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TECHNICAL BULLETIN

SANITARY CONTROL AND SURVEILLANCE OF FIELD WATER SUPPLIES

HEADQUARTERS, DEPARTMENTS OF THE ARMY, NAVY, AND AIR FORCE
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WASHINGTON, DC, 1 May 1999

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“ This document presents information regarding potable water supply and water quality in a field environment. It reflects all changes resulting from staffing of the draft document throughout Army, Navy, Air Force, and Marine environmental health and distribution. Use this electronic version while the official manuscript, figures, and forms are being processed for publication. Note that minor formatting or grammar changes may occur, but all technical information and recommendations are final and will not change.”

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Sanitary Control and Surveillance of Field Water Supplies

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Purpose

a. This publication --

(1) Results from the need to standardize the surveillance and control of potable water quality in a field environment throughout Department of Defense (DOD) and improve inter-service coordination. Drinking water aboard all floating vessels will be managed as specified in Technical Bulletin (TB) 43-0153 and Navy Medical (NAVMED) P-5010-6.

(2) Provides information and guidance --

(a) To DOD military and civilian personnel concerned with the location, production, sanitary control, and surveillance of field water supplies.

(b) To be used during training exercises and actual deployments to provide the best possible water for human consumption and other purposes in the field.

(c) That will aid preventive medicine and environmental/occupational health personnel in preserving combat effectiveness by providing technical information to the commanding officer or officer-in-charge concerning potable water.

(3) Applies to all DOD activities.

b. Provisions of this publication are subject to three international agreements: North Atlantic Treaty Organization Standardization Agreement (NATO STANAG) 2136, NATO STANAG 2885, and Quadripartite (American-British-Canadian-Australian Armies) Standardization Agreement (QSTAG) 245. When an amendment, revision, or cancellation of this publication is proposed that will affect or violate the agreement concerned, the preparing activity will take proper action through international standardization channels.

c. References to “preventive medicine,” “medical,” or other terms, unless otherwise specifically stated, refer to the medical personnel of any service charged with the responsibility of water quality or sanitary inspections.

1-2. References. Appendix A provides a list of references and prescribed and referenced forms.

1-3. Abbreviations and terms. The glossary provides a list of abbreviations and terms used in this publication.

1-4. Procedures and responsibilities

a. Procedures.

(1) Unit commanders --

(a) Ensure there are sufficient quantities of safe water for their personnel.

(b) Take actions necessary to maintain an adequate supply of potable water. Such actions include properly treating raw water supplies to remove unacceptable levels of organic and inorganic substances and harmful microbes, and enforcing water discipline.

(c) Ensure that their personnel are familiar with the dangers of consuming untreated water and know the proper methods for disinfecting their personal drinking water supplies if necessary, and consume the required amounts of drinking water.

(2) Preventive medicine personnel and units advise the commanding officer on water quality issues. This entails assisting in selecting water sources, surveying the potable water system, and conducting routine bacteriological tests. Both chemical and microbiological analyses of field water supplies are required in all circumstances. Specific responsibilities are detailed in chapters 3 and 6.

(3) All personnel --

(a) Familiarize themselves with, and follow, proper water discipline. This includes consuming water that has been properly treated and conserving and protecting the potable water supply.

(b) Ensure that potable water does not become contaminated from careless or improper handling.

b. Responsibilities.

(1) Army. AR 40-5 and AR 700-136 outline specific responsibilities for Army personnel.

(2) Navy. NAVMED P-5010-9 outlines specific responsibilities for Navy personnel.

(3) Air Force. Air Force Instruction 48-119, paragraph 9.6.3 outlines specific responsibilities for Air Force personnel.

1-5. Technical assistance

Requests for technical assistance should be forwarded through appropriate service command channels. Appendix B lists the locations of laboratories capable of providing technical support.

Section II. HUMAN REQUIREMENTS FOR POTABLE WATER

1-6. General

Safe water, in sufficient quantities, is essential to every human being. Insufficient quantity or quality of water is not only debilitating to the individual, but can have a major impact on unit operational readiness. Water that is not properly treated and disinfected can spread diseases such as cholera, shigellosis, typhoid, and paratyphoid fever. Untreated water can also transmit viral hepatitis, gastroenteritis, and parasitic diseases such as amoebic dysentery, giardiasis, cryptosporidosis, and schistosomiasis.

1-7. Potability versus palatability

a. Potable water. One way that water may be classified is by how fit it is for drinking. Potable water is water that does not contain disease-producing organisms, poisonous substances, and chemical or biological agents and radioactive contaminants at levels which produce disease or injury. Potable water may or may not be palatable.

b. Palatable water.

(1) Palatable water is pleasing in appearance and taste. It is significantly free from color, and foul taste or odor. Also, it is cool and aerated. Palatable water may not be potable.

(2) Cooler water encourages acceptance. Therefore, efforts to maintain water at the optimum temperature (60 degrees Fahrenheit (ºF) or 16 degrees Celsius (ºC)) should be made by shading or other means such as mechanical water chillers or adding potable ice.

1-8. Water management

a. Ensuring that personnel consume sufficient quantities of water is extremely important. This keeps personnel in good physical and mental condition to complete their mission. The daily water requirements for personnel in the field vary with a number of factors including the weather, geographical area, and the tactical situation. Dehydration can occur quickly in both extremely hot, cold, or mountainous climates if personnel do not drink the required quantities of water. Personnel in extreme environments must drink water even if they do not "feel thirsty."

b. The using unit commander will enforce water management as follows:

(1) In hot climates, ensure troops drink adequate amounts of water to prevent dehydration and heat casualties.

(2) In areas where water supplies are scarce, ensure equal rationing to all personnel and give priority to consumption over other uses such as laundry or showers.

(3) In areas where water is not limited, minimize waste such as ponding or puddling which, if not controlled, could form insect breeding areas.

1-9. Body water loss

The healthy human body loses water by urinating, breathing, and sweating. An individual subjected to high heat stress may lose water in excess of 1 quart (1 liter (L)) per hour by sweating. The sweat loss, in addition to body salt loss, must be replaced to ensure mission effectiveness. Sustained dehydration can result in heat stress; deterioration of performance; and, if left untreated, ultimately death.

1-10. Water replacement

The preferred method of water replacement is taking small amounts of water throughout the work period. During a period of moderate activity with moderate environmental conditions prevailing, the water requirement is 0.5 quart (0.5 L) or more per hour per person and is best taken at 20- to 30-minute intervals. As activities or conditions become more severe, the command will ensure that individual water intake is increased accordingly. Table 1-1 shows how heat condition information can determine water intake and work/rest cycle requirements. These work:rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hours of work in the specified heat category. Individual water needs will vary by ¼ of one quart per hour. Hourly fluid intake should not exceed 1.5 quarts. The unit commander will provide the required amount of safe drinking water. When sufficient quantities do not exist, modify work/rest cycles to prevent dehydration.

Table 1-1. Water intake requirements

Heat Category	WBGT Index °F[1]	EASY WORK[2] Work/Rest[5]	Qt/hr	MODERATE WORK[3] Work/Rest	Qt/hr	HARD WORK[4] Work/Rest	Qt/hr
1	78-81.9	NL[6]	½	NL	¾	40/20	¾
2	82-84.9	NL	½	50/10	¾	30/30	1
3	85-87.9	NL	¾	40/20	¾	30/30	1
4	88-89.9	NL	¾	30/30	¾	20/40	1
5	> 90	50/10	1	20/40	1	10/50	1

1. MOPP gear adds 10°F to WBGT Index.
2. Examples of easy work include walking on hard surfaces at a 2.5 mph pace with a 30 lb. load, conducting manual of arms training, marksmanship training, and drill and ceremony.
3. Examples of moderate work include walking on hard surfaces at a 3.5 mph pace with less than a 40 lb. load, walking on loose sand at 2.5 mph with no load, calisthenics, patrolling, individual movement techniques (that is, low crawl, high crawl), defensive position construction, and field assaults.
4. Examples of hard work include walking on hard surfaces at a pace of 3.5 mph and a load greater than 40 lb., walking on loose sand at a 2.5 mph pace with any load.
5. Rest means minimal physical activity (sitting or standing) and should be accomplished in the shade if possible.
6. NL = No limit to work time per hour.

CHAPTER 2

FIELD WATER QUALITY STANDARDS

2-1. Development of standards

a. General. The DOD tri-service standards for field water quality were developed for field-water constituents and properties of military concern that are naturally occurring or introduced by man into water. The standards were developed to protect against performance-degrading effects resulting from the ingestion of field water. These United States (U.S.) standards are identified in tables C-1 and C-2. Additional information on the water quality standards listed in appendix C is contained in chapter 6, section III; chapter 7; and appendix D.

b. Multi-national standards. Field water quality standards have been developed by international agreements among the NATO Forces and the Quadripartite Armies. These organizations have agreed, when operating on land, to adopt minimum requirements for potability of drinking water to be issued to troops in combat zones or in any other emergency situations. The NATO STANAG 2136 provides guidance on short-term (1 to 7 days) standards under these conditions, while the QSTAG 245 (Quadripartite standards) provides guidance on both short-term and long-term (greater than 7 days) standards. As a member nation of both organizations, the U.S. has agreed to accept and provide water meeting these standards when participating in mutual logistical water support under field conditions. It should be noted that the DOD tri-service standards are as stringent or more stringent than the minimum Quadripartite or NATO standards.

c. Short-term consumption. The standards in table C-1 apply to units operating for 7 consecutive days or less when the commander determines that an operational condition exists which prevents troop access to drinking water meeting long-term consumption standards. Preventive medicine personnel should advise commanders on selection of water sources and the use of short-term consumption standards. The commander must accept the risk of potential troop performance degradation, increased incidence of disease, casualties from toxic substances, and reduced combat efficiency with each day the imposition remains in effect.

d. Long-term consumption. The standards in table C-2 apply to all situations that continue for more than 7 days where potable water is produced by water purification units. The standards in table C-5 were developed by the U.S. Environmental Protection Agency (EPA) for municipal drinking water systems. These standards should be adopted as a goal to provide the highest quality water possible. In applying these standards to assess potential health hazards, it is important to consider the target population, duration of exposure, and other factors used to develop the standards. More information on health risk assessment and the applicable water quality standards is contained in chapter 7.

2-2. Nonconsumptive uses

a. Nonconsumptive uses of water are listed in table C-3. Uses range from personal hygiene to vehicle washing. The water quality associated with nonconsumptive uses protects personnel from contracting diseases from water that comes in contact with their skin or are incidentally inhaled or ingested in small amounts. They also protect equipment and clothing from deterioration.

b. Variances from water quality standards are as follows.

(1) Water of the next higher quality may be used for any of the purposes listed in table C-3 when water conservation considerations permit.

(2) Water of the next lower quality will not be used unless an emergency exists. When such emergencies exist, preventive medicine personnel will be contacted to evaluate the situation. The command surgeon will be the final authority on the use of lower quality water.

2-3. Standards

a. If the water production point will be operational for less than 7 days, use table C-1 to determine the constituents to analyze and the applicable standards. If the water point will be operational for more than 7 days, use table C-2.

b. In temperate regions or conditions, follow the standards for a 5 liter per day (L/day) per person consumption rate. In arid regions or conditions, and also most arctic or mountainous regions, follow the standards for a 15 L/day per person consumption rate.

c. Where water is produced by U.S. forces for U.S. and NATO or Quadripartite forces, follow the most stringent standard for the applicable consumption rate and duration (that is, less than 7 days or up to 1 year).

d. When water is obtained from NATO or Quadripartite forces, it should meet the QSTAG (for Quadripartite nations) or STANAG (for NATO nations) standards for the applicable consumption rate and duration in tables C-1 or C-2.

