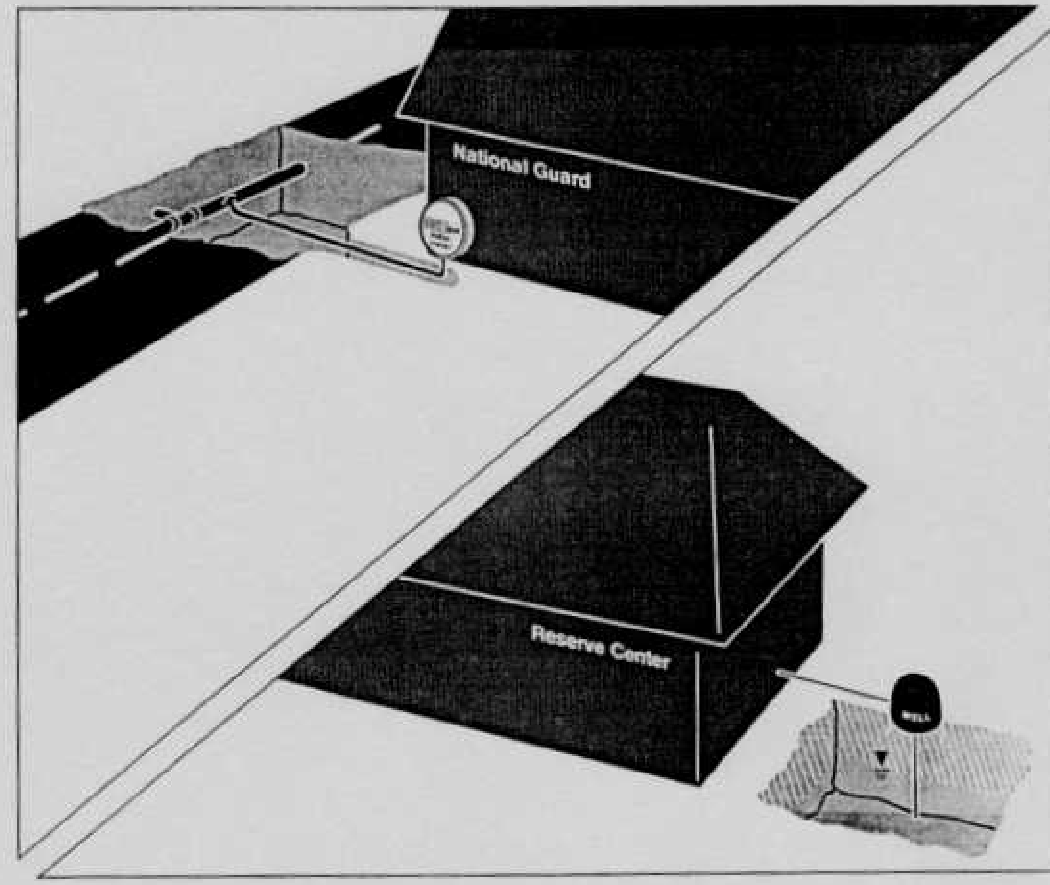
USACHPPM

Providing Safe Drinking Water From Unregulated Water Systems

(USACHPPM INFORMATION PAPER NO. 31-016)



U.S. Army Center for Health Promotion and Preventive Medicine

Readiness Thru Health

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U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) lineage can be traced back over a half century to the Army Industrial Hygiene Laboratory which was established at the beginning of World War II under the direct jurisdiction of The Army Surgeon General. It was originally located at the Johns Hopkins School of Hygiene and Public Health with a staff of three and an annual budget not to exceed three thousand dollars. Its mission was to conduct occupational health surveys of Army-operated industrial plants, arsenals, and depots. These surveys were aimed at identifying and eliminating occupational health hazards within the Department of Defense's (DOD) industrial production base and proved to be extremely beneficial to the Nation's war effort.

Most recently, the organization has been nationally and internationally known as the U.S. Army Environmental Hygiene Agency (AEHA) and is located on the Edgewood area of Aberdeen Proving Ground, Maryland. Its mission had been expanded to support the worldwide preventive medicine programs of the Army, DOD and other Federal agencies through consultations, supportive services, investigations and training.

On 1 August 1994, the organization was officially redesignated the U.S. Army Center for Health Promotion and Preventive Medicine and is affectionately referred to as the CHPPM. As always, our mission focus is centered upon the Army Imperatives to that we are optimizing soldier effectiveness by minimizing health risk. The CHPPM's mission is to provide worldwide scientific expertise and services in the areas of:

- Clinical and field preventive medicine
- Environmental and occupational health
- Health promotion and wellness
- Epidemiology and disease surveillance
- Related laboratory services

The Center's quest has always been one of customer satisfaction, technical excellence and continuous quality improvement. Our vision is to be a world-class center of excellence for enhancing military readiness by integrating health promotion and preventive medicine into America's Army. To achieve that end, CHPPM holds everfast to its core values which are steeped in our rich heritage:

- Integrity is our foundation
- Excellence is our standard
- Customer satisfaction is our focus
- Our people are our most valuable resource
- Continuous quality improvement is our pathway

Once again, the organization stands on the threshold of even greater challenges and responsibilities. The CHPPM structure has been reengineered to include General Officer leadership in order to support the Army of the future. The professional disciplines represented at the Center have been expanded to include a wide array of medical, scientific, engineering, and administrative support personnel.

As the CHPPM moves into the next century, we are an organization fiercely proud of our history, yet equally excited about the future. The Center is destined to continue its development as a world-class organization with expanded preventive health care services provided to the Army, DOD, other Federal agencies, the Nation, and the world community.

PROVIDING SAFE DRINKING WATER FROM UNREGULATED WATER SYSTEMS

USACHPPM INFORMATION PAPER NO. 31-016

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Introduction...

Environmental regulations for drinking water, legislated by the Safe Drinking Water Act, ensure that consumers are drinking safe and appealing water. As with all regulations, there are limits on their applicability and some drinking water systems may not be regulated. Such **unregulated systems** are often left without guidance to ensure the health and well-being of their consumers. Many small Army facilities are served by such unregulated systems. This information paper (IP) provides guidance for these facilities to establish a reasonable and executable drinking water management program to enhance the quality of drinking water provided and to ensure health protection. The information contained in this IP was written with small Army facilities in mind such as depots, National Guard armories, and Reserve centers; however, larger Active Army installations that purchase their water from a neighboring town may find this information useful as well.

How To Use This Document...

This IP was designed to serve as a reference manual for unregulated drinking water systems. Although information can be read front to back, particular information can be readily extracted through use of the table of contents.

- ***Management Measures for Purchased Water Systems*** ..... See Chapter **3**.
- ***Management Measures for Individual Water Systems*** .... See Chapter **4**.
- ***Sample Collection and Analysis*** ... See Chapter **5**.
- ***Practical Distribution System Operation and Maintenance*** ... See Chapter **6**.
- ***Point-of-Entry/Point-of-Use Treatment "Filters"*** .... See Chapter 7.

Assistance Available...

One of the most common obstacles unregulated systems have is obtaining technical and analytical assistance. **The USACHPPM Water Supply Management Program (WSMP) provides consultative expertise to Army and Department of Defense (DOD) installations worldwide for environmental health aspects of drinking water supply, treatment and distribution at relatively low cost.** USACHPPM's matrixed resources include a fully accredited laboratory, drinking water engineers and scientists, risk assessment and communication experts, and a team of physicians. Assistance can range from quick telephone consultations to onsite visits.

Contact the WSMP at ...

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For an overview of our program and to view copies of some of our technical guidance documents, be sure to visit our ***world wide web*** site at http://chppm-www.apgea.army.mil/dwater.

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Chapter 1
On Your Own -- Drinking Water Systems Not Regulated by the EPA

1-1. Where Does My Drinking Water Come From?

a. Army facilities receive their drinking water in one of two ways: from operating their own drinking water system either directly or through a contractor (referred to as "individual" systems) or from purchasing their water from a neighboring supplier (referred to as "purchased" water systems).

b. Individual water systems have a source of water (ground water or surface water), typically provide some type of treatment (generally a minimum of disinfection), and distribute the water for domestic and/or industrial use. Many large Army installations have sizable water treatment plants which draw water from lakes, rivers, or several wells and produce several million gallons of water per day. Many small facilities, which employ only a few personnel, use only one well and apply a common disinfectant such as sodium hypochlorite or even household bleach to provide minimal treatment.

c. Purchased water systems may or may not further treat the drinking water they receive. Larger Army facilities may need to reapply a disinfectant to maintain a residual throughout their distribution system. Small one or two building facilities may not do any more than pay a water bill to the supplier and rely completely upon the treatment used by the supplier to ensure safe drinking water.

d. All Army facilities, whether supplied by an individual or purchased drinking water system, must ensure that the drinking water they provide is safe. Systems regulated via the Safe Drinking Water Act (SDWA) are able to ensure this safety by following enforced drinking water regulations. Systems not regulated via the SDWA, or "unregulated systems," are left without such formal guidance and must develop their own drinking water management program based upon site-specific needs and resources.

1-2. Is My System Regulated?

a. The drinking water quality regulations established as a result of the SDWA apply to public water systems (except as described below). The SDWA defines a public water system as one which conveys water for the purpose of human consumption to 25 or more people or to 15 or more service connections for at least 60 days out of the year (reference 1). Although a system may meet this definition, it may be exempt from the requirements of the SDWA if it meets **ALL** four of the following conditions:

(1) contains a drinking water system which consists only of distribution and storage facilities and provides no physical or chemical treatment of the drinking water anywhere in the system;

(2) obtains all of its drinking water from a regulated system;

(3) does not sell the drinking water it receives; and

(4) does not provide water to commercial carriers conveying passengers in interstate commerce (reference 1).

b. The SDWA encouraged States to obtain primacy for drinking water regulations, and all States except Washington, D.C. and Wyoming have done so. Primacy States have developed their own drinking water regulations which are at least as stringent as Federal regulations. Some States have standards more stringent than Federal requirements. Some have a more strict definition of a public water system and apply the State drinking water regulations to systems which serve a smaller number of people or service connections (reference 2). Other States may require monitoring by systems which meet the four criteria for exemption from Federal requirements as described above.

c. Personnel responsible for Army individual systems must determine if the system meets the definition of a public water system. If it does, the system must meet all applicable drinking water regulations. Personnel responsible for Army purchased water systems will likely need to contact the State to determine which drinking water regulations apply. Purchased water systems, unless they provide further treatment, usually meet the four conditions described above to be exempt from the SDWA requirements. Most States, however, often require such systems to perform some distribution system monitoring. Table 1 contains some examples of Army facility water supplies and suggested status. Actual status should be confirmed by contacting the State regulatory authority.

d. Personnel responsible for systems which are regulated via the SDWA should consult USACHPPM Technical Guide (TG) No. 179, Guidance for Providing Safe Drinking Water At Army Installations (reference 3). The TG No. 179 provides guidance for meeting the drinking water regulations pursuant to the SDWA. The management and sampling guidance presented in this IP applies to unregulated systems and would not keep a regulated system in compliance.

TABLE 1. EXAMPLES OF WATER SYSTEMS' REGULATORY STATUS

Facility Description	***Regulated Via SDWA?***
Small facility* served by individual system, less than 25 employees	Probably not, check with local health department for any health regulations
Small facility* served by individual system, more than 25 employees	Regulated via SDWA, contact State regulatory authority
Army-operated campground served by individual system, seasonal use	Potentially regulated depending on number of days operating (≥60 yes, <60 not)
Range well used intermittently for training purposes	Probably not, check with local health department for any health regulations
Small facility served by purchased water system, less than 25 employees	Not regulated
Small facility served by purchased water system, no treatment provided, more than 25 employees	Probably not regulated, check with State regulatory authority for any operational or maintenance requirements that may apply
Small facility served by purchased water, treatment provided, more than 25 employees	Regulated via SDWA, contact State regulatory authority, may have reduced monitoring program for such facilities

* A facility may be a depot, National Guard armory, or a Reserve center with less than 15 buildings served by a drinking water system.

