TECHNICAL BULLETIN

OCCUPATIONAL AND ENVIRONMENTAL HEALTH

SANITARY CONTROL AND SURVEILLANCE OF WATER SUPPLIES AT FIXED INSTALLATIONS

HEADQUARTERS, DEPARTMENT OF THE ARMY

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OCCUPATIONAL AND ENVIRONMENTAL HEALTH SANITARY CONTROL AND SURVEILLANCE OF WATER SUPPLIES AT FIXED INSTALLATIONS

*This bulletin supersedes only so much of TB MED 229, 29 August 1975, as pertains to fixed installations.

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ILLUSTRATIONS

CHAPTER 1

GENERAL

1-1. Purpose. This technical bulletin provides public health and preventive medicine information and guidance to Department of the Army (DA) civilian and military personnel concerned with the production and surveillance of potable waters at fixed installations. This bulletin implements the provisions of:

a. Title 40, Code of Federal Regulations (CFR), Part 141, National Interim Primary Drinking Water Regulations (NIPDWR), as amended by 45 Federal Register (FR) 57332, 27 August 1980.

b. Title 40, Code of Federal Regulations, Part 143, National Secondary Drinking Water Regulations (NSDWR).

1-2. Background. *a.* The Safe Drinking Water Act (SDWA) (Public Law 93-523) was signed into law on 16 December 1974. The SDWA and subsequent amendments directs the US Environmental Protection Agency (EPA) to develop primary drinking water regulations for all public water systems from a health standpoint. As a result of this legislation, primary enforcement authority (primacy) is to be adopted by the individual States. The vast majority of States have been granted primacy.

Note. The words "he," "his," and "him" as used in this bulletin are intended to include both the masculine and feminine genders and any exception to this will be so noted.

b. Under the SDWA, EPA has developed secondary drinking water regulations for all public systems. Contaminants covered by these regulations may adversely affect the aesthetic quality of drinking water. The NSDWR are not Federally enforceable, as are NIPDWR; rather they are intended as guidelines for the States, but may be incorporated into State law and enforced by the respective State.

1-3. Policy. *a.* In States where primary enforcement has been granted by EPA, Army installations classified as suppliers of water shall comply with substantive and procedural requirements of NIPDWR as implementing the SDWA and promulgated by State regulatory authorities (AR 40-5 and AR 420-46).

b. In States and territories not having primacy, Army installations classified as suppliers of water shall comply with the substantive and procedural requirements of NIPDWR as implementing the SDWA and administered by the applicable EPA regional office (AR 420-46).

c. In the OCONUS areas outside those defined in AR 420-46, Army installations classified as suppliers of water shall comply with the substantive and procedural requirements of NIPDWR as implementing the SDWA, or the host country, whichever is more stringent. Any requests for deviation from the CONUS drinking water standards shall be submitted in writing to the theater surgeon with a copy furnished to The Surgeon General, HQDA (DASG-PSP), WASH DC 20310.

1-4. References. A listing of references is contained in appendix A.

1-5. Definitions. Except as indicated in appendix B, terms used in this bulletin are defined in AR 310-25.

1-6. Responsibilities. *a. The Chief of Engineers.* The Chief of Engineers is responsible for the design, construction, operation, and maintenance of the water supply system. The Chief of Engineers is also responsible for providing an adequate quantity of water that complies with the quality recommendations of the US Army Medical Department (AMEDD) relative to factors that may affect the health of Army personnel and employees.

b. The Surgeon General. The Surgeon General is responsible for insuring that sanitary control and surveillance of installation water supplies from source to consumer are accomplished; and making such recommendations as may be necessary to protect the health of the consumer.

c. Commander. The installation commander is responsible for providing an adequate amount of potable water that is free from disease-producing organisms, hazardous concentrations of toxic materials, and objectionable color, odor, and taste. As a minimum, installation commanders located in the 50 States, District of Columbia, and those OCONUS areas specified in AR 420-46 are responsible for assuring compliance with the SDWA as defined by AR 420-46. In geographical areas not specifically defined above, those installations classified as suppliers of water shall comply with the

SDWA as implemented by NIPDWR or the host country, whichever is more stringent. The installation medical authority and the facilities engineer are the two primary sources of assistance to the installation commander in meeting these requirements. Guidelines to assist the installation commander are presented in *d* and *e* below.

d. Installation medical authority. Continuous and effective coordination between the installation medical authority and the facilities engineer is necessary to insure the effective provision of and sanitary control of the installation's potable water supply. In coordination with the facilities engineer, the installation medical authority shall:

(1) Coordinate the surveillance monitoring of the potable water supply and distribution system as required to fulfill the requirements of NIPDWR and other applicable regulations. USAEHA can provide assistance in this area. USAEHA may be able to perform this analysis if certified by the appropriate State regulatory agency.

(2) Maintain liaison with appropriate Federal, State, and local regulatory authorities regarding current drinking water regulations.

(3) Interpret results of water quality analyses.

(4) Approve concentrations of and types of chemical additions to potable water supplies.

(5) Maintain records, in accordance with NIPDWR and AR 340-18-15, that reflect the chemical, radiological, and microbiological quality of the installation potable water.

(6) Conduct programmed sanitary inspections of the entire potable water system on a yearly basis.

(7) Perform special sanitary surveys as conditions warrant.

(8) Inform installation personnel of any degradation/contamination of the potable water system and recommend appropriate action.

(9) Perform independent surveillance of Army owned-contractor operated facilities (if applicable) in accordance with paragraph 8–2*b*.

(10) Conduct bacteriological, concurrent chlorine residual and fluoride surveillance analysis (if applicable) of the potable water system for supplied and purchased sources in accordance with NIPDWR.

(11) Provide information and guidance to the installation commander concerning the following:

(a) Current requirements for, availability of, and regulations concerning potable water.

(b) The need for and methods of water conservation.

(c) Available methods to reduce pollution of water by installation activities.

e. Facilities Engineer.

(1) Develop, in coordination with AMEDD personnel, adequate water supply treatment techniques to insure a water supply that is free of disease-producing organisms, hazardous concentrations of toxic materials, and objectionable color, odor, and taste. As a minimum, insure the water supply meets all applicable NIPDWR and State water quality standards as defined by AR 420–46.

(2) Pursue, in coordination with AMEDD personnel, an aggressive program to identify, isolate, and correct potential sources of contamination to the distribution system.

(3) Coordinate with appropriate Federal, State, and local agencies to establish a meaningful exchange of information regarding local water resources and drinking water regulation implementation as stated in AR 40–5 and AR 420–46.

(4) Insure operating personnel are trained to meet levels of proficiency consistent with the operator certification requirements applicable to their location.

(5) Encourage operating personnel to attend seminars, short courses, and other formal instruction to remain abreast of new developments in water treatment practices.

(6) Maintain sufficient data regarding quality control of the water system to assure providing water of acceptable potability.

(7) Develop and implement a program to correct system deficiencies, and upgrade equipment when necessary.

(8) Coordinate with the installation medical authority to collect and ship water samples in conjunction with Army drinking water surveillance requirements.

(9) Notify the installation medical authority upon discovery that a water main break or similar occurrence has taken place.

(10) Flush and disinfect all new mains and extensions prior to placing them into service.

(11) Coordinate with the installation medical authority to establish a program to periodically flush all water mains.

CHAPTER 2

IMPORTANCE OF POTABLE WATER

2-1. General. There are few environmental factors that impact more on the individual's well-being than the availability of an adequate potable water supply. As water is a necessity to sustain life, a closely controlled and adequate potable water supply is mandatory.

2-2. Microbiological considerations. *a.* The microbiological contaminants of primary concern in drinking water include bacteria, viruses, and pathogenic protozoa. The average annual number of waterborne disease outbreaks in the United States reported for 1938-1978 is shown in figure 1. As can be seen from the figure, there was a decrease in the number of outbreaks during the late 1930's and 1940's, but this trend was reversed in the early 1950's. There has been a pronounced increase in the outbreaks reported by the Center of Disease Control in Atlanta, Georgia, since the late 1960's and 1970's. The reason for the apparent increase is not entirely clear, but it could be either the result of improved reporting or an overall decrease in the raw water quality provided to water treatment plants. Summaries of the most important waterborne infectious diseases that occurred in 1971-1978 are listed in tables 1 and 2. Examination of tables 1 and 2 reveals that:

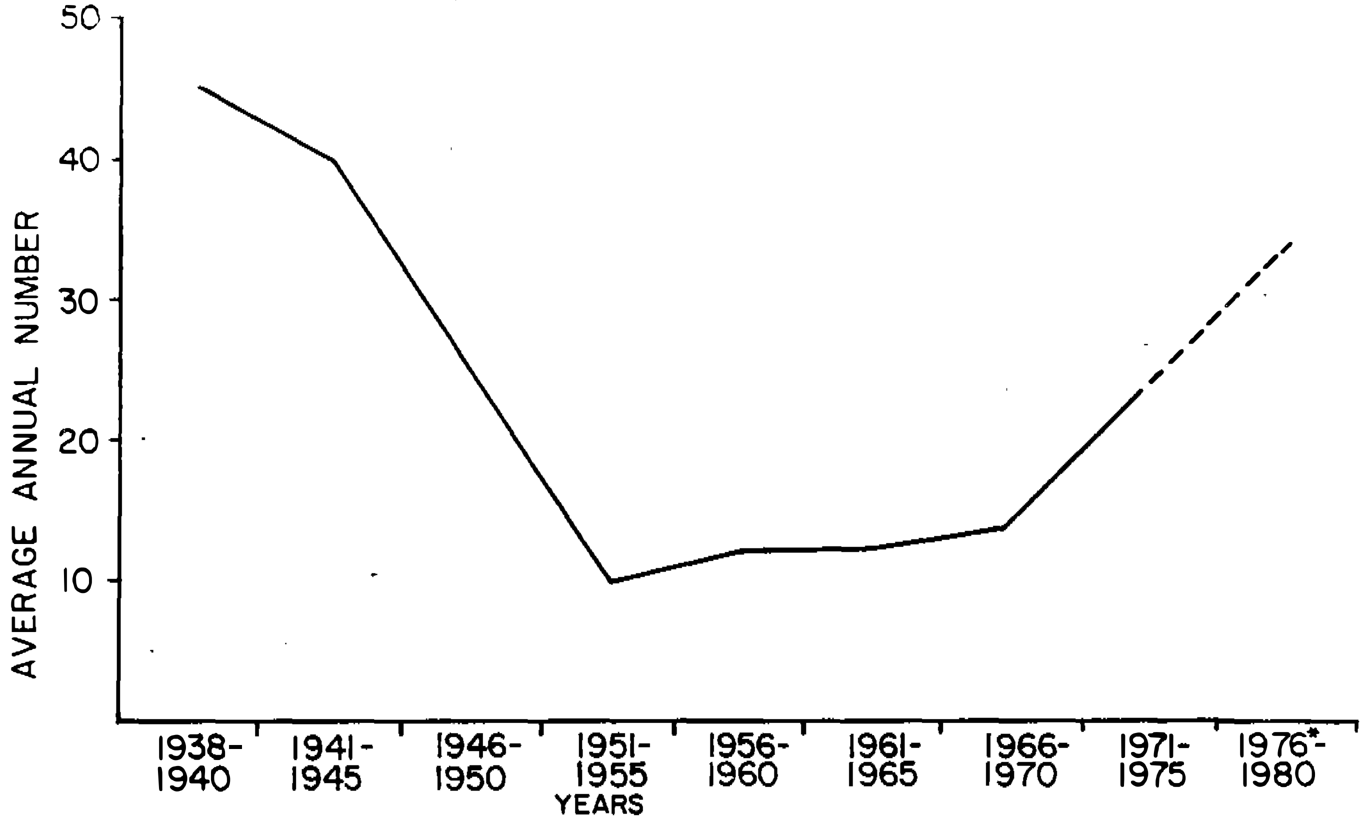

Figure 1. Average annual number of waterborne disease outbreaks, 1938–1978.

Source: Center for Disease Control: Water-Related Disease Outbreaks, Annual Summary 1978. Issued May 1980. HHS Publication No. (CDC) 80-8385.

(1) The etiological agent was determined in only 45 percent of the disease outbreaks that involved 48,246 cases during the period 1971–1978 (table 1). The remaining majority (55 percent) were classified as acute gastrointestinal infection.

(2) Semipublic water systems were associated with 56 percent of the outbreaks and accounted for 23 percent of the total cases during 1978.

(3) Municipal systems accounted for 30 percent of the outbreaks, but 77 percent of the cases during 1978.

(4) Individual systems during 1978 accounted for 13 percent of the outbreaks, but less than 1 percent of the cases. *Note:* Outbreaks associated with individual systems, as opposed to those associated with municipal and semipublic systems, are probably underreported.

b. One of the greatest deficiencies of customary methods for evaluating the bacteriological quality of water is that results from tests are unknown until after the sampled water has already entered the distribution system and has been used. Successful regulation of the microbiological quality of drinking water therefore depends on the use of raw water supplies of relatively unchanging high quality. Localized contamination characteristics of leaking or broken water lines, back syphonage and cross-connections are unlikely to be detected early enough to prevent exposure. Additionally, the low residual disinfectant maintained in the distribution system will almost certainly be overcome by such contamination. Despite the potential shortfalls of current microbiological monitoring techniques, it is nonetheless essential that these methods continue to be employed. The goals of microbiological monitoring are:

(1) Provide an indicator of the effectiveness of disinfection.

(2) Detect sanitary defects in the water distribution system.

Table 1. Waterborne Disease Outbreaks by Etiology and Year, 1971-1978

	1971	1972	1973	1974	1975	1976	1977	1978	Total (%)
Acute gastrointestinal9 illness		13	13	11	17	25	19	16	123(55)
Giardiasis	0	4	3	5	1	3	4	4	24(11)
Chemical	1	3	0	5	3	3	6	2	23(10)
Shigellosis	3	3	4	3	1	2	1	4	21(9)
Hepatitis A	6	5	2	0	1	0	1	0	15(6)
Salmonellosis	0	1	0	1	0	1	2	2	7(3)
Viral gastroenteritis	0	0	0	0	0	1	1	3	5(2)
Typhoid fever	0	1	2	1	0	0	0	0	4(2)
Enterotoxigenic *E. coli*	0	0	0	0	1	0	0	0	1(1)
Campylobacter fetus ssp *jejuni*	0	0	0	0	0	0	0	1	1(1)
TOTAL	19	30	24	26	24	35	34	32	224(100)

Table 2. Waterborne Disease Outbreaks, 1971-1978

	1971	1972	1973	1974	1975	1976	1977	1978	Total
Outbreaks	19	30	24	26	24	35	34	32	224
Cases	5,182	1,650	1,784	8,363	10,879	5,068	3,860	11,435	48,246

c. In oversea areas, water continues to be a major consideration in the spread of disease. Special attention to water handling and treatment in these areas is required to minimize the spread of such disease.

2-3. Physical-chemical considerations. While the effects of microbiological contamination of potable water may manifest themselves in a period of days, a much more long-term relationship may appear when examining the effects of physical-chemical contaminants. Physical-chemical contaminants may be present in the water supply as a result of a variety of factors. Naturally occurring inorganic and organic contaminants are plentiful in the environment and readily assimilated by water which acts as a solvent for many of them. Trace metals, other inorganics, and organics may also be assimilated by water as a result of the waste disposal and industrial actions of man. Recent trends lead one to believe that increasing concern will be generated by both the regulating agencies and the using public over the presence of both naturally occurring and manmade organics in drinking water.

2-4. Radiological considerations. *a.* As with physical-chemical contaminants, minute traces of radioactivity are normally found in all drinking water. These levels vary considerably throughout the United States and the world. The concentration and composition of these radioactive constituents depend principally on the radiochemical composition of the soil and rock strata through which the raw water has passed.

b. The long-term effects of radiological contaminants in drinking water continues to be examined. Radioactivity in water systems may be broadly categorized as either naturally occurring or manmade. Radium-226 is the most important of the naturally occurring radionuclides likely to occur in public water systems. Although radium may occasionally be found in surface water due to man's activities, it is usually found in ground water as the result of geological conditions and is not subject to prior control. In contrast to radium, manmade radioactivity is widespread in surface water because of fallout radioactivity from nuclear weapons testing. In some localities this radioactivity is increased by small releases from nuclear facilities (such as nuclear power plants), hospitals, and scientific and industrial users of radioactive materials. The residual radioactivity in surface waters from fallout due to atmospheric nuclear weapons testing is mainly strontium-90 and tritium.