2-4. Treatment methods

The reverse osmosis water purification unit (ROWPU) is the preferred method of treatment for all potable field water supplies because it reliably provides a high quality potable water, even from a low quality, contaminated source. While other treatment methods such as diatomaceous earth (DE) filtration can effectively remove suspended material and microbiological organisms, no other method effectively removes the wide range of inorganic and organic contaminants which are also harmful to human health. The reverse osmosis (RO) portion of the ROWPU shall not be bypassed for increased quantity or other reasons.

CHAPTER 3

PREVENTIVE MEDICINE RESPONSIBILITIES FOR WATER POINT RECONNAISSANCE

Section I. WATER SOURCES

3-1. General

This chapter provides background material to assist preventive medicine personnel evaluate the available water sources. All water sources in the field should be considered unsafe until they have been evaluated by preventive medicine personnel and approved by the command medical authority. Water may be obtained from various sources in the field including rivers, streams, ponds, lakes, wells, ice, and snow. In choosing a raw water source, consider the following factors:

a. Quantity. Will the source provide an adequate supply of potable water for all personnel for the expected duration of operations?

b. Quality. Look upstream or around the general area of the site to observe the following.

(1) Is the water free of contamination such as algae; sewage; naturally occurring toxic elements or compounds; industrial pollution; or nuclear, biological, or chemical (NBC) warfare agents?

(2) Is the water objectionable due to turbidity, color, odor, or taste?

(3) Is the water source protected from possible organic contamination by sewage or runoff from latrines, showers, motor pools, etc.?

(4) Are there sources of inorganic contamination by mining wastes or runoff, etc.?

(5) Can the water be treated adequately with the resources available?

c. Accessibility. Is the source accessible to water purification and transport equipment?

3-2. Existing public water systems

These are the easiest and, in most cases, the safest sources because this water may have been treated to some extent. However, these sources may not be safe in areas with civil unrest, and can be intentionally contaminated, particularly by terrorist groups. For these reasons, all water produced from existing facilities will be considered unsafe until evaluated by preventive medicine personnel and approved as a potable water source by the command medical authority.

3-3. Surface water

Surface water includes lakes, rivers, streams, and ponds. These sources are usually more accessible than other sources and capable of supplying adequate quantities; however, water quality can be a problem. In lakes and ponds, place the intakes as far from shore as possible to minimize the effects of contamination from sources along the shore. Also, intakes should be neither too close to the bottom nor too near the surface to avoid picking up mud and other debris.

3-4. Ground water

Ground water (wells and springs) is usually less contaminated than surface water. However, it is sometimes difficult to determine what quantities are available. The use of ground water by combat personnel is usually limited to existing wells and springs. Ground-water sources must be located at least 100 feet from all existing sources of contamination (for example, latrines, septic tanks) and situated so that the drainage is away from the well or spring.

3-5. Nonpotable water sources

All water sources that have not been tested by preventive medicine personnel and approved by the command surgeon as potable will be considered nonpotable.

a. When a water source has been tested and approved for consumption by the command surgeon, preventive medicine personnel or the unit conducting operations will post the source with a sign that reads: "POTABLE WATER SOURCE."

b. When a water source has been tested and is not approved for consumption by the command surgeon, preventive medicine personnel or the unit conducting operations will post the source with a sign that reads: "NONPOTABLE WATER. DO NOT DRINK." Such sources include construction water points, untested faucets, cisterns, vehicle washing supplies, etc. The sign will be replaced with a "POTABLE WATER SOURCE" sign after the command surgeon has approved the source as potable.

Section II. WATER POINT RECONNAISSANCE

3-6. General

A team which includes water purification, engineer, and preventive medicine personnel will accomplish water source reconnaissance. Preventive medicine personnel will inspect and test untreated water sources for specific parameters related to health issues. Water purification or engineer personnel will perform tests to determine treatability. The logistics staff officer (Army and Marine Corps), or the civil engineering section (Air Force), or commanding officer (Navy) will coordinate the reconnaissance. The reconnaissance should be documented on DD Form X340 (Water Source Reconnaissance Report). Local reproduction of this form is authorized. A copy for reproduction purposes is located at the back of this publication.

3-7. Site examinations

Preventive medicine personnel will examine the proposed source water site and the surrounding area for sources of pollution and evidence of contamination. Water purification units should not be located near areas where evidence of pollution or contamination exists. If a polluted or contaminated source must be used as a last resort, controls to minimize the amount of contaminated water to the intake or to improve raw water quality should be constructed, if possible.

For example, ensuring that intake lines are submerged 8 to 12 inches below the water surface of a source with a visible sheen would significantly improve treated water quality.

a. Sources of pollution include, but are not limited to: landfills; agricultural and livestock wastes; industrial discharges; domestic sewage discharges; and petroleum, oil, and lubricant (POL) sites.

b. Visible evidence of contamination includes, but is not limited to, dead fish or vegetation, excessive algae growth, oil slicks, and sludge deposits. Not all contamination is visible.

3-8. Water testing requirements

a. Required water source tests. Tests for the water quality parameters listed in tables C-1 and C-2 will be conducted onsite to determine if the source can be made potable by water purification. If the tests cannot be performed onsite, a sample will be collected for testing these parameters upon return to a base of operation. The field water testing equipment discussed in chapter 8, section II can perform most of these tests. The test results should be used to compare one prospective source to another to choose the source with the best source water quality. Because most, if not all, sources will be treated using the ROWPU or other treatment equipment, it is not mandatory for the chosen source water quality to meet the standards in appendix C. When treated, the water produced and distributed must meet these standards.

b. Additional water source tests. Due to current technology shortfalls, preventive medicine personnel must use their best judgement to determine the suitability of each site for use as a source. Factors that have the greatest short-term (acute) impact, such as microbiological quality, are of greatest importance. Other factors are involved in the determination of suitability, which include, but are not limited to, color, odor, turbidity, pH, chlorine demand, watershed vegetation and forestation, organic debris in the water, and the type of source. The preventive medicine personnel should combine good judgement with any available testing resources to determine the water quality of each site under consideration for a source. Detailed water quality analyses performed by the supporting laboratories in appendix B should also be considered as an additional resource, to provide additional water quality information on prospective sources or currently used sources. These types of analyses need not be completed immediately, but should be accomplished on a prioritized basis as operations continue to mature.

CHAPTER 4

WASTE FROM FIELD WATER OPERATIONS

4-1. General

a. Environmental considerations. When operating in a field or garrison environment, commanders must comply with EPA, local, or host nation standards. Commanders with field water purification units participating in field training exercises or contingency operations in the U.S. or its possessions will coordinate with the facility engineer to determine how to dispose of wastewater and other treatment wastes. Outside the continental U.S., commanders will coordinate wastewater disposal with the host nation environmental agency.

b. Procedures.

(1) Regulated discharges. In cases where a discharge permit has been secured, the water purification section chief will comply with the permit to prevent contamination of the receiving water body. In cases where a permit has been denied, the water purification section chief will contact the installation environmental officer to determine if wastewater could be discharged into a sanitary sewer system, or held in a tank at the point of production, pumped into a truck, and transported to the wastewater treatment plant. Such action should also involve coordination with the chief of the wastewater treatment plant.

(2) Unregulated discharges. If a discharge permit is not required, the water purification section chief should take precautions to avoid contamination of the receiving body of water. Wastewater should be discharged at least 50 yards away from the raw water intake and downstream for flowing sources or downwind for standing bodies of water. Backwash water and sludge should be discharged into sumps to prevent gross contamination of the water source. Sump dimensions will depend on the amount of water to be wasted, the type of soil around the location of the sump, and the water table in the area. When the unit vacates the area, sumps will be properly closed and marked.

c. Technical assistance. Requests for technical assistance in disposing of wastewater should be referred to the appropriate Army, Navy, or Air Force laboratory or agency listed in appendix B.

4-2. Disposal of wastewaters

a. Regulatory information.

(1) In the U.S., the EPA (or a State with an EPA approved program) establishes rules and regulations for wastewater discharges under the National Pollutant Discharge Elimination System (NPDES), established under the Clean Water Act (CWA). Dischargers must apply for and obtain a site-specific NPDES Permit (or State equivalent) or general NPDES permit.

(2) The EPA must publish and update ambient surface water quality criteria under the CWA. These criteria are not legally enforceable; however, many states require that the levels be met in surface waters. The ambient criteria refer to pollutant concentrations found in the receiving water and not solely the discharge.

(3) Foreign countries will have their own guidance on disposal of wastes as well as ambient water quality criteria. Usually the Final Governing Standards, derived from the DOD Overseas Environmental Baseline Guidance Document (OEBGD) and the host nation standards, contain these requirements. Coordination should be made with the installation facility engineer to determine the requirements for discharge.

b. Wastewater generation.

(1) Wastewaters generated during the ROWPU operation are brine, backwash water from the multimedia filter(s), and wastewater produced from cleaning the reverse osmosis membranes (ROMs). Chlorinated product water, if not issued, may have to be disposed of as wastewater. The local environmental authority should be contacted to determine disposal methods.

(2) The amount of wastewater generated will depend on the source water quality and operational practices. For fresh water sources, approximately 50 percent product water and 50 percent brine is produced. If the water source is brackish to saline, approximately 25 percent product water and 75 percent brine is generated. Generally, the multimedia filter is backwashed every 20 hours of operation or when the pressure loss across the filter rises more than 5 pounds per square inch (psi) over initial readings and when the ROWPU is shut down. Approximately 1,000 gallons of backwash wastewater is produced during a 13-minute backwash cycle.

(3) The ROMs are cleaned when the ROM gauge increases by 20 percent over the initial reading, the RO pressure indicator rises above 960 psi for seawater or 500 psi for fresh and brackish water, or when the product water flow decreases or the brine flow increases noticeably. Source water quality will directly impact how often the ROMs must be cleaned. The two methods of cleaning ROMs are to circulate citric acid solution or Triton X-100®, a detergent, through the vessels which will generate at least 350 gallons of wastewater. Additional information on discharge characteristics of the cleaning solutions can be found in paragraph e of this section.

®Triton X-100 is a registered trademark of Rohm and Haas Co., Philadelphia, Pennsylvania.

c. Brine. The contaminants present in the brine are the same as those in the source water, only at different concentrations. The suspended solid concentration will be less than that of the raw water; however, the dissolved solids, alkalinity, metals, and chloride concentrations are greater in the brine. Phosphate concentration is increased in the brine due to the use of sodium hexametaphosphate.

(1) Return to source. The impact of returning brine to the source water is largely dependent on the volume of the source body of water and also mixing zones and flows, particularly at the point of discharge. Brine returned to the source should be discharged 50 yards downstream from the raw water intake on flowing sources, or 50 yards downwind for standing bodies of water. For training operations, each discharge site should be evaluated and approved by the local regulatory authority for a permitted discharge.

(2) Discharge to sewage treatment plant (STP). Most brines can be treated at an STP; however, an elevated metal concentration in the brine may upset biological media at the STP. This is more of a concern in brackish or saline sources with high total dissolved solids (TDS) content.

(3) Discharge to ground. In lieu of other options, the standard field wastewater disposal method, a soakage pit or trench, is an alternative in many areas except where high ground-water tables exist. Other options include evaporation beds in arid areas and various conventional land treatment methods. For discharge of brines produced by treating seawater, returning the brine to the source water is more favorable than land disposal because of the increased potential to degrade ground water.

(4) Blend of brine and product water. The concept of blending brine and product water should only be considered for training situations for ROWPU operators and not for field training exercises. If the brine is unable to be disposed of due to the high concentrations of contaminants, and extra product water is available, the two can be blended to dilute the constituent concentrations. The primacy authority may then allow the blended solution to be returned to the source, discharged to the STP, or discharged to the ground. To dilute the brine to a concentration low enough to discharge would require most of the product water.

d. Backwash. The high total suspended solids (TSS) concentration presents the greatest challenge to disposal of backwash waters. Metals and phosphate levels may also exceed EPA water quality criteria. Returning the backwash waters to the source is not a likely option because of the inability to meet discharge permit requirements. Ideally, the backwash water can be discharged to the STP, either directly while backwashing or by collecting and hauling the backwash waters to the STP. As a last resort, the backwash water may be discharged to soaking pits, trenches, or other similar ground disposal options.

e. ROM cleaning.