1-3. Is My Water Quality Good?

a. Drinking water quality directly impacts human health, and therefore, it must be safeguarded. Every Army facility should be aware of its source of drinking water and should have a management system in place to ensure that it is safe, meets all applicable regulations, and meets consumers needs.

b. Army facilities served by unregulated systems, regardless of size and source, should appoint at least one person to be in charge of drinking water issues. Management of an individual system may require a person with training in water treatment and plumbing. Management of a purchased water system may only require someone to be a liason between the facility and the water supplier. A reasonable amount of time needs to be allotted for the person chosen to attend to drinking water issues. Personnel in charge of individual systems may need several hours a week to operate water treatment equipment, refill chemical supplies, collect and analyze operational and special water samples, maintain distribution and storage facilities, and repair internal plumbing fixtures. Personnel in charge of purchased water systems may only need a few hours every month to maintain contact with the supplier and to address any consumer complaints.

c. Water system personnel may need to perform some detective work to determine if the management and attention given to drinking water issues at the facility is adequate. These personnel should visit buildings on the facility to see where the building obtains drinking water and should check with employees to see if they are satisfied with the facility's drinking water. Heavy use of bottled water at the facility indicates consumers' mistrust or displeasure with the drinking water provided. Numerous personnel complaints regarding the drinking water or personnel illness potentially associated with drinking water present more obvious indications that there is a problem with the facility's drinking water.

d. Physical indications of problems with drinking water quality or quantity include: frequent interruptions of supply, low water pressure, staining of plumbing fixtures (blue-green from copper plumbing or reddish-brown from iron/steel plumbing), colored (red, black or cloudy) or foul smelling drinking water, dilapidated and unmaintained storage tanks, and unmaintained drinking water treatment equipment (references 4 and 5).

e. Other site-specific characteristics that indicate a need to verify the quality of the drinking water provided are: use of a surface water source, close proximity to heavy industry or heavily fertilized or pest controlled agriculture, known spills of contaminants near-by, and underground storage tanks or septic systems in close proximity to wells (references 6 and 4).

f. The above mentioned examples certainly are not a complete list of situations which may indicate a need to take a closer look at a facility's drinking water. Occasional sampling of the drinking water or close communication with the supplier are the only ways to ensure good water quality.

Chapter 2
Importance of Safe Drinking Water

2-1. Sources of Contamination.

a. What goes up must come down and what goes in eventually comes out. These very basic principals of life as we know it continue to threaten many of America's sources of drinking water. Air pollutants come to the earth in the form of "acid" rain which ends up in our streams, rivers, and lakes. Mismanagement of hazardous materials and wastes has led to spills and leaks which pollute both ground and surface waters. Even the earth's natural surface and inhabitants contaminate our source waters with elemental metals, radiological particles, bacteria, viruses, and other protozoans. Table 2 contains some examples of activities that could potentially contaminate ground-water or surface-water sources (references 6, 7, and 8).

TABLE 2. ACTIVITIES THAT CONTAMINATE DRINKING WATER SOURCES[1]

Activity	*Potential contaminants*
Agricultural Activities: spraying, fertilizing, and livestock management	pesticides and herbicides, nitrates, nitrites, bacteria, *Crypto sporidium*, *Giardia*, other microbiological contaminants
Wastewater Treatment Plant Discharge	nitrates, nitrites, bacteria, viruses, protozoans, heavy metals, other chemicals (organic and inorganic)
Improper Household Waste Disposal	cleaning fluids, degreasers, used motor oil, paints and paint thinners, soaps and detergents
Leaking Storage Tanks (Above or Underground)[2]	petroleum products, acids, bases, other organic chemicals
Hazardous Material Spills*	petroleum products, acids, bases, other organic chemicals
Landfills	various organic and inorganic chemicals
Injection Wells	arsenic, heavy metals, cyanide, various organic and inorganic chemicals
Mining Operations	arsenic, heavy metals, oxidation by-products, acids
Drilling Operations	petroleum products, chloride, sodium, barium, strontium, radionuclides

1. Reference 9.
2. Examples of activities/industries associated with use/handling of listed hazardous materials or materials which may contaminate drinking water include: gas stations, dry cleaners, distribution centers, chemical manufactures, water and wastewater treatment facilities, car-care centers, airports, golf courses, electroplaters, metal finishers, laboratories, machine shops, railroads, highway maintenance storage areas (salts), military bases, oil/gas production facilities, printers, photo finishers, refineries, wood shops, leather tanning facilities, textile production.

b. Contaminants can be categorized as follows: inorganics, which contain metals and nonmetals, that occur both naturally and as a result of pollution; organics that result mostly from pollution; radiological contaminants that are naturally occurring; microbiological contaminants that result from animal populations and mismanaged wastewater; and disinfection by-products that result from reactions between disinfectants applied to the drinking water and naturally occurring organic material in the water (reference 10). Contamination by many of these substances is often defined by their concentration, rather than just their presence, in drinking water. For instance, a certain amount of fluoride in our drinking water is a desirable condition; too much fluoride can cause health and aesthetic problems. Other substances indicate contamination of drinking water by their presence alone, such as benzene or trichloroethylene.

2-2. Health Effects of Contamination.

Drinking water contaminants can cause immediate short-term (acute) or delayed long-term (chronic) health effects in humans. An example of an acute health effect is the gastrointestinal illness caused by ingestion of microbial pathogens. The potentially severe symptoms such as diarrhea and vomiting associated with diseases caused by such pathogens occur within a few hours to several days (reference 11). Chronic health effects, such as cancer, occur after water with low doses of a contaminant has been consumed over several years or a lifetime. Whether or not a consumer experiences adverse health effects from a contaminant is affected by the concentration of the contaminant and the duration of exposure.

2-3. Health-Protective Criteria for Contaminants.

a. To protect consumers from the adverse health effects of contaminants in drinking water, the EPA has developed numerous limits on contaminant concentrations based upon health effects and assumed exposure duration. These limits come in several forms: maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), 1-day, 10-day and longer-term health advisories (HAs), and action levels (ALs). Although unregulated systems are not required by Federal law to meet these limits, they can be used as references to ensure that the system is providing safe drinking water to its consumers.

b. An MCLG is the highest level of a contaminant at which no known adverse health effects occur (references 10 and 12). Often this level is zero; health effects may occur if any of the contaminant is present. The MCLG is the most protective of all the limits. Often technology does not allow us to detect or treat drinking water to this level and for this reason, the MCLG is not enforced by the EPA. The EPA sets another level, the MCL, as close to the MCLG as feasible taking into consideration cost, technology and acceptable risk. The MCLG and the MCL are developed based upon an assumed lifetime exposure to the drinking water contaminant. The MCL is the enforceable standard for a contaminant, and protection of human health is based upon this limit (references 10 and 12). Currently, ALs only exist for lead and copper. The concentrations of these two inorganic contaminants can increase throughout a drinking water distribution system. An AL is the concentration of lead or copper in water which triggers treatment and other health protective actions by the water system (reference 12). Appendix D contains a list of the current MCLGs, MCLs, and ALs as of September 1996.

c. Many contaminants which do not have enforceable standards have HA limits. The HAs are developed through risk assessments based upon scientific studies of health effects. Since risk is dependent upon both concentration and exposure period, HAs present limits for contaminants in drinking water based upon various exposure durations. Each contaminant may have several HA limits: a 1-day exposure limit, a 10-day exposure limit, a longer-term (approximately 7 years or 10 percent of an individual's average lifetime) exposure limit, and some contaminants even have a life-time exposure limit. It is important to note, though, that HAs do not incorporate the potential of carcinogenic risk. For substances that are known or probable human carcinogens, the EPA does not recommend a lifetime HA. Appendix D contains a list of the current HAs as of September 1996.

d. The rotational nature of and potential of exposure to unique compounds during many of the U.S. military's activities have resulted in the need for additional health protective limits based upon a shorter exposure duration such as a military field activity. These health limits are the Department of Defense Tri-Service Standards for Field Water established to protect military personnel from performance-degrading health effects that could jeopardize the accomplishment of military missions (reference 13). These levels are sometimes higher than MCLs since the exposure duration is shorter than a lifetime. Appendix D contains a list of the current Tri-Service Standards for Field Water as of September 1996.

e. Unregulated systems are not required to monitor their drinking water for comparison to any of these above mentioned limits. However, these limits can be used to ensure the safety of drinking water when monitoring is performed. Choosing the proper limit for comparison (the contaminant's MCL, HA, etc.) depends upon situation specifics such as population served and exposure duration. Usually, systems compare monitoring results to MCLs, since these are the limits that must be met by public water systems. In the absence of MCLs, HAs are used. HAs are also used if the concentration of a contaminant exceeds the MCL but exposure is known to be less than lifetime. Use of health protective limits in unregulated systems is not an exact science and may require the experienced judgement of a water quality professional. If monitoring results show levels of contaminants above the MCLs contained in Appendix D or if contaminants not listed in Appendix D are detected in drinking water, the USACHPPM or the local health department should be contacted for appropriate recommendations.

Chapter 3
Management Measures for Purchased Water Systems

3-1. Basics of a Purchased Water System Management Program.

a. A purchased water system management program should consist of three basic steps: assurance that the water purchased is safe and acceptable, maintenance of water quality once it enters the facility, and interaction with facility consumers to ensure needs are being met. The time needed to execute such a management system is dependent upon the size and diversity of the facility.

b. Purchased water systems rely on a regulated water supplier for a safe and acceptable supply of drinking water. The quality of the water provided can be verified by requesting a copy of the regulatory monitoring results from the supplier (reference 2). The monitoring results should be compared to the State drinking water regulatory limits (or the MCLs listed in Appendix D) to ensure that the water purchased by the system is protective of human health. The SDWA requires suppliers to notify customers when monitoring results, monitoring frequencies, or treatment applied does not meet enforced standards. Personnel responsible for purchased water systems can also use this notification as an alert of potentially poor water quality from the supplier. The notification provided will include a description of the problem as well as directions of any precautionary measures that should be taken. Since this notification may come via a newspaper article, a local radio or television station announcement, or a direct letter from the health department or the water supplier, a purchased water system's management program should incorporate review of such media.

c. Maintenance of safe water quality in the facility's distribution system is dependent upon the basic operational techniques described in Chapter 6. Even small facilities should have some type of maintenance program which ensures protection of cross-connections and proper operation of any water treatment or storage units used. At a minimum, a maintenance program should include an annual "walk-through" to check the building's potable water facilities for any unusual circumstances.

d. Employee complaints regarding the drinking water provide excellent feedback on the quality of drinking water provided at the tap and should be given immediate attention. Often they indicate a problem such as the introduction of contaminants to the drinking water from dangerous cross-connections. These complaints should be passed on to the supplier so that they can determine if it is a localized or widespread problem (reference 2). Appendix E contains information on common water quality complaints.

3-2. Water Supplier Information to Gather.

a. Regulated water suppliers are required to periodically monitor the drinking water produced. The frequency of monitoring varies and is often affected by previous monitoring results (reference 12). Some contaminants may only be monitored once every 9 years. Total coliform (bacteria) is monitored monthly, regardless of previous monitoring results. This varying frequency creates some difficulty when deciding what monitoring reports to request from the supplier -- an annual summary, all results, monthly reports? Upon starting a purchased water management program, it would be beneficial to ask for the last monitoring results obtained for each contaminant. These results will set up a profile of the water quality provided. Subsequently, annual or even triennial summaries should provide adequate information.

b. Probably the most effective way to obtain monitoring results is to set up an appointment with the supplier's public affairs or customer service office. Public water systems are often reluctant to send copies of monitoring results on a routine basis due to the resulting increase in paperwork. Direct discussion of the facility's needs with the supplier should not only result in meeting those needs, but also in establishing a good rapport with the supplier.

3-3. Additional Monitoring to Further Protect Health.

a. For the most part, purchased water systems can depend upon the supplier to perform all necessary drinking water quality monitoring. Most contaminants are monitored right at the treatment facility. Some contaminants, however, such as lead, copper, bacteria and total trihalomethanes (by-products of the disinfection process) can enter drinking water or increase in concentration after the water has left the treatment plant. Water suppliers monitor these contaminants at various locations throughout the distribution system. Smaller Army facilities can estimate water quality provided to their building(s) from the results of nearby sample sites in the supplier's monitoring program. Larger Army facilities may want to request that the supplier include a building or two on the facility in the supplier's sampling plan. If this cannot be accomplished, it may be prudent for a purchased water system to perform some of their own monitoring. Table 3 contains a list of other contaminants for which purchased water systems may wish to consider testing.

b. A specific contaminant of concern which can increase in concentration throughout the facility's distribution system is lead. Lead can pose a significant risk to human health if too much of it enters the body. The greatest risk is to young children (especially under the age of 6) and the fetuses of pregnant women, since they absorb lead more easily (reference 14). If these high risk populations are present at an Army facility served by a purchased water system, assessment of lead concentrations at the tap should be performed so that decisions can be made about how to best protect these consumers. Often, high lead concentrations at the tap can be reduced by consumers (see Table 4). Other times a point-of-use or point-of-entry treatment device may be needed (see Chapter 7). The USACHPPM can assist facilities in developing a sampling plan and interpreting contract lab results to determine the best actions to provide protection of consumers.

