3H B are in the 17th, 18th, 19th, and 20th editions. Methods 7110 C is in the 18th, 19th and 20th editions. Method 7500-U C Fluorometric Uranium is only in the 17th edition, and 7500-U C Alpha spectrometry is only in the 18th, 19th and 20th editions. Method 7120 is only in the 19th and 20th editions. Methods 302, 303, 304, 305 and 306 are only in the 13th edition. Method 3125 is only in the 20th edition.

⁶ Annual Book of ASTM Standards, Vol. 11.01 and 11.02, 1999; ASTM International any year containing the cited version of the method may be used. Copies of these two volumes and the 2003 version of D 5673-03 may be obtained from ASTM International. 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428-2959.

⁷ "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments", Chapter A5 in Book 5 of *Techniques of Water-Resources Investigations of the United States Geological Survey*, 1977. Available at U.S. Geological Survey (USGS) Information Services, Box 25286, Federal Center, Denver CO 80225-0425.

⁸ "EML Procedures Manual", 28th (1997) or 27th (1990) Editions, Volumes 1 and 2; either may be used. In the 27th Edition Method Ra-04 is listed as Ra-05 and Method Ga-01-R is listed as Sect. 4.5.2.3. Available at the Environmental Measurements Laboratory, U.S. Department of Energy (DOE), 376 Hudson Street, New York, NY 10014-3621.

⁹ "Determination of Ra-226 and Ra-228 (Ra-02)", January 1980, revised June 1982. Available at Radiological Sciences Institute Center for Laboratories and Research, New York State Department of Health, Empire State Plaza, Albany, NY 12201.

¹⁰ "Determination of Radium 228 in Drinking Water", August 1980. Available at State of New Jersey, Department of Environmental Protection, Division of Environmental Quality. Bureau of Radiation and Inorganic Analytical Services, 9 Ewing Street, Trenton, NJ 08625.

¹¹ Natural uranium and thorium-230 are approved as gross alpha calibration standards for gross alpha with co-precipitation and evaporation methods; americium-241 is approved with co-precipitation methods.

¹² If uranium (U) is determined by mass, a 0.67 pCi/μg of uranium conversion factor must be used. This conversion factor is based on the 1:1 activity of U-234 to U-238 that is characteristic of naturally occurring uranium.

¹³ "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry," Revision 5.4, which is published in "Methods for the Determination of Metals in Environmental Samples-Supplement I," EPA 600-R-94-111, May 1994. Available at NTIS, PB 95-125472.

B. When the identification and measurement of radionuclides other than those listed in subsection (A) of this section is required, the following references are to be used, except in cases where alternative methods have been approved in accordance with § 415.

1. *Procedures for Radiochemical Analysis of Nuclear Reactors Aqueous Solutions*, H.L. Krieger and S. Gold, EPA-R4-73-014, USEPA, Cincinnati, Ohio 45268, May 1973.
2. *HASL Procedures Manual*, Edited by John H. Harley. HASL 300, ERDA Health and Safety Laboratory, New York, NY, 1973.

C. For the purpose of sampling radioactivity concentrations in drinking water, the required sensitivity of the radioanalysis is defined in terms of a detection limit. The detection limit shall be that concentration which can be counted with a precision of ± 100% at the 95% confidence level (1.96 sigma, where sigma is the standard deviation of the net counting rate of the sample).

1. To determine compliance with § 211 (A), the detection limit shall not exceed 1 pCi/l. To determine compliance with § 211 (B), the detection limit shall not exceed 3 pCi/l.
2. To determine compliance with § 211, the detection limits shall not exceed the concentrations listed in Table 400.10.

TABLE 400-A-11 DETECTION LIMITS FOR MAN-MADE BETA PARTICLE AND PHOTON EMITTERS

RADIONUCLIDE	DETECTION LIMIT
Tritium	1,000 pCi/l

Strontium-89	10 pCi/l
Strontium-90	2 pCi/l
Iodine-131	1 pCi/l
Cesium-134	10 pCi/l
Gross Beta	4 pCi/l
Other Radionuclides	1/10 of the applicable limit

406-A TOTAL TRIHALOMETHANES SAMPLING, ANALYTICAL AND OTHER REQUIREMENTS

- A. Sampling and analyses made pursuant to this section shall be conducted by the total trihalomethane methods as directed in § 207 and in Technical Notes on Drinking Water Methods, EPA-600/R-94-173, October 1994, which is available at NTIS, PB95-104766.