(1) The ROMs are cleaned with citric acid or Triton X-100. For ROWPUs that use a copper-nickel alloy tubing in conveying water, high levels of copper, nickel, lead, and zinc are detected in wastewater during the citric acid element cleaning. This phenomena will diminish over successive citric acid element cleaning cycles over the lifetime of equipment operation.

(2) Direct discharge of wastewaters generated during citric acid and Triton X-100 cleaning cycles to surface waters is unlikely because of high 5-day biochemical oxygen demand (BOD_5) and low pH in the citric acid wastewaters; and high BOD_5, suspended solids, and grease and oil levels in the Triton X-100 wastewaters.

(3) As with backwash water, the ROM cleaning solution should be discharged to an STP. Again, the wastewater can be directly discharged or collected and hauled to the STP. To facilitate handling the contaminant load by the STP, the wastewater can be bled to the sewer, as opposed to being discharged all at once (slug). The elevated metal content in wastewaters, generated during citric acid cleaning on new ROWPUs using a copper-nickel alloy tubing in conveying water, may upset biological media at the STP.

(4) Land disposal methods, such as a soakage pit or trench, will probably not be allowed for wastewater generated during the citric acid cleaning and should only be considered a last resort for wastewater generated during the Triton X-100 cleaning cycle.

f. Product water. For ROWPU operator training purposes, product water is not normally used for troop consumption; therefore, disposal is required unless the installation can find a use for this water (such as backwash water or brine dilution water). A permit will be required if disposal to the raw water source is desired. Discharge to a number of different streams is possible if training will be conducted at a variety of locations. Other disposal options include discharge to the ground and to the STP.

g. Operator protective equipment. Under normal operation, ROWPU operators--

(1) Must use shoulder-length butyl-rubber gloves, rubber aprons, and rubber boots when handling potentially contaminated ROMs and when using cleaning solutions.

(2) Must use goggles and/or face guards when working with citric acid and Triton X-100, which are severe eye and skin irritants.

(3) Should wash their face and hands with antibacterial soap and water at the completion of operations or before they eat or smoke.

(4) Must wear a face shield and a National Institute for Occupational Safety and Health (NIOSH)-approved dust mask when there is potential for water from the ROMs to be aerosolized. The operators can only substitute the military chemical protective mask when there is potential for an NBC environment.

4-3. Disposal of solid wastes - spent reverse osmosis membranes and cartridge filters

a. Regulatory information.

(1) Parts 260-280, title 40, Code of Federal Regulations (40 CFR 260-280), commonly referred to as the Resource Conservation and Recovery Act (RCRA), defines hazardous wastes and provides regulatory controls for the handling and management of hazardous wastes. To be considered a hazardous waste, spent cartridge filters must display one of the following characteristics as defined in 40 CFR 261: ignitability, corrosivity, reactivity, or toxicity. Under most circumstances, ROMs and cartridge filters will not meet this criteria, and thus will not be considered hazardous.

(2) In foreign countries, coordinate with the installation point of contact or the environmental coordinator in the host nation, and the host nation environmental authorities to obtain information on disposal of spent ROMs and cartridge filters. Maintain good housekeeping practices to include containing and collecting spent ROMs and cartridge filters in a central location. The spent ROMs and cartridge filters may be transported back to the U.S. for disposal.

b. Contaminant transportation. The functions of ROWPU filtration systems, and the nature of the potential contaminants, make it extremely unlikely that contaminants would adhere to filters and ROMs in concentrations that would exceed regulatory limits. Compounds that determine toxicity are typically found in a dissolved state. Multimedia and cartridge filters remove particulates but allow dissolved compounds and particles less than 5 microns to pass. Consequently, potential contaminants may pass through the filters and come into contact with the ROMs. The ROM will either pass or reject the potential contaminants based upon their molecular weights. Rejected compounds are captured in the brine storage tank and are disposed using procedures described in paragraph 4-2c. A small amount of the compounds listed in 40 CFR 261 could adhere to suspended solids in the raw water; however, filtration and subsequent backwashing removes these compounds from the filters into the backwash water.

c. Disposal. Dispose of spent ROWPU cartridge filters and ROMs as a solid, nonhazardous waste in accordance with State and local requirements.

4-4. Disposal of NBC-contaminated wastes

a. Treatment of NBC-contaminated water. Treatment of NBC-contaminated water will be performed as a last resort if no other source exists. Water purification units will treat water in an uncontaminated environment only (that is, in an area where the soil and air is not contaminated). If no other option exists, and water must be purified in a contaminated area (that is, nuclear weapons have been extensively used on the battlefield and uncontaminated areas are nonexistent), the treated water should be containerized so as not to become further contaminated subsequent to purification. Water purified prior to the use of nuclear weapons on the batttlefield should be consumed first. Use of ground-water sources should be a priority. Surface water sources should only be used if ground-water sources are unavailable.

b. Decontamination. If a contaminated source must be purified, the treatment device must be thoroughly decontaminatd before being used again. Chemical corps personnel should be consulted to assist in decontamination procedures for the equipment, and for protective measures for personnel performing the decontamination.

c. Disposal. Brine or backwash generated from NBC purification operations should only be discharged back to the original source. Discharging to a sump or another surface source would only contaminate clean soil, ground water, or surface water. The brine should be disposed of downstream or away from shore, so that contaminant concentrations in the source do not increase as purification operations occur. The multimedia filter media, cartridge filters, ROMs, and ion exchange and activated carbon media should all be disposed of as NBC-contaminated wastes. Chemical personnel should be consulted on the proper procedures for handling and disposal.

d. Radiation safety. If appropriate radiation hazard measures are taken, health risk to the operator and the soldier will be minimized. The principles of time, distance, and shielding should be applied to the waste generated as a result of contaminated water purification. Operators should keep exposure time to a minimum, stay away from the equipment if it is not necessary to be present during some phases of operation, and shield the waste container with whatever is available (for example, sand bags, park another truck nearby, etc.). Radiation warning signs can be posted, if available, to keep unnecessary personnel away from the purification equipment. Other areas occupied by troops should be set up well away from the purification operation if possible.

CHAPTER 5

DISINFECTION

Section I. INTRODUCTION

5-1. General

Disinfection destroys harmful organisms (pathogenic viruses, bacteria, and protozoans) present in the water by exposing them to specific concentrations of disinfecting agents or to heat. Potable water supplies will be disinfected because no other treatment process or combination of processes that excludes disinfection will reliably remove disease-producing organisms from water. The unit commander will instruct individuals not to drink from unapproved water sources.

5-2. Basic disinfecting procedures

The basic procedures for disinfecting water are given in section II below. The unit preventive medicine authority, in conjunction with the command surgeon, may modify these procedures in the field environment to adapt to the local conditions or circumstances. Such factors as the quality of the water source, diseases endemic to the area of operation, diseases experienced within the unit, and the integrity of the unit's water system must be considered.

Section II. CHLORINATION

5-3. Chlorine disinfection

a. General. Chlorine is the disinfectant agent usually specified for military use. Presently, this is the only widely accepted agent that destroys organisms in water and leaves an easily detectable residual. Absence of chlorine residual may indicate inadequate disinfection. Sudden disappearance of chlorine residual signals potential contamination in the system. No other available disinfectant is as acceptable or adaptable for potable water treatment operations as chlorine.

b. Efficiency. The efficiency of chlorine disinfection is affected by the following variables:

(1) A combination of the form of chlorine present, the pH of the water, and the contact time. As the pH of the water increases from 5 to 9, the form of the chlorine residual changes from hypochlorous acid (HOCl), the most effective form, to hypochlorite ion (OCl^-), which is less effective. The most effective disinfection occurs when the

pH is between 5.5 and 6.5. At the same pH, a longer contact time also results in increased disinfection.

(2) The type and density of organisms present (virus, bacteria, protozoa, helminth, or others) and their resistance to chlorine. Bacteria are the most susceptible to chlorine disinfection whereas the cysts of the protozoa *Entamoeba histolytica, Giardia lamblia,* and *Cryptosporidium parvum* are the most resistant.

(3) The temperature of the water. At lower temperatures, microorganism kill tends to be slower, and higher chlorine residuals or longer contact times are needed.

(4) The concentration of substances other than disease-producing organisms that exert a chlorine demand. During disinfection, chlorine demand can be exerted by chemical compounds such as those containing ammonia and organic material. While most, if not all, of these compounds are removed in RO treatment, many are not effectively removed by DE or other filtration processes and may be present to exert chlorine demand during disinfection.

(5) Adequate mixing of chlorine and chlorine demanding substances. The disinfecting agent must be well dispersed and thoroughly mixed to ensure that all of the disease-producing organisms come in contact with the chlorine for the required contact time.

(6) The suspended solids concentration. Suspended solids can surround and protect organisms from the disinfectant.

5-4. Chlorine residuals

a. Production point.

(1) ROWPU-treated water. Water purification personnel will add sufficient chlorine to ROWPU-treated water at the production site to maintain a 2.0 milligrams per liter (mg/L) free-available chlorine (FAC) residual after a 30-minute contact time. This is the minimum level required to provide disinfection of treated water. In most cases, chlorinating ROWPU-treated water above 2.0 mg/L FAC is not necessary because no additional disinfection
occurs. Addition of chlorine to achieve the desired free chlorine residuals can be accomplished using appendix E.

(2) Other treatment types. Water purified by means other than ROWPU will be disinfected by adding chlorine at the production site to maintain a 5.0 mg/L FAC residual after a 30-minute contact time.

b. Bulk water transfer and distribution. Water purification personnel will adjust the chlorine level at potable water issue points along the tactical water distribution system (TWDS), storage systems (800k, 300k, and 40k systems), and during bulk transport (3k and 5k semitrailer-mounted fabric tanks) so that FAC residuals remain at 2.0 mg/L. Maintaining 2.0 mg/L or greater in the distribution system may require chlorine levels at the production site greater than 2.0 mg/L after a 30-minute contact time. If chlorine residuals at the completion of bulk water transport are greater than 0 mg/L FAC but less than 2.0 mg/L FAC, the water must be rechlorinated to 2.0 mg/L FAC. It may then be issued immediately. If chlorine residuals fall to 0 mg/L FAC, the water must be rechlorinated to 2.0 mg/L and held for 30 minutes prior to issue.

c. Individual and unit level. Regardless of the treatment methodology, a minimum 1.0 mg/L FAC residual must be maintained in unit level distribution containers (400-gallon water trailers, lyster bags, and lightweight collapsible pillow tanks). The intent of this requirement is to provide water that is both potable and palatable to the military member. Therefore, water purification personnel should make every attempt to provide water to the individual service member with the lowest chlorine residual possible that ensures potability. Preventive medicine personnel will monitor to ensure chlorine residuals maintain potability.

d. Chlorine-resistant organisms. Disease-producing organisms such as *Entamoeba histolytica, Giardia lamblia*, and *Cryptosporidium parvum* are resistant to normal chlorine residuals. In areas where they are prevalent, the command surgeon may require higher than normal residuals, longer contact times, and increased frequency of chlorine measurements. The ROWPUs can remove these organisms completely when the ROMs are used as part of treatment. The DE treatment units cannot reliably remove 100 percent of all of these organisms.

e. Residual measurement.

(1) Water purification or preventive medicine personnel will measure--

(a) The chlorine residual at least every hour of operation at water purification points. At bulk distribution points, chlorine residual will be measured prior to bulk loading for transport.

(b) The chlorine residual at least daily at company level and smaller unit water supplies contained in water trailers, fabric drums, and lyster bags. Field food service personnel will measure chlorine residuals in water supply prior to starting food preparation at each meal.

(2) See appendix F for further guidance on measuring chlorine residual and pH.