TABLE 3. ADDITIONAL MONITORING FOR PURCHASED WATER SYSTEMS

Contaminant	*Standard*	*Affects..*	*Enters System Via...*
pH	6.5 - 8.5 units	1	
Temperature	--	2	
Disinfectant Residual	Detectable	Health[3]	
Total/Fecal[4] Coliform	Absence of any coliforms	Health	Bacteriological regrowth, Cross-connections
Nitrate	MCL = 10 mg/L	Health	Cross-connections
Total Trihalomethanes	MCL = 0.1 mg/L	Health	Time-dependent reactions between residual disinfectant (e.g., chlorine) and organic matter in the water
Corrosion Index[5]	Noncorrosive		
Lead	AL[6]= 0.015 mg/L	Health	Corrosion of distribution and internal plumbing materials
Iron	SMCL[7]= 0.3 mg/L	Aesthetics	Corrosion of distribution system materials (e.g., cast iron mains)
Copper	AL= 1.3 mg/L SMCL= 1.0 mg/L	Health Aesthetics	Corrosion of distribution system materials (copper pipes)
Zinc	SMCL= 5 mg/L	Aesthetics	Corrosion of distribution system materials (galvanized steel)
Cadmium	MCL= 0.005 mg/L	Health	Corrosion of distribution system materials (galvanized steel)

1. The pH affects the corrosivity of water and the disinfection process. pH values should be compared to those tested by the water supplier. Large (>1.0) changes in pH throughout the distribution system may indicate excessive residence time (stagnant water conditions) or a potential cross-connection. The pH is also used to calculate the corrosion index.
2. Temperature differences greater than 10 degrees higher or lower than water coming from the treatment facility may indicate stagnant water problems.
3. A detectable disinfectant residual provides protection against microbiological contaminants.
4. Fecal coliform testing typically performed only if total coliform results are positive. Positive fecal coliform results indicate more strongly the possible presence of fecal pathogens than do positive total coliform results (reference 14).
5. Determination of corrosivity of water shall include measurement of pH, calcium hardness, alkalinity, temperature, and total dissolved solids. These values can be used to calculate the Langelier Saturation Index (LSI), a common index for measuring the corrosivity of drinking water. Calculation equations for the LSI can be found in Standard Methods for Examination of Water and Wastewater (reference 15). Some labs may perform this calculation. Negative LSI values are associated with corrosive waters, positive values with noncorrosive waters.
6. AL = Action Level. Regulated water systems must meet the action level in at least 90 percent of the samples collected. For purposes of protecting health, unregulated systems could apply this limit to all samples collected.
7. SMCL = Secondary Maximum Contaminant Level. SMCLs are not Federally enforceable, but are recommendations to improve the aesthetic quality of drinking water.

TABLE 4. INTERIM CONSUMER REDUCTION OF LEAD AT THE TAP

1. Flush taps prior to collecting water for drinking or cooking. Flushing the tap means running the cold water faucet until the water gets noticeably colder, usually 30 seconds to a minute for single family homes and a few minutes longer for small apartments or offices in large buildings.

2. Use only the cold water tap for drinking and cooking; hot water is more corrosive and will leach more lead from interior plumbing.

3. To conserve water, fill a couple of bottles of water for drinking after flushing the tap and store them in the refrigerator.

4. Remove loose lead solder and debris from newly installed plumbing materials by removing the faucet strainers from the tap and running the water at full speed for 3 to 5 minutes.

5. Have an electrician check your wiring to determine if it is grounded to the piping in your house. If electric wiring can be grounded elsewhere, contract a certified electrician to do so. The excess electrical current to the pipes promotes corrosion.

Chapter 4
Management Measures for Individual Water Systems

4-1. Basics of an Individual Water System Management Program.

a. The basic principals of an individual water system management program resemble those for a purchased water system: assurance that the drinking water provided is safe and acceptable, maintenance of water quality from treatment to tap, and interaction with facility consumers to ensure needs are being met. The responsibilities and actions involved with those principals, however, are much more detailed and require a greater amount of time and resources. The importance of a management program at Army facilities that are served by individual water systems cannot be over emphasized since the facility alone is responsible for ensuring the safety of the drinking water.

b. The first step in an individual water system's management program is assuring that the source is providing safe drinking water. There are several routine tests that should be performed, and additional tests may be needed based upon the surrounding activities and consumer complaints. The quality of the source water will govern the need for treatment prior to distributing the water for consumption. The Army requires all water to be disinfected (AR 420-46), and TM 5-660 and TB MED 576 provide information on disinfection techniques and equipment available (references 16, 17, and 18). Other types of water treatment, such as filtration and ion exchange, are discussed in several water quality references listed in the bibliography (Appendix B). If water quality indicates the need for treatment other than disinfection, the help of a contractor may be required.

c. Once it is determined that the source and its applicable treatment provide a safe supply of drinking water, the distribution system must be maintained in order to preserve that safety. The basic distribution system operational/maintenance techniques to be included in a water system's management program are described in Chapter 6. An individual water system maintenance program should also incorporate operation and maintenance of treatment equipment.

d. Employee feedback can be a helpful tool in administering an individual water system's management program. Complaints regarding the drinking water serve as indicators of problems in the distribution system or may indicate insufficient treatment or malfunctioning equipment. Appendix E contains information on common water quality complaints and potential causes. Praises or at least lack of complaints should indicate the success of the management program.

4-2. Ground-Water Versus Surface-Water Supplies.

Individual water systems can use ground water or surface water as a source of drinking water. Most systems receive their drinking water from a well. Wells use ground water as a source. Surface-water sources such as lakes, rivers, springs, cisterns, and rain catchments are more susceptible to contamination, especially from microbiological contaminants, and therefore, may require more complex treatment. Surface water sources may also require more extensive and more frequent testing since their quality changes more readily than ground-water sources. Unregulated individual systems that use surface water as a source should contact the USACHPPM or the local health department to ensure the safety of the source and the adequacy of the facility's management program to ensure the continued protection of the consumers. Systems using ground water should ensure that any State health department requirements for construction and protection of wells are met.

4-3. Testing the Drinking Water.

a. The quality of water provided by a source is affected by local geology and climate, the extent of human activity in the area, and its proximity to contamination sources (reference 6). The quality of drinking water provided by a system is affected by the quality of the source, the treatment provided, and the construction of the system. Determining what tests to perform to sufficiently evaluate and monitor this quality can be somewhat of a challenge and is governed by both need and economics.

b. Ideally, drinking water should be tested so that a comparison can be made with the MCLs listed in Appendix D. This is the same criteria that water supplied to public water system users must meet. Such testing can be rather expensive and is often unnecessary to protect employees. (See section 2-3 for an explanation of the protection provided by MCLs.) Table 5 provides a reasonable list of routine tests that should be performed by individual water systems.

c. Personnel responsible for unregulated water systems must assess the need for additional testing based upon situation-specific conditions: location of actual and potential sources of contamination, current water quality conditions, and consumer feedback. A visual inspection of the area surrounding the source provides an idea of what actual or potential contaminants may exist in the source water. Section 2-1 details activities that could contaminate drinking water sources. The size of the area inspected will depend upon the system's resources. Nearby public water systems using a similar source may also be able to provide information on existing or potential contamination. Unusual tap water quality and consumer feedback can also be indicators of poor source water quality, or may indicate contamination occurring within the distribution system. Table 6 provides some examples of situation-specific conditions and the resulting water quality tests required to ensure the safety of the drinking water provided.

TABLE 5. ROUTINE TESTS

Parameter	*Sampling Location*	*Frequency*[1]	*Typical Range or Standard*	*Affects...*
pH[2]	S, DS[3]	annually	6.5 - 8.5 units	--
Temperature	S, DS[4]		--	--
Disinfectant Residual	DS[5]	weekly	Detectable (≥0.1)	Health[6]
Total/Fecal Coliform	S[7] DS	annually quarterly	Absence of any coliforms	Health
Nitrate	S	annually	MCL= 10 mg/L	Health
Total Dissolved Solids	S	annually	SMCL[8]= 500 mg/L	Aesthetics[9]
Sulfate	S	triennially	SMCL= 250 mg/L	Aesthetics[9]
Chloride	S	triennially	SMCL= 250 mg/L	Aesthetics
Iron	S, DS[12]	triennially	SMCL= 0.3 mg/L	Aesthetics
Manganese	S	triennially	SMCL= 0.05 mg/L	Aesthetics
Hardness	S	triennially	50 - 150 mg/L as $CaCO_3$	Aesthetics
Total Trihalomethanes[10]	DS		MCL= 0.100 mg/L	Health
Corrosion Index[11]	S	triennially	SMCL= Noncorrosive	12
Lead[13]	DS	at least one time	AL= 0.015 mg/L	Health

NOTES: S - source DS - distribution system (taps) MCL - Maximum Contaminant Level AL - Action Level
SMCL - Secondary Maximum Contaminant Level

1. Frequencies based upon recommendations by the EPA (reference 4).
2. The pH affects the corrosivity of water and the disinfection process. The pH value is also used in the calculation of the corrosion index.
3. pH values throughout the distribution system should be similar (desirably +/- 0.5 units) to the value measured at the source. Large changes (approximately >1.0 units) could indicate stagnant water conditions or a potential cross-connection.
4. Temperature differences in the distribution system (>10 degrees) may indicate stagnant water conditions.
5. If a disinfectant is applied to the water, the residual leaving the treatment facility should be closely monitored, perhaps daily, to ensure proper operation of disinfecting equipment. The furthest points in the distribution system should be checked to ensure a detectable residual extends throughout the distribution system.
6. A detectable disinfectant residual provides protection against microbiological contaminants.
7. Total/fecal coliforms need only be monitored at the source if a disinfectant is not applied prior to distribution.
8. SMCLs are not Federally enforceable, but are recommendations to improve the aesthetic quality of drinking water.
9. High values of TDS/sulfate may have a temporary laxative effect during adjustment to new water.
10. Trihalomethanes are formed by time-dependent reactions between a disinfectant (e.g., chlorine) and organic matter in the water. Because the reactions are time-dependant, points further in the distribution system can be expected to have higher values of trihalomethanes than locations closer to the source. Trihalomethanes should be monitored if changes in source water quality occur or the disinfection process is changed.
11. Determination of corrosivity of water shall include measurement of pH, calcium hardness, alkalinity, temperature, and total dissolved solids. These values can be used to calculate the Langelier Saturation Index (LSI), a common corrosion index. Calculation equations for the LSI can be found in Standard Methods for the Examination of Water and Wastewater (reference 15). Some labs may calculate the LSI. Make this request when submitting samples for analysis. Corrosive water has a negative LSI value.
12. If water is found to be corrosive, systems may want to consider testing for other distribution system metals subject to leaching such as iron, lead, copper, cadmium, and zinc.
13. Most of the lead concentration in drinking water comes from the corrosion of plumbing materials. Lead content should be monitored at the source if elevated levels of lead are detected at the tap to ensure that the source is not contaminated. If source is located near a potential source of lead contamination, triennial sampling of the source should be performed. Regulated water systems must meet the action level in at least 90 percent of tap water samples collected. For purposes of protecting health, unregulated systems could apply this limit to all samples collected.

TABLE 6. ADDITIONAL TESTS FOR CONSIDERATION

Conditions at Water System	*Tests to Ensure Safety of Water*[1,2]
Surrounding Location Conditions	
Radon in indoor air or located in radon-rich region	radon, radionuclides
Agricultural activities	pesticides, herbicides, nitrate, nitrite, total/fecal coliforms
Coal or other mining operations	metals (iron, selenium, other metal mined), pH, corrosion index
Natural gas drilling operation	chloride, sodium, barium, strontium, radionuclides
Dump, junkyard, landfill, factory or dry-cleaning operation	volatile organic compounds (VOCs), synthetic organic chemicals (SOCs), total dissolved solids (TDS), sulfate, chloride, inorganics[3]
Gas station or fuel storage tanks	VOCs
Seawater or heavily salted roads	chloride, TDS, sodium
Storage/stockpiles	materials stored (e.g., ores, metals)
Unusual Tap Water Conditions	
Discolored water	manganese (black), iron (orange/brown)
Objectionable odors	hydrogen sulfide (rotten eggs), VOCs (gasoline, plastic)
Objectionable taste	copper, aluminum, zinc, manganese, iron (metallic), VOCs (organic)
Cloudy, frothy water	color, detergents
Consumer Feedback	
Recurrent gastrointestinal illness	total/fecal coliforms
Stained plumbing fixtures or laundry	iron (orange), manganese (black), copper (blue/green)
Corrosion of pipes or rapid wear of water treatment equipment (bearings, gaskets)	pH, corrosion index, copper, lead, zinc, cadmium, iron

1. Many of the tests listed are suggestions from the EPA Home Water Testing Fact Sheet (reference 4).
2. The EPA manual, Managing Ground Water Contamination Sources In Wellhead Protection Areas, provides an excellent reference on the potential ground-water contaminants resulting from various activities (reference 9).
3. Inorganic analyses for consideration include: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium and zinc.