CHAPTER 3

WATER SOURCES

3-1. General. *a.* Depending on local conditions, water supplies for installations may be obtained from any of a number of sources. Commonly used waters sources include underground sources, such as springs or wells; and surface sources, such as rivers, streams, or lakes. Additionally, an installation may secure its water supply from adjacent municipal facilities. Information concerning the development and maintenance of water sources can be found in TM 5-660, TM 5-813-2, and FM 5-166.

b. A properly conducted sanitary survey should furnish sufficient data to base the acceptance or rejection of the water as a present or potential source. This sampling survey should be aided by chemical and bacteriological analyses, and a knowledge of the significance of the factors involved. Personnel, trained and competent in environmental engineering and the epidemiology of waterborne diseases, should conduct the sanitary survey. A sanitary survey of an existing supply should be conducted when considered essential for the maintenance of a good sanitary quality. A yearly sanitary survey is recommended. A sanitary survey of a new source should be made in conjunction with the collection of initial engineering data covering the development of the source.

c. At many installations, isolated water sources, such as wells and springs, service training areas. In many cases, these isolated water sources do not service residents and are not classified as public water systems. Water systems that meet these criteria should be classified as field sources. Sanitary control of field sources is addressed in the field portion of TB MED 229 (to be superseded by TB MED 577).

3-2. Selection of water source. *a. General.* To insure the selection of an adequate source, it is essential to determine both the average daily demand that will be placed upon it as well as the peak demand rate. The average daily demand should be estimated to determine the ability of the water source to meet continuing demands during periods when surface flows and ground water elevations are at a minimum. The peak demand rate, including fire protection requirements, should be estimated to determine plumbing requirements, pressure losses, and storage requirements in order to supply sufficient water to all parts of a distribution system during peak demand periods. Use of peak demand data will enable system design with sufficient contact time to insure adequate disinfection under worst-case conditions. Further information on this subject may be obtained in the TM 5-813-1 through TM 5-813-7, and TM 5-810-5.

b. Cost estimate. In addition to capacity, consideration should also be given to the proximity and quality of the source, the expected development costs, and life of the project. Annual operating expenses that include the cost of power and chemicals, as well as personnel salaries, should be considered over the expected life of the project in order to arrive at a sound final selection.

c. Public water systems. Where feasible, approved public water systems should be considered for use. Factors considered, in addition to the present-day quantity and quality of the supply, should include an evaluation of the municipality's ability to produce adequate supplies of potable water over an extended period of time. The mission of the post or unit should be considered if the water supply depends on an outside source. Also, the projected mobilization needs for water should be considered in evaluating a public water source. Public water systems should also be considered for their applicability as backup water systems. If two independent potable water supplies are to be interconnected, approval of the producers shall be obtained.

3-3. Wells. Ground water occurs in geologic formations called aquifers. Aquifers contain sufficient saturated permeable material to yield significant quantities of water to wells and springs. An aquifer serves as a transmission conduit and storage reservoir that transports water under a hydraulic or pressure gradient from recharge areas to surface bodies of water, wetlands, springs, areas of evapotranspiration, wells, and other water-collecting devices. Ground water, when available in sufficient quantity, is usually a preferred source of water supply. Such water can be expected to be clear, cool, colorless, and quite uniform in character. It is generally of better microbiological quality and contains much less organic material than surface water but may be more highly mineralized. At present, wells serve small to medium-sized installations although a system of multiple wells may be used to develop a supply for a large installation. Consult TM 5-813-2 on this subject. Additional information may be found in EPA Publication 430/9-74-007 and AWWA Manual M21.

a. Types of wells. Wells are classified according to the construction method; i.e., dug, bored, driven, drilled, and jetted. Each type of well has distinguishing physical characteristics and is best utilized to satisfy a particular requirement. FM 5-166 and TM 5-660 provide descriptions of particular well types and design considerations.

b. Sanitary protection. Proper sanitary measures shall be taken to insure the purity of the water whenever ground water is pumped from a well for human consumption. Potential sources of contamination may exist either above or below ground surface. Where possible, wells should be located on ground that is higher than a potential source of contamination. The area should be well drained to divert surface waters from the well and to minimize the possibility of flooding. Listed below are guidelines for the sanitary protection of wells:

(1) The annular space outside the casing should be filled with watertight cement grout in accordance with FM 5-166.

(2) For artesian aquifers, the casing should be sealed into the overlying impermeable formations to retain the artesian pressure.

(3) When a water-bearing formation containing water of poor quality is penetrated, the formation should be sealed off to prevent the infiltration of water into the well and developed aquifer.

(4) Every well should be provided with an overlapping watertight cover at the top of the casing, or a raised pipesleeve to prevent contaminated water or other harmful materials from entering the well.

(5) All abandoned wells should be plugged and properly sealed, as required by Federal, State, or local authority, to prevent possible contamination of the ground water formation. The basic concept behind the proper sealing of any abandoned well is that of restoration, as far as feasible, of the controlling geological conditions that existed before the well was drilled or constructed. If this restoration can be properly accomplished, an abandoned well will not create a physical or health hazard. AWWA Standard A100-66 provides further guidance on this subject. Table 3 depicts the minimum recommended radial distances between water supplies and various potential sources of contamination.

*Table 3. Minimum Recommended Radial Distances Between Water Supplies and Various Potential Sources of Contamination**

Potential contamination sources	*Well or suction line (distance in feet)*
Building sewer	50
Septic tank (watertight)	50
Disposal field	100
Seepage pit	150
Cesspool	150

* The distances given are suggested minimum values for community water supply wells. In many instances, local conditions may dictate an increase in these distances. Although the minimum distances above may be adequate in unconsolidated or fine-grained rock formations, several times these distances may be inadequate in coarse-grained materials. A sanitary survey, conducted by qualified individuals, shall be a matter of policy in the construction or drilling of any new well with nearby potential contamination sources. For assistance in a particular locale, contact the State or local health agency.

Source: Water Well Standards, Dept of Water Resources, State of California, February, 1968.

c. Disinfection. After well construction or repair, and prior to being placed into service, the well shall be disinfected with a chlorine solution. The chlorine solution used for disinfecting the well shall be applied to insure an initial concentration of at least 50 milligrams per liter (mg/L) of chlorine in all parts of the well. The period of detention shall be 24 hours for all wells. Upon completion of the disinfection process, the well shall be flushed to remove objectionable chlorine residues. The well shall be considered flushed when the residual chlorine level is reduced to 2 mg/L or until noticeable chlorine taste disappears. The water shall not be considered acceptable for human consumption until the microbiological quality has been tested by a State-approved laboratory and found to be acceptable.

3-4. Springs. *a. General.* Springs are formed at the interception of an aquifer with the ground surface, or by leakage of an artesian aquifer through a fracture or solution zone. Contrary to popular belief, spring water is not always of good microbiological quality; therefore, extreme precaution should be exercised in the development of springs. Generally, the same principles that apply to location, protection, development, and operation of wells apply to springs. Therefore, the factors presented above for well location shall also be considered when conducting a sanitary survey of a spring.

b. Contamination. When utilized as a water source, spring water is usually captured in a small catchment reservoir of such dimension as to enclose or intercept as much of the spring as possible. Some of the desirable features of catchment reservoirs are prescribed in EPA 430/9-74-007.

c. Spring disinfection. After a new or cleaned spring has been prepared for use, the entire spring reservoir shall be disinfected with a chlorine solution and flushed prior to collecting samples for microbiological examination. EPA Publication 430/9-74-007 describes the recommended disinfection procedure.

3-5. Surface water sources. *a. General.* Because of the ease of physical and microbiological contamination of surface water, additional factors not usually associated with ground water sources should be considered when selecting surface water sources. As a general rule, surface water should be used only when ground water sources are not economically justifiable or are of an inadequate quality or quantity.

b. Source selection. In examining surface waters for potential use as drinking water sources, care should be exercised. A number of interrelated factors should be considered. These include, but are not limited to, sources of point source and nonpoint source pollution, proposed intake location; and water uses identified for the particular water source by responsible Governmental agencies. Raw water quality should be examined and a treatment scheme proposed to insure compliance with applicable regulations and to provide the best possible water supply for Army use before a final determination regarding the acceptability of the source is made.

c. Acceptable uses of potable water sources. Surface waters that are used as a potable water source may exhibit desired recreational qualities. Care should be exercised in determining what types of recreational activities (swimming, boating, etc.) are suitable for these waters. The periodic sanitary surveys are excellent vehicles to evaluate the impact of recreational uses on these water sources.

3-6. Bottled water. Bottled water is commonly utilized in the United States as a source of drinking water. Bottled water may be derived from a surface or subsurface water source, depending on the bottler, and has been shown to be of variable quality. It is commonly contended that bottled water may be of better quality than locally available public water supplies. This may not be the case. Bottled water can be only as good as the source from which obtained and the quality of treatment received. Bottled water used at Army installations shall meet all the requirements of the NIPDWR for physical, chemical, bacteriological, and radiological parameters.

CHAPTER 4

WATER DISTRIBUTION SYSTEMS

4-1. General. The existence of substandard facilities for water distribution may adversely affect the quality of the water being supplied even though the water leaving a treatment facility may be of satisfactory chemical and microbiological quality. The safety and palatability of the water should not be impaired by defects in the system. The distribution system should not leak, and its various mains and branches should not be submerged in surface water or ground water. Dead-end mains shall be minimized to insure effective circulation of the water. Wherever possible, water mains shall be laid above the elevation of sanitary sewers at crossover points and at least 10 feet horizontally from such sanitary sewers when they are parallel. All crossover points should be identified. A record of crossover points, once identified, shall be maintained by the installation medical authority. A common trench shall never be used.

4-2. Cross-connections. No interconnection between a potable water distribution system and a sanitary sewage system shall be permitted. Each installation shall undertake an organized program that includes instruction, inspection, and required improvements in order to detect and remove all potential or existing cross-connections, and to insure that proper measures (e.g., air gaps and back-flow prevention devices) are taken to prevent back siphonage. Only through routine inspection and periodic surveys can the control and elimination of existing and potential hazards be accomplished. EPA Publication 430/9-73-002 and AWWA Publication No. 20106 provide excellent information concerning methods and devices for backflow prevention, testing procedures for backflow prevention, and administration of a cross-connection control program.

4-3. Water main flushing and disinfection. *a. Flushing new mains.* Facilities engineers shall flush and disinfect all new mains and extensions to existing mains prior to placing them into service. The purpose of this flushing is to remove debris from the new mains. The flushing velocity should be at least 2.5 feet per second (fps). The flow required to produce this velocity in various diameter pipes is shown in table 4. Adequate drainage should be assured prior to flushing to avoid ponding or erosion in the vicinity of the flushing valve or orifice.

*Table 4. Flows Required to Flush Pipelines**

Pipe (in)	Flow required to produce 2.5 fps velocity (gpm)	Orifice size (in)	Hydrant outlet nozzles	
			Number	Size (in)
4	100	15/16	1	2 1/2
6	220	1 3/8	1	2 1/2
8	390	1 7/8	1	2 1/2
10	610	2 5/16	1	2 1/2
12	880	2 13/16	1	2 1/2
14	1,200	3 1/4	2	2 1/2
16	1,565	3 5/6	2	2 1/2
18	1,980	4 3/16	2	2 1/2

*With 40 pounds per square inch (psi) residual pressure, a 2½-inch hydrant outlet nozzle should discharge approximately 1,000 gallons per minute (gpm); and a 4½-inch hydrant nozzle should discharge approximately 2,500 gpm.

b. Flushing existing mains. Existing water mains should be flushed, as a matter of policy, at least annually. The purpose of periodic flushing is to remove settled or otherwise accumulated material. Such material, if not removed, may restrict flows, cause damage to plumbing systems, and degrade the quality of the water flowing through the mains. A program to provide for periodic flushing of all water mains shall be established by the facilities engineer and coordinated with the appropriate installation medical authority.

c. Disinfection.

(1) *General.* After new or repaired water mains have been flushed to remove the dirt and debris introduced during repair or construction, they shall be disinfected prior to being put into service. Disinfection is effected by the application of a solution of high chlorine concentration for a specified period of time. Afterwards, the solution is flushed from the line and a microbiological examination performed to insure that adequate disinfection has occurred.

(2) *Feed method.* The new or repaired main may be filled with a chlorine solution such that after 24 hours there remains a residual of not less than 25 mg/L total available chlorine (TAC). An initial solution concentration of 50 mg/L FAC should be adequate to achieve this final concentration.

(3) *Slug method.* Alternatively, potable water and chlorine may be introduced into the main proportionately to produce a "slug" of at least 300 mg/L. The contact period may be reduced to 3 hours.

(4) *Swabbing.* In addition to the flushing and disinfecting procedures described above, the interior of all repair pipe lengths and fittings should be swabbed with a 5 percent (50,000 mg/L) chlorine solution prior to installation (see TM 5-700 for chlorine concentration calculations). After the repairs are completed, the repaired section should be flushed and disinfected as previously discussed. The purpose of swabbing is to insure that residue in the joints and fitting connections is oxidized.

(5) *Post disinfection flushing and microbiological analysis.* Regardless of the method used to disinfect new or repaired mains, the high-concentration chlorine solutions must be flushed from the line after disinfection is complete. Samples shall then be collected downflow from the affected pipe length, or on both sides of the length if the direction of flow is variable or unknown (see AWWA Standard C601-68). These samples shall be checked for microbiological contamination to insure that disinfection has been adequate. Once it has been determined that disinfection has been adequate (based upon appropriate microbiological results), the new or repaired main can be returned to service. Consult AWWA Standard C601-68 for more guidance on this subject.

4-4. Pressure. Water distribution systems should be designed to provide an acceptable operating pressure in distribution mains, building service connections, and within buildings. The distribution system should not be broken into a two-level system unless the pressures, due to variation in topography, exceed 100 psi. Pressures higher than 70 psi may cause damage to the distribution system and appurtenances. Maintenance of proper pressure levels is important to minimize possible contamination of water systems due to uncorrected cross-connections. Cross-connections are the largest single cause for the spread of waterborne disease in the United States. For additional information on this subject consult TM 5-813-5.

4-5. Use of nonpotable waters. *a. General.* Nonpotable distribution systems shall be designed so as to prevent interconnection (e.g., by use of incompatible coupling devices) with a potable system. Also, the marking NONPOTABLE shall be stenciled on the nonpotable distribution system to identify it from the potable system. Color-coding of pipes may be used to distinguish potable from nonpotable systems. Nonpotable systems shall be physically separated from any potable water distribution system. Whenever possible, precautions should be implemented (i.e., removal of control valves, etc.) so that only authorized personnel can operate the nonpotable system. The use of a nonpotable distribution system or dual distribution system shall be approved by the installation medical authority.

b. Personal hygiene. Under emergency conditions, it may be permissible to use a water of a lesser bacteriological or chemical quality than that prescribed for potable waters. Examples of this practice are single use applications such as laundering, showering, and bathing. The practice should be restricted to an emergency environment and should only be adopted after a thorough evaluation has shown other alternatives to be uneconomical or impracticable. It is essential to the physical well-being of the population served that the advice of the installation medical authority and facilities engineer be sought prior to a final determination being made on the acceptability of this practice.

CHAPTER 5

WATER STORAGE

5-1. General. Distribution reservoirs are used to maintain required flow rates and pressures, as well as to provide sufficient storage capacity for emergencies. The judicious siting of water storage tanks in relation to the source of supply should permit the use of the most economical pipe sizes and pumping capacity. TM 5-813-4 provides detailed information regarding selection of storage tanks for use on military installations.

5-2. Maintenance. Inspection, maintenance, and repair of storage tanks are essential to the efficient operation of a distribution system. Corrosion and scaling in storage tanks may adversely affect the quality of the stored water, and ultimately result in their structural failure. Additionally, the quality of the water is adversely affected by these conditions. Potable water reservoirs shall be covered and the vents screened to prevent contamination by birds, insects, vermin, and debris. TM 5-661 provides guidance concerning the inspection and care of elevated and ground storage tanks. Additional information on inspection, painting, and repairing of tanks, standpipes, and reservoirs used for water storage may be obtained from AWWA Standards D101-53 and D102-78. Paint systems utilized for water contact surfaces should be procured from reputable manufacturers/suppliers and shall meet the specifications contained in AWWA Standard D102-78.