Section III. EMERGENCY DISINFECTANTS

5-5. General

Only water disinfected by some means, personal or otherwise, should be consumed by personnel in emergency situations. Individual personnel should select the clearest, cleanest water with the least odor and then treat the water using individual water purification procedures. Such procedures are limited to disinfection using iodine tablets, boiling, Chlor-Floc®, or chlorine ampules. Individual, hand-held treatment devices may also be used, as long as they are used in conjunction with a disinfectant such as iodine or Chlor-Floc. This is necessary because most hand-held purifiers do not provide disinfection. Those devices that do provide disinfection as a part of the treatment do not provide a means to determine when the disinfection process is no longer effective.

5-6. Iodine

Iodine is the active disinfectant used in individual water purification tablets. A bottle of 50 tablets (national stock number (NSN) 6850-00-985-7166) is the standard issue to personnel. Each tablet liberates 8 mg of iodine per liter of water. Two tablets per quart of water should be used, regardless of water temperature, and a 30-minute contact time before drinking the water. If the water to be treated is cloudy or discolored, Chlor-Floc should be used.

5-7. Boiling

Boiling is an expedient means of disinfecting small quantities of water when no other means are available. To be effective in killing most disease-

®Chlor-Floc is a registered trademark of Control Chemical Inc., Johannesburg, South Africa.

producing organisms, the water must be held at a rolling boil for 1 to 2 minutes. The command surgeon may prescribe longer boiling times in areas where certain heat-resistant organisms are prevalent or at high altitudes. When cooled, the boiled water must be kept in a covered, uncontaminated container since boiling does not impart any residual disinfectant. Where cryptosporidium is suspected to be present, boiling is the recommended emergency treatment due to the ineffectiveness of chlorine and iodine against this organism.

5-8. Chlor-Floc

Chlor-Floc is an emergency disinfectant that also removes suspended particles from water by flocculation. It should be used when the water to be treated is cloudy or discolored, and in an operational mode that allows for settling and filtration of treated water. The Chlor-Floc treatment system (NSN 6850-01-374-9921) includes 3 packages of 10 tablets each (NSN 6850-01-352-6129), a treatment bag (NSN 6850-01-374-9923), and a cloth filter (NSN 6850-01-374-9922). Each tablet liberates 8 mg of FAC per liter of water. Use Chlor-Floc as follows:

a. Fill water treatment bag (about halfway) with 1 quart of water. A clean container can be used if the water treatment bag (provided in the kit) is not available.

b. Add one 600-mg tablet to the water treatment bag. One tablet treats 1 quart of water.

c. Shake the bag for 1 minute. Make sure the tablet dissolves completely.

d. Swirl water in the bag for 10 seconds.

e. Wait 4 minutes.

f. Swirl water in the bag for an additional 10 seconds.

g. Wait 15 minutes.

h. Pour water through the cloth filter (provided in the kit) into a clean canteen. Do not drink or pour the water into the canteen without filtering it.

i. The filter and treatment bag can be reused if rinsed with treated water after use. Always filter through the same side of the cloth.

j. Do not use the same filter for more than a 24-hour period.

5-9. Chlorine bleach

In emergency situations, when calcium hypochlorite is not available for disinfection of bulk supplies, standard chlorine bleach can be used. Bleach is usually a 5 percent available chlorine solution, or 50,000 mg/L FAC. Add two drops of bleach per quart of water to be disinfected, and let stand 30 minutes before drinking. If a dropper is not available, wet a cloth or stick with bleach, and allow it to drip into the water. If larger amounts of water must be disinfected using bleach or high test hypochlorite (HTH) chlorine ampules, see table 5-1.

Table 5-1. Amounts of HTH and bleach to achieve a 5 mg/L chlorine dose in various volumes of water

Volume (gallons)	HTH Ampules	5% Bleach MRE Spoonfulls
5	½	½
10	1	1
20	1	2
50	3	3
100	6	7
150	8	10
250	14	17
400	22	26
500	27	33

5-10. Emergency disinfection during training

Realizing that forces will fight as they are trained, individual purification of water supplies must be taught and practiced for it to be performed correctly during combat. Training troops in emergency disinfection procedures on a source of unknown water quality for the benefit of “realistic training” must be weighed against the risk of illness from consuming water from a contaminated source. Although emergency disinfection procedures will remove many pathogenic organisms, the iodine, Chlor-Floc, and bleach methods are only moderately effective against giardia cysts, and ineffective against cryptosporidia. In addition, none of the emergency disinfection procedures mentioned can remove industrial or agricultural contamination such as heavy metals or pesticide contamination. For this reason, training in individual emergency purification procedures should only be performed on water sources tested and known to be free of these contaminants.

CHAPTER 6

INSPECTION, TESTING, AND CERTIFICATION

Section I. PREVENTIVE MEDICINE INSPECTION PROGRAM

6-1. Garrison inspections

If equipment and personnel cannot be inspected in the field, they will be inspected semiannually in the operating mode in garrison. Personnel from preventive medicine sections and detachments should maintain a liaison with water purification teams and should conduct joint training on water quality analysis sets and kits.

6-2. Field inspections

a. Inspection requirement. The preventive medicine section or detachment will perform periodic inspections as follows:

(1) Each water purification and/or packaging operations must receive an initial inspection prior to certification of the treated water as potable. These inspections should be documented using DD Form X342 (Water Point Inspection Report). Local reproduction of this form is authorized. A copy for reproduction purposes is located at the back of this publication. Routine inspections of all activities should occur at least monthly or as determined by the command medical authority.

(2) Shower/bath operations should be inspected to ensure sanitary conditions and appropriate water quality using DD Form X343 (Shower/Decontamination Point Inspection). Local reproduction of this form is authorized. A copy for reproduction purposes is located at the back of this publication.

(3) Potable water containers such as 400-gallon water trailers, tank trucks and fabric tanks or drums should be inspected before major field training exercises or deployments using DD Form X341 (Potable Water Container Inspection). Local reproduction of this form is authorized. A copy for reproduction purposes is located at the back of this publication.

(4) Inspection criteria for purification points and containers are given in section II below. The command medical authority will set the frequency of follow-up inspections conducted after an initial inspection. The water point team chief will accompany the preventive medicine inspector to answer questions and note any deficiencies or problems.

b. Report requirements.

(1) Inspection findings and water sample analytical results will be recorded on DD Form X341.

(2) The preventive medicine section or detachment will retain original report, leave one copy with the inspected unit, and send copies to the command surgeon and to the headquarters of the unit producing the water or running the operation.

Section II. PREVENTIVE MEDICINE INSPECTION CRITERIA

6-3. General

The inspection criteria listed in paragraphs 6-4 through 6-7 are applicable to all types of water purification and distribution equipment, and include site conditions around the water point. These criteria ensure production of potable water. The water purification personnel operating the equipment are responsible for prompt corrections of any deficiencies noted in the preventive medicine inspection.

6-4. Site conditions

a. Development. Water purification personnel will ensure--

(1) Drainage is provided to prevent ponding at filling points.

(2) Dust control measures are practiced to prevent dustborne bacteria from contaminating water and equipment.

(3) Rodent and insect breeding areas are controlled to prevent the spread of disease to team members and other personnel.

b. Bivouac area.

(1) The area will be located at least 100 feet (30 m) downgradient from a well or downstream from the raw water intake of a surface water source.

(2) Latrines will be located at least 100 yards (91 m) downstream or downgradient from water sources and/or purification operations and properly constructed and maintained.

(3) Handwashing devices will be supplied with soap and water.

(4) Garbage and trash will be properly stored and disposed of at least 100 feet from water point operations.

c. Water source.

(1) No pollution sources should exist in the immediate surrounding area upstream or upgradient from the water point.

(2) Water purification personnel will conduct tests for chemical agents and radioactivity. The frequency of tests is related to MOPP conditions as shown in table 6-1.

Table 6-1. Frequency of tests for chemical agents

Threat Level	MOPP	Test Frequency
No known threat	0	Weekly
Slight threat	1	Daily
Medium threat	2	Twice daily
Severe threat	3	Four times daily
Imminent threat	4	Hourly
Known contamination	4	Hourly and before issue of each batch of water

6-5. Reverse osmosis water purification unit treatment operations

a. Intake line.

(1) Intake strainer should be attached to intake.

(2) Float and anchor should hold intake at least 4 inches (10 centimeters (cm)) from surface or bottom.

b. Effluent line.

(1) Backwash water sump should be present.

(2) Sludge sump should be present (if necessary).

(3) Effluent discharges should be at least 25 yards (23 m) from intake and downstream for flowing surface sources.

c. ROWPU.

(1) Trailer skids should be level.

(2) Filter backwash tank should be filled with brine from the reject stream.

(3) Grounding should be used.

(4) Separate storage tanks should be used for raw water and brine water, if raw water storage is necessary.

d. Generator.

(1) Grounding should be used.

(2) Fire extinguisher should be present.

(3) Hearing protection should be used by operators within 50 feet (15 m).

(4) Ventilation should be sufficient to prevent carbon monoxide intoxication. Outdoor operation of generators should provide sufficient ventilation.

e. Operator protective equipment.

(1) Operators should wear rubber hip boots, long rubber gloves, rubber aprons, and eye protection when working in water or with wastewater where diseases such as schistosomiasis and leptospirosis are endemic or prevalent.

(2) Operators should wear MOPP gear underneath the water protective equipment listed in e(1) above where chemical agents are likely.

6-6. Monitoring, storage, and distribution of treated water

a. Water monitoring (operator).

(1) Water Quality Analysis Set - Purification (WQAS-P) (NSN 6630-01-343-8495) should not contain expired chemicals.

(2) Water purification personnel conduct the WQAS-P tests for pH, temperature, TDS, turbidity, and chlorine residual. Field tests should occur as frequently as necessary to ensure proper equipment performance, water potability prior to issue, and detection of significant changes in source water quality which could affect equipment operations. Tests for chemical agents in water should be performed as noted in table 6-1.

(3) Water purification chemical usage will recorded, as appropriate. (Army personnel will use DA Form 1713-R (Daily Water Production Log--ROWPU).)

(4) Readings of equipment gauges and meters will be recorded as appropriate. (Army personnel will use DA Form 1713-R.)

(5) Chlorine residuals of treated water will be checked at least every hour and recorded. (Army personnel will use DA Form 1713-R.)

(6) Water Testing Kit - Chemical Agents (M272) (NSN 6665-01-134-0885) should contain sufficient analysis materials for 1 day of testing at MOPP 4.

b. Water storage.

(1) Tanks will be level.

(2) Safety bottom apron will be placed under tanks.

(3) Open top tanks will be covered.

(4) Tanks will be maintained in a sanitary condition.

(5) Capacity should be sufficient to support issue operations.

c. Water distribution.

(1) Standpipe hoses should be at least 4 feet (1.2 m) above ground surface to prevent contamination.

(2) Hose nozzles will be clean and kept off the ground.

(3) Operators will check water container interiors for cleanliness prior to filling them. See chapter 8, section III, for equipment cleaning and sanitizing guidance.

(4) Tankers, trailers, drums, cans, pumps, or other containers or equipment intended or previously used for storage or distribution of petroleum products or other material not for human consumption will not be used for storage or distribution of potable water under any circumstances.

6-7. Recordkeeping and supply storage

a. Records. Water production personnel will keep records of equipment gauges and meters, chlorine residual and pH of treated water, chemical usage, amount of water issued, and the units which have been issued water.

b. Supply storage.

(1) Fuel and chemicals on hand should be sufficient for the anticipated duration of operations or until resupply can be effected.

(2) Chemical containers will be labeled properly, capped tightly, and kept dry.

(3) Activated carbon and calcium hypochlorite will be stored separately to prevent mixing which could result in a violent reaction.

6-8. Container appearance

a. The interior and exterior of the container will be clean and in a good state of repair.

b. The exterior of the container will be stenciled with the words “POTABLE WATER ONLY.”

6-9. Four hundred-gallon water trailers

a. Manhole covers.