4-4. Protection of the Source.

Individual water systems must rely on their own resources to ensure that their source of drinking water continues to provide a safe supply of drinking water. Many public water systems are required to establish programs to protect their supplies (reference 9). Similar measures can be taken by unregulated systems. The Wellhead Protection Program, established via the SDWA, is based upon very simple concepts implemented to protect ground-water wells used as a source of drinking water (references 1 and 7). These concepts -- identification of source and contributing area, identification of potential sources of contamination within that area, and safe management or removal of those sources -- can be used by unregulated systems to develop a source protection plan (references 7 and 20). Most individual systems will need to perform the first two steps in order to determine the need for additional testing (see section 4-3). The additional step of managing or removing the potential sources of contamination will prove worthwhile in reducing the need for future monitoring. These steps may or may not be officially written up as a "protection plan," but their application is a natural progression in the management of an individual water system. The formality with which a protection program is developed will depend upon the facility's available resources.

Chapter 5
Sample Collection and Analysis

5-1. General.

Personnel responsible for unregulated water systems should give adequate thought and attention to proper sample collection and analysis. Sample collection and analysis require labor and funding resources, neither of which Army facilities can afford to waste. Once the type of analysis required is determined -- e.g., total coliform, lead, VOCs, iron -- each point below should be addressed so that efforts will not have to be repeated unnecessarily. The installation or Major Army Command (MACOM) Environmental Office can provide assistance in developing sampling and analysis plans and in locating qualified laboratories.

5-2. Sampling Plans.

a. Sampling or monitoring plans outline the type of samples to be collected, the locations from which they will be collected, and the date and frequency at which they will be collected. Regulated systems are required to develop written sampling plans for both total coliform samples and lead and copper samples, and they must conscientiously manage their sampling programs to ensure that regulatory sampling frequencies are met. Unregulated systems should consider developing similar plans and maintain sampling records in a central location to ensure the most representative and efficient monitoring possible.

b. There are three basic types of sample locations: raw or source water, treated water, and distributed water. Source water samples are collected at the raw water source prior to application of any treatment. These samples provide information on the suitability of the source for drinking purposes and the existence of contamination. Treated water samples are collected after the water passes through the applied treatment process, typically at the entrance to the distribution system. Treated water samples are used for comparison with most of the drinking water standards since most contaminants do not change their concentrations after treatment. For those contaminants that may change their concentrations in the distribution system (e.g., corrosion by-products such as lead and copper, total/fecal coliforms and disinfection by-products), samples should be collected throughout the system to adequately depict the quality of distributed water supplied to all consumers. The exact number of distribution system samples required will depend upon the system's size. Locations should be chosen near the source, in the middle of the system, and at the furthest points from the source. Storage tank samples should be collected when the water level in the tank is falling to ensure that water coming directly from the tank, and not from a supply line, is collected.

5-3. Sample Collection.

a. Erroneous lab results are often the result of incorrect sample collection procedures. Important points of collection include whether or not the water should be flushed from the tap prior to collection, the type of sample container used, and the preservative used to maintain sample integrity prior to analysis. There are several sampling guides available (references 21-25) and many labs offer sample collection services.

b. Sample collection provides an excellent opportunity for evaluating basic drinking water quality conditions. The following field water measurements should be taken whenever collecting samples: pH, temperature, and disinfectant residual, and possibly conductivity and turbidity. A physical check for color, clarity, taste, and odor should also be performed. Field measurements and physical observations, along with the time, date, location description, and name of the person collecting the sample should be recorded for each sample collected. Figure 1 contains an example field data sheet. Comparing the field measurements among samples and performing a general check of the physical quality of the drinking water may lead to consideration of additional analyses (see Table 6).

c. After samples are collected, they should be labeled with the sample number, collection location, and required analyses, and should be properly packed to protect against breakage and leaking. Many drinking water analyses require that samples be maintained at 4 degrees Celcius. Arrangements should be made for shipping these samples in ice. Sample shipments should be accompanied by a packing list which includes the total number of samples enclosed, the individual sample numbers and locations, the required analyses for each sample, and a point of contact. Chain-of-custody procedures should be followed when sample results will be used to support litigation actions. Such procedures prevent tampering and provide legal documentation of samples' handling. Chain-of-custody samples should be shipped in a sealed container, and each person entering the container is required to sign the chain-of-custody form (Figure 2).

5-4. Analysis.

a. All drinking water analyses should be performed by a State-certified or accredited lab. The State health department can provide a list of such labs (reference 2). Labs should not be chosen based upon cost alone. Consideration should be given to whether or not the lab provides sample collection services and whether or not they provide interpretation of results. Lab results are useless data if not properly used to determine whether or not the water is safe to drink.

b. The USACHPPM accredited lab is available to perform nonroutine monitoring for Army drinking water systems. The WSMP can arrange for such assistance at

reasonable rates. Our services include analyses, a health and engineering evaluation of lab results, and recommendations regarding the protection of health and application of treatment. The USACHPPM WSMP can be contacted by phone: (410)671-3919 or DSN 584, by facimile: (410)671-8104, or by electronic mail: chppm_dwater@chppm-ccmail.apgea.army.mil.

DRINKING WATER SUPPLY FIELD DATA SHEET

Project Number: ____________ Sampler Name: ____________

Project Name: ____________ Sampler DSN: ____________

Sample No.	Sample Name *	Sample Location ** (coordinates)	Type of Sample ***	Date	Time	Temp (C/F)	pH	FAC (mg/L)	Turbidity (NTU)	Conductivity (umhos/cm)	Remarks +

* e.g. Bldg No., well No., WTP
** i.e. Latitude/longitude grid coordinates or Standard military grid coordinates
*** e.g. Raw well water, TW-treated water, RS-raw surface, DS-distributed system, T-tap, FD-first draw, F-flushed, WC-water coolers
\+ i.e. unusual conditions such as any taste and/or odor problems, discoloration, lack of clarity, etc.

AEHA Form 328-R, 1 FEB 93

Figure 1. Example Field Data Sheet For Sample Collection.

CHAIN-OF-CUSTODY RECORD

The proponent of this form is the Directorate of Laboratory Sciences

INSTALLATION ____________ PROJECT NO. ____________

PROJECT OFFICER ____________

PACKED BY ____________

NOTE: For use of this form, see AEHA TG 155, or DLS SOP No. 5

DATE SAMPLED	FIELD IDENTIFICATION NUMBER	LAB NUMBER	SAMPLE TYPE	COMP	GRAB	TOTAL NUMBER OF CONTAINERS	SAMPLE PARAMETER
				TOTAL			

DATE SHIPPED ____________ CARRIER USED ____________ SEAL INTACT YES ☐ NO ☐

LAB NUMBER	RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME	COMMENTS

REMARKS

CHPPM FORM 235-R-E, Replaces AEHA Form 235-R, 1 JUN 93, which is obsolete.

Figure 2. Example Chain-of-Custody Form.

Chapter 6
Practical Distribution System Operation and Maintenance

6-1. General.

The quality of drinking water received at the tap is affected by conditions within the distribution system. Bacterial regrowth, cross-connections, corrosive water, and deteriorating plumbing materials may add many contaminants to the drinking water after it leaves the treatment facility (reference 26). Proper and conscientious operation and maintenance of the distribution system is the only protection available from such deterioration of drinking water quality. Lack of proper distribution system operation and maintenance practices has led to contamination of regulated drinking water systems throughout the Army (reference 27). It is suspected that inadequate practices in unregulated water systems cause many water quality contamination problems as well. The information below provides some general guidelines for proper operation and maintenance of a distribution system. More information on proper operation and maintenance practices can be found in the numerous references on distribution systems listed in the bibliography (Appendix B).

6-2. Flushing.

a. Routine and systematic flushing of a distribution system reduces the accumulation of sediment and stagnant water in the distribution system mains. Flushing programs also assist in providing corrosion control, taste-and-odor control, color and high turbidity control, improved disinfectant residuals, and bacterial regrowth control (reference 28). Beneficial flushing is dependent upon water velocity, flushing direction, and frequency.

b. Recommended water velocity to adequately flush debris from distribution system mains is 5.0 feet per second (fps), with a minimum velocity of 2.5 fps. Some sections of the distribution system may require velocities as high as 12 fps to remove sand and sediment deposits (reference 26). Table 7 shows the flow rates required to obtain a minimum of 2.5 fps in various pipe sizes.

c. Flushing programs must be designed to systematically flush water from the source outward; otherwise, poor quality water may be merely relocated rather than replaced with clean water (reference 26). A hydraulic analysis of the system by a capable waterworks engineer may be required to determine the direction flushing should progress. A main should be flushed until clean water runs from the outlet for several minutes. The length of the main being flushed at any one time should be kept to a minimum to minimize pressure losses and the length of time needed to complete flushing (reference 28).

d. The frequency for flushing mains will depend upon the stability of distributed water quality and water conservation needs. Records of water quality complaints will assist in determining the required flushing frequency. Complaints from areas served by dead-end mains may be more frequent, and localized flushing may be required on a monthly basis. Longer periods of time between complaints indicate that flushing frequency can be prolonged.

e. Simple recordkeeping will assist a facility in developing an efficient and effective flushing program. Personnel responsible for flushing should keep records of the date and time of flushing, location of hydrants/valves used to flush, time required for a hydrant to produce clean water, and a description of the quality of water flushed from the main (cloudy, black, rusty, etc.).

TABLE 7. FLOW RATE REQUIRED TO PRODUCE 2.5 FPS VELOCITY*

Pipe Size		*Flow rate*	
in.	*mm*	*gpm*	*L/s*
4	100	100	6.3
6	150	220	14
8	200	390	25
10	250	610	39
12	300	880	56
16	400	1600	99

Notes: in = inches mm = millimeters gpm = gallons per minute
L/s = liters per second
* Source: Maintaining Distribution-System Water Quality, American Water Works Association, 1986 (reference 26).

6-3. Pressures.

a. Pressure is the front line water quality characteristic that triggers complaints from consumers. Too low *or* too high, water pressure greatly affects the usability of the drinking water provided. Adequate pressure also helps to maintain safe water quality in the distribution system by protecting against backflow or backsiphonage from cross-connections and against entrance of bacteriological contaminants along hairline fractures in distribution mains (reference 29). Most States require a minimum pressure in the distribution system to ensure this protection. A maximum limit may also be set to protect consumer's plumbing systems from complications associated with pressures that are too high. Such regulations may or may not apply to unregulated drinking water systems. Purchased systems may be regulated by the supplier, since back siphonage or backflow can affect the water quality supplied to other customers as well.

b. Operationally, pressures should be maintained somewhere between a maximum of 100 pounds per square inch (psi) and a minimum of 20 psi under fireflow conditions (reference 29). Pressure goals should be a minimum of 35 psi in all points of the distribution system (reference 30). Pumps and valves are used within the distribution system to regulate pressures. Small facilities that purchase their water can contact the supplier if the water pressure in their building is inadequate. Larger facilities should perform their own pressure checks throughout the distribution system. A trained plumber or distribution system operator may be required to perform pressure corrections.

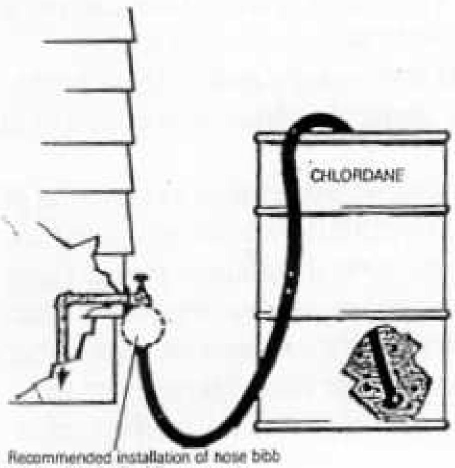
6-4. Disinfectant Residuals.