CHAPTER 6

WATER TREATMENT

6–1. General. Water, like many other natural resources is procured as a raw material, manufactured into a commodity suitable for use, and distributed for consumption. A safe and dependable water supply greatly enhances the physical and mental well-being of the individual. Each water source should be evaluated individually to determine the type and degree of treatment needed. Disinfection is required for all water used for drinking. Disinfection alone may suffice for a deep well, whereas sedimentation, coagulation, flocculation, filtration, and disinfection are usually necessary for most surface sources. It is the responsibility of the installation commander to insure that the water supply is free of disease-producing organisms, hazardous concentrations of toxic materials, and objectionable color, odor, and taste. The installation commander shall insure that, as a minimum, the water supply meets or exceeds all applicable NIPDWR and State water quality standards as specified in AR 420–46. All water shall be considered unsafe until approved by the responsible installation medical authority. TM 5-660 provides further information regarding the specifics of various treatment methods.

6–2. Disinfection. *a. General.* Potable water sources shall be disinfected because no other treatment process, or combination of processes that excludes disinfection, will reliably remove all disease-producing organisms from water. All methods of disinfection shall satisfy the following criteria. The disinfectant should:

(1) Mix uniformly to provide intimate contact with potentially present microbial populations.

(2) Have a wide range of effectiveness to account for the expected changes in the conditions of treatment or in the characteristics of the water being treated.

(3) Not be toxic to humans at the concentration levels present in the finished water.

(4) Have a residual action sufficient to protect the distribution system from microbiological growths and act as an indicator of recontamination after initial disinfection.

(5) Be readily measurable in water in the concentrations expected to be effective for disinfection.

(6) Destroy virtually all microorganisms.

(7) Be practical to use and maintain.

b. Chlorination.

(1) *General.* Under normal operating conditions, chlorination is the most widely utilized procedure for the routine disinfection of water. The efficiency of chlorine disinfection is affected by the following seven variables:

(a) The types and concentrations of the chlorine forms present.

(b) The pH of the water affects the disinfecting action of chlorine, particularly combined available chlorine residual. At pH 6.5 and a temperature of 22° C, 0.3 ppm of combined residual causes a 100 percent bacterial kill. With the same temperature, at pH 7.0 the combined residual must be increased to 0.6 ppm, and the pH 8.5 must be increased further to 1.2 ppm to accomplish the same degree of bacterial kill. Data for this pH–chlorine residual relationship are presented in figure 2.

(c) The type and density of organisms (virus, bacteria, protozoa, helminth, or others) and their resistivity to chlorine. It is generally accepted that, of the waterborne diseases, those caused by bacteria are the most susceptible to chlorine disinfection. At the other extreme, certain pathogenic organisms such as the cysts of the protozoa *E. hystolytica* and *Giardia lamblia* are the most resistant. Therefore, two parallel recommendations for chlorine residuals are often made: the lower one sufficient for bactericidal purposes and the higher one for cysticidal purposes. Available information suggests that cysticidal residuals are also virucidal. Figure C–1 presents data concerning the bactericidal and cysticidal effectiveness of free available chlorine (FAC) and combined chlorine residuals at various pH and temperature levels. Bactericidal levels are routinely used for all water supplies at CONUS installations since waterborne bacteria are likely to be the most prevalent organisms. Cysticidal levels shall be instituted whenever epidemiological evidence indicates the presence of nonbacterial waterborne disease such as amebiasis, infectious hepatitis, or schistosomiasis.

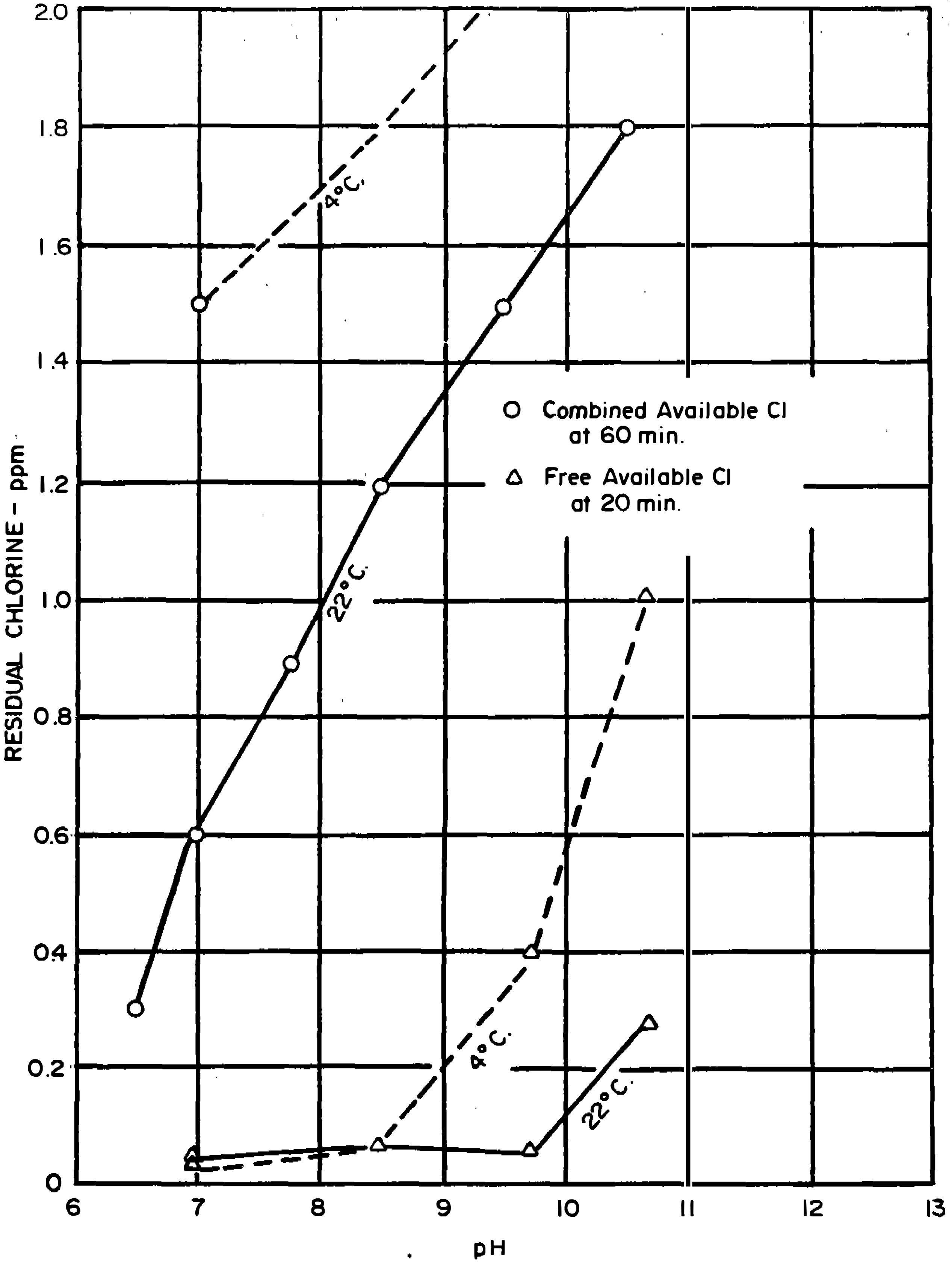

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Figure 2. Effect of temperature and pH on residual chlorine required for bacterial kill.

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(d) The contact time of the organisms with the chlorine.

(e) The temperature of the water markedly affects the disinfecting action of residual chlorine. At lower temperatures, bacterial kill tends to be slower and higher residuals are needed. The effect of low temperatures is greater with combined available chlorine than with free available chlorine. This is shown in figure 2.

(f) The concentration of substances exerting chlorine demand. During disinfection, chlorine demand can be exerted by chemical compounds including those containing ammonia and the whole spectrum of organics. Many of these compounds are not effectively removed in conventional water treatment processes and are therefore present to exert chlorine demand during disinfection.

(g) Homogeneous mixing of chlorine and chlorine demanding substances. The disinfecting agent must be well dispersed and homogeneously mixed in order to insure that the contact time provided for disinfection is applied throughout the water supply.

(2) *Chlorine residual.* A measurable chlorine residual (FAC or combined) shall be maintained at all times in all parts of the potable water distribution system under constant circulation. This applies to military-owned and -operated supplies from ground and surface sources. This does not apply to water furnished directly to installations, leased buildings, and similar facilities by a satisfactory public water supply distribution system, or from a supplier of bottled water that has been approved by the appropriate State or host nation health authority. If water provided to an installation from an approved outside source does not have a measurable chlorine residual (FAC or combined), then this should be considered in the microbiological monitoring program of the installation medical authority. Coordination between the supplier, the facilities engineer and the PVNTMED activity is essential in this situation. Installation chlorination of the supplied water (rechlorination) shall be considered if an unhealthful situation may be present. It should be pointed out, however, that rechlorination (or other chemical addition) of purchased water may make the installation a new *supplier of water* responsible for all requirements of the SDWA implemented by NIPDWR. Final interpretation of whether or not an installation is classified as a *supplier of water* rests with the State regulatory authorities (if primacy has been granted) or with regional EPA officials (if in a nonprimacy State).

(3) *Chlorination in the event of system problems.* Water from systems where sanitary, physical, or operating defects or other special hazards are known to exist; or where microbiological examinations show that satisfactory quality cannot be obtained without rechlorination, should be chlorinated to the bactericidal levels shown in table 5.

(4) *Health effects of chlorination.* Notwithstanding the disinfecting capability of chlorine, concern has been generated over the health effects of chlorinated organics. Specifically, triholomethanes (THMs) were adopted into the maximum contaminant levels (MCLs) of NIPDWR. THMs are commonly found in chlorinated drinking water, particularly in drinking waters obtained from surface water sources. THMs are formed by the reaction of naturally occurring organic substances with chlorine in the course of drinking water treatment and distribution. Chlorination methods employed by the installation may have a dramatic effect on the resultant level of THMs observed. As a minimum, installations obtaining their raw water from surface sources and practicing pre- and postchlorination should practice chlorination optimization. Prechlorination dosages should be reduced to the lowest level consistent with the maintenance of a trace chlorine residual through the treatment system prior to postchlorination. Postchlorination should then be used to achieve required chlorine residuals for the distribution system. Employment of this technique allows for the most effective use of chlorine consistent with minimizing THM formation.

Table 5. Minimum Free and Combined Batericidal Chlorine Residual Required in the Event of Water System Problems

pH value	Minimum concentration of *free* chlorine residual after 10 minutes (mg/L)	Minimum concentration of *combined* chlorine residual after 60 minutes (mg/L)
6.0	0.2	1.0
7.0	0.2	1.5
8.0	0.4	1.8
9.0	0.8	Not applicable
10.0	0.8	Not applicable

(5) *Determination of chlorine residuals.* Both FAC and combined chlorine residuals are applicable at permanent CONUS and equivalent oversea facilities. Residual FAC shall be determined by using the N,N, diethyl-p-phenylenediamine (DPD) method (described in app D) or another EPA approved method that measures specifically for *free* chlorine. *Combined* chlorine residuals can be determined by tests that provide the total chlorine present from which the free component can be subtracted.

(6) *Chlorination methods.*

(a) Marginal chlorination. In marginal chlorination, the initial chlorine demand has been satisfied but some oxidizable substances remain. This is the most common type of chlorination practiced in CONUS and their oversea equivalent.

(b) Superchlorination-dechlorination. This procedure involves the application of chlorine in greater concentrations than are required to afford acceptable bactericidal efficiencies. This practice provides control of taste and odor producing substances in addition to control of bacterial effects. Surplus chlorine is removed by dechlorination with sulfur dioxide, aeration, or activated carbon before the water enters the distribution system.

(c) Break-point chlorination. In break-point chlorination, sufficient chlorine is applied to produce a chlorine residual composed of predominantly FAC with little or no *combined* chlorine present. A detailed discussion of break-point chlorination is found in paragraph 7-1*b*(4), TM 5-660.

(7) *Surveillance.* Water plant personnel should insure that adequate chlorine levels are maintained by regular and frequent chlorine analyses, both at the point of application and at various points in the water distribution system. Testing of treated water for chlorine residual prior to distribution shall be accomplished at least daily, more frequently if the character and variability of the water supply so dictates, and at least daily at various points in the water distribution system. In addition, the installation medical authority shall also test for chlorine residual at the time of microbiological sampling (see app E).

c. Other methods. Methods of disinfection other than chlorination are being used throughout the world. Within CONUS, authority for use of a method of disinfection other than chlorination rests with The Surgeon General (HQDA (DASG-PSP), WASH, DC 20310). Outside CONUS authority for the use of a method of disinfection other than chlorination rests with the Theater Surgeon. A copy of the OCONUS request shall be furnished to The Surgeon General (HQDA (DASG-PSP), WASH, DC 20310).

6-3. Fluoridation. *a. General.* Fluorides are a small but important element in the human diet. Part of the required concentration may be obtained in food, but the greatest portion should come from the potable water supply. Application of fluoride to water supplies, when feasible, is recommended when the natural fluoride content of the water supply is below levels necessary for prevention of dental caries in children. Recommended practice is prescribed in table 6. The maximum allowable fluoride level is 2.4 mg/L as established by the NIPDWR. The maximum allowable fluoride concentration decreases with an increase in temperature. If the health-significant levels are exceeded in a public water system, control methods should be installed or a variance obtained from the regulatory authority. Although fluorides, when taken internally in recommended concentrations, are beneficial in the prevention of dental caries, excessive amounts may produce objectionable dental fluorosis (mottling of tooth enamel). The fluorosis increases in severity as fluoride concentration rises above the recommended upper control limits.

Table 6. Recommended Fluoride Levels in Drining Water

Annual average of maximum daily air temperature, ° F	NIPDWR recommended control limits fluoride concentration in mg/L (maximum allowable)			
	Lower	Optimum	Upper	MCL
53.7 and below	1.1	1.2	1.3	2.4
53.8–58.3	1.0	1.1	1.2	2.2
58.4–63.8	0.9	1.0	1.1	2.0
63.9–70.6	0.8	0.9	1.0	1.8
70.7–79.2	0.7	0.8	0.9	1.6
79.3–90.5	0.6	0.7	0.8	1.4

b. Installation fluoridation. When it has been determined to be feasible and desirable from a dental health position, installations requiring fluoridation or defluoridation shall prepare a request through command channels to The Surgeon General (HQDA (DASG-PSP), WASH DC 20310). Oversea installations shall submit requests through appropriate channels to the Theater Army Commander, ATTN: Surgeon, providing logistical support (see app F). Consult appendix G to request authority to fluoridate.

c. Surveillance.

(1) *Water plant.* Water plant personnel shall insure that required fluoride levels are maintained by regular and frequent fluoride analyses, both at the point of production and at various points in the water distribution system. Testing of treated water prior to distribution shall be accomplished daily, or more frequently, if the character and variability of the water supply so dictates. Sampling from representative points in the distribution system shall be performed at least weekly as a means of further evaluation of plant control effectiveness. In addition, the installation medical authority shall also test for fluoride at random sample points at the time of microbiological sampling. Sampling and analysis shall be done in accordance with methodology required by NIPDWR.

(2) *Installation medical authority.* The installation medical authority is responsible for and shall coordinate the fluoride surveillance monitoring discussed in (1) above. For those installation treatment facilities that are Army-owned and contractor-operated, with the contractor tasked to conduct fluoride analysis requirements, the installation medical authority shall institute an independent surveillance program. This independent program should include conducting routine fluoride analyses at a frequency determined by the installation medical authority and also insuring that analytical methodology discussed in (1) above is followed.

(3) *Quality control.* Once per quarter, USAEHA or, if overseas, the supporting environmental engineering agency/department shall request samples from the installation medical authority and the facilities engineer for fluoride determination. The sender shall determine the fluoride content on an aliquot of the sample using his techniques and forward the remainder of the sample to the requester. The results shall be returned to the sender for comparison and determination of analytical accuracy.

(4) *Initial fluoridation.* During initial fluoride operation. the installation medical authority shall test fluoride residuals daily and have a comparative weekly sample check by USAEHA or supporting environmental engineering agency/department. This procedure shall continue a minimum of 2 months or until results indicate that the system is operating satisfactorily.