(1) Manhole covers will seal effectively to prevent contamination of contents. Rubber gaskets will be intact and will not have cracks, missing pieces, excessive dry rot, or an improper fit.

(2) The manhole cover locking mechanism will function.

(3) The manhole cover and interior will not be rusted.

(4) The manhole cover insulation should not be damaged.

(5) The pressure relief valve will operate effectively. The pressure relief valve may be tested by blowing air into the bottom. The valve is operating effectively if air escapes through the holes in the top of the valve.

b. Dispensing spigots.

(1) All spigots will function.

(2) The "T" handle will open and close freely.

(3) The protective box will be intact.

(4) Locking devices for spigot covers will function properly.

c. Drain.

(1) The drain plug will be easily removable.

(2) Threads in the plug and drain hole will not be stripped or damaged. Thread corrosion will be removed at least semiannually.

(3) Interior surface cracks around the drain hole are a result of excessive pressure applied to remove or install the plug. Subsurface cracks that expose the fiberglass body should be repaired by direct support maintenance per TM 9-2330-267-14&P, paragraph 5-10.

(4) The plug will be installed hand tight only.

d. Interior surfaces.

(1) Stainless steel and aluminum tanks.

(a) Interior seams will be free of rust; rusted seams will be scrubbed with a nonmetallic brush using a nonabrasive, nonchlorinated cleanser, such as hand dishwashing detergent, and will be thoroughly rinsed.

(b) Interiors will not be painted or coated with any material.

(c) Cracks and dents that expose the polyurethane foam insulation are not permitted and the tank should be repaired.

(2) Fiberglass tanks.

(a) Stains. Stains on the interior surface resulting from natural water impurities (such as iron or manganese) are permitted as long as they do not interfere with disinfection. Stains resulting from rusting apparatus, the storage of unauthorized liquids, or improper painting should not be permitted. Such stains will be cleaned and disinfected per TM 9-2330-267-14&P, paragraph 3-7a.

(b) Chips. Chips of the interior surface provide ideal areas for biological growth and entrapment of dirt or waterborne solids. Surface chips that do not expose the fiberglass body of the tank may be permitted if they cover less than 10 percent of the interior. Chips in excess of 10 percent or any chips which expose the fiberglass subsurface are not permitted and the tank should be repaired by direct support maintenance per TM 9-2330-267-14&P, paragraph 5-10.

(c) Cracks. Cracks are the most commonly observed interior surface defect. They can harbor microbiological organisms which constitute a health hazard. Surface cracks covering greater than 10 percent of the interior should be removed and the surface refinished. Minor surface cracks covering less than 10 percent of the interior should be noted by the inspector but are permitted. Subsurface cracks that expose the fiberglass body are not permitted and the tank should be repaired by direct support maintenance per TM 9-2330-267-14&P, paragraph 5-10.

(d) Flaking. Flaking of interior surface paint may result from the use of an unauthorized paint or improper subsurface preparation. The cause of such flaking should be determined and remedial action should be taken.

6-10. Tank trucks

a. Manhole covers. Inspection criteria are the same as those for 400-gallon water trailers except that paragraph 6-9a(5) is omitted.

b. Dispensing valves.

(1) Valves should operate freely and close tightly.

(2) Threads for hose couplings should be intact and undamaged.

(3) Dust caps should be attached to dispensing valve ports whenever the valve is not in use.

c. Filling ports.

(1) Rubber gaskets will be intact, fit properly, and be free of dry rot.

(2) Mesh screens inside the port should be free of rust.

d. Interior surfaces. Metal interiors will not be painted and should be free of rust.

6-11. Fabric water tanks and drums

a. Exterior. If the container has been repaired, any patch or temporary plug will be secure.

b. Valve assembly.

(1) The check-valve adapter will be undamaged.

(2) The check valve will open easily.

(3) The dust cap will be attached to the coupler whenever the coupler is not in use.

6-12. Water trailer locations and dry distribution points

a. Site conditions.

(1) Manholes and ports will be closed.

(2) Soakage pits will be constructed.

b. Water conditions.

(1) Water will be tested for chlorine residual.

(a) At places where purification operations do not occur but water tanks or other bulk containers have been pre-positioned for potable water resupply (otherwise known as dry distribution points), potable water chlorine residuals will be at least 2 mg/L or at a higher level if prescribed by the command surgeon.

(b) When unit water supplies have been procured from a potable distribution point, the potable water chlorine residual at the point of consumption (such as unit water trailers, collapsible fabric drums, or lyster bags) will be at least 1 mg/L or at a higher level if prescribed by the command surgeon.

(c) When individual units do not have access to ROWPU-treated water and must disinfect a raw water supply (such as a stream, pond, lake, or other fresh water body), water chlorine residual after a 30-minute chlorine contact time will be at least 5 mg/L or at a higher level if prescribed by the command surgeon.

(2) Indicate from where the water was procured.

Section III. PREVENTIVE MEDICINE TESTING AND CERTIFICATION

6-13. Product water samples

The preventive medicine inspector will perform analyses at each water point on treated water samples for the constituents listed in tables C-1 and C-2. If the inspector cannot perform the analyses onsite, a sample will be collected for analyses upon return to a central base of operation.

6-14. Analyses

a. If the water produced will be supplied to U.S. forces only, each water sample should be analyzed for the constituents that have a standard (that is, a number) listed under either column labeled “tri-service” in tables C-1 or C-2.

b. If water will be provided to NATO or Quadripartite forces, then the samples should be analyzed for those constituents for which a standard exists in the tri-service, and QSTAG (for Quadripartite forces) or STANAG (for NATO forces) column of tables C-1 or C-2, depending on the forces served.

c. An attempt to analyze a sample for the parameters in table C-4 should be made. Those laboratories listed in appendix B can be of assistance in completing the analyses.

6-15. Standards

a. Water quality standards are discussed in paragraph 2-3 of this publication.

b. If the concentration of one or more of the constituents in tables C-1, C-2, or C-4 exceeds the applicable standard, the preventive medicine inspector should take the following actions:

(1) Verify the result and immediately notify the water purification section team chief of the problem.

(2) Identify the health threat and impact of the contaminant on personnel using the information in chapter 7.

(3) Suggest possible ways to correct the problem.

(4) Resample the product water after corrections have been implemented.

(5) If the problem is not resolved, notify the command surgeon of the problem immediately. The command surgeon can advise the unit commander of the health threat caused by the contaminant using the information in chapter 7 and appendix D. The unit commander may modify a contaminant standard based on the particular situation and the command surgeon’s advice.

(6) Review the daily water production log for units that received nonacceptable water and take follow-up or corrective action if necessary.

c. The chlorine residual will be maintained as directed in chapter 5.

6-16. Certification

Preventive medicine personnel will certify treated water as potable water for consumption after conducting microbiological and chemical analyses of the treated water in support of an assessment of potential health threats. The issue of water to using units should not be delayed while chemical or microbiological analyses are completed. However, the preventive medicine section should ensure that all analyses and determination of potential risks are completed in a timely manner.

CHAPTER 7

HEALTH EFFECTS

Section I. DETERMINING HEALTH RISKS

7-1. Health risk information uses

a. The information presented on risk will aid military planners and risk managers to decide if certain water constituents might reduce performance of military personnel consuming water with contaminants above the applicable standard and thereby jeopardize mission accomplishment. Knowing the quality of field water generally expected in geographic regions worldwide allows military planners and risk managers to--

(1) Anticipate water treatment and monitoring capabilities needed for a particular region.

(2) Estimate the possible performance-degrading health risks that could result from the absence or failure of those capabilities.

b. Monitoring field-water quality should always be practiced, especially in densely populated areas, locations of intense agricultural production, sites near industrial manufacturing centers, and areas where dissolved solids are likely to reach high concentrations.

7-2. Field water contaminants of concern

a. Turbidity, color, and TDS are the physical properties that are of military concern in field water. The other chemical constituents that are of major military concern in field water are chloride, magnesium, sulfate, arsenic, cyanide, pesticides (insecticides, herbicides), and metabolites of algae and associated bacteria.

b. Bacteria, viruses, and parasites (for example, protozoa and helminths) are categories of water-related infectious organisms that are also of great military concern.

c. Radioactivity and the threat agents hydrogen cyanide, organo-phosphorous nerve agents, trichothecene mycotoxin, lewisite, mustard, and 3-quinuclidinyl benzilate (BZ) incapacitant are also of concern.

d. The DOD tri-service field water quality standards were derived to protect populations of military personnel against performance-degrading health effects that could jeopardize the accomplishment of military missions.

7-3. Geographical considerations

Section VI presents an evaluation of the general chemical and biological quality of the water resources in selected geographical regions of the world that represent potential theaters of operation for U.S. military forces. This evaluation is the result of an analysis of available water quality monitoring data and various indicators of water quality conditions (for example, geohydrology, climate, sanitation, industrialization). The Armed Forces Medical Intelligence Center (AFMIC) maintains up-to-date information for use in alerting military planners to the chemical or biological quality of water supplies (that is, ground and surface waters) that are indicative of major geographic regions, such as Africa, the Middle East, Europe, Asia, and Latin America. Additionally, important locations that lack meaningful field-water quality monitoring data are identified to indicate the need for monitoring water quality especially in these areas.

7-4. Assessing potential health threats

a. Established criteria.

(1) Military standards.

(a) Criteria for assessing the potential health threat for populations of military personnel exposed to field water with the physical properties, chemical substances, or infectious organisms of military concern at concentrations exceeding safe levels were developed from the dose-response relationships of these constituents.

(b) Appendix D contains figures summarizing the toxicity data for these likely constituents of untreated field water to enable military risk managers to quickly assess the potential performance-degrading (acute) effects that a measured concentration of a particular constituent can have on exposed personnel.

(2) EPA standards.

(a) These standards were developed to protect the general public against chronic health effects due to the ingestion of contaminated water. This includes target populations, such as infants, children, and the elderly, that are not normally representative of a military force. These standards can be used as an additional resource for medical personnel to determine if a potential long-term health threat exists from the consumption of contaminated drinking water. The EPA standards, shown in table C-5, establish maximum contaminant levels (MCLs) that are protective of health over a lifetime.

(b) Consuming water with contamination exceeding an MCL might not cause decreased performance or hamper mission accomplishment, but could effect the health of personnel many years later. The major assumptions used to arrive at most MCLs are the consumption of 2 L/day of water with the contaminant of concern, a 350-day per year exposure frequency, a 70-year exposure duration, and an adult weighing 70 kilograms.

(c) Some contaminants pose a greater risk to a specific population, and thus incorporate different assumptions. Two such cases are lead and nitrate, where infants and small children are at a higher risk than adults.

(3) Other guidance. Additional guidance is available for risk determination in the form of health advisories and other assessment data. These sources can be applied where the target population and exposure duration are known. Appendix C lists the support agencies that can be of assistance in providing more information on these additional sources of health risk information.

b. Factors to consider.

(1) Target population. Determine if the contaminant is more dangerous to a specific group such as infants, children, pregnant women or developing fetuses, the elderly, the sick, or immunocompromised. The EPA MCLs and health advisories are developed to protect the population at greatest risk of negative health effects due to contamination. The military population is comprised of healthy adults. Military forces providing water to a civilian population should consider the change in consumer population to include infants, the elderly, and the sick.

(2) Exposure duration. Attempt to determine how long the population will be exposed to the contaminant. Many EPA health advisories and MCLs are determined using a 70-year exposure period. This is not relevant to a 1-year or less exposure for deployed forces.

(3) Contaminant effects. Contaminants can be absorbed through the skin, ingested, or inhaled with water vapors, or a combination of the three. The particular method of entrance to the body for each contaminant, along with information such as whether the contaminant has chronic (long-term) or acute health effects, and what organs or organ systems the contaminant effect, should be determined.