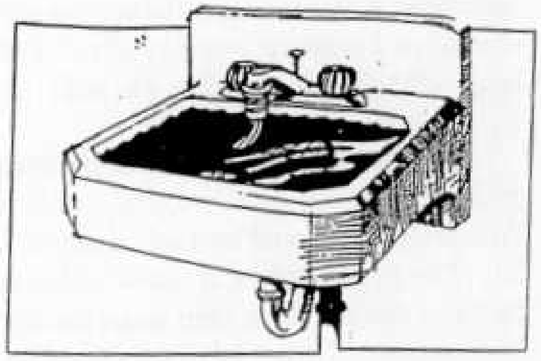
A disinfectant residual, or remaining disinfectant chemical in distributed drinking water, provides protection against recontamination by microbiological contaminants. Such contaminants can enter distributed drinking water through cross-connections and hairline fractures in distribution system structures during low or depressurized conditions. Disinfectant residuals entering a distribution system are typically around 1.0 mg/L to ensure a residual of approximately 0.2 mg/L at the furthest points in the system. Residuals have a tendency to dissipate with time as the water moves through the distribution system, thus, water at the furthest points in the system or in points of low water usage will have a lower residual than that found in high use locations or locations close to the source. Dead end mains may require more frequent flushing to maintain a fresh water with a detectable residual.

6-5. Cross-connections.

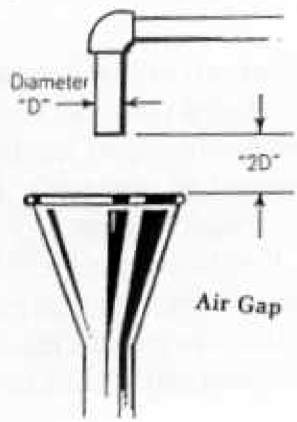
a. A cross-connection is a physical or probable connection between the drinking water distribution system (to include household and building plumbing systems) and a source of contamination. Cross-connections must be properly protected with backflow prevention devices that prohibit the contaminated substance to be siphoned, or backflow, into the potable water lines. Common backflow preventers include air-gaps, check-valves, and reduced pressure principle valves. Figures 3 through 8 show some common cross-connections and backflow prevention devices.

Figures 3 and 4. Common Submerged Inlets.

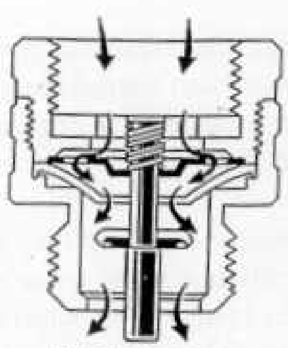




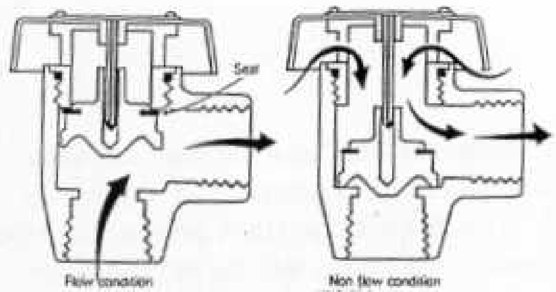
Figures 5 through 8. Common Backflow Preventers.



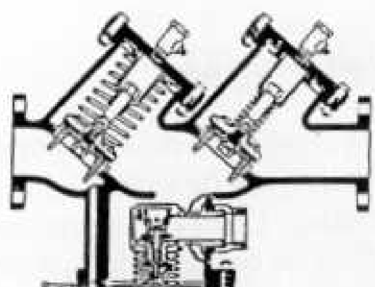
Air Gap



Hose Bibb Vacuum Breaker



Atmospheric Vacuum Breaker



Reduced Pressure Zone Backflow Preventer

b. Many primacy States and local regulatory agencies have regulations regarding cross-connections. Purchased water systems may be regulated by the supplier, since back siphonage or backflow can affect the water quality supplied to other customers. Even if not regulated, all buildings on a facility should be surveyed for existing cross-connections and proper backflow prevention devices should be installed to ensure protection of the employees' health. A contractor or experienced plumber may be necessary to perform these duties. The EPA has produced an excellent manual, Cross-Connection Control Manual, to assist facilities in developing a program to pick out cross-connections, install adequate preventive devices, and maintain those devices to ensure proper operation (reference 31).

6-6. Storage Tanks.

a. Water storage facilities are used to store treated drinking water for use when demands within the distribution system are greater than what the well(s) or treatment facility can meet (reference 30). They also serve to improve flows, regulate pressures, and provide reserves for fire-fighting and power outages (reference 18). Since the water stored is already treated, it is imperative that water storage tanks be operated and maintained in a manner that protects the water quality.

b. Tank operation is usually governed by time of day and pressures throughout the distribution system. Tanks fill when water demand is low and empty when water demand is high. Storage facilities should be designed for frequent (at least daily) "turn-over" so that water cannot become stagnant, and a disinfectant residual is always maintained in water leaving the storage tank.

c. Corrosion, sediment buildup, and structural flaws can reduce stored water quality by allowing contaminants to enter the drinking water. Inspections and regular maintenance of storage facilities are required to check for and repair such problems. Storage facilities should also be regularly sampled, especially during warm weather periods, to determine both bacteriological and physical water quality of the water leaving the storage tank. Indicators that a tank must be cleaned include: increased turbidities (higher than turbidity of water coming from treatment facility), excessive color, foul tastes and odors, and positive bacteriological samples (reference 30).

d. Potable water storage facilities should be drained, cleaned, and disinfected annually (reference 29). Further maintenance such as repairs, relining, and painting should be performed as inspections dictate. Storage tanks should be inspected for structural integrity each season of operation, as ice and heat expansion can cause damage. Interior inspections should only be performed by trained professionals. Paint, protective linings, and cathodic protection can reduce water quality problems caused by corrosion of the storage tank materials.

e. The American Water Works Association (AWWA) has published standards which provide best management guidance for the construction, operation, and maintenance of distribution system facilities (references 32-40). The standards relating to storage facilities are contained in the D series (references 35-40). The standard for disinfecting tanks after cleaning and painting is contained in Standard No. C652-92 (reference 32). The National Sanitation Foundation (NSF) also publishes lists of materials approved for contact with drinking water. More information on the NSF can be found in section 7-2.

6-7. Drinking Water Fountains/Coolers.

Drinking water fountains or coolers are an important source of drinking water for employees at a facility. A primary concern regarding these appurtenances is that older models were shown to contribute to elevated levels of lead in drinking water. The EPA has listed unacceptable coolers in the Federal Register (references 41 and 42). Only acceptable coolers should be used at Army facilities, especially in areas serving high risk populations (see section 3-3). Guidance for the evaluation (via sampling and analysis) of coolers is available in several EPA documents written for child care centers and schools (references 43 and 44).

Chapter 7
Point-of-Entry/Point-of-Use Treatment "Filters"

7-1. Definitions.

Point-of-entry (POE) and point-of-use (POU) treatment or "home-treatment" devices provide additional or alternative treatment of distributed drinking water at the point of the consumer. POE devices treat the drinking water at the water's entry point to a building to provide water that meets health protective limits throughout the building. POU devices are tap or location specific treatment devices. They can only provide water that meets standards at the tap upon which they are installed. The water supplier is responsible for maintenance of POE/POU devices if the supplier installs such devices.

7-2. Use and Considerations.

a. POE/POU devices have many beneficial uses and can provide relatively inexpensive treatment of water for either health protection or improvement of the aesthetic quality of drinking water. If these devices are used for protection of health, it is very important that the correct device is chosen. No matter what the intended purpose, to protect health or to improve water acceptability, it is important to follow manufacture's instructions for both operation and maintenance of the device (reference 45).

b. The most important consideration when choosing a POE/POU device is to choose the right device for the desired treatment. After a facility has tested the drinking water, they should check with the manufacturer to ensure that the device under consideration can remove the contaminants of concern. You may need more than one device to remove all of them. Research the treatment units that are available, and compare not only cost, but also capacity, performance capabilities, warranty, maintenance provisions, general operation, and company support services. The NSF provides a certification program for POE/POU devices and has developed a list of approved devices. Proper devices should be chosen from this list to ensure consumer safety. A list of approved POE/POU devices can be obtained by writing the NSF at NSF International, 3475 Plymouth Rd., PO Box 130140, Ann Arbor, MI 48113-0140, phone (313) 769-8010, Fax 313-769-0109. Once a particular device is chosen and in place, drinking water quality should be checked to ensure that the device is providing the desired results.

c. Another consideration in deciding whether or not a POE/POU device can meet a water system's needs is the required maintenance and operation of devices. Responsibility for this maintenance should be firmly established and publicized. This responsible party should be familiar with and able to operate the POE/POU device installed. POE devices should be located in an area that provides adequate room for normal operations and routine maintenance such as changing filters, as well as nonroutine repairs such as replacing parts. POU devices must be used very cautiously, as they are often installed and then forgotten. A schedule of necessary filter and media changes should be posted on a visible calender.

APPENDIX A
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APPENDIX B
BIBLIOGRAPHY OF RELATED READING MATERIALS

GENERAL

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APPENDIX D
DRINKING WATER QUALITY STANDARDS & HEALTH PROTECTIVE LIMITS

EPA's Drinking Water Regulations and Health Advisories
(Source: EPA 822-R-96-001)

These regulations and health advisory tables are revised every 6 months by EPA's Office of Water. Although no permanent mailing list is kept, copies may be ordered free of charge from the:

SAFE DRINKING WATER HOTLINE
1-800-426-4791
Monday thru Friday, 9:00 AM to 5:30 PM EST.

Copies of the supportive technical documentation for the health advisories can be obtained for a fee from the:

Educational Resource Information Center (ERIC)
1929 Kenny Road
Columbus, OH 43210-1080
Telephone number (614) 292-6717
FAX (614) 292-0263
e-mail ERICSE@osu.edu
Payment by Purchase Order/check/Visa or Mastercard.

The Health Advisories available and their ERIC order numbers are included at the end of this publication. For further information regarding the Drinking Water Regulations and Health Advisories, call Barbara Corcoran in EPA's Office of Water at (202) 260-1332.

LEGEND

Abbreviations column descriptions are:

MCLG - Maximum Contaminant Level Goal. A non-enforceable concentration of a drinking water contaminant that is protective of adverse human health effects and allows an adequate margin of safety.

MCL - Maximum Contaminant Level. Maximum permissible level of a contaminant in water which is delivered to any user of a public water system.

RfD - Reference Dose. An estimate of a daily exposure to the human population that is likely to be without appreciable risk of deleterious effects over a lifetime.

DWEL - Drinking Water Equivalent Level. A lifetime exposure concentration protective of adverse, non-cancer health effects, that assumes all of the exposure to a contaminant is from a drinking water source.

(*) The codes for the **Status Reg** and **Status HA** columns are as follows:

F	-	final
D	-	draft
L	-	listed for regulation
P	-	proposed
T	-	tentative *(not officially proposed)*

Other codes found in the table include the following:

NA	-	not applicable
PS	-	performance standard 0.5 NTU - 1.0 NTU
TT	-	treatment technique
**	-	No more than 5% of the samples per month may be positive. For systems collecting fewer than 40 samples/month, no more than 1 sample per month may be positive.
***	-	guidance

- Large discrepancies between Lifetime and Longer-term HA values may occur because of the Agency's conservative policies, especially with regard to carcinogenicity, relative source contribution, and less-than-lifetime exposures in chronic toxicity testing. These factors can result in a cumulative UF (uncertainty factor) of up to 5 to 5000 when calculating a Lifetime HA.

The scheme for categorizing chemicals according to their carcinogenic potential is as follows: *

Group A: Human carcinogen

Sufficient evidence in epidemiologic studies to support causal association between exposure and cancer

Group B: Probable human carcinogen

Limited evidence in epidemiologic studies (Group B1) *and/or* sufficient evidence from animal studies (Group B2)

Group C: Possible human carcinogen

Limited evidence from animal studies and inadequate or no data in humans

Group D: Not classifiable

Inadequate or no human and animal evidence of carcinogenicity

Group E: No evidence of carcinogenicity for humans

No evidence of carcinogenicity in at least two adequate animal tests in different species *or* in adequate epidemiologic and animal studies

Drinking Water Health Advisories (HAs) are defined as follows:

One-day HA

The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to 5 consecutive days of exposure, with a margin of safety.

Ten-day HA

The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects up to 14 consecutive days of exposure, with a margin of safety.