(5) *Records.* The maintenance of accurate records is most important in the fluoridation treatment processes. Plant operators shall complete DA Form 4141 (Facilities Engineering Operating Log, Water-General) to record and report the quantity of fluoride added and the average results of daily fluoride tests expressed in mg/L to the nearest tenth (0.1). Results of fluoride analysis performed by the installation medical authority shall be recorded on DD Form 686 (Fluoride/Bacteriological Examination of Water). The necessity of keeping accurate records of fluoridation cannot be overemphasized.

d. Methods and application. Further details including methods of application, chemical sources, storage, handling, and safety procedures are given in appendix G.

6-4. Corrosion control. *a. General.* Corrosion is a phenomenon associated with a metal and the water within a water distribution system. Corrosion in water distribution systems can be described as a two-phase process. In the first phase, the metal dissolves in the water. In the second phase, the oxide of the dissolved metal deposits itself at the corrosion site. For a metal to corrode and thus revert to its native stable state as an oxide is a natural tendency. However, due to differences in mineral and gas content of water supplies, some waters promote the solution of metal more rapidly than others. Others may help to develop a protective mineral or oxide layer that protects against continued corrosion. Waters that generally permit corrosion to take place are called *corrosive waters;* and waters in which the metal does not corrode are called *noncorrosive* or *protective.* Physical factors that affect corrosion and corrosion control are temperature, velocity of water movement over the metal, changes in direction and velocity of flow, and contact with a second metal or nonmetal. Conventionally, the Langlier Index (and others) have developed as a means of determining the relative corrosivity of the water in question. Langlier Index takes into account pH, temperature, alkalinity, hardness and total dissolved solids content of the water.

b. Causes. Corrosion results from the flow of electric current between two electrodes (anode and cathode) on the metal surface. These areas may be microscopic and in very close proximity causing general uniform corrosion and often *red water;* or, they may be large and somewhat remote from one another causing pitting, with or without tuberculation. Electrode areas may be induced by various conditions, some due to the characteristics of the metal and some to the character of the water at the boundary surface. Impurities in the metal, variations in the composition of the metal itself, sediment accumulations, adherent bacterial slimes, and accumulations of the products of corrosion are related to the development of electrode areas for corrosion circuits.

c. Control. A number of installations practice chemical corrosion control for the purpose of increasing the longevity of the distribution system. If corrosion is not controlled, water main replacement may be necessary. Protective measures that may be necessary to control against corrosion include the use of different alloys in pipe manufacture, the use of protective coatings in new main installation, and in-place coating/lining after main cleaning. Chemical control is a supplement to protective control; not a substitute for it. Chemical control cannot be expected to overcome improper flow conditions, poor design, defective materials, and faulty coatings. Polyphosphates and silicates are routinely used for chemical corrosion control. Polyphosphates have been reported to be effective in reducing corrosion by domestic waters; however, a case-by-case evaluation must be made as to the potential for effectiveness. Polyphosphates may also result in substantial phosphorus loadings in receiving wastewater treatment facilities. Silicates are popular for chemical corrosion control in waters of low hardness or alkalinity.

d. Further information. Consult AWWA Standard No. 10008 for a more detailed discussion of corrosion and corrosion control.

CHAPTER 7

WATER QUALITY STANDARDS

7-1. General. The suitability of water for any given use is a function of its quality in terms of its physical, chemical, radiological, and microbiological constituents. In order for water to be acceptable for human consumption, it must be palatable, and more importantly, free of any constituents that would cause adverse physiological effects. Additionally, it should not be destructive to the materials used in its transportation and storage. Potable water should also be suitable for the ancillary uses associated with human habitation (i.e., personal hygiene, laundering of clothes, and dishwashing). The purpose for the establishment of drinking water quality standards is to provide a basis for the selection or rejection of a water supply intended for human consumption. It should be emphasized that the standards are maximum values and every reasonable attempt should be made to obtain water of a better quality. Interpretation of water quality data shall be made only by a qualified sanitary engineer, environmental science officer, or medical officer.

7-2. Treated water standards. *a. General.* Water made available for human consumption shall be of the highest quality. Quality standards for treated water reflect the maximum values of various constituents that should be present in drinking water. The applicable water quality standards are presented in appendix H.

b. Physical quality. The principal physical characteristics of water are color, odor, and turbidity. Temperature may also be considered to be a physical quality. The basis for physical quality standards is primarily related to consumer acceptance of the water. Waters having physical characteristics exceeding the limits in appendix H should not, as a general rule, be used for drinking. However, when water of a lesser physical quality is used due to local conditions, concurrence should be obtained from the installation medical authority. *Note:* If water quality exceeds NIPDWR (app H), then appropriate coordination with regulatory authorities is also required.

c. Chemical quality. The chemical quality of water is a function of all the chemical constituents present and any interactions between these constituents. The chemical quality of water may be described in terms of an inclusive parameter (e.g., total harness, alkalinity, pH) or it may be described in terms of a particular cation or anion (e.g., arsenic, barium, or calcium).

(1) *Basis.* Chemical water quality standards have been established based on either of the following primary arguments. These are the physiological impact and attendant effect the water will have on humans; and secondly, the consumer response concerning the palatability or useability of the water. The effect of a particular chemical constituent or of an inclusive parameter of chemical quality should determine whether a mandatory limit or desirable limit is established for that parameter. Chemical constituents having a deleterious physiological effect shall have a mandatory limit that shall not be exceeded under any circumstances. Other constituents, such as iron and manganese, have no significant adverse physiological effect, but may restrict the uses of the water for laundering of clothes. These constituents normally have a desirable limit that shall not be exceeded unless a water supply of better quality is not available. Appendix H lists the chemical water quality standards for potable water.

(2) *Pesticides.* Pesticide chemicals are toxic and shall be properly stored, handled, and utilized to achieve the desired results without creation of undesirable toxic hazards and environmental contamination. Their persistence in the environment makes it desirable that limits be placed on the concentrations of these pesticides in drinking water. Reference limits are provided in appendix H.

d. Microbiological quality.

(1) *General.* The microbiological quality of a drinking water indicates its potential for transmitting waterborne disease. These diseases may be caused by viruses, bacteria, protozoa, or by higher organisms. Microbiological examination should reveal the quality of the raw water source and is an aid in determining the treatment required. These examinations are essential to the maintenance of the water quality in accordance with established potability standards. The direct measurement of pathogenic organisms in a water sample is extremely difficult. The density of these organisms is usually very low, even in a badly polluted water supply, and the analytical techniques used in their

determination are difficult. For these reasons, indicator organisms are used to indicate the presence of fecal contamination in a water supply. The most common organisms used as indicators of possible contamination are bacteria of the coliform group such as *Escherichia coli, Klebsiella pneumoniae,* and *Enterobacter aerogenes.* These organisms occur in large quantities in the intestines of warm-blooded animals and are used as presumptive evidence of fecal contamination of water. These organisms are not exclusive to the human intestine. Their occurrence, particularly in low densities, does not always mean that human fecal contamination has occurred. However, the presence of any coliform organism in treated drinking water is an indication of either inadequate treatment or the introduction of undesirable materials to the water after treatment.

(2) *Microbiological tests.* Microbiological examinations of potable waters are usually conducted to determine either the presence or absence of coliform group, and the total number of bacteria present per milliliter of sample. Title 40, CFR 141, refers to both the membrane filter and multiple tube fermentation techniques as approved methods for implementation of NIPDWR. However, States assuming primacy may designate one method over the other.

(a) Membrane filter technique. Because of its relative simplicity the membrane filter technique has gained wide acceptance throughout the military as the preferred technique for the presumptive determination of the presence of coliform organisms in drinking water. The membrane filter technique, as described in the current edition of *Standard Methods for the Examination of Wastes and Wastewater,* shall be used except when the State assuming primacy requires the multiple tube fermentation technique.

(b) Multiple tube fermentation technique. Another method sometimes used for total coliform determination is the multiple tube fermentation technique (also called most probable number technique). This method can be found in a current edition of *Standard Methods for the Examination of Water and Wastewater.* The test is a method capable of providing significant data when high suspended solids in the sample limit the use of filter techniques.

(c) Standard plate count. The standard plate count is made to indicate the number of bacteria that can grow under the conditions of the test. It is considered to have varying significance for finished water, particularly if the plating is not complete within 6 hours after collection of the sample. However, the test is valuable in ascertaining the microbiological efficiency of the various units in a water treatment process. Excessively high counts may indicate serious contamination in the system; and therefore, warrant further investigation.

(3) *Other microbiological tests.* In addition to the techniques previously described for total coliforms and total plate count, methods exist to more specifically identify the origin of bacteriological contamination present. Fecal coliform and fecal strep techniques are two commonly used methodologies for this purpose. Specific testing procedures, such as these, are recommended for drinking water when more generalized testing yields positive results. Fecal coliform bacterial densities may be determined by using either the multiple tube or the membrane filter procedure. The membrane filter technique has been shown to have 93 percent accuracy for differentiating between coliforms from warm-blooded animals and coliforms from other sources. Fecal streptococcal group organisms may be identified also by using either membrane filter or multiple tube methodologies. The normal habitat of fecal streptococci is the pntestines of man and animals; thus these organisms are indicators of fecal pollution. Because of organism survival characteristics, it is not recommended to use only the fecal streptococci when investigating or determining water quality. Other fecal indicators (fecal coliforms and total coliforms) should be used concurrently. Many other methods exist to further define the origin of bacteria in drinking water. Further discussion on the microbiology of drinking water and appropriate methodologies may be found in *Drinking Water and Health* and *Standard Methods for the Examination of Water and Wastewater.* Consultation on this subject may also be obtained by contacting a representative of the US Army Environmental Hygiene Agency (see app F).

(4) *Microbiological standards.* The microbiological standards are specified in the NIPDWR standards, or appropriate State standards when the States have primacy. See appendix H.

e. Radiological quality.

(1) *General.* Radioactive elements may appear in water supplies as a result of naturally occurring contamination. Radioactive elements may also enter water from indiscriminate disposal of hospital or industrial radionuclides as well as a result of leakage from reactors.

(2) *Radiological standards.* Radiological water quality standards are based on the premise that radiation has an adverse physiological effect on humans and any unnecessary exposure should be avoided. The physiological effects that are

associated with overexposure to radiation necessitates the rejection of any treated water containing excess quantities of radionuclides. Proper treatment methods should be able to provide drinking water of desired radiological quality in most cases. The NIPDWR standards for radionuclides are summarized in appendix H.

CHAPTER 8

WATER QUALITY SURVEILLANCE

8–1. Objectives. The objectives of water quality surveillance are to insure that the quality of drinking water on US Army installations meets the minimum health standards as set forth by The Surgeon General; to assure that the distribution system is protected from undue corrosion or scaling of mineral constituents; and that economically optimum treatment is carried out by the treatment plant. These objectives shall be met by a program of water quality monitoring under the direction of The Surgeon General and in coordination with the Chief of Engineers (AR 420–46). Consult appendix H for applicable treated water quality standards.

8–2. Surveillance sampling. *a. Treated water at Army-owned and Army-operated facilities.* Surveillance sampling to meet the objectives of the preceding paragraph shall be accomplished on treated waters supplied by the installation at Army-owned and Army-operated facilities. Treated water is defined to include any treatment provided to raw surface or ground water sources and also includes rechlorination or fluoridation of purchased water. Surveillance sampling of purchased water is explained in paragraph 8–2*c*. In addition, Army installations which, through interservice agreements or sale, furnish treated water to other non-Army, military authorities or to civilian communities become *suppliers of water*. All Army installations classified as *suppliers of water* shall provide surveillance monitoring services, for the areas covered by their treated waters, in accordance with NIPDWR and NSDWR, as applicable. See paragraph 8–2*c* for the interpretation of the term *supplier of water*. Compliance with State drinking water regulations or NIPDWR requires surveillance monitoring. Drinking water shall be analyzed at laboratories certified by State regulatory agencies (in States having primacy) or by the regional EPA office (in States not having primacy).

(1) *Surveillance responsibility.* The installation medical authority, in coordination with the facilities engineer, is responsible for coordinating the surveillance monitoring of the potable supply and distribution system. The analyses shall be conducted by a certified military or civilian laboratory. The installation medical authority shall insure that the number of samples collected from the installation distribution system shall be no less than that required by the NIPDWR for the effective population served. The installation medical authority shall maintain liaison with the certified laboratory, the water supplier, and the appropriate (Federal, State, or local) regulatory authority. He shall review results of the analyses to insure conformance with and shall take necessary actions to comply with NIPDWR and NSDWR, as applicable. Appendix I contains summarized NIPDWR surveillance requirements. The surveillance requirement, to include payment for analytical services, is the installation medical authority's responsibility.

(2) *Physical, inorganic, organic, and radiological surveillance.*

(a) Surface water sources. Analyses for the inorganic chemicals specified in the NIPDWR shall be conducted at yearly intervals for community water systems. Analyses for the specified organic chemicals, excluding trihalomethanes, shall be at a frequency specified by the State but never less frequent than 3-year intervals for community water systems. Trihalomethanes shall be monitored on a quarterly basis as required by the State. For community water systems, analyses for radiological activity shall be conducted at least once every 4 years. Initial radiological analyses shall be conducted on either the analysis of an annual composite of four consecutive quarterly samples or the average of the analyses of four samples obtained at quarterly intervals. Once an acceptable data base is available, the State may modify the sampling scheme. Likewise, where there is reason for concern, the State may increase monitoring requirements. Water shall be analyzed for manmade radioactivity in those systems serving over 100,000 persons or those systems specified by the State. Few Army systems will be affected by this portion of the NIPDWR; however, guidance and sampling requirements of the various States shall be followed. Turbidity analysis shall be conducted at least once daily for both community and noncommunity systems using the Nephelometric Method on a sample collected at an entry point into the distribution system (refer to the current edition of *Standard Methods for the Examination of Water and Wastewater).* Turbidity analysis is the facilities engineer's responsibility. Nitrate analysis is the

only inorganic analysis required of noncommunity systems; however, additional analyses may be specified by the State. Organic and radiological analyses are not required for noncommunity systems.

(b) Ground water sources. Community water systems using only ground water sources shall have the inorganic analyses conducted at least every third year in accordance with the NIPDWR. Organic analyses shall be conducted as specified by the State. Analyses for natural radioactive substances shall be as specified for surface water sources. Analyses for ground water sources for manmade radioactive substances shall be as specified by the State. Turbidity need not be monitored for ground water sources. Nitrate analyses for ground water supplied noncommunity systems will be conducted as specified by the State.

(3) *Microbiological surveillance.* For community water systems, the number of samples collected from the installation distribution system shall be no less than that required by the NIPDWR for the effective population served. For noncommunity water systems, at least one microbiological sample per month shall be collected unless increased by a State requirement.

(4) *Supporting laboratories.* Samples for physical, inorganic, organic, and radiological analyses shall be sent to the Commander, US Army Environmental Hygiene Agency, ATTN: HSE-LA, Aberdeen Proving Ground, MD 21010. The USAEHA laboratory has been certified by the EPA to provide analytical laboratory support for accomplishing NIPDWR analyses. Microbiological analyses shall be accomplished by certified laboratories.

b. Treated water at Army-owned and contractor-operated facilities.

(1) *Surveillance responsibility.* The installation medical authority is responsible for coordination of surveillance monitoring as discussed in paragraph *a*(1) above. The surveillance requirement, to include payment for analytical services, is an installation medical authority responsibility. The installation medical authority shall insure that all NIPDWR or corresponding State drinking water regulation requirements are accomplished. In cases where the contractor is tasked to accomplish NIPDWR or corresponding State drinking water regulation requirements, the installation medical authority shall institute an independent surveillance program to include the following:

(a) Insure that a potable water quality survey is accomplished every 3 years.

(b) Conduct microbiological surveillance of the treated water in accordance with paragraph 8-2*a*(3).

(c) Conduct routine inspection of drinking water records at a frequency determined by the installation medical authority.

(d) Insure that the sampling and preservation procedures discussed in paragraph 8-7*a* are followed.

(2) *Other responsibilities.* Physical, inorganic, organic, and radiological surveillance shall be accomplished in accordance with paragraph 8-2*a*(2).

c. Purchased water.