(4) Consumption level. The amount of water ingested every day can also affect troops. Because the activity level of the military population performing a mission is very high, the daily water intake is larger than that of a civilian population. Most MCLs and health advisories are derived using a consumption level of 2 L/day. The tri-service field water quality standards are based on a 5 L/day or 15 L/day consumption rate.

Section II. WATERBORNE DISEASES

7-5. Waterborne diseases in general

Water is a carrier of many organisms that cause intestinal disease. An epidemic of one of these diseases among military members can be more devastating than enemy action and can cause great damage to morale as well as health. A heavy responsibility thus rests upon water purification personnel and the unit field sanitation team to maintain proper disinfectant residuals. The types of water treatment methods to be used when certain chlorine-resistant organisms are encountered should be prescribed by the command surgeon who can recognize or anticipate the presence of these organisms. The command surgeon will recommend such additional chlorination or other treatment methods as may be necessary.

7-6. Microbiological contamination of raw water sources

In addition to the native water bacteria, a given water may and usually does contain a variety of bacteria as a result of contamination from external sources. These sources include the air, soil, and human and animal excreta.

a. The number of bacteria in the air bears a close relation to the quantity of larger suspended particles or dust. The kinds of microorganisms vary somewhat in different localities, but certain forms are generally present. Molds and yeasts are quite common and may outnumber the bacteria.

b. Soils may contain tremendous numbers of bacteria, most of which are found in the upper 6 inches of soil. Most of these microorganisms are native to the soil and their biochemical activities are important to the mechanism of decomposition of organic matter in the soil. Bacteria other than those that make up the normal flora of the soil may be present as contamination.

c. Any pathogens present may be regarded as originating from one of two sources: the flesh of animals or persons who have died of infectious disease and the excreta of infected persons or animals.

7-7. Causes and development of waterborne diseases

a. Types of diseases. The principle diseases contracted by humans from ingesting contaminated water are diarrheal disorders due to certain *E. coli* which produce toxins, salmonellosis, shigellosis, cholera, amebiasis, giardiasis, and several others. Viral hepatitis and typhoid fever are nondiarrheal infections which can be waterborne. Schistosomiasis and leptospirosis, also waterborne diseases, principally occur from walking, working, or bathing in contaminated water.

b. Onset of symptoms. A waterborne disease rarely produces symptoms in its victims immediately after drinking contaminated water. A period of time, known as the incubation period, must pass before the victim comes down with the disease. During this incubation period the disease organisms are growing and multiplying within the host. Therefore, an absence of symptoms for several days after drinking untreated water is no guarantee that the water is safe. The absence of disease among the local inhabitants is also no assurance of safety because they may have developed immunity.

7-8. Evaluation of risk from waterborne infectious organisms

a. The health effects caused by infectious waterborne agents are quite varied. For example, *Shigella, Salmonella,* and enteroviruses can cause vomiting and diarrhea symptoms, which can seriously degrade a soldier's ability to perform. However, these diseases are seldom fatal. On the other hand, cholera can produce life-threatening health effects.

b. Another important point to consider when evaluating the risk from waterborne infections is the relationship between latency (that is, time from ingestion to the onset of symptoms) and illness. The latency period for the pathogenic microorganisms of concern generally is 1 to 3 days. This means that the expected percentage of troops that will become ill may still be capable of executing their military responsibilities for up to 1 day and maybe even for up to 3 days after ingesting field water containing any of the microorganisms of concern. Thus, the type of situation confronting a unit in the field may influence decisions regarding the use of water.

7-9. Control of waterborne diseases

a. General. Control of waterborne diseases requires command emphasis to implement preventive measures by units and individuals. The unit field sanitation team, when properly trained, provides the commander with the preventive medicine expertise to accomplish the preventive medicine countermeasures listed in paragraph b below.

b. Countermeasures for drinking water.

(1) Safeguard supplies from contamination.

(2) Check unit water supply for chlorine residual daily in water trailers and other unit water containers to ensure adequate residual.

(3) Maintain chlorine residuals as described in paragraph 5-4, or at the level prescribed by the command surgeon.

(4) Maintain adequate stocks of iodine tablets and chlorination kit supplies.

(5) Protect water trailers and other containers in hot regions to keep water as cool as possible and in cold regions to prevent water from freezing. In hot regions, water containers can be shaded using tents, shelter halves or tarpaulins, or by using a small mobile water chiller. In cold regions, water containers can be kept warm by enclosing them in heated shelters or within heated vehicles. In addition, 5-gallon water cans can be placed within an insulating jacket (NSN 7240-01-119-4956) for both hot and cold regions.

c. Water purification personnel. Water purification personnel will wear rubber hip boots, long rubber gloves, and eye protection when working with or in water known or suspected to contain schistosomes or leptospirae. Similar precautions will be observed when handling filter backwash water in areas where schistosomes or leptospirae are present.

7-10. Waterborne diseases of concern to the military

a. Diarrhea. Acute diarrhea caused by campylobacter, certain strains of *Escherichia coli* which produce toxins, or some noncholera vibrios constitute the majority of travelers' diarrhea cases worldwide. They may be spread by food or other routes as well as by water. The acute onset of diarrhea, abdominal pain, often nausea, vomiting and fever occurs after an incubation period of about 2-5 days. The acute illness is usually limited to 3-5 days or less. Diagnosis is made by isolation of organisms from stool, using tests to demonstrate toxins, special media, or other techniques.

b. Cholera. Cholera is caused by an enterotoxin produced by the bacillus *Vibrio cholerae*. Although mild cases exhibiting diarrhea are common, acute cases can result in death within a few hours if untreated. This intestinal disease produces profuse watery stools, occasional vomiting, rapid dehydration, and circulatory collapse. Diagnosis is confirmed by culturing O-group 1 cholera vibrios from feces or vomitus. Cholera occurs mainly in Asia, Africa, and parts of the Mediterranean. The incubation period lasts from a few hours to 5 days and is usually 2-3 days. Infectivity continues until a few days later after recovery though a carrier state may persist for several months. Susceptibility is variable and in endemic areas most persons acquire antibodies by early adulthood. Partial active immunity is conferred for 3-6 months by current vaccines.

c. Typhoid. Typhoid fever, the best studied enteric fever, is a severe prolonged disease with a high rate of complications. It is characterized by sustained fever, headache, malaise, anorexia, enlargement of the spleen, a nonproductive cough, constipation, and involvement of lymphoid tissues. Caused by the bacillus *Salmonella typhi*, typhoid occurs worldwide. The period of incubation usually lasts 1-3 weeks. Infectivity continues from the first week through convalescence. Susceptibility is general.

d. Amebiasis. Amebiasis is caused by a protozoan, *Entamoeba histolytica*. This protozoan may be acquired via the infective cyst which is passed in the feces. Although most cases are asymptomatic, acute cases exhibit fever, chills, and bloody diarrhea. Diagnosis is by microscopic detection of cysts or trophozoites in fresh fecal specimens. Occurrence is worldwide. The incubation period is commonly 2-4 weeks. Infectivity continues through the period of cyst passing, which may last several years. Susceptibility is general.

e. Giardiasis. Giardiasis, another protozoan infection, principally affects the upper small intestine. Giardia cysts can be passed by wild animals (such as beavers), thus apparently pristine waters could be unsafe to drink without disinfection. As with amebiasis, most cases are asymptomatic. After an incubation period of 7-21 days, acute cases may present abdominal cramps, flatulence, diarrhea, fatigue, and weight loss. If untreated, passage of cysts may continue for 3 months or, rarely, longer. Diagnosis is usually made by microscopic detections of cysts or trophozoites in fresh fecal specimens. In doubtful cases, the diagnosis can be made by examining upper intestinal fluid or biopsy obtained by special procedures.

f. Cryptosporidiosis. Crypotsporidiosis is an infection caused by the *Cryptosporidium parvum* oocyst, which is most often transmitted through the feces of cattle and other domestic animals, and humans. The occurrence is worldwide, and infection with this organism is not easily detected unless looked for specifically. The incubation period is not precisely known, but 1-12 days is the likely range, with an average of about 7 days. People with intact immune functions may have asymptomatic or self-limited infections. Individuals with impaired immunity generally clear their infections when the causes of immunosuppression are removed. Symptoms include diarrhea, which may be profuse and watery, and associated cramping abdominal pain; general malaise, fever, nausea, and vomiting occur less often.

g. Shigellosis. Known also as bacillary dysentery, shigellosis is an acute bacterial disease primarily involving the large intestine. It is characterized by diarrhea accompanied by fever, nausea, and sometimes vomiting. The severity of the illness is a function of the age of the patient, pre-existing state of nutrition, the size of the infecting dose, and the serotype of the organism. Bacteriological diagnosis is by isolation of *Shigella* from feces or rectal swabs. Shigellosis is endemic in both tropical and temperate climates. The incubation time is 1-7 days. Persons infected remain capable of spreading the disease until *Shigella* are no longer present in the feces, usually within 4 weeks of the illness. Susceptibility is general.

h. Viral Hepatitis A (Viral hepatitis). Caused by hepatitis A virus, viral hepatitis ranges from a mild illness lasting 1-2 weeks to a severely disabling disease lasting several months. The onset of the symptoms is abrupt with fever, malaise, anorexia, nausea, and abdominal discomfort, followed by jaundice. Diagnosis is established by the demonstration of virus in the stool, or a four-fold or greater rise in specific antibodies. Viral hepatitis occurs worldwide and tends toward cyclic recurrences. The incubation period is from 15-50 days and most commonly from 28-30 days. Maximum infectivity occurs during the later half of the incubation period until after the first week of jaundice. Susceptibility is general.

i. Schistosomiasis.

(1) Schistosomiasis is a disease that is contracted simply by being in water with schistosomes, not ingestion of contaminated water. Three human blood flukes, *Schistosoma mansoni, S. japonicum*, and *S. haematobium*, are the major species which cause human disease. Each of these species has a specific geographic distribution. *S. mansoni* occurs in the Arabian Peninsula, Africa, South America, and the Caribbean; *S. japonicum* in Japan, China, and the Philippines; and *S. haematobium* in Africa and the Middle East. Two major factors are responsible for the endemicity of schistosomiasis in specific geographic areas: the presence of the specific snail intermediate host and the lack of sanitary disposal of human feces. After maturation within the body, adult flukes can cause intestinal or urinary tract complications. Diagnosis depends upon detection of eggs in the stool, urine, or biopsy specimen. The incubation period lasts 4-6 weeks after infection. The period of infectivity lasts as long as the person discharges eggs in feces or urine, up to 10 years or longer. Susceptibility is general.

(2) Schistosome dermatitis, or swimmer's itch, is caused by the larvae of certain schistosome of birds or mammals that may penetrate the human skin and cause a dermatitis. These organisms do not enter the blood stream or cause other systemic effects. Such infections may occur among bathers in lakes in many parts of the world including the Great Lakes region of North America and certain coastal beaches.

j. Leptospirosis. Leptospirosis is a bacterial disease contracted through skin contact with surface water contaminated with urine of infected animals. The leptospira penetrates the skin readily through abrasions or mucus membranes. This disease is characterized by the rapid onset of fever, headache, chills, severe muscular pain in the calves and thighs, and conjunctival suffusion. Leptospirosis occurs worldwide. The incubation period is from 4 to 19 days, and most commonly 10 days. Infected persons may excrete leptospira in the urine from 1 to 11 months after the acute illness.

k. Metabolites of algae and related aquatic bacteria. Drinking water standards cannot be recommended for the toxic substances associated with cyanobacteria in algal blooms. It is best not to use an algicide to eliminate the algal mass in hopes of immediately obtaining drinking water. Furthermore, the chemical nature of these odors makes them difficult to remove by standard methods of chlorination. Reverse osmosis treatment is effective at removing these taste and odors associated with algae.

l. Water-related infectious organisms. There are no relatively simple field tests for measuring the specific concentration of any of the variety of infectious organisms of concern. Until such tests are available for determining the concentration of specific infectious organisms in field water, the membrane-filter technique should be used for the presumptive determination of the presence of coliform organisms in water. Other commercially available products can detect the presence or absence of total and fecal coliforms and can be used. The reliability of the treatment and disinfection capability of a unit is important. This is especially true in developing countries where it is assumed that the concentrations of organisms could vary more widely than in developed countries and, therefore, at times are likely to be greater in concentration.