Long-term HA

The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects up to approximately 7 years (10% of an individual's lifetime) of exposure, with a margin of safety.

*EPA is in the process of revising the Cancer Guidelines.

Lifetime HA

The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects over a lifetime of exposure, with a margin of safety.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
ORGANICS													
Acenaphthene	-	-	-	-	-	-	-	-	0.06	-	-	-	-
Acifluorfen	T	zero	-	F	2	2	0.1	0.4	0.013	0.4	-	0.1	B2
Acrylamide	F	zero	TT	F	1.5	0.3	0.02	0.07	***0.0002***	0.007	-	0.001	B2
Acrylonitrile	T	zero	-	D	-	-	-	-	-	-	-	0.006	B1*
Adipate (diethylhexyl)	F	0.4	0.4	-	20	20	20	60	0.6	20	0.4	3	C
Alachlor	F	zero	0.002	F	0.1	0.1	-	-	0.01	0.4	-	0.04	B2
Aldicarb**	D	0.007	0.007	D	-	-	-	-	0.001	0.035	0.007	-	D
Aldicarb sulfone**	D	0.007	0.007	D	-	-	-	-	0.001	0.036	0.007	-	D
Aldicarb sulfoxide**	D	0.007	0.007	D	-	-	-	-	0.001	0.035	0.007	-	D
Aldrin	-	-	-	D	0.0003	0.0003	0.0003	0.0003	0.00003	0.001	-	0.0002	B2
Ametryn	-	-	-	F	9	9	0.9	3	0.009	0.3	0.06	-	D
Ammonium sulfamate	-	-	-	F	20	20	20	80	0.28	8	2	-	D
Anthracene (PAH)***	-	-	-	-	-	-	-	-	0.3	-	-	-	D
Atrazine	F	0.003	0.003	F	0.1	0.1	0.05	0.2	0.035	0.2*	0.003*	-	C
Baygon	-	-	-	F	0.04	0.04	0.04	0.1	0.004	0.1	0.003	-	C
Bentazon	T	0.02	-	F	0.3	0.3	0.3	0.9	0.0025	0.08	0.02	-	D
Benz(a)anthracene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	B2
Benzene	F	zero	0.005	F	0.2	0.2	-	-	-	-	-	0.1	A
Benzo(a)pyrene (PAH)	F	zero	0.002	-	-	-	-	-	-	-	-	0.0002*	B2*
Benzo(b)fluoranthene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	B2
Benzo(g,h,i)perylene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	D
Benzo(k)fluoranthene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	B2
bis-2-Chloroisopropyl ether	-	-	-	F	4	4	4	13	0.04	1	0.3	-	D
Bromacil	L	-	-	F	5	5	3	9	0.13	5	0.09	-	C
Bromobenzene	L	-	-	D	-	-	-	-	-	-	-	-	-

* Under review.
**NOTE: The HA value or the MCLG/MCL value for any two or more of these three chemicals should remain at 0.007 mg/L because of similar mode of action.
***PAH = Polyaromatic hydrocarbon
*See 40CFR Parts 141 and 142
NOTE: Anthracene and Benzo(g,h,i)perylene — not proposed in Phase V.
NOTE: Changes from the last version are noted in Italic and Bold Face print.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Health Advisories									Cancer Group
	Status Reg.	MCLG (mg/l)	MCL (mg/l)	Status HA	10-kg Child			70-kg Adult					
					One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Bromochloroacetonitrile	T	-	-	D	-	-	-	-	-	-	-	-	-
Bromochloromethane	-	-	-	F	*0.1*	*0.1*	*0.1*	*0.5*	0.013	*0.05*	0.09	-	-
Bromodichloromethane (THM)	P	zero	0.1*/0.08*	D	6	6	4	13	0.02	0.7	-	0.06	B2
Bromoform (THM)	P	zero	0.1*/0.08*	D	5	2	2	6	0.02	0.7	-	0.4	B2
Bromomethane	T	-	-	F	0.1	0.1	0.1	0.5	0.001	0.04	0.01	-	D
Butyl benzyl phthalate (PAE)***	-	-	-	-	-	-	-	-	0.2	7	-	-	C
Butylate	-	-	-	F	2	2	1	4	0.05	2	0.35	-	D
Butylbenzene n-	-	-	-	D	-	-	-	-	-	-	-	-	-
Butylbenzene sec-	-	-	-	D	-	-	-	-	-	-	-	-	-
Butylbenzene tert-	-	-	-	D	-	-	-	-	-	-	-	-	-
Carbaryl	-	-	-	F	1	1	1	1	0.1	4	0.7	-	D
Carbofuran	F	0.04	0.04	F	0.05	0.05	0.06	0.2	0.006	0.2	0.04	-	E
Carbon tetrachloride	F	zero	0.005	F	4	0.2	0.07	0.3	0.0007	0.03	-	0.03	B2
Carboxin	-	-	-	F	1	1	1	4	0.1	4	0.7	-	D
Chloral hydrate	P	0.04	0.06**	D	7	0.2	0.2	0.6	0.0002	0.06	0.06	-	C
Chloramben	-	-	-	F	3	3	0.2	0.5	0.015	0.5	0.1	-	D
Chlordane	F	zero	0.002	F	0.06	0.06	-	-	0.00006	0.002	-	0.003	B2
Chlorodibromomethane (THM)	P	0.06	0.1*/0.08*	D	6	6	2	8	0.02	0.7	0.06	-	C
Chloroethane	L	-	-	D	-	-	-	-	-	-	-	-	B
Chloroform (THM)	P	zero	0.1*/0.08*	D	4	4	0.1	0.4	0.01	0.4	-	0.6	B2
Chloromethane	L	-	-	F	9	0.4	0.4	1	0.004	0.1	0.003	-	C
Chlorophenol (2-)	-	-	-	D	*0.5*	*0.5*	*0.5*	*2.0*	0.005	0.2	0.04	-	D
p-Chlorophenyl methyl sulfide/sulfone/sulfoxide	-	-	-	**	-	-	-	-	-	-	-	-	D
Chloropicrin	L	-	-	-	-	-	-	-	-	-	-	-	-
Chlorothalonil	-	-	-	F	0.2	0.2	0.2	0.5	0.015	0.5	-	0.15	B2
Chlorotoluene o-	L	-	-	F	2	2	2	7	0.02	0.7	0.1	-	D
Chlorotoluene p-	L	-	-	F	2	2	2	7	0.02	0.7	0.1	-	D
Chlorpyrifos	-	-	-	F	0.03	0.03	0.03	0.1	0.003	0.1	0.02	-	D
Chrysene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-***	B2
Cyanazine****	T	0.001	-	D	0.1	0.1	0.02	0.07	0.002	0.07	0.001****	-	C

* Current MCL **A HA will not be developed due to insufficient data; a "Database Deficiency Report has been published.
* 1994 Proposed rule for Disinfectants and Disinfection By-products : Total for all THMs combined cannot exceed the 0.08 level.
**Total for all haloacetic acids cannot exceed 0.06 level. ***PAE = phthalate acid ester ****Draft HA updated for the Phase VIB regulation, which has been postponed. It includes the change of the cancer classification from D to C, thus justifying the use of an additional 10-fold safty factor for the lifetime HA.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Health Advisories									
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)	Status HA	One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	Cancer Group
Cyanogen chloride	T	-	-	-	-	-	-	-	-	-	-	-	-
Cymene p-	-	-	-	D	-	-	-	-	-	-	-	-	-
2,4-D	F	0.07	0.07	F	1	0.3	0.1	0.4	0.01	0.4	0.07	-	D
DCPA (Dacthal)	L	-	-	F	80	80	5	20	0.5	20	4	-	D
Dalapon	F	0.2	0.2	F	3	3	0.3	0.9	0.026	0.9	0.2	-	D
Di(2-ethylhexyl)adipate	F	0.4	0.4	-	20	20	20	60	0.6	20	0.4	3	C
Diazinon	-	-	-	F	0.02	0.02	0.005	0.02	0.00009	0.003	0.0006	-	E
Dibromoacetonitrile	L	-	-	D	2	2	2	8	0.02	0.8	0.02	-	C
Dibromochloropropane (DBCP)	F	zero	0.0002	F	0.2	0.05	-	-	-	-	-	0.003	B2
Dibromomethane	L	-	-	-	-	-	-	-	-	-	-	-	D
Dibutyl phthalate (PAE)	-	-	-	-	-	-	-	-	0.1	4	-	-	D
Dicamba	L	-	-	F	0.3	0.3	0.3	1	0.03	1	0.2	-	D
Dichloroacetaldehyde	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloroacetic acid	P	zero	0.06**	D	1	1	1	4	0.004	0.1	-	**	B2
Dichloroacetonitrile	L	-	-	D	1	1	0.8	3	0.008	0.3	0.006	-	C
Dichlorobenzene o-	F	0.6	0.6	F	9	9	9	30	0.09	3	0.6	-	D
Dichlorobenzene m- *	-	-	-	F	9	9	9	30	0.09	3	0.6	-	D
Dichlorobenzene p-	F	0.075	0.075	F	10	10	10	40	0.1	4	0.075	-	C
Dichlorodifluoromethane	L	-	-	F	40	40	9	30	0.2	5	1	-	D
Dichloroethane (1,2-)	F	zero	0.005	F	0.7	0.7	0.7	2.6	-	-	-	0.04	B2
Dichloroethylene (1,1-)	F	0.007	0.007	F	2	1	1	4	0.009	0.4	0.007	-	C
Dichloroethylene (cis-1,2-)	F	0.07	0.07	F	4	3	3	11	0.01	0.4	0.07	-	D
Dichloroethylene (trans-1,2-)	F	0.1	0.1	F	20	2	2	6	0.02	0.6	0.1	-	D
Dichloromethane	F	zero	0.005	F	10	2	-	-	0.06	2	-	0.5	B2
Dichlorophenol (2,4-)	-	-	-	D	0.03	0.03	0.03	0.1	0.003	0.1	0.02	-	D
Dichloropropane (1,1-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropane (1,2-)	F	zero	0.005	F	-	0.09	-	-	-	-	-	0.06	B2
Dichloropropane (1,3-)	L	-	-	D	-	-	-	-	-	-	-	-	-

* The values for m-dichlorobenzene are based on data for o-dichlorobenzene.
** A quantitative risk estimate has not been determined.
** Total for all haloacetic acids cannot exceed 0.06 level.

Drinking Water Standards and Health Advisories

Chemicals	Standards: Status Reg.	Standards: MCLG (mg/l)	Standards: MCL (mg/l)	Status HA	Health Advisories, 10-kg Child: One-day (mg/l)	10-kg Child: Ten-day (mg/l)	10-kg Child: Longer-term (mg/l)	70-kg Adult: Longer-term (mg/l)	70-kg Adult: RfD (mg/kg/day)	70-kg Adult: DWEL (mg/l)	70-kg Adult: Lifetime (mg/l)	70-kg Adult: mg/l at 10^{-4} Cancer Risk	Cancer Group
Dichloropropane (2,2-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropene (1,1-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropene (1,3-)	T	zero	-	F	0.03	0.03	0.03	0.09	0.0003	0.01	-	0.02	B2
Dieldrin	-	-	-	F	0.0005	0.0005	0.0005	0.002	0.00005	0.002	-	0.0002	B2
Diethyl phthalate (PAE)	-	-	-	D	-	-	-	-	0.8	30	5	-	D
Diethylene glycol dinitrate	-	-	-	*	-	-	-	-	-	-	-	-	-
Di(2-ethylhexyl)phthalate (PAE)	F	zero	0.006	D	-	-	-	-	0.02	0.7	-	0.3	B2
Diisopropyl methylphosphonate	-	-	-	F	8	8	8	30	0.08	3	0.6	-	D
Dimethrin	-	-	-	F	10	10	10	40	0.3	10	2	-	D
Dimethyl methylphosphonate	-	-	-	F	2	2	2	6	0.2	7	0.1	0.7	C
Dimethyl phthalate (PAE)	-	-	-	-	-	-	-	-	-	-	-	-	D
1,3-Dinitrobenzene	-	-	-	F	0.04	0.04	0.04	0.14	0.0001	0.005	0.001	-	D
Dinitrotoluene (2,4-)	L	-	-	F	0.50	0.50	0.30	1	0.002	0.1	-	0.005	B2
Dinitrotoluene (2,6-)	L	-	-	F	0.40	0.40	0.40	1	0.001	0.04	-	0.005	B2
tg 2,6 & 2,4 dinitrotoluene **	-	-	-	-	-	-	-	-	-	-	-	0.005	B2
Dinoseb	F	0.007	0.007	F	0.3	0.3	0.01	0.04	0.001	0.04	0.007	-	D
Dioxane p-	-	-	-	F	4	0.4	-	-	-	-	-	0.7	B2
Diphenamid	-	-	-	F	0.3	0.3	0.3	1	0.03	1	0.2	-	D
Diphenylamine	-	-	-	F	1	1	0.3	1	0.03	1	0.2	-	D
Diquat	F	0.02	0.02	-	-	-	-	-	0.0022	0.08	0.02	-	D
Disulfoton	-	-	-	F	0.01	0.01	0.003	0.009	0.00004	0.001	0.0003	-	E
Dithiane (1,4-)	-	-	-	F	0.4	0.4	0.4	1	0.01	0.4	0.06	-	D
Diuron	-	-	-	F	1	1	0.3	0.9	0.002	0.07	0.01	-	D
Endothall	F	0.1	0.1	F	0.8	0.8	0.2	0.2	0.02	0.7	0.1	-	D
Endrin	F	0.002	0.002	F	0.02	0.02	0.003	0.01	0.0003	0.01	0.002	-	D
Epichlorohydrin	F	zero	TT	F	0.1	0.1	0.07	0.07	0.002	0.07	-	0.4	B2
Ethylbenzene	F	0.7	0.7	F	30	3	1	3	0.1	3	0.7	-	D
Ethylene dibromide (EDB)	F	zero	0.00005	F	0.008	0.008	-	-	-	-	-	0.00004	B2
Ethylene glycol	-	-	-	F	20	6	6	20	2	40	7	-	D
ETU	L	-	-	F	0.3	0.3	0.1	0.4	0.00008	0.003	-	0.03	B2
Fenamiphos	-	-	-	F	0.009	0.009	0.005	0.02	0.00025	0.009	0.002	-	D