(1) *NIPDWR and NSDWR application.* The NIPDWR and NSDWR may apply to Army systems using purchased water if:

(a) The system has collection and treatment facilities.

(b) The purchased water is obtained from a water system to which NIPDWR and NSDWR do not apply.

(c) Water is sold for potable use.

(d) The purchased water is supplemented with water from Army sources.

(e) Additional treatment (i.e., rechlorination, fluoridation, or addition of chemicals for corrosion control) is provided.

Note: Final interpretation of whether or not an installation is classified as a "supplier of water" rests with the State (for States that have assumed primacy) or the applicable EPA region (for States that have not assumed primacy). If final determination is made that an installation which purchases its potable water is a "supplier of water," then that installation shall comply with the requirements of paragraph *a* above. Suppliers of water are required by the NIPDWR and NSDWR to provide physical, inorganic, organic, radiological, and microbiological monitoring of the water system.

(2) *Surveillance responsibility.* The installation medical authority shall coordinate with the supplier of water to insure that the requirements of NIPDWR and NSDWR are being fulfilled. Independent analyses are not required for physical, chemical, and radiological contaminants provided the installation medical authority is satisfied that the requirements of Federal, State and local regulatory authorities are being fulfilled. The installation medical authority shall conduct bacteriological surveillance of the purchased water in accordance with paragraph *a*(3) above.

d. Bottled water. Bottled water is a type of purchased water. Bottled water shall comply with the requirements of NIPDWR and NSDWR for physical, chemical, bacteriological, and radiological contaminants as applicable. The installation medical authority is responsible for insuring the quality of this supply source and shall approve, from a medical perspective, the pugchase of a bottled water for distribution on an installation. A program of microbiological monitoring of bottled drinking water shall be instituted if this source is provided. This surveillance and monitoring program does not apply to bottled water purchased for resale (i.e., commissary sales).

8–3. Surveillance sampling on surface transportation watercraft. *a.* All Army floating vessels shall use the procedures contained in AR 56-9 to provide and maintain a safe, sanitary water supply.

b. Bacteriological, physical, and chemical requirements of potable water for all vessels shall meet the criteria set forth in AR 40-5 and this technical bulletin.

c. Assistance in monitoring these requirements shall be obtained from medical facilities ashore since this is beyond the capability of personnel assigned to the vessels.

8–4. Surveillance sampling overseas. All army installations located outside CONUS shall maintain the same drinking water standards as prescribed for CONUS Army installations. Any requests for deviation from CONUS drinking water standards shall be submitted in writing to the Theater Surgeon with a copy furnished to The Surgeon General, (HQDA (DASG-PSP), WASH, DC 20310).

8–5. Military-unique chemicals and other potentially hazardous materials. A representative of the US Army Environmental Hygiene Agency (Duty Hrs: AUTOVON 584-3816, Nonduty Hrs: AUTOVON 584-4375) should be consulted immediately upon suspicion of contamination of a water source by military-unique chemicals or other potentially hazardous materials. The appropriate analyses shall then be performed by US Army Environmental Hygiene Agency personnel who are trained in the latest means of detection and treatment.

8–6. Operational surveillance. In addition to the surveillance sampling program previously mentioned, water treatment personnel should collect additional samples to provide quality control for any treatment processes that are employed. Examples of this type of analyses are: Coagulant demand, turbidity, color, odor, chlorine residual, fluoride, iron, manganese, pH, temperature, hardness, total alkalinity, and total dissolved solids. The latter five analyses are required for the determination of the Langlier Index used as an indicator of corrosive properties of treated water. Operational sampling should be accomplished as frequently as necessary to insure the maintenance of effective treatment control and to minimize the cost of treatment. Consult TM 5-660 for additional information on this subject.

8–7. Procedures. *a. Sampling and preservation.*

(1) *Physical, inorganic, organic, and radiological surveillance.* For those installations having public water systems, sampling and sample preservation requirements are contained in NIPDWR and NSDWR, or corresponding State drinking water regulations. Installations not having public water systems shall contact the supporting laboratory or activity to verify laboratory capability, appropriateness of the analytical request, sampling techniques, and sample preservation requirements.

(2) *Microbiological surveillance.* Sampling and sample preservation requirements for installations not having public water systems shall be identical to those requirements as stated in NIPDWR and NSDWR, or corresponding State regulations for installations having public water systems. As a general guide, appendix J presents the sampling techniques to be used in determining the microbiological quality of water. Samples collected for microbiological analysis should be examined as soon as possible after collection. Ideally, samples should not be held for more than 6 hours between collection and initiation of analyses. The exception to this rule is for samples mailed from distant installations; these samples may be held for up to 30 hours. This is important because of the extensive changes that may take place in the bacterial flora even though the samples are stored at temperatures as low as 4° C.

(3) *Sampling location plan.* A map of the installation water distribution system showing all sampling points shall be maintained by the installation medical authority. Only those samples of water distributed for drinking and culinary purposes should be used in evaluation of potability. Sampling points such as dining facilities, hospitals, barracks, and residential and administrative areas should be chosen so as to be representative of principal use. Samples should not be collected routinely from hot water faucets, mixing faucets, fixtures that are leaking, drinking fountains, fire hydrants, or outlets connected to dead end sections of the distribution system. On those installations where more than one independent distribution system is in use, each system shall be considered as

a separate and distinct installation for the purpose of determining the number and frequency of samples to be drawn.

b. Analytical methodology.

(1) *Physical, inorganic, organic, and radiological surveillance.* The NIPDWR, NSDWR, and corresponding State drinking water regulations establish approved analytical methods for surveillance of public water systems. For other types of surveillance, the current edition of *Standard Methods for the Examination of Water and Wastewater* should be used.

(2) *Microbiological surveillance.* For those installations having public water systems, approved analytical methods are contained in NIPDWR or corresponding State drinking water regulations. The membrane filter and multiple tube fermentation techniques are the approved methods. The membrane filter technique, because of ease, is the preferred method. However, State drinking water regulations may specify only the multiple tube fermentation technique. The standard sample for the examination of finished waters using the membrane filter techniques is 100 milliliters (mL). Proportionally smaller volumes should be filtered when contamination is suspected. Incubated filter pads should not contain more than 60 coliform colonies and not more than 200 colonies of all types. For all other surveillance not governed by drinking water regulation, the membrane filter and fermentation methods should be used, with the membrane filter technique the method of choice.

8-8. Reporting and recordkeeping. The NIPDWR requires operators of public water systems to provide to the regulatory agency chemical and microbiological results within 40 days following the analyses. Records of microbiological analyses shall be kept for 5 years, whereas chemical analysis records shall be kept for 10 years. Other information concerning sample collection and laboratory analyses shall also be kept. Consult the NIPDWR, subpart D, or corresponding State regulations for complete reporting and recordkeeping details.

8-9. Remedial action. *a. Suspected Bacteriological Contamination.* Appendix K presents information that may be used as a guide in determining the type action warranted when bacteriological contamination is suspected. The important fact to remember is not to unduly alarm the consumer. Overreaction on the part of responsible personnel only results in increasing the magnitude of the suspected problem; often to an extent entirely out of proportion to the seriousness of the problem. If contaminated samples are found and the coliform colonies in a single standard sample exceed four per 100 milliliters, daily samples shall be collected and examined from the same sampling point until the results obtained from at least two consecutive samples show less than one coliform per 100 milliliters. If results of greater than one coliform colony per 100 milliliters are obtained for 2 or more days, then consultation is recommended with the applicable Army laboratory/agency listed in appendix F. Additional testing to indicate the source of contamination may be warranted. Consult paragraph 7-2*d*(3) for further guidance.

b. Noncompliance with NIPDWR.

(1) If a particular sampling point has been confirmed to be in noncompliance with the standards listed in appendix H, the installation commander, in coordination with the installation medical authority, shall:

(a) Notify all potentially affected customers and the regulatory authority.

(b) Provide alternative drinking water until the supply is again known to be safe.

(2) For those installations operating public water systems, there is a public notification requirement under NIPDWR when MCLs are exceeded. Public notification is required when applicable testing procedures are not followed; schedules of a variance or an exemption are not followed; variance or an exception is granted; and when required monitoring is not accomplished. Public notification is explained in detail in NIPDWR, subpart D, or corresponding State drinking water regulations (AR 420-46).

CHAPTER 9

CONTINGENCY PLANNING

9–1. General. The management and operation of a water supply, treatment, and distribution is a complex task directed towards guaranteeing a continuous, uninterrupted supply of high quality water for domestic and industrial use. This chapter is concerned with highlighting the need for contingency planning that can assist an installation maintain a continuous, uninterrupted water supply during natural and manmade disasters. Preventive medicine personnel should have a keen interest in this area because history has shown that disaster contaminated water can be a major potential agent for the spread of infectious disease.

9–2. Points to consider. In establishing contingency plans, coordination between the facilities engineer and the installation medical authority is essential. Specific responsibilities must be defined for each organization. Other factors to be considered include:

a. Establishment of a priority of service listing for major areas and users on the installation.

b. Locate major valves and backflow prevention devices for isolating damaged areas to prevent the spread of contamination.

c. Locate and identify alternate water storage, purification, and power generation equipment (e.g., use of swimming pool treatment facilities, use of field water treatment equipment from Active Army, Reserve and National Guard units).

d. Establish procedures to elevate disinfectant (chlorine) levels to provide additional disinfectant capability.

e. Establish procedures for notification of installation residents and work force of emergency potable water considerations.

Note: The above listing is not intended to be all inclusive. It is designed to indicate potential areas that need further analysis on a case-by-case basis.

9–3. Additional information. For assistance in developing contingency plans to cope with an emergency or disaster, consult the AWWA Manual M19.

APPENDIX A

REFERENCES

A-1. Army Regulations.

AR 40-5, Health and Environment.
AR 56-9, Watercraft.
AR 200-1, Environmental Protection and Enhancement.
AR 310-25, Dictionary of United States Army Terms.
AR 340-18-15, Maintenance and Disposition of Facilities Functional Files.
AR 420-46, Water and Sewage.

A-2. Technical Bulletins (Medical).

TB MED 229, Sanitary Control and Surveillance of Water Supplies at Fixed and Field Installations. (The field installation portion of the TB MED will remain in effect until republished as TB MED 577).
TB MED 223, Respiratory Protection Program. (To be republished as TB MED 502.)
TB MED 163, Sanitary Control of Army Swimming Pools and Swimming Areas. (To be republished as TB MED 575.)

A-3. Field Manual.

FM 5-166, Well Drilling Operations.

A-4. Technical Manuals.

TM 5-660, Operation of Water Supply and Treatment Facilities at Fixed Army Installations.
TM 5-661, Inspection and Preventive Maintenance Services for Water Supply Systems at Fixed Installations.
TM 5-700, Field Water Supply.
TM 5-810-5, Plumbing.
TM 5-813-1, Water Supply: General Considerations.
TM 5-813-2, Water Supply: Water Sources.
TM 5-813-3, Water Supply: Water Treatment.
TM 5-813-4, Water Supply: Water Storage.
TM 5-813-5, Water Supply: Water-Distribution Systems.
TM 5-813-6, Water Supply for Fire Protection.
TM 5-813-7, Water Supply for Special Projects.
TM 5-884-2, Engineering and Design, Water Supply-Emergency Construction.

A-5. USA Health Services Command Pamphlet.

HSC PAM 40-3, Environmental Health Program.

A-6. Public Law.

Public Law 93-523, Safe Drinking Water Act.

A-7. Code of Federal Regulations.

Title 40, Code of Rederal Regulations (CFR), Part 143, National Secondary Drinking Water Regulations.
Title 40, CFR, Part 141, National Interim Primary Drinking Water Regulations, as amended by 45 Federal Register (FR) 57342, 27 August 1980.

A-8. Miscellaneous.

Center for Disease Control, *Water-Related Disease Outbreaks,* Annual Summary 1978, US Department of Health and Human Services Publication No. (CDC) 80-8385.

National Institute for Occupational Safety and Health. *Criteria for a Recommended Standard ... Occupational Exposure to Chlorine,* DHEW (NIOSH) 79-170, May 1976.

Federal Water Pollution Control Administration. *Water Quality Criteria,* Report of the National Technical Advisory Committee to the Secretary of Interior, Washington, DC, April 1968.

US Environmental Protection Agency, *Quality Criteria for Water,* July 1976.

US Environmental Protection Agency, Division of Water Supply, *Cross-Connection Control Manual,* EPA-430/9-73-002.

US Environmental Protection Agency, Division of Water Supply, *Manual of Individual Water Supply Systems,* EPA-430/9-74-007.

US Environmental Protection Agency, Office of Water Supply, *National Interim Primary Drinking Water Regulations,* EPA/570/9-76/003.

US Environmental Protection Agency, Office of Research & Development, *Handbook for Evaluating Water Bacteriological Laboratories,* EPA/670/9-75/006, August 1975.

US Environmental Protection Agency, Office of Research & Development, *Microbiological Methods for Monitoring the Environment,* EPA/600/8-78/017, December 1978.

US Environmental Protection Agency, Office of Water Programs, *Manual for Evaluating Public Drinking Water Supplies,* Public Health Service Publication 1820-71.

US Environmental Protection Agency, Office of Water Supply, *Manual for the Interim Certification of Laboratories Involved in Analyzing Public Drinking Water Supplies,* EPA 600/8-78-008, May 1978.

US Environmental Protection Agency, Office of Water Programs, *Fluoridation Engineering Manual,* USGPO 1973-759-907/1129, Ervin Bellack, 1972.

US Environmental Protection Agency, Water Supply Division, *Bottled Water Study,* September 1972.

American Water Works Association, *Handbook of Occupational Safety and Health Standards for Water Utilities,* 1974. AWWA No. 20104.

American Water Works Association, *Emergency Planning for Water Utility Management,* AWWA Manual M19, 1973.

American Water Works Association, *Groundwater,* 1973, AWWA Manual M21.

American Water Works Association, *Standard for Deep Wells,* 1946. AWWA No. A100-66.

American Water Works Association, *Standard for Disinfecting Water Mains,* 1968. AWWA No. C601-68.

American Water Works Association, *Standard for Inspecting and Repairing Steel Water Tanks, Standpipes, Reservoirs, and Elevated Tanks, for Water Storage,* 1953. AWWA D101-53.

American Water Works Association, *Standard for Painting and Repainting Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage,* 1978. AWWA No. D102-78.

American Water Works Association, *Water Treatment Plant Design,* 1969. AWWA No. 10006.

American Water Works Association, *Water Utility Accounting,* 1980. AWWA No. 10007.

American Water Works Association, *Water Quality and Treatment,* 1971. AWWA No. 10008.

American Water Works Association, *Taste and Odor Control Experiences Handbook,* (no date). AWWA No. 20101.

American Water Works Association, *Water Distribution Operator Training Handbook,* 1976. AWWA No. 20103.

American Water Works Association, *Handbook of Occupational Safety and Health Standards for Water Utilities,* 1974. AWWA No. 20104.

American Water Works Association, *Cross-connection and Backflow Prevention Handbook,* 2d ed., 1974. AWWA No. 20106.

American Water Works Association, *Trihalomethanes in Drinking Water,* 1980. AWWA No. 20212.

American Water Works Association, *Simplified Procedures for Water Examination, Including Supplement on Instrumental Methods,* (1978). AWWA No. 30012. AWWA Manual M12.

American Water Works Association, *Recommended Practice for Backflow Prevention and Cross-Connection Control,* 1970. AWWA No. 30014. AWWA Manual M14.

American Water Works Association, *Work Practices for Asbestos-Cement Pipe,* 1978. AWWA No. 30016. AWWA Manual M16.

American Water Works Association, *Emergency Planning for Water Utility Management,* 1973. AWWA No. 30019. AWWA Manual M19.

American Water Works Association, *Water Chlorination Principles and Practices,* 1973. AWWA No. 30020. AWWA Manual M20.

American Water Works Association, *Ground Water,* 1973. AWWA No. 30021. AWWA Manual M21.

Standard Methods for the Examination of Water and Wastewater, latest edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation.

State (California Water Pollution Control Board (McKee)) Water Quality Criteria, Publication No. 3–A, Documents Section, State Printing Division, Sacramento, CA, 1963.