Section III. PHYSICAL PROPERTIES

7-11. Turbidity and color

a. Health effects stemming from the presence of turbidity or color in field-water supplies center on the risk of voluntary dehydration caused by refusal to consume water. These effects can be seen in figures D-1 and D-2. The effects of dehydration can cause significant performance degradation and thereby jeopardize accomplishment of a mission. The relationship between turbidity and color and water rejection has been documented through the use of action-tendency scales, which are used to attempt to quantify behavioral responses to stimuli. The actual debilitating effects of dehydration progress in sequence, including discomfort, weariness, apathy, impaired coordination, delirium, and heat stroke.

b. Turbidity levels greater than 1 nephelometric turbidity unit (NTU) can also interfere with disinfection. This is particularly true when the turbidity is composed primarily of organic matter. Turbid waters are also aesthetically inferior, which can lead to decreased water consumption and possible dehydration. Color levels greater than 50 color units for short-term exposure and exceeding 15 color units for long-term exposure can also increase the risk of dehydration because of reduced consumption. These color levels are not associated directly with any adverse health effects. Thus, limiting turbidity to 1 NTU and color to either 50 color units for short-term exposures or 15 color units for long-term exposures will diminish averse responses to field water. Turbidity levels $\leq$1 NTU also tend to improve the efficiency of disinfection for most pathogenic microorganisms. *Giardia* and *Cryptosporidium*, which can cause severe diarrheal illness, are two organisms resistant to disinfection, thus their elimination must be accomplished by filtration processes to levels less than 0.1 NTU.

7-12. Total dissolved solids

The health effects related to concentrations of TDS above the recommended standards in field water center on the risk of dehydration caused by water rejection. Figure D-3 provides a health-effects summary for TDS. Dehydration can result in performance degradation. The relationship between TDS concentration and water rejection has been documented through the use of action-tendency scales. For example, about 2 percent of a military population might refuse to drink water containing the recommended TDS standard of 1,000 mg/L and thereby be at risk of dehydration. Moreover, at a TDS concentration above 2,800 mg/L, about 50 percent of the exposed military population might refuse to drink the water.

Section IV. CHEMICAL CONTAMINATION

7-13. Chloride

a. Even though chloride might produce laxative effects at concentrations exceeding 600 mg/L, laxative effects are not the health effects of greatest concern for chloride.

(1) The health effects of greatest concern for military populations exposed to elevated concentrations of chloride ion in field water are not direct; rather, they are associated with the dehydration of military personnel who reduced their consumption of field water because of its poor taste. Figure D-4 presents a summary of chloride-related health effects.

(2) The effects of dehydration can result in significant performance degradation. Only about 2 percent of a military population would be at risk of dehydration due to refusing to drink water with the recommended chloride standard of 600 mg/L; however, more than 10 percent might refuse to drink field water containing a chloride concentration of 1,000 mg/L.

b. Laxative effects that result from the consumption of water containing an elevated concentration of chloride appear to be associated with the process of osmoregulation of fluids in the intestinal tract. It has been reported that a single oral dose of 0.5 L water containing 7.4 grams per liter (g/L) of magnesium chloride ($MgCl_2$) (4.5 g/L of Cl^-) can induce a laxative effect. Synergisms between laxative producing solutions such as chloride, magnesium, and sulfate are not addressed because of a lack of data.

7-14. Magnesium

a. The performance-degrading health effects stemming from elevated levels of magnesium ion above the recommended standards for field-water supplies center on the risk of dehydration caused by acute laxative action and are summarized in figure D-5. However, the relationship between magnesium concentration in drinking water and such action is poorly documented except for data concerning clinical administration of magnesium ions in a saline laxative.

b. Field-water quality standards for 5 and 15 L/d consumption rates are based on the single dose of magnesium ions reported to cause laxative effects in fasted individuals when administered clinically as a saline laxative.

(1) This dose is 480 mg and the equivalent field-water quality standards for 5 and 15 L/d for magnesium (Mg^{+2}) are 100 and 30 mg/L, respectively. Concentrations above these levels are considered to be associated with increasing incidence of laxative effects which can lead to dehydration.

(2) The actual debilitating effects of dehydration include discomfort, weariness, apathy, impaired coordination, delirium, and heat stroke. Unfortunately, the proportion of the exposed military population that could be affected by performance-degrading symptoms at concentrations above recommended safe levels cannot be estimated from the available data.

7-15. Sulfate

a. Health effects stemming from levels of sulfate ion above recommended standards in field-water supplies also come about through the risk of dehydration caused by acute laxative action. These effects are summarized in figure D-6. This dehydration can cause significant performance degradation. The relationship between sulfate concentration in drinking water and laxative effects is poorly documented.

b. Field-water quality standards for sulfate are based on the single oral dose of sulfate ions reported to cause laxative effects in fasted individuals when administered clinically as a saline laxative.

(1) This dose is 1,490 mg and the equivalent field-water quality standards for sulfate (SO_4^{-2}) are 300 mg/L and 100 mg/L for 5 and 15 L/d consumption rates, respectively, and exposure periods up to either 7 days or 1 year.

(2) The actual debilitating effects of dehydration include discomfort, weariness, apathy, impaired coordination, delirium, and heat stroke. Unfortunately, at levels of sulfate above the recommended standards neither the proportion of the exposed military population affected by laxative effects nor the severity of those effects can be estimated from the available data.

7-16. Arsenic and lewisite

a. Arsenic exists in many forms in water. Generally speaking, organic arsenic forms are more toxic than inorganic forms. Reports of human exposure to inorganic arsenic via ingestion include several in which the arsenic was consumed in drinking water. Where exposures were high enough to cause observable health effects, several different organ systems are affected, including the circulatory, gastrointestinal, integumentary (skin), nervous, hepatic, renal, and immune systems. These effects would certainly interfere with the performance of military personnel. Lewisite is an organic trivalent arsenic compound that is a threat agent; ingestion of lewisite can cause gastrointestinal injury and may be lethal.

b. Four epidemiological studies document adverse effects when the levels of arsenic exceed 0.40 mg/L over the long term. In addition, while the literature suggests that people may be able to tolerate levels of arsenic in drinking water approaching 1 mg/L for short periods, higher concentrations could cause facial edema and gastrointestinal symptoms such as anorexia, nausea, epigastric fullness, vomiting, and abdominal pain. Skin lesions, upper respiratory symptoms, headache, chill, sore throat, rhinorrhea, and signs of neuropathy are among the chronic symptoms that might also occur. These effects would certainly interfere with the performance of military personnel. Consequently, the recommended standards for arsenic were derived to protect military personnel from both acute and chronic effects. Figure D-7 summarizes arsenic health effects. For exposure periods of up to 7 days, the standards for 5 and 15 L/d consumption rates are based on a daily dose of 1.5 mg/d, and for exposure periods up to 1 year, the standards are based on a daily dose of 0.32 mg/d.

c. The recommended arsenic based standards for lewisite are 0.08 mg/L for a 5 L/day consumption rate and 0.027 mg/L for a 15 L/day consumption rate, based on lewisite doses of 0.22 mg/L and 0.075 mg/L, respectively. These standards were developed from the daily dose of the arsenic fraction of lewisite that showed no effects from ingestion by rabbits. Figure D-8 summarizes lewisite health effects. Unfortunately, the proportion of the exposed military population that could be affected by performance-degrading symptoms at concentrations above recommended safe levels cannot be estimated from the available data.

7-17. Cyanide

a. Exposure to cyanide in drinking water can lead to a variety of performance-degrading health effects. Once a toxic level has accumulated in the blood, the cyanide exerts its effects rapidly, acting as a chemical asphyxiant. The nervous and respiratory systems are the first to fail. Typical symptoms of acute exposure to cyanide include headache, breathlessness, weakness, palpitation, nausea, giddiness, and tremors.

b. Concentrations of cyanide in field water that could produce toxic levels in the blood and lead to performance-degrading health effects in military personnel consuming up to 5 or 15 L/d for periods up to either 7 days or 1 year are estimated to be greater than 6 and 2 mg/L, respectively. These standards are shown in figure D-9. Moreover, the higher the cyanide concentration above the safe level, the greater the risk that many of the exposed military personnel will develop symptoms that can be performance degrading or lethal. Concentrations of 24 to 48 mg/L for a consumption of 5 L/d cause metabolic acidosis, and concentrations greater than 48 mg/L cause life-threatening toxicity.

7-18. Lindane

Lindane, a representative pesticide in use worldwide, induces a wide variety of dose-dependent symptoms when ingested in drinking water. These symptoms include nausea, vomiting, frontal headache, restlessness, upper abdominal pain, diarrhea, tremors, ataxia, and reflex loss. At high doses, epileptiform seizures can occur, followed by major systemic failure and even death. The lowest daily dose of lindane reported to cause adverse health effects in humans was 30 mg/d. Unfortunately, the proportion of the exposed military population that could be affected by performance-degrading symptoms at concentrations above recommended safe levels cannot be estimated from the available data. A health effects summary for lindane can be seen in figure D-10.

Section V. CHEMICAL AGENT AND RADIOLOGICAL CONTAMINATION

7-19. Hydrogen cyanide

Hydrogen cyanide is used as a chemical agent. It is also referred to as hydrocyanic acid or prussic acid. Its effects are the same as those described for cyanide (para 7-17), and the recommended standards to prevent performance-degrading effects are considered to be the same.

7-20. Organophosphorus nerve agents

a. Concentrations of organophosphorus (OP) nerve agents in field water greater than the recommended standards can produce performance-degrading health effects that can include abdominal cramps, vomiting, diarrhea, and headache. Sufficiently high levels consumed over the course of a 7-day period may even lead to death. However, the concentration of OP nerve agents at which death might occur from repeated ingestion in drinking water over the course of several days has not been determined. Consequently, an estimate of that level for exposure lasting up to 7 days is 12 micrograms per liter (μg/L) for a consumption rate of 5 L/d and 4 μg/L for a consumption rate of 15 L/d.

b. Because OP nerve agents are designed to be poisonous, there is probably a narrow margin between safe levels in water and those producing performance-degrading health effects, even under circumstances where an OP nerve agent is ingested in several drinks separated in time over the course of a day for an exposure period lasting up to 7 days. These standards are summarized in figure D-11.

7-21. Trichothecene mycotoxin T-2

The first performance-degrading effects to occur after ingestion of concentrations of trichothecene mycotoxin T-2 in field water greater than the recommended interim standards are nausea and vomiting, as seen in figure D-12. On the basis of data from clinical trials where cancer patients were treated with a chemotherapeutic agent considered analogous to trichothecene mycotoxin T-2, the mildest symptoms would be associated with concentrations just above the short-term (<7 days) interim exposure limit of 26 μg/L for a consumption rate of 5 L/d and 8.7 μg/L for a consumption rate of 15 L/d. The data from clinical tests also indicate that the most severe symptoms are associated with concentrations more than 30 times greater than these levels.

7-22. Mustard

Sulfur mustard, a blistering agent, may be used in any of three formulations; distilled mustard (HD), thickened mustard (THD), or impure mixture (HT) containing 60 percent HD. All are only slightly soluble in water. Based on animal studies, acute effects, such as nausea or gastrointestinal upset, are not expected to occur following consumption of water containing 140 μg/L (5 L/day consumption) or 47 μg/L (15 L/day consumption) for up to 7 days, provided that no other toxic compounds are present. Sulfur mustard is a known human carcinogen, and a consumption of 5 L/day of water containing 140 μg/L for 7 days could impose a cancer risk of 1 in 100,000.