* An HA will not be developed due to insufficient data; a "Database Deficiency Report" has been published.
** tg = technical grade

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		10-kg Child			70-kg Adult					
					One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Fluometron	-	-	-	F	2	2	2	5	0.013	0.4	0.09	-	D
Fluorene (PAH)	-	-	-	-	-	-	-	-	0.04	-	-	-	D
Fluorotrichloromethane	L	-	-	F	7	7	3	10	0.3	10	2	-	D
Fog Oil	-	-	-	D	-	-	-	-	-	-	-	-	-
Fonofos	-	-	-	F	0.02	0.02	0.02	0.07	0.002	0.07	0.01	-	D
Formaldehyde	D	-	-	D	10	5	5	20	0.15	5	1	-	B1**
Gasoline, unleaded (benzene)	-	-	-	D	-	-	-	-	-	-	0.005	-	-
Glyphosate	F	0.7	0.7	F	20	20	1	1	0.1	4	0.7	-	E
Heptachlor	F	zero	0.0004	F	0.01	0.01	0.005	0.005	0.0006	0.02	-	0.0006	B2
Heptachlor epoxide	F	zero	0.0002	F	0.01	-	0.0001	0.0001	1E-5	0.0004	-	0.0004	B2
Hexachlorobenzene	F	zero	0.001	F	0.05	0.05	0.06	0.2	0.0008	0.03	-	0.002	B2
Hexachlorobutadiene	T	0.001	-	F	0.3	0.3	0.1	0.4	0.002	0.07	0.001	-	C
Hexachlorocyclopentadiene	F	0.06	0.06	-	-	-	-	-	0.007	0.2	-	-	D
Hexachloroethane	L	-	-	F	5	5	0.1	0.5	0.001	0.04	0.001	-	C
Hexane (n-)	-	-	-	F	10	4	4	10	-	-	-	-	D
Hexazinone	-	-	-	F	3	3	3	9	0.033*	1*	0.2*	-	D
HMX	-	-	-	F	5	6	5	20	0.05	2	0.4	-	D
Indeno(1,2,3,-c,d)pyrene (PAH)	-	-	-	D	-	-	-	-	-	-	-	-***	B2
Isophorone	L	-	-	F	15	15	15	15	0.2	7	0.1	4	C
Isopropyl methylphosphonate	-	-	-	D	30	30	30	100	0.1	4.0	0.7	-	D
Isopropylbenzene	-	-	-	D	-	-	-	-	-	-	-	-	-
Lindane	F	0.0002	0.0002	F	1	1	0.03	0.1	0.0003	0.01	0.0002	-	C
Malathion	-	-	-	F	0.2	0.2	0.2	0.8	0.02	0.8	0.2	-	D
Maleic hydrazide*	-	-	-	F	10	10	5	20	0.5	20	4	-	D
MCPA	-	-	-	F	0.1	0.1	0.1	0.4	0.0015	0.06	0.01	-	E
Methomyl	L	-	-	F	0.3	0.3	0.3	0.3	0.025	0.9	0.2	-	D
Methoxychlor	F	0.04	0.04	F	0.05	0.05	0.05	0.2	0.005	0.2	0.04	-	D
Methyl ethyl ketone	-	-	-	F	-	-	-	-	-	-	-	-	*
Methyl parathion	-	-	-	F	0.3	0.3	0.03	0.1	0.00025	0.008	0.002	-	D

* Under review.
** Carcinogenicity based on inhalation exposure.
***See 40CFR Parts 141 and 142

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^-4 Cancer Risk	
Methyl tert butyl ether	L	-	-	D	24	24	3	12	0.03	1.0	0.02-0.2*		C***
Metolachlor	L	-	-	F	2	2	2	5.0	0.1	5.0	0.1	-	C
Metribuzin	L	-	-	F	5	5	0.3	0.5	0.013**	0.5	0.1	-	D
Monochloroacetic acid	L	-	-	D	-	-	-	-	-	-	-	-	-
Monochlorobenzene	F	0.1	0.1	F	2	2	2	7	0.02	0.7	0.1	-	D
Naphthalene	-	-	-	F	0.5	0.5	0.4	1	0.004	0.1	0.02	-	D
Nitrocellulose (non-toxic)	-	-	-	F	-	-	-	-	-	-	-	-	-
Nitroguanidine	-	-	-	F	10	10	10	40	0.1	4	0.7	-	D
Nitrophenol p-	-	-	-	F	0.8	0.8	0.8	3	0.008	0.3	0.06	-	D
Oxamyl (Vydate)	F	0.2	0.2	F	0.2	0.2	0.2	0.9	0.025	0.9	0.2	-	E
Paraquat	-	-	-	F	0.1	0.1	0.05	0.2	0.0045	0.2	0.03	-	E
Pentachloroethane	-	-	-	D	-	-	-	-	-	-	-	-	-
Pentachlorophenol	F	zero	0.001	F	1	0.3	0.3	1	0.03	1	-	0.03	B2
Phenanthrene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	D	6	6	6	20	0.6	20	4	-	D
Picloram	F	0.5	0.5	F	20	20	0.7	2	0.07	2	0.5	-	D
Polychlorinated biphenyls (PCBs)	F	zero	0.0005	P	-	-	-	-	-	-	-	0.0005	B2
Prometon	L	-	-	F	0.2	0.2	0.2	0.5	0.015*	0.5*	0.1*	-	D
Pronamide	-	-	-	F	0.8	0.8	0.8	3	0.075	3	0.05	-	C
Propachlor	-	-	-	F	0.5	0.5	0.1	0.5	0.013	0.5	0.09	-	D
Propazine	-	-	-	F	1	1	0.5	2	0.02	0.7	0.01-r	-	C
Propham	-	-	-	F	5	5	5	20	0.02	0.6	0.1	-	D
Propylbenzene n-	-	-	-	D	-	-	-	-	-	-	-	-	-
Pyrene (PAH)	-	-	-	-	-	-	-	-	0.03	-	-	-	D
RDX	-	-	-	F	0.1	0.1	0.1	0.4	0.003	0.1	0.002	0.03	C
Simazine	F	0.004	0.004	F	0.07	0.07	0.07	0.07	0.005	0.2	0.004	-	C
Styrene	F	0.1	0.1	F	20	2	2	7	0.2	7	0.1	-	C
2,4,5-T	L	-	-	F	0.8	0.8	0.8	1	0.01	0.35	0.07	-	D
2,3,7,8-TCDD (Dioxin)	F	zero/	3E-08	F	1E-06	1E-07	1E-08	4E-08	1E-09	4E-08	-	2E-08	B2

* Under review. NOTE: Phenanthrene — not proposed.

** The RfD for metribuzin was revised Dec. 1994 to 0.013 mg/kg/day. Based on this revised RfD the Lifetime HA would be 0.1 mg/l assuming a 20% relative source contribution for drinking water. This information has not been incorporated in the Health Advisory document.

*** Tentative.

* If the cancer classification C is accepted, the Lifetime HA is 0.20; otherwise it is 0.200 mg/l.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Tebuthiuron	-	-	-	F	3	3	0.7	2	0.07	2	0.5	-	D
Terbacil	-	-	-	F	0.3	0.3	0.3	0.9	0.013	0.4	0.09	-	E
Terbufos	-	-	-	F	0.005	0.005	0.001	0.005	0.00013	0.005	0.0009	-	D
Tetrachloroethane (1,1,1,2-)	L	-	-	F	2	2	0.9	3	0.03	1	0.07	0.1	C
Tetrachloroethane (1,1,2,2-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	F	zero	0.005	F	2	2	1	5	0.01	0.5	-	0.07	-
Tetranitromethane	-	-	-	**	-	-	-	-	-	-	-	-	-
Toluene	F	1	1	F	20	2	2	7	0.2	7	1	-	D
Toxaphene	F	zero	0.003	F	-	-	-	-	0.1*	-	-	0.003	B2
2,4,5-TP	F	0.05	0.05	F	0.2	0.2	0.07	0.3	0.0075	0.3	0.06	-	D
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroacetic acid	P	0.3	0.06**	D	4	4	4	13	0.1	4.0	0.3	-	C
Trichloroacetonitrile	L	-	-	D	0.05	0.05	-	-	-	-	-	-	-
Trichlorobenzene (1,2,4-)	F	0.07	0.07	F	0.1	0.1	0.1	0.6	0.001	0.04	0.07	-	D
Trichlorobenzene (1,3,5-)	-	-	-	F	0.6	0.6	0.6	2	0.006	0.2	0.04	-	D
Trichloroethane (1,1,1-)	F	0.2	0.2	F	100	40	40	100	0.035	1	0.2	-	D
Trichloroethane (1,1,2-)	F	0.003	0.005	F	0.6	0.4	0.4	1	0.004	0.1	0.003	-	C
Trichloroethanol (2,2,2-)	L	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene	F	zero	0.005	F	-	-	-	-	-	0.3	-	0.3	B2
Trichlorophenol (2,4,6-)	L	-	-	D	-	-	-	-	-	-	-	0.3	B2
Trichloropropane (1,1,1-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trichloropropane (1,2,3-)	L	-	-	F	0.6	0.6	0.6	2	0.006	0.2	0.04	0.5	B2
Trifluralin	L	-	-	F	0.08	0.08	0.08	0.3	0.0075	0.3	0.005	0.5	C
Trimethylbenzene (1,2,4-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Trimethylbenzene (1,3,5-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trinitroglycerol	-	-	-	F	0.005	0.005	0.005	0.005	-	-	0.006	-	-
Trinitrotoluene	-	-	-	F	0.02	0.02	0.02	0.02	0.0005	0.02	0.002	0.1	C
Vinyl chloride	F	zero	0.002	F	3	3	0.01	0.05	-	-	-	0.0015	A
Xylenes	F	10	10	F	40	40	40	100	2	60	10	-	D

* Under review.