National Academy of Sciences, *Drinking Water and Health,* Volumes 1 (1977), 2 (1980), 3 (1980), National Academy of Sciences, 2101 Constitution Avenue, Washington, DC.

National Academy of Sciences, *Water Quality Criteria 1972,* A Report of the Committee on Water Quality Criteria, Environmental Studies Board, National Academy of Sciences, National Academy of Engineering, Washington, DC (1972). Water Quality and Treatment, *A Handbook of Public Water Supplies,* 3d ed., McGraw-Hill Book Co., AWWA.

International Standards for Drinking Water, World Health Organization, 1963. *Annual Book of ASTM Standards,* Part 31 Water 01–031080–16, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

Ehlers, V., and E. Steel, *Municipal and Rural Sanitation,* 6th ed., McGraw-Hill Book Company, Inc., 1965.

Fair, G. A., J. C. Geyer, and D. A. Okun, *Water and Wastewater Engineering,* John Wiley and Sons, Inc., New York, 1968.

Sawyer, C. N., and P. L. McCarty, *Chemistry for Environmental Engineering,* 3d ed., McGraw-Hill Book Company, Inc., 1978.

Todd, K., *Ground-water Hydrology,* John Wiley and Sons, Inc., New York, 1963.

White, G. C., *Handbook of Chlorination,* 1st ed., VonNostrand, R., 1972.

APPENDIX B

DEFINITIONS

Aquifer—A permeable, water-bearing geologic formation.

Break-point chlorination—The application of chlorine to produce a residual of free available chlorine with little or no combined chlorine present.

Combined available chlorine—The chlorine products formed by the reaction of the equilibrium products of amononia with the equilibrium products of chlorine to form chloramines. Combined available chlorine has significantly less disinfecting power.

Community water system—A public water system that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

Contaminant—Any potentially harmful physical, chemical, microbiological, or radiological substance or matter in water.

Crossover point—Any point or points at which a potable water main makes contact or crosses over or under a nonpotable liquid conduit (sewer, nonpotable water supply).

Cross-connection—

a. Any physical connection through which a supply of potable water could be contaminated or polluted.

b. A connection between a supervised potable water supply and an unsupervised supply of unknown potability.

Disinfection—The act of inactivating the larger portion of microorganisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used.

Field water supply system—That assemblage of collection, purification, storage, transportation, and distribution equipment and personnel to provide potable water to field units in both training and actual employment environments.

Finished water—Treated water.

Fixed installation—An installation that, through extended use, has gained those structures and facilities not initially found or intended for use at a "temporary" standard facility (i.e., paved roads, fixed electrical distribution systems, fixed water treatment facilities, and underground distribution lines).

Free available chlorine—The chlorine equilibrium products present in the forms hypochlorous acid ($HOCl$) and hypochlorite ions (OCl^-).

Health hazards—Any condition, including any device or water treatment practice, that may create an adverse effect on a person's well-being.

Installation Medical Authority—Installation medical authority refers to the unit surgeon, command chief surgeon, US Army Medical Department Activity/US Army Medical Center commanders, and the Director of the Health Services or his representative responsible for provision of medical support at the unit, command or installation concerned in consultation with sanitary engineers and environmental science officers when appropriate.

Marginal chlorination—Application of chlorine to produce the desired total chlorine residual without reference to the relative amounts of free or combined chlorine present.

Maximum contaminant level—The maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system; except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Substances added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

Noncommunity water system—A public water system that serves at least 25 people at least 60 days per year, or has at least 15 service connections used by intermittent users at least 60 days per year.

Nonpotable water—Water that has not been examined, properly treated, and approved by appropriate authorities as being safe for domestic consumption. All waters are considered nonpotable until declared potable.

Palatable water—Water that is pleasing to the taste; significantly free from color, turbidity, taste, and odor. Does not imply potability.

Potable water—Water that has been examined and treated to meet appropriate standards and declared fit for domestic consumption by responsible installation medical authorities.

Primacy—A State government has primary enforcement authority under the Safe Drinking Water Act. Primacy is delegated to the State by the EPA Administrator. Before assuming primacy, the State shall establish drinking water regulations no less stringent than the present NIPDWR.

Public water system—A system for the provision to the public of piped water for human consumption. A system that has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. This term includes:

a. Any collection, treatment, storage, and distribution facilities under the control of the operator of such system; and used primarily in connection with such system.

b. Any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system. A public water system is either a "community water system" or a "noncommunity water system."

Raw water—

a. Untreated water; usually the water entering the first treatment unit of a water treatment plant.

b. Water used as a source of water supply taken from a natural or impounded body of water, such as a stream, lake, pond, a ground water aquifer.

Sanitary defects—Conditions that may permit the contamination of a water supply during or after treatment. These include connections to unsafe water supplies, raw water bypasses in treatment plants, plumbing fixtures improperly designed and installed, and leaking water and sewer pipes in the same trench.

Sanitary survey—An onsite review of the water source, facilities, equipment, operation, and maintenance of a public water system for the purpose of evaluating adequacy of such source, facilities, equipment, operation, and maintenance for producing and distributing safe drinking water.

Shall—Indicates a requirement that is necessary or essential to meet the currently accepted standards of protection of Federal rules and regulations.

Should—Indicates an advisory recommendation that is to be applied when practicable.

Spring—A spring is a concentrated discharge of ground water appearing at the ground surface.

Standard sample—The aliquot of finished drinking water that is examined for the presence of coliform bacteria.

Super-chlorination—The application of chlorine in dosages far in excess of the chlorine demand for disinfection.

Supplier of water—Any person who owns or operatres a public water system.

Total available chlorine—The sum of the chlorine forms present as free available chlorine and combined available chlorine.

Treated water—Water that has undergone processing such as sedimentation, filtration, softening, disinfection, etc., and is ready for consumption. Included is purchased potable water that is retreated (chlorinated, fluoridated, etc.).

Trihalomethanes (THM)—A class of organic compounds, commonly found in chlorinated or brominated drinking waters. THM are formed by the reaction of naturally occurring organic substances (commonly called precursors) with chlorine or bromine in the course of water treatment operations and distribution. The four organic halogen compounds that constitute total trihalomethanes are: Trichloromethan (chloroform), bromodichloromethane, dibromochloromethane and tribromomethane (bromoform).

Water quality—The chemical, physical, radiological, and microbiological characteristics of water with respect to its suitability for a particular purpose.

APPENDIX C

PRINCIPAL WATERBORNE DISEASES OF CONCERN WITHIN CONUS

C-1. The principal diseases contracted by man from ingesting contaminated water are gastroenteritis, giardiasis, typhoid fever, salmonellosis, shigellosis, and infectious hepatitis. In addition, schistosomiasis occurs in some tropical areas and is a hazard in bathing waters in many other areas.

C-2. The transmittal of these diseases is by no means limited only to water. With the exception of schistosomiasis, they all enter man by the fecal-oral route; however, the impact of a waterborne disease may be catastrophic because a single contaminated water supply may affect an entire population rather than isolated individuals. The incidence of waterborne outbreaks is on the increase, and they are possibly due to accident, negligence, or a drastic change in conditions with which an existing treatment plan is unable to cope.

C-3. Figure C-1 gives the minimum chlorine residuals after a 30-minute contact time which are required for bactericidal and cysticidal destruction of pathogens. Note that the minimum recommended FAC residual for the destruction of pathogens is 0.2 ppm (mg/L).

C-4. A discussion relating to waterborne diseases of concern outside CONUS will be addressed in TB MED 577 when published.

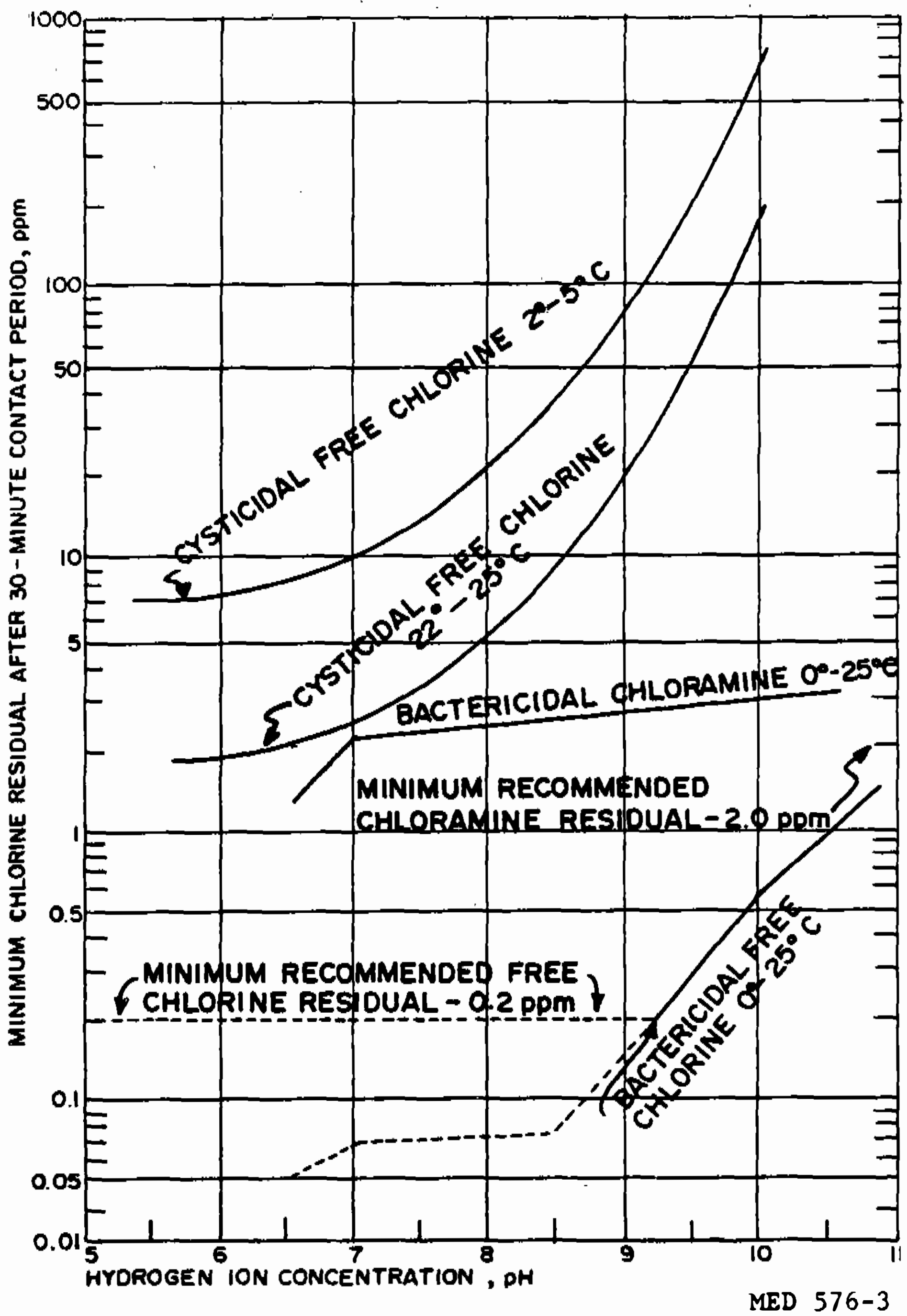

Figure C-1. Minimum 30-minute free chlorine and chloramine residuals for naturally clear or filtered waters.

Source: Reprinted from *Water Treatment Plant Design* by permission. Copyright 1971, the American Water Works Association.

APPENDIX D

MEASUREMENT OF RESIDUAL CHLORINE (DPD METHOD)

D-1. General. The instructions for the Wallace & Tiernan Kit, available through the Federal Supply System, are presented below. This kit can be ordered using the nomenclature in paragraph D-6. Other kits can be utilized in lieu of this kit; consult manufacturer's specific instructions as required.

D-2. Procedure. See general test precautions below.

a. Place the chlorine color comparator disc in the comparator.

b. Thoroughly rinse two test tubes and fill both tubes with the water sample exactly to the etched mark on the tubes.

c. Position the comparator with the eyepiece facing you, and place the two water filled tubes into the openings at the top of the comparator.

d. Add two DPD free residual chlorine tablets (DPD #1) into the tube in the right opening of the comparator. Cap the test tube and shake to disintegrate the tablets. For those kits with hard-to-dissolve tablets, a stirring rod is usually provided to "crush" the tablets. Exercise caution in crushing the tablet so that other parts of the kit are not damaged.

e. Hold the comparator close to your eye, and face a good light source (daylight but not the direct rays of the sun, daylight illuminator, or artificial light reflected from a white surface). Be sure your fingers do not cover the light window in the back of the comparator. Rotate the chlorine color comparator disc until a color on the disc matches the color of the indicator (left) tube. The reading can be made directly from the round window in front of the comparator. The value is expressed in mg/L.

f. If the color of the indicator tube is between two colors on the chlorine color comparator disc, the value shall be estimated. Choose a value between the readings corresponding to the colors on either side of the indicator color.

g. Color matching should be completed as soon as possible after the addition of the DPD tablets (step *e*). It is important that the reading be made within 1 minute; delays of 2 minutes or more should be avoided.

D-3. Precautions. *a. General.* As with all chemicals, caution should be exercised in handling DPD tablets. To insure greatest accuracy, several other precautions should be followed.

b. Color discs. Color discs are adjusted for sample tubes having a 26 mm depth and on the basis of 15 cc of water sample. The graduated mark on the sample tubes is at 15 cc. The disc supplied with the comparator measures 0.1 to 10.0 ppm chlorine residual.

(1) *Cleanliness.*

(a) Before taking readings be sure that the glass color standards in the disc are clean.

(b) When taking samples, adding tablets, and mixing in the sample tubes, be sure that the hands are free of all traces of chemical so that the sample will not be contaminated. Any contamination of the samples will produce erroneous readings.

(2) *Color and turbidity.* To eliminate errors due to natural color and turbidity of the sample, make sure that water is added to the right-hand tube before making color comparison.

(3) *Sunlight.* Do not allow direct sunlight to fall on the samples being tested. Sunlight causes the color developed by the tablet to fade.

D-4. Total chlorine and combined available chlorine determinations. *a. General.* Total chlorine and combined available chlorine may also be determined using the DPD test kit.

b. Tablets. DPD #4 tablets are available to measure total chlorine.

c. Methodology. Total chlorine is measured using the procedure prescribed above. Combined available chlorine can be found by subtraction in accordance with the following relationship:

Combined Available Chlorine = Total Chlorine − Free Available Chlorine Combined available chlorine is a measure of disinfecting chlorine residual attributable to chloramine compounds.

D-5. pH determinations. *a. General.* pH may also be determined using the test kit described in paragraph 6.

b. Reagent. Phenol red indicator solution is available to measure pH.

c. *Methodology.* pH is measured using the procedure prescribed above with the exception that phenol red indicator solution is substituted for the appropriate DPD tablet.

D-6. Equipment. If new equipment kits are needed, or available equipment is not adequate, DPD chlorine residual kits should be ordered using the following information:

NSN	*Item*
6630-01-042-0998	Disk, Color Standard, Free Chlorine, DPD Method Wallace & Tiernan Company. $43.99 each (estimated), SB 8-75-11, 24 March 1978. Item is used to modify the existing comparator, National Stock Number (NSN) 6630-00-087-1838. The kit consists of one color disk for use with DPD reagent, a revised instruction book, a revised plastic inclosed instruction card, and an instruction sheet on the steps to be taken to modify the existing comparator.
6630-01-044-0334	Comparator, Color, Hydrogen Ion and Residual Chlorine. Wallace & Tiernan Company, Catalog No. WIV 20486-2-2. $144.56 each (estimated), SB 8-75-12, 7 April 1978. Item is used in performing pH and chlorine determinations of water in the field. The item consists of one color comparator with prismatic eyepiece assembly, four rectangular sample cells, one pH reagent bottle, one DPD chlorine color disk, one pH color disk, operating instructions, service data and carrying case. For DPD #1 test tablets, order NSN 6810-01-044-0315. DPD is the current method of choice for detection of chlorine residual in drinking water. (Replacement item for NSN's 6630-00-087-1838 and 6630-01-027-3914.)
6810-01-044-0315	Chlorine Test Tablet, DPD Method, 100's. Wallace & Tiernan Company, Catalog No. U-23321. $3.00 per box (estimated), SB 8-75-12, 7 April 1978. Item is used with NSN 6630-01-044-0334, Comparator, to determine chlorine content in water. Item consists of 100 foil wrapper LaMotte-Polin DPD Chlorine #1 tablets.