** A HA will not be developed due to insufficient data; a "Database Deficiency Report" has been published.

** Total for all haloacetic acids cannot exceed 0.06 mg/l level.

Drinking Water Standards and Health Advisories

Chemicals	Standards: Status Reg.	Standards: MCLG (mg/l)	Standards: MCL (mg/l)	Status HA	Health Advisories, 10-kg Child: One-day (mg/l)	10-kg Child: Ten-day (mg/l)	10-kg Child: Longer-term (mg/l)	70-kg Adult: Longer-term (mg/l)	70-kg Adult: RfD (mg/kg/day)	70-kg Adult: DWEL (mg/l)	70-kg Adult: Lifetime (mg/l)	70-kg Adult: mg/l at 10^{-4} Cancer Risk	Cancer Group
INORGANICS													
Aluminum	L	-	-	D	-	-	-	-	-	-	-	-	-
Ammonia	-	-	-	D	-	-	-	-	-	-	30	-	D
Antimony	F	0.006	0.006	F	0.01	0.01	0.01	0.015	0.0004	0.01	0.003	-	D
Arsenic	*	-	0.05	D	-	-	-	-	-	-	-	0.002	A
Asbestos (fibers/l >10µm length)	F	7 MFL	7 MFL	-	-	-	-	-	-	-	-	700 MFL	A
Barium	F	2	2	F	-	-	-	-	0.07	2	2	-	D
Beryllium	F	0.004	0.004	D	30	30	4	20	0.005	0.2	-	0.0008	B2
Boron	L	-	-	D	4	0.9	0.9	3	0.09	3	0.6	-	D
Bromate	L	zero	0.01	-	-	-	-	-	-	-	-	-	-
Cadmium	F	0.005	0.005	F	0.04	0.04	0.005	0.02	0.0005	0.02	0.005	-	D
Chloramine	P	4***	4	D	1	1	1	1	0.1	3.3	3/4***	-	-
Chlorate	L	-	-	D	-	-	-	-	-	-	-	-	-
Chlorine	P	4	4	D	-	-	-	-	0.1	-	-	-	D
Chlorine dioxide	T	0.3	0.8	D	-	-	-	-	0.01	0.35	0.3	-	D
Chlorite	L	0.08	1	D	-	-	-	-	0.003	0.1	0.08	-	D
Chromium (total)	F	0.1	0.1	F	1	1	0.2	0.8	0.005	0.2	0.1	-	D
Copper (at tap)	F	1.3	TT**	-	-	-	-	-	-	-	-	-	D
Cyanide	F	0.2	0.2	F	0.2	0.2	0.2	0.8	0.022	0.8	0.2	-	D
Fluoride*	F	4	4	-	-	-	-	-	0.12	-	-	-	-
Hypochlorite	P	4[1]	-	-	-	-	-	-	-	-	-	-	-
Hypochlorous acid	P	4[1]	-	-	-	-	-	-	-	-	-	-	-
Lead (at tap)	F	zero	TT**	-	-	-	-	-	-	-	-	-	B2
Manganese	L	-	-	D	-	-	-	-	0.14[3]	-	-	-	-
Mercury (inorganic)	F	0.002	0.002	F	-	-	-	0.002	0.0003	0.01	0.002	-	D
Molybdenum	L	-	-	D	*0.02*	*0.02*	*0.01*	0.05	0.005	0.2	0.04	-	D
Nickel	F	0.1[4]	0.1[4]	F	1	1	0.5	1.7	0.02	0.6	0.1	-	D
Nitrate (as N)	F	10	10	F	-	10*	-	-	1.6	-	-	-	*

* Under review.
** Copper — action level 1.3 mg/L, Lead — action level 0.015 mg/L
*** Measured as free chlorine.
[1] Regulated as chlorine.
[2] In food.
[3] In water.
[4] Being remanded

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Nitrite (as N)	F	1	1	F	-	1*	-	-	0.16*	-	-	-	-
Nitrate + Nitrite (both as N)	F	10	10	F	-	-	-	-	-	-	-	-	-
Selenium	F	0.05	0.05	-	-	-	-	-	0.005	-	-	-	-
Silver	-	-	-	D	0.2	0.2	0.2	0.2	0.005	0.2	0.1	-	D
Sodium	-	-	-	D	-	-	-	-	-	20**	-	-	-
Strontium	L	-	-	D	25	25	25	90	0.6	90	17	-	D
Sulfate	P	*500*	*500*	D	-	-	-	-	-	-	-	-	-
Thallium	F	0.0005	0.002	F	0.007	0.007	0.007	0.02	0.00007	0.002	0.0004	-	-
Vanadium	T	-	-	D	-	-	-	-	-	-	-	-	D
White phosphorous	-	-	-	F	-	-	-	-	0.00002	0.0005	0.0001	-	D
Zinc	L	-	-	F	6	6	3	10	0.3	10	2	-	D
Zinc chloride (measured as Zinc)	L	-	-	F	6	6	3	10	0.3	10	2	-	D
RADIONUCLIDES													
Beta particle and photon activity (formerly man-made radionuclides)	F	zero	4 mrem	-	-	-	-	-	-	-	-	4 mrem/y	A
Gross alpha particle activity	F	zero	15 pCi/L	-	-	-	-	-	-	-	-	15 pCi/L	A
Combined Radium 226 & 228	*F*	*zero*	*5 pCi/L*	-	-	-	-	-	-	-	-	20 pCi/L	A
Radon	P	zero	300 pCi/L+	-	-	-	-	-	-	-	-	150 pCi/L	A
Uranium	P	zero	20 µg/L	-	-	-	-	-	0.003	-	-	-	A

* Under review. ** Guidance.
+1991 Proposed National Primary Drinking Water Rule for Radionuclides

Secondary Maximum Contaminant Levels

Chemicals	Status	SMCLs (mg/L)
Aluminum	F	0.05 to 0.2
Chloride	F	250
Color	F	15 color units
Copper	F	1.0
Corrosivity	F	non-corrosive
Fluoride*	F	2.0
Foaming agents	F	0.5
Iron	F	0.3
Manganese	F	0.05
Odor	F	3 threshold odor numbers
pH	F	6.5 — 8.5
Silver	F	0.1
Sulfate	F	250
Total dissolved solids (TDS)	F	500
Zinc	F	5

Status Codes: P — proposed, F — final

* Under review.

Microbiology

	Status	MCLG	MCL
Cryptosporidium	L	-	-
Giardia lamblia	F	zero	TT
Legionella	F#	zero	TT
Standard Plate Count	F#	NA	TT
Total Coliforms	F	zero	**
Turbidity	F	NA	PS
Viruses	F#	zero	TT

Key: PS, TT, F, defined as previously stated.

\# Final for systems using surface water; also being considered for regulation under groundwater disinfection rule.

Field Water Standards
(Source: Draft: TB MED 577, Reference 13)

DOD Tri-Service Field Water Quality Standards - Short Term

SHORT TERM REQUIREMENTS (<7 DAYS)

	U.S. Tri Service (June 1996)		QSTAG 245 (SEP 1985)	STANAG 2136 (July 1994)
CONSUMPTION RATE	5 L/Day	15 L/Day	5 L/Day	5 L/Day
Physical Properties				
Color (Color Unit)	50	50		50
Odor (Threshold Odor Number)	3	3		3
pH	5 - 9	5 - 9	5 - 9.2	5 - 9
Temperature (Degrees C)	4 - 35	4 - 35	4.0 - 35	4 - 35
TDS (mg/L)	1000	1000	1500	1000
Turbidity (NTU)	1	1	5	1
Chemical Properties				
Arsenic (mg/L)	0.3	0.1	2	0.3
Cyanide (mg/L)	6	2	20	6
Chloride (mg/L)	600	600		600
Lindane (mg/L)	0.6	0.2		
Magnesium (mg/L)	100	30		100
Sulfate (mg/L)	300	100		300
Microbiological				
Coliform (#/100 ml)	1*	1*	1	1
Virus (#/100 ml)			1	1
Spores/Cysts (#/100 ml)			1	1
Chemical Agents				
Hydrogen Cyanide (ug/l)	6	2		
BZ (Incapacitants) (ug/l)	7	2.3		
Lewisite (arsenic fraction) (ug/l)	80	27		
Sulfur Mustard (ug/l)	140	47	200	200
Nerve Agents (ug/l)			20	20
VX (ug/L)	15	5		
GD (ug/L)	12	4		
GB (ug/L)	28	9.3		
GA (ug/L)	140	46		
T-2 Toxins ug/l	26	8.7		
Radiological				
Radiological	8 uCi/L	3 uCi/L		

* ALTHOUGH THE MICROBIOLOGICAL STANDARD IS 1 cfu/100 ml "COLILERT" AND "COLISURE" MAY BE USED.

DOD Tri-Service Field Water Quality Standards - Long Term

LONG TERM REQUIREMENTS (< 1 YEAR)

	U.S. Tri Service (June 1996)		QSTAG 245 (Sep 1985)	STANAG 2136 (July 1994)
CONSUMPTION RATE	5 L/Day	15 L/Day	5 L/Day	5 L/Day
Physical Properties				
Color (Color Unit)	15	15	15	15
Odor (Threshold Odor Number)	3	3		3
pH	5 - 9	5 - 9	5 - 9.2	5 - 9
Temperature (Degrees C)	15 - 22	15 - 22	15 - 22	15 - 22
TDS (mg/L)	1000	1000	1500	1000
Turbidity (NTU)	1	1	1	1
Chemical Properties				
Arsenic (mg/L)	0.06	0.02	0.05	0.06
Cyanide (mg/L)	6	2	0.5	6
Chloride (mg/L)	600	600	600	600
Lindane (mg/L)	0.6	0.2		
Magnesium (mg/L)	100	30	150	100
Sulfate (mg/L)	300	100	400	300
Microbiological				
Coliform (#/100 ml)	1*	1*	1	1
Virus (#/100 ml)			1	1
Spores/Cysts (#/100 ml)			1	1
Chemical Agents				
Hydrogen Cyanide (ug/l)	6	2		
Mustard (ug/l)			50	50
Nerve Agents (ug/l)			5	5
Radiological				
Radiological	.1uCi/L	.05 uCi/L	.06 uCi/L	2.2 Bq/ml

* ALTHOUGH THE MICROBIOLOGICAL STANDARD IS 1 cfu/100 ml "COLILERT" AND "COLISURE" MAY BE USED.

APPENDIX E
TROUBLE SHOOTING CONSUMER COMPLAINTS

Complaint	Possible Causes		Complaint Investigation	
	Distribution System	Private Plumbing System	Information Needed	Field Investigation
Cloudy/Milky Water (Air in Water)	Shutdown of water mains Low main pressure Temperature changes Cross-connections Leaking plumbing glands	Overheating of hot water tank Warming of cold water lines Zinc Cross-connections	Location? Determine the location's pressure zone. When was air/milkiness first noticed? Does air disappear when glass of water stands? Is air present in both cold and hot water? Has water to location been shut off recently? New galvanized pipe installed recently?	Check water at location of problem. Eliminate air by flushing. Take sample to lab if necessary. Report results/cause to consumer.
Dirty/Colored Water	Water treatment plants (need to remove Mn, turbidity, Iron, etc.) Breaks in water mains Dead ends Cross-connections New, recoated, or repaired water mains Fireflow through mains Flushing operations Changes in pressure	Hot water system Cross-connections Scale House piping Plumbing repairs	Location? Determine the location's pressure zone. When was dirty water first noticed? Description of water. Color? Are both hot and cold water dirty? Is the water dirty at all faucets? Are particles large, small or colored? Does water look milky or contain air?	Check water at location of problem. Eliminate dirty water by flushing. If flushing doesn't work, may need to flush mains. Take sample to lab if necessary. Apply treatment if necessary. Report results/cause to consumer.
Hard Water/ Scale/ Spots	Change of supply Water treatment plant (need to soften or recharge brine) Cross-connections Dead ends	Cross-connections Point-of-entry softener requires recharge of brine	Location? Determine the location's pressure zone. When was hard water first detected? How was it determined that water was harder than usual? Any water softeners used?	Check water at location of problem. Recharge any applicable water softening equipment. Take sample to lab if necessary. Report results/cause to consumer.
Sickness or Skin Irritation	Change in supply Cross-connection Other?	Cross-connection Faulty plumbing Contaminated containers/fountain	Location? Determine the location's pressure zone. Any changes in pressure in that area of system? Main breaks? When did sickness or skin irritation first occur? Why is the water suspect? Have all consumers at location been affected? Have affected consumers been out of town? Has a doctor been consulted?	Check taste, odor, color, turbidity, pH, temperature and disinfectant residual at location. Check for cross-connections. Take sample to lab for bacteriological and partial chemical test (probably VOC scan). Contact USACHPPM or health dept. Report results/cause to consumer..
Foul Taste/Odor	Change in supply Turn-over in surface water source Over chlorination Dead ends Bacteriological re-growth Cross-connections Newly reparied mains Broken mains Unmaintained storage tanks	Hot water system Cross-connection Piping Kitchen sink odors Automatic ice makers	Location? Determine the location's pressure zone. When was taste/odor first detected? Is the taste/odor detectable in both hot and cold water? Description of taste/odor.	Check water at location of problem. Check pH, disinfectant residual, temperature at location. Flush location lines. Flush mains (esp. if dead end). Take sample to lab if necessary. Report results/cause to consumer.