Note: DPD #4 tablets for measuring total chlorine and phenol red indicator solution are not currently available through the Federal Supply System. Installation procurement personnel should be contacted for these requests.

Source: The Department of the Army Supply Bulletin, Army Medical Department Supply Information.

APPENDIX E

MODEL POTABLE WATER MONITORING PROGRAM FOR THE INSTALLATION MEDICAL AUTHORITY

E-1. Coordinate with applicable Federal, State, and local regulatory agencies in implementing drinking water regulations. USAEHA can be a source of guidance on this subject.

E-2. Establish a written SOP detailing the potable water monitoring program to be followed by your branch or activity.

E-3. Maintain a list of all water sources including the type, location, quality, and quantity of each. Maintain information on the treatment provided to each water source.

E-4. Maintain a current set of plans of the water distribution system. Maintain a record of all crossover points with the distribution system.

E-5. Maintain records of surveys, analyses, actions, and other information pertinent to the sanitary surveillance of the potable water system.

E-6. Maintain copies of all appropriate regulatory agency and US Army drinking water regulations and guidelines.

E-7. Collect samples for bacteriological analyses as required by NIPDWR and the effective installation population (inclues purchased and bottled water).

E-8. Perform chlorine residual tests and collect samples for fluoride determinations (where applicable) in conjunction with bacteriological sampling.

E-9. Participate in the quarterly fluoride quality assurance program performed by USAEHA.

E-10. Establish an in-house quality assurance program for all analytical methods used.

E-11. Obtain and maintain certification of the PVNTMED laboratory for applicable bacteriological analysis.

E-12. Review the results of all required potable water analysis performed at the installation or by consultants.

E-13. Inspect the water source, treatment plant, and storage and distribution system on a monthly basis.

E-14. Approve concentrations of and types of chemical additions to potable water supplies.

E-15. Inspect the water treatment plant laboratory and review analytical procedures to insure compliance with *Standard Methods* on a quarterly basis.

E-16. Establish a program to inspect for and eliminate cross-connections.

E-17. Coordinate with the facilities engineer to: *a.* Provide feedback on inspections and analyses.

b. Insure that PVNTMED personnel are notified when distribution system breakage, modification, flushing, or shutdown occur.

c. Insure that a coordinated program of flushing all water mains is established and performed at periodic intervals.

d. Install test loops and monitor them monthly to determine the amount of scaling/corrosion taking place.

e. Insure that adequate chlorine residuals are maintained in all portions of the distribution system under constant circulation.

f. Develop contingency plans for natural or manmade disasters.

E-18. Vigorously pursue an aggressive continuing education program in health related potable water training.

E-19. Institute the applicable environmental health guidance found in HSC PAM 40-3.

APPENDIX F

ARMY LABORATORIES/AGENCIES AND AREAS SERVED

Laboratory or agency	Area served
US Army Environmental Hygiene Agency Regional Division (North) Fort George G. Meade, MD 20755 AUTOVON 923-6205	Connecticut, Delaware, District of Columbia, Eastern Kentucky, Indiana, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia.
US Army Environmental Hygiene Agency Regional Division (South) Fort McPherson, GA 30330 AUTOVON 588-3234	Alabama, Arkansas, Florida, Georgia, Western Kentucky, Louisiana, Mississippi, Oklahoma, Panama, Puerto Rico, South Carolina, Tennessee, Central and Eastern Texas.
US Army Environmental Hygiene Agency Regional Division (West) Fitzsimons Army Medical Center Aurora, CO 80045 AUTOVON 943-8881	Alaska, Arizona, California, Colorado, Idaho, Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, West Texas, Utah, Washington, Wisconsin, Wyoming.
Commander US Army Pacific Environmental Health Engineering Agency, Sagami APO San Francisco 96343 Ask overseas operator for: Camp Zama 228-4111	Hawaii, Japan, Korea, Okinawa, Philippines, Thailand, and all other Far East.
Commander Tenth Medical Laboratory ATTN: Preventive Medicine Division APO New York 09180 Ask overseas operator for: Gibbs Barracks in Landstuhl 2223-8203	Europe, Africa, Middle East.
Commander US Army Environmental Hygiene Agency ATTN: HSE-EW Aberdeen Proving Ground, MD 21010 AUTOVON 584-3816	Support to Laboratories listed and areas not specified.

APPENDIX G

FLUORIDATION

G-1. Chemical Sources. The fluoride ion is most commonly obtained by forming aqueous solutions of sodium fluoride, sodium silicofluoride, or hydrofluosilicic acid. Other less common sources are ammonium fluosilicate and calcium fluoride. The choice of chemical source is based on cost, availability, consumption rate, and handling characteristics. When purchasing fluoride chemicals, American Water Works Association, Park Avenue, New York, NY, 10016, specifications should be used.

a. Sodium fluoride is commercially available as a fine, white, crystalline powder (sometimes artificially colored nile blue) which is 95 to 98 percent sodium fluoride and contains roughly 43 percent fluoride. Its solubility, approximately 4 percent, is essentially independent of temperature. Thus, a saturated aqueous solution will increase fluoride ion concentration approximately 1 mg/L at a feed rate of 58 gallons (19.4 lb sodium fluoride) per million gallons.

b. Sodium silicofluoride (NSN 6810-00-088-7252) is similar in appearance to sodium fluoride but contains 60 percent fluoride in commercial grades. Solubility is temperature dependent over normal water supply operating temperature ranges, varying from 0.43 percent to 0.75 percent. Fourteen pounds dissolved in 1 million gallons of water will increase the fluoride concentration 1 mg/L.

c. Hydrofluosilicic acid normally is furnished in aqueous solutions containing 23 to 30 percent fluoride. This solution boils at approximately 221° F and freezes near 4° F. Thirty-five pounds of 23.8 percent solution will increase the fluoride concentration 1 mg/L in 1 million gallons of water. In order to insure procurement of known concentration, purchase documents should specify the permissible variation in acid strength.

G-2. Application. Ideally, fluoride should be added to a water subsequent to all treatment processes except chlorination. Chlorine interferes with fluoride residual determinations and other treatment processes will remove part of the fluoride concentration. For example, lime softening removes approximately one quarter of the fluoride present and ordinary filtration accounts for losses between 0.1 and 0.3 mg/L. Consideration should also be given to the need for thorough diffusion of the fluoride.

a. Feeders. The type of feeder used will depend on the amount of material to be fed and the other treatment processes in use. Dry feeders and pressure feeders are two classes of feeders commonly used. Pressure feeders are used to inject hydrofluosilicic acid or solutions formed by dry feeders which must be injected into pressure lines.

b. Piping. Ordinary steel pipe can be used in transporting sodium fluoride solution but is not suitable for sodium silicofluoride or hydrofluosilicic acid solutions because of increased corrosive activity of the solution. Several types of plastic and plastic-lined pipes are available that are suitable for fluoride solutions. The most satisfactory material is rubber hose that can be threaded through an oversized pipe to provide support, present a neat appearance, and prevent air pockets. Gravity flow is preferable but ample pitch is necessary and the line must be vented at the solution tank. If the discharge end of the solution pipe is below liquid level, it should be vented at the last point where it makes a vertical drop.

c. Well supplies with only disinfection.

(1) At installations supplied by wells that are equipped with automatically controlled pumps that do not deliver to a common point, it will be necessary to have an individual fluoride feeder for each well requiring fluoridation. For these installations, the most accurate and economical method of fluoridation is the application of sodium fluoride solutions of less than 4 percent. For the preparation of solutions (less than saturated—4 percent), a weighed amount of the chemical is added to a definite weight or volume of water, and the mixture is mechanically or manually stirred until a homogeneous solution results. To reduce the hazard created by the poisonous dust of the powdered form, it is recommended that the granular form (20-40 mesh) of sodium fluoride be used in this operation. The use of "saturator tanks" for the preparation of the solutions is recommended.

(2) Where the source of water is from wells pumping to a central point, such as a reservoir or

ground storage tank, and then pumped into the distribution system, the method of application of fluorides can be by either pressure feeders or dry feeders, whichever method is determined to be the most feasible.

d. Purchased water supplies. The commamder of the installation should arrange with the contractor, whether municipal or private water company, for the installation of fluoridation. Only after these efforts fail should fluoridation be done by the installation for treatment of purchased supplies.

e. Maintenance of a definite fluoride content. The maintenance of a definite fluoride content requires a feeding rate paced by flow. Installations of the constant-rate type, especially where the source is from well supplies, will require automatic start-stop mechanisms to permit the equipment to function only while the well pumps are in operation. A relay should be provided in the starting circuit to a deep well pump motor to start and stop the chemical feeder motor. For installations where the flow varies hourly or is changed several times a day, automatic proportioning requires that this flow be metered to automatically change the feeder rate in proportion to the flow. Accuracy of this proportioning can be determined and recorded by checking the volume pumped with the weight of fluoride used. Automatic proportioning should be provided on all well pumps that start and stop automatically and do not deliver to a common point.

f. Prevention of overfeeding. Every precaution should be incorporated to prevent overfeeding in all fluoride dosing installations. If proportioning pumps are used, there is little possibility of overfeeding when the chemical solution is introduced into the system under pressure or when the solution is raised by the pump to a higher elevation. Suction boxes may be used with dry feeders and dissolvers. There is small danger of unloading the feeding hopper, causing overdosage, in dry feeders with hoppers holding one or two bags of chemical (100 to 200 lbs). Danger of overfeeding is greatest when tall extension hoppers holding large quantities of chemical are in use, and for this reason, are not recommended for Army installations.

G-3. Handling and storage. *a. Dry fluoride compounds.* Storage should be convenient to the feed equipment in the plant. All chemicals should be stored in a dry room, free from condensing water vapor or floor washing and drainage. Moisture sufficient to damage the chemical will be absorbed through concrete floors and make feeding through dry feed equipment difficult. All packages, even steel drums, should be placed on grids or boards to permit circulation of air and prevent sweating on the bottom of the container. Hopper filling openings should be at a suitable height to avoid the use of stepladders, boxes, and platforms.

b. Hydrofluosilicic acid. Because of the corrosiveness of hydrofluosilicic acid, care will be taken in selecting materials for storage and handling such as natural rubber, neoprene, and plastics. Lined tanks generally are used for shipping and storage. Storage tanks should be covered and if placed indoors, ventilated. Storage at lower temperatures reduces volatility.

G-4. Safety. The hazards of handling fluorides by water works personnel can be eliminated or controlled by selecting the fluoride compound that will be most appropriate for the installation (para G-1), employing proper handling procedures (para G-2 and G-3), utilizing personal protective devices, and installing ventilation for the control of dust or vapor.

a. Workers exposed to fluoride chemical s should be thoroughly indoctrinated by medical and safety personnel on health and safety hazards of handling of these materials. Workers should, in addition, be placed under medical surveillance. The inhalation of fluoride dust or vapor is the principal hazard to workers. Direct contact with either aqueous solutions, vapor or dust, produces irritation and burning of the mucous membranes, eyes and skin which makes this an important secondary hazard. The dust hazards can be minimized by using the crystalline sodium fluoride where this is applicable. Powdered compounds should be handled carefully when emptying sacks or barrels into hoppers, etc. The dust hazard can be reduced by installing a dust control sleeve between the sack or barrel and the hopper. Spilled fluorides should be removed by wet mopping. Rubber or neoprene gloves, chemical goggles, and NIOSH approved toxic-dust or all-dust respirators shall be provided each worker for protection against intermittent short term dust exposures (TB MED 223 (TB MED 502 to be published)).

b. Where the exposures are expected to be of long duration or continuous, breathing zone sampling shall be accomplished to determine occupational exposure. Local exhaust ventilation may be required to control occupational exposure. The design of effective ventilating equipment requires the services of a qualified industrial hygienist or ventilation engineer. The criterion for control is based upon maintaining atmospheric concentrations of fluoride under 2.5 milligrams per cubic meter of air where a worker is exposed continuously 8 hours per day.

Refer to the current Occupational Safety and Health Act (OSHA) standard. Pneumatic conveying systems, if used, should be the vacuum-operating type. For charging chutes, a motor-operated dust collector with a capacity of at least 400 cubic feet of air per minute should be provided to remove all dust incident to filling the hopper with chemical. The collector should be arranged to automatically return the dust to the hopper without handling. A 6-inch duct to discharge the filtered air to the outside of the building (25 feet from any intake) should be provided.

c. Hydrofluosilicic acid is slightly volatile and it should be handled in a closed system. If this is not feasible, personal protection will be provided for intermittent short-term exposure or local exhaust ventilation for more prolonged or continuous exposure. Protective equipment includes a NIOSH-approved air-purifying or Bureau of Mines (BM)-approved (NIOSH approved) atmosphere supplying respirator (TB MED 223 (TB MED 502 to be published)), chemical goggles, rubber or neoprene gloves, and apron.

d. Aqueous solutions or dust should be removed from the skin immediately by bathing or washing with copious amounts of water from safety showers and eye lavages which should be made available at the worksite. The slightly higher cost of using artifically colored fluorides is justified because its ready identification increases the safety of handling and storing stocks of material.

e. Cross-connections between solution tanks and the potable water supply system will be avoided. Lowered pressure in the water distribution system could permit the concentrated fluoride solution to siphon back into the water system directly to drinking fountain or plumbing fixtures and provide an overdose of fluoride. Cross-connections will be avoided in fluoride solution tanks or dry feed dissolvers with mechanical agitation by terminating the water supply line at a point above the highest chemical solution level and providing an air break. A nonmechanical siphon breaker or vacuum breaker will be installed in the piping of dry feed machines utilizing water pressure for agitation.

f. Before incineration is performed, consultation with the governing medical authority is recommended in order to insure that violation of applicable air pollution regulations will not occur. Used paper sacks may be disposed of by incineration or burying in the sanitary fill. The operation should be personally supervised by the water works personnel to assure satisfactory disposal. Because of the fluoride chemical remaining in the sacks, burning of the paper containers may produce sufficient hydrogen fluoride concentration in the smoke to cause damage to trees and shrubbery.

G-5. Information required to request authority to fluoridate or defluoridate. As a minimum, requests to fluoridate or defluoridate shall contain the concurrance of installation dental, PVNTMED, and facilities engineer authorities. Requests shall contain the following information:

a. The naturally occurring fluoride content of the installation water supply. The fluoride content of surface water supplies varies considerably with stream flow, whereas the fluoride content of subsurface supplies is relatively constant. Therefore, requests from installations having surface supplies should include maximum fluoride concentration (taken during low stream flow), minimum fluoride concentration (taken during high and low stream flow), and average fluoride concentration. Requests from installations with subsurface supplies need only state the average of several samples.

b. The number of persons who will benefit from the procedure. Give the current number of children under 12, the number of children 12 to 16, and the number of young adults between 16 and 20 years of age. Include military personnel living on the installation or in housing projects that are supplied by the installation water system.

c. The general proposal for introducing the fluoride into the water system. The application of fluorides should be subsequent to all treatment processes, with the exception of chlorination. At small plants using well water, the fluoride should be injected into the discharge line of well pumps. There should be included, as a part of the request, a diagram of the water supply system showing sources and annual flow of each source; treatment plants, including description of present water treatment, main distribution lines; dependent housing areas; and point or points where it is proposed to introduce the fluoridation.

d. Proposed feeder information.

(1) Type and manufacturer.
(2) Safety devices for feed control.
(3) Method of feed control and its accuracy.
(4) Location of feeder and housing required.
(5) Point of application of compound.
(6) Type and capacity of dry storage.
(7) Dust control and similar facilities of the installation.
(8) Corrosion-resistant materials used in handling compound, both dry and in solution.

e. Proposed analytical technique, laboratory facilities, and testing personnel to be used for routine feed control.

f. Protective equipment proposed for individual handlers.

g. Medical plan for periodic physical examination of handlers and for general occupational health surveillance of the work environment.

h. Quantity of fluoride required per 1,000 gallons of water to establish a concentration of 1.0 part per million. (Note. Until the correct concentration is known, use this figure to determine the approximate cost and amount of fluoride.)

i. Estimated installation cost of feeder and accessories or defluoridation process with accessories.

j. Estimated operating cost per 1,000 gallons of treated water.

k. Statements attesting to the competency of water works supervisory and operating personnel available at the installation to operate such a system.

APPENDIX H

TREATED WATER QUALITY STANDARDS

Section I. NATIONAL INTERIM PRIMARY DRINKING WATER REGULATIONS (NIPDWR)

H-1. The maximum contaminant levels (MCL) for inorganic chemicals are:

Contaminant	*MCL (mg/L)*
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.
Selenium	0.01
Silver	0.05
Fluoride*	
53.7° F and below	2.4
53.8° F to 58.3° F	2.2
58.4° F to 63.8° F	2.0
63.9° F to 70.6° F	1.8
70.7° F to 79.2° F	1.6
79.3° F to 90.5° F	1.4

*The MCL for fluoride is based upon the annual average of the maximum daily air temperature for the location of the installation.

H-2. The MCL for organic chemicals are:

Contaminant	*MCL (mg/L)*
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2, 4-D	0.1
2,4,5-TP Silvex	0.01
Trihalomethanes*	0.10

*The MCL of 100 ppb is based on population and is effective on 29 November 1983 for installations serving 10,000–75,000 persons. For installations serving 10,000 or less persons, the individual States may, at their discretion, adopt an effective date for the MCL.

H-3. The MCL for turbidity is applicable to both community water systems and noncommunity water systems using surface water sources in whole or in part. The MCL for turbidity in drinking water, measured at a representative entry point(s) to the distribution system, are:

a. One turbidity unit for monthly average (5 turbidity units monthly average may apply at State option).

b. Five turbidity units (maximum) average for 2 consecutive days.

H-4. The MCL for coliform bacteria, applicable to community water systems and noncommunity water systems, is as follows:

a. When the membrane filter technique is used, the number of coliform bacteria shall not exceed any of the following:

(1) One coliform colony/100 ml for the average of all monthly samples (see note below); or

(2) Four coliform colonies/100 ml in more than one sample if less than 20 samples are collected per month; or

(3) Four colonies/100 ml in more than 5 percent of the samples if 20 or more samples are examined per month.

b. When using the multiple tube fermentation test with 10 ml portions (Most Probable Number—MPN):

(1) Coliforms shall not be present in more than 10 percent of the portions per month (see note below); and

(2) Not more than one sample may have three or more portions positive when less than 20 samples are examined per month; or

(3) Not more than 5 percent of the samples may have three or more portions positive when 20 or more samples are examined per month.

Note: At the primacy agency's discretion, systems required to take 10 or fewer samples per month may be authorized to exclude one positive routine sampler per month from the monthly calculation if: As approved on a case-by-case basis the State determines and indicates in writing to the public water system that no unreasonable risk to health existed under the conditions of this modification. This determination should be based upon a number of factors not limited to the following: (1) The system provided and had maintained an active disinfectant residual in the distribution system, (2) the potential for contamination as indicated by a sanitary survey, and (3) the history of the water quality at the public water system (e.g., MCL or monitoring violations), the supplier initiates a check sample on each of 2 consecutive days from the same sampling point within 24 hours after notification that the routine sample is positive, and each of these check samples is negative; and the original positive routine sample is reported and recorded by the supplier as required.

The supplier shall report to the State its compliance with the conditions specified in this paragraph and a summary of the corrective action taken to resolve the prior positive sample result. If a positive routine sample is not used for the monthly calculation, another routine sample must be analyzed for compliance purposes. This provision may be used only once during two consecutive compliance periods.

H-5. The NIPDWR bacteriological monitoring requirements for populations up to 50,000 are listed below. For larger populations refer to NIPDWR requirements.

Population served	*Minimum number of samples per month*
25 to 1,000	1
1,000 to 2,500	2
2,501 to 3,300	3
3,301 to 4,100	4
4,101 to 4,900	5
4,901 to 5,800	6
5,801 to 6,700	7
6,701 to 7,600	8
7,601 to 8,500	9
8,501 to 9,400	10
9,401 to 10,300	11
10,301 to 11,100	12
11,101 to 12,000	13
12,001 to 12,900	14
12,901 to 13,700	15
13,701 to 14,600	16
14,601 to 15,500	17
15,501 to 16,300	18
16,301 to 17,200	19
17,201 to 18,100	20
18,101 to 18,900	21
18,901 to 19,800	22
19,801 to 20,700	23
20,701 to 21,500	24
21,501 to 22,300	25
22,301 to 23,200	26
23,201 to 24,000	27
24,001 to 24,900	28
24,900 to 25,000	29
25,001 to 28,000	30
28,001 to 33,000	35
33,001 to 37,000	40
37,001 to 41,000	45
41,000 to 46,000	50
46,001 to 50,000	55

H-6. The MCL for radiological contaminants are:*

Gross Alpha particle activity	15 pCi/L
Combined Radium-226 and Radium-228	5 pCi/L
Gross Beta particle activity	50 pCi/L
Tritium	20,000 pCi/L
Strontium-90	8 pCi/L

* Screening indicators have been established for radiological contaminants. Gross Alpha present at less than or equal to 5 pCi/L, as an indicator, elimates the need to analyze for Radium 226 and 228. Gross Beta present at less than or equal to 8 pCi/L, as an indicator, eliminates the need to analyze for tritium and strontium-90.

H-7. The NIPDWR amendments were published in the Federal Register (45 FR 57332, 27 August 1980). These amendments should be consulted concerning nitrate monitoring for noncommunity water systems; sodium monitoring for community water systems; corrosivity parameter monitoring for community water systems; and microbiological indicators for community and noncommunity water systems.

Section II. NATIONAL SECONDARY DRINKING WATER REGULATIONS (NSDWR)

H-8. The secondary MCL are as follows:

Contaminant	*MCL (mg/L)*
Chloride	250
Color	15 color units
Copper	1
Corrosivity	Noncorrosive
Foaming Agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 threshold odor number
pH	6.5-8.5
Sulfate	250
TDS	500
Zinc	5

Note: The contaminants covered by this regulation are those that may adversely affect the aesthetic quality of the drinking water. These secondary levels represent reasonable goals for drinking water quality, but are not Federally enforceable. The individual States may establish higher, lower or no levels for these contaminants as appropriate to their particular circumstances. All Army facilities shall endeavor to provide drinking water of the highest quality in consonance with the NSDWR as well as the Federally enforceable NIPDWR.

APPENDIX I

NIPDWR SURVEILLANCE REQUIREMENTS

System	Source	Test	Sampling interval
Community water	Surface water	Inorganics	every year
		Organics	every 3 years
		Radiochemicals	every 4 years
		Turbidity	daily
		Coliform bacteria	monthly*
		Trihalomethanes	quarterly**
	Ground water	Inorganic	every 3 years
		Organics	State option
		Radiochemicals	every 4 years
		Turbidity	State option
		Coliform bacteria	monthly*
		Trihalomethanes	quarterly**
Noncommunity water	Surface water	Inorganics	State option
		Organics	State option
		Radiochemicals	State option
		Turbitity	daily
		Coliform bacteria	one per quarter
	Ground water	Inorganics	State option
		Organics	State option
		Radiochemicals	State option
		Turbidity	State option
		Coliform bacteria	one per quarter

* Number of samples dependent on number of people served by system.

** For systems serving greater than 10,000 population. For those systems serving populations less than 10,000 monitoring is at State discretion.

Note: NIPDWR amendments were published in the Federal Register (45 FR 57332, 27 August 1980). These amendments should be consulted concerning nitrate monitoring for noncommunity water systems; sodium monitoring for community water systems; corrosivity parameter monitoring for community water systems; and microbiological indicators for community and noncommunity water systems.

APPENDIX J

MICROBIOLOGICAL SAMPLING TECHNIQUE FOR DRINKING WATER QUALITY DETERMINATION

Sample Size:	For most purposes, a half liter sample shall suffice; however, prior coordination with the testing agency is recommended.
Type Container:	A sterile, clean container with a screw cap should be used in microbiological sampling.

PROCEDURE

J-1. Open the cold water tap and allow the water to flow freely for several minutes to insure drawing water directly from the mains. Determine the chlorine residual and pH, and record the value.

Note: Samples shall not be collected from faucets with aerators, swivel or add-on devices unless these devices are removed prior to running the water in this step.

J-2. Reduce the flow to produce a small stream of water. Carefully remove the cap or stopper of the sample bottle by grasping the outside of the cap. Do not touch any surfaces which the sample will contact. Retain the cap in the hand. Fill the bottle to within one-half inch of the bottom of the neck and affix the cap.

J-3. Complete the information required on DD Form 686 (Fluoride/Bacteriological Examination of Water) identifying the sample as to exact source, time of collection, chlorine residual, special circumstances, if any, and the address to which the report will be forwarded. Identify the sample bottle and the data card by the same number.

J-4. Care should be taken to destroy the killing action of the chlorine residual in the sample by neutralizing the chlorine with sodium thiosulfate. Sample bottles prepared by the laboratory will contain this chemical. DO NOT FLUSH IT OUT! The sodium thiosulfate is added prior to sterilization of the sample container.

J-5. Sodium thiosulfate should be added to the sample container prior to collection of the sample. This chemical stops the bacteriocidal action of the chlorine residual present in the drinking water sample. Consult the current edition of *Standard Methods for the Examination of Water and Wastewater* for preparation of this chemical. DO NOT RINSE OR FLUSH THE SAMPLE CONTAINER PRIOR TO COLLECTING THE SAMPLE AS THE SODIUM THIOSULFATE WILL BE WASHED OUT!

J-6. In the case of individual potable water samples sent to the laboratory by courier, the elapsed time between collection and examination ideally should not exceed 6 hours. (The exception to this 6-hour rule is for samples mailed from distant installations; these samples may be held for up to 30 hours.) Samples should be refrigerated to 4°C during shipment. The time and temperature of storage of all samples should be recorded and should be considered in the interpretation of data.

J-7. Flaming water taps before collecting potable water samples is not necessary if reasonable care is exercised in the choice of sampling tap (clean, free of attachments, and in good repair) and if the water is allowed to flow adequately at a uniform rate before sampling. Alterations in the valve setting to change the flow rate during collection could affect the sample quality adversely. Superficially passing a flame from a match or an alcohol-soaked cotton applicator over the tap a few times may have psychological effect on observers, but it will not have a lethal effect on attached bacteria. The application of intense heat with a blow torch may damage the valve-washer seating or create a fire hazard to combustible materials adjacent to the tap. If successive samples from the same tap continue to contain coliforms, however, the tap should be disinfected with a hypochlorite solution to eliminate external contamination as the source of these organisms (see EPA-670/9-75-006).

APPENDIX K

REMEDIAL ACTIONS TO BE TAKEN IN EVENT CONTAMINATED WATER SAMPLES ARE FOUND

Condition	*Possible Cause*	*Recommendations*
1. No known sanitary defects, health hazards, or incidents of gastrointestinal disease.	The contaminated samples might indicate a localized situation within the piping of the building where the sample was collected, or a faulty sampling technique.	*a.* Collect repeat samples promptly at the points of previous collection. *b.* Expedite shipment of samples so that a prompt report may be obtained from the laboratory. *c.* Make an immediate investigation to determine if any unusual conditions have occurred, such as repairs to the water mains, faucets, or piping within the building, or in the vicinity of the sampling point. *d.* Test for chlorine at various outlets so as to insure the proper dosage. *e.* If the foregoing investigation indicates the necessity, flush the portion of the system by opening outlets, until a proper chlorine residual is recorded; carry out localized chlorination if deemed necessary. *f.* Resample in accordance with paragraph 8-9, if necessary. *g.* If examination shows that conditions defined in paragraph 2 below exist, then the remedial actions recommended in that paragraph shall be followed. *h.* See paragraph 7-2*d*(3) and paragraph 8-9.
2. Occurrence of a major disaster, such as the inundation of the source, breakdown in treatment plant units, gross contamination of the system through a cross-connection, failure of an underwater crossing, damage from an earthquake, etc.	Self evident.	*a.* Immediate rejection of water supply system and institution of an emergency treatment supply system. Treat all drinking water and water used for culinary purposes. *b.* After the necessary repairs have been completed, chlorinate and flush the entire system. *c.* Collect samples from representative points throughout the entire system until negative microbiological results are obtained on at least two consecutive sets of standard samples collected on different days. *d.* Remove restrictions on the use of water.
3. Occurrence of an outbreak of one of the so-called waterborne diseases.	Contamination of the water system at the source, in reservoirs, treatment plant facilities, or distribution system and not generally apparent at the onset of the outbreak.	*a.* Carry out recommendations under Condition 1 with special emphasis on the investigation of the source, reservoirs, treatment processes, and distribution system. *b.* Increase the chlorine dosage and residual in the system. *c.* If the conditions contributing to the contamination are found to be serious, such as a direct contamination with sewage, reject the supply and institute emergency treatment until the condition is corrected.

APPENDIX L

SAFE OPERATION OF CHLORINATION FACILITIES

L-1. Chlorine storage and use areas should be isolated from other work areas and should be maintained in a dry condition. All chlorine cylinders shall be secured to prevent rolling or falling. Empty containers should be segregated from full containers and appropriately tagged. Cylinders shall not be stored near ventilation systems, heat sources, or areas of elevated temperature. Storage should be above ground in a well-ventilated area separated from other occupied areas by a gas tight partition.

L-2. The room shall be ventilated at a rate of one air change every 2 minutes by means of exhaust grilles located not more than 6 inches (15 cm) above floor level. The ventilated air shall be exhausted to the outdoors and not into interior areas. Mechanical ventilation in above-ground chlorination facilities may be provided to reduce any unnecessary exposure in case of leakage or spill of chlorine. The vapor-tight fan switch should be located outside the room and should be equipped with an indicator light. All doors shall be hinged to open outward and at least one door should have a viewport to permit operators to look into the room before entering. Written operating instructions for the handling and use of chlorine shall be posted near the chlorination facility.

L-3. The following warning sign should be affixed in a readily visible location at or near entrances to the chlorination room:

CAUTION

CHLORINE HAZARD AREA
UNAUTHORIZED PERSONS KEEP OUT
CAUSES BURNS, SEVERE EYE HAZARD
MAY BE FATAL IF INHALED
PROTECTIVE MASKS FOR CHLORINE
LOCATED AT ____________
IN CASE OF EMERGENCY CALL

L-4. Where chlorine cylinders are used, a small squeeze bottle of dilute ammonium hydroxide shall be placed outside the area; a small amount shall be squirted into the chlorine cylinder room prior to entry. If a "snow" forms, a chlorine leak exists, and emergency notification of a leak shall be made. The squeeze bottle shall be labeled:

FOR CHLORINE LEAK DETECTION
AMMONIUM HYDROXIDE
CAUSES BURNS TO SKIN, EYES

L-5 Chemical goggles shall be worn by personnel entering the area for routine inspection. When cylinders are changed or adjustments made to the system, impervious gloves, chemical goggles, and full faceshield shall be worn (unless a full facepiece respirator or hood is used).

L-6. At least one Bureau of Mines (BM) or National Institute for Occupational Safety and Health (NIOSH)-approved chlorine gas mask shall be available and located directly outside the chlorination facility entrance. Masks shall be housed in suitable containers to provide clean, protected storage and ready access for required inspection (consult TB MED 223 (TB MED 502 to be published)) and emergency use. The mask storage container shall be clearly posted with a warning sign affixed on or near the storage container as follows:

FOR EMERGENCY USE ONLY
NOT FOR USE IN REPAIRING
CHLORINE LEAKS

Utilities and other personnel having day-to-day contact with the water chlorination facilities shall be trained in the care and use of gas masks as part of the installation respirator program (TB MED 223 (TB MED 502 to be published)). Canister type gas masks are acceptable for use only when the concentration of chlorine vapor is *known* to be less than 1 percent and oxygen content is greater than 16 percent. Thus, when a worker enters a heavily contaminated area for repair, or other purposes, a self contained breathing apparatus (SCBA) is required.

L-7. Leak repairs shall be made only by personnel properly trained in the use of and equipped with SCBA. It is recommended that SCBA equipment (two sets) be maintained at a central location (i.e., fire station) so that they can be used throughout the installation where the need arises. SCBA equipment shall be maintained in accordance with the respirator program (TB MED 223 (TB MED 502 to be published)).

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The proponent agency of this regulation is the Office of The Surgeon General. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to HQDA (DASG-PSP), WASH DC 20310.

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

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