7-23. BZ

BZ is a hallucinogen with unpredictable effects at high doses. These effects, which may include changes in heart rate or blood pressure, weakness, disorientation or delirium, are not observed in subjects consuming BZ in water at levels equivalent to 7 μg/L (5 L/day consumption) or 2.3 μg/L (15 L/day consumption) for up to 7 days. Figure D-13 summarizes the health effects for BZ in field water.

7-24. Radioactivity

a. Annual limits of intake (ALI) for over 400 radionuclides were determined. If the sophisticated measurements necessary to identify individual radionuclides can be performed (unlikely in the field), the limits in water are calculated by dividing by the expected amount of water to be consumed over the relevant time period. The four cases of interest are 5 and 15 L/day over 7 days (35 and 105 L, respectively) for short-term exposures and 5 and 15 L/day over 365 days (1825 and 5475 L, respectively) for long-term exposures. If more than one radionuclide is present, then fractions of ALIs should be calculated for each radionuclide and summed. This sum should not exceed 1.

b. It is unlikely that individual radionuclides will be identified in the field, so a standard for gross beta or alpha activity based on the most limiting radionuclide was developed. These calculations led to the following standards: for exposures <7 days, 8 micro curie per liter (μCi/L) (300 kilobacque per liter (kBq/L)) and 3 μCi/L (100 kBq/L) for 5 and 15 L/day consumption rates; and for exposures <1 year, 0.1 μCi/L (5 kBq/L) and 0.05 μCi/L (2 kBq/L) for 5 and 15 L/day consumption rates. These concentrations of radioactive constituents would not lead to any performance-degrading effects, based on water consumption alone. Figure D-14 presents performance degredation effects from radiation.

c. There are many possible health effects that might result from exposure to radiation. These effects can be broken down into two broad categories: chronic and acute.

(1) Chronic effects are not regarded as performance-degrading over the short term (<7 days) or long term (<1 year) as defined in this publication.

(2) Acute effects include anorexia, nausea, fatigue, vomiting, diarrhea, and acute radiation syndrome. These acute effects consist of three subgroups; central nervous system (CNS), digestive tract, and blood syndromes, all of which can result in death.

d. The immediate acute effects of nausea, anorexia, fatigue, vomiting, and diarrhea can all be performance degrading. Nausea and vomiting, for example, would not be expected for whole body doses less than 50 centiGray (cGy) (rad), but would be expected at a frequency of 15-20 percent (individual response varies) following a dose of 100 (cGy) (rad) and a frequency of 20-50 percent following a dose of 200 cGy (rad), with the expected time of occurrence of 3-30 hours post exposure. A time variable symptom-free phase often follows the immediate acute symptoms, which is then followed by the main illness (if any occurs). The severity of the immediate acute symptoms and time of onset vary with dose, as does the latent period. As dose increases, so does the severity of the immediate acute symptoms. Time of onset and latent period decrease with dose. It is unlikely that any of the symptoms would be seen due to radiation exposure received from the water alone, if treated to the levels stated in b above. The waste created in the treatment of radiologically-contaminated water could present a significant hazard, and operators should be careful to avoid exposure to the waste product as much as practicable. (See section 4-4.) If more information is desired on the effects of radiation and specific medical treatment options, refer to FM 8-10-7 and FM 8-9/NAVMED P-5059/AFJMAN 44-151.

Section VI. EVALUATION OF GEOGRAPHIC REGIONS

7-25. Climate and geohydrology

a. Studies of the correlations between water salinity and both climate and geohydrology indicate a causal relationship. Thus, climatic and geohydrologic information can be used to predict which regions are likely to have highly saline water supplies.

b. Regions with warm to hot, arid climates, and consequent high rates of water evaporation, very often have limited water supplies with relatively high salinity. Such regions are virtually all located in the trade-wind deserts of the world and in the semiarid regions that lie poleward of these deserts. Trade-wind deserts are located on the westward sides of continents between latitudes of about 20 to 35 degrees both north and south of the equator. There is a potential for high salinity water poleward to about 40 degrees latitude.

c. In addition to trade-wind desert areas, there is a likelihood that highly saline waters will be encountered in regions with outcrops of bedrock containing such soluble minerals as salt and gypsum/anhydrite. An example of major importance to this study is the region of Northern Iran and Iraq together with adjacent portions of Syria and Turkey. In Iran, the Hormuz salt pierces the overlying bedrock to form salt domes and salt glaciers, which can expose salt at the land surface. In an even wider area in the same region, the gypsum- and salt-bearing Fars formation underlies many of the intermontane valleys. Much of the water in this very large region is likely to be well above average in salinity.

d. Even in regions with reasonably high rainfall, areas underlain by salt and anhydrite can have waters with high salinity. Two examples are the Colorado River of west-central Colorado and the Salzkammergut near Salzburg, Austria. The

Colorado River has a reach underlain by gypsum and anhydrite near its headwaters in the high-altitude, moderately humid Rocky Mountains. The amount of calcium sulfate dissolved in the water is significant, and the salinity of the river water is markedly increased below the reach. The Salzkammergut is a high-rainfall area in the Eastern Alps of Central Europe. Salt occurs in the region; it has been mined there for thousands of years. Some water supplies in the region have unusually high levels of salt, undoubtedly as a result of leaching of salt by percolating waters.

7-26. Organic chemical contamination

a. Organic chemicals, both industrial and agricultural, are found throughout the world in all types of natural waters. Ordinarily, only pesticides, particularly lindane, may occur at a high enough concentration in potential sources of field water to be a threat to military health.

(1) Low, nontoxic levels of pesticides are likely to be associated with surface water supplies near major agricultural areas. Potential health risks from pesticides in those areas would result primarily from transient releases of pesticides from field applications or even spills. In general, any small body of water in the immediate vicinity of agricultural activities (that is, irrigation canals, rice paddies, ponds, and reservoirs), with high potential for contamination and little potential for dilution, poses a real threat to troop health.

(2) In addition, military personnel should be alert to the possibility of extreme contamination levels in areas requiring the direct application of pesticides to water. For example, a concentration of lindane in water of 1,920 mg/L was reported in rice paddy water. Areas of rice production, which are principally located in Third World countries, are at considerable risk for contamination of water by pesticides, particularly by lindane.

b. In addition, transient releases from industrial facilities storing large quantities of organic chemicals and from transshipment points related to these industries could result in elevated levels of organic contaminants in surface waters. Manufacturing areas could also contain factories that potentially could release contaminants, especially organic chemicals, into ground and surface waters. Although it is not possible to list all such facilities that could cause difficulties, major organic chemical production centers and petroleum refineries are the most significant possible sources of surface water contamination from a regional perspective. The AFMIC maintains information on the locations of some of these facilities, which can alert military planners to potential water-supply contamination by organic chemicals under battlefield conditions. Deliberate contamination using industrial or agrochemicals is also a potential threat.

7-27. Water-related infectious organisms

Data are not available for globally assessing the precise locations of all the aquatic infectious organisms of military concern. In fact, most of the infectious organisms can be considered commonplace, especially in the Third World. However, two indicators are useful as warnings that high concentrations of infectious organisms may exist in the field water of a particular region. Poor sanitation is one indicator and infant mortality rates (deaths in infants less than 1 year old) is the other. In fact, locations of moderate to high infant mortality correspond to areas of poorest sanitary conditions, and the majority of deaths in this age group are due to the infectious diseases. The AFMIC maintains current information on infectious diseases, including waterborne pathogens, in most countries around the globe. Figure D-15 summarizes aquatic bacteria health effects.

CHAPTER 8

EQUIPMENT

Section I. TREATMENT, STORAGE, AND DISTRIBUTION EQUIPMENT

8-1. 600-gallon per hour ROWPU

The 600-gallon per hour (gph) ROWPU--

a. Is intended for the production of potable water from fresh, brackish, or saline water sources.

b. Is trailer-mounted or skid-mounted, air dropable, and requires a dedicated 5-ton prime mover.

c. Is designed to purify 600 gallons of water per hour from fresh water sources (1,500 mg/L TDS or less) at a temperature of 77 °F (25 °C).

d. Can produce 400 gallons of water per hour from saline water sources (35,000 mg/L TDS or more) at a temperature of 77 °F (25 °C).

(1) As the raw water temperature drops, the production capability of the ROWPU is reduced, so that, at 50 °F (10 °C), this ROWPU produces 300 gph on fresh water sources and 200 gph on saline water sources.

(2) Additionally, other external factors, such as turbidity, also affect production rates.

e. Is capable of effectively removing potentially hazardous concentrations of chemical and biological agents and radioactive by-products of nuclear origin for a limited period.

8-2. 3,000-gallon per hour ROWPU

The 3,000-gph ROWPU--

a. Is intended for both direct and general support water production operations.

b. Is contained within a special 8 X 8 X 20 foot International Standard Organization (ISO) container with an overpack.

c. Is mounted on a standard 30-foot military trailer and can be shipped aboard U.S. Air Force aircraft.

d. Is powered by a 60-kilowatt (kW) utility diesel generator that is mounted on the rear of the trailer.

e. Is designed to purify 3,000 gallons of water per hour from fresh water sources (1,500 mg/L TDS or less) at a temperature of 77 °F (25 °C).

f. Can produce 2,000 gallons of water from saline water sources (35,000 mg/L TDS or more) at a temperature of 77 °F (25 °C).

(1) As the raw water temperature drops, the production capability of the ROWPU is reduced, so that, at 50 °F (10 °C), this ROWPU produces 1,500 gph on fresh water sources and 1,000 gph on saline water sources.

(2) Additionally, other external factors, such as turbidity, also affect production rates.

g. Is capable of effectively removing potentially hazardous concentrations of chemical and biological agents and radioactive by-products of nuclear origin for a limited period.

8-3. 3,000-gallon onion tank

The 3,000-gallon onion tank is a highly mobile, easily transportable, manually inflatable/collapsible fabric water tank. Packaged, the tank is 23 X 28 X 42 inches and weighs 130 pounds. Filled with water, the tank is 56 X 148 X 94 inches and weighs 24,020 pounds.

8-4. Potable water storage and distribution systems

The potable water storage and distribution systems (PWS/DS)--

a. Are the primary means for the receipt and storage of bulk water and for its issue to combat forces under tactical conditions.

b. Are intended for use in arid environments by both direct and general support water units.

c. Total capacity depends on the number and size of fabric tanks assigned and used.

d. Have the capability of receiving and distributing water to and from both hoseline and tank truck.

e. Can issue water to either tank trucks (semitrailer-mounted fabric tank (SMFT)), water buffalos, forward area water point supply system (FAWPSS), or small unit containers, such as 5-gallon cans.

f. Are based on a modular concept; that is, any number of tanks may be used on an individual basis, and other tanks may be valved off at either their input or output valves.

8-5. Forward area water point supply system

a. The FAWPSS is--

(1) A portable, self-contained, gas or diesel operated unit that dispenses potable drinking water to troop units.

(2) Operated by a 125-gallon per minute (gpm) centrifugal pump.

b. Six 500-gallon water storage and dispensing drums are attached, two at a time. Quick-disconnect couplings connect the drums to the pump. These drums provide water to the 125-gpm pump which, through hoses and valves, pumps water to four distribution nozzles where the water is discharged.

8-6. Semitrailer-mounted fabric tank

a. These tanks are designed and intended to transport drinking water only.

(1) The 3,000-gallon SMFTs are used by direct support water supply units to deliver water to major users that have no organic transportation capable of receiving needed water supplies directly from the water points.

(2) The 5,000-gallon SMFTs are used by medium truck companies for line haul of potable

water, as well as some local haul to users that have no organic transportation capability.

b. The transport or contact with POL products will contaminate the tanks and will result in permanent damage to the material and possible structural failure.

c. These tanks can only be transported full or empty. A partially filled tank will result in the lading shifting (surge). This shifting will result in loss of vehicle control and possible rupture of the tank wall.

d. The assembled unit consists of a collapsible tank with pressure gage, end fittings, tie-down straps, emergency repair items, hose, and tools to secure the tank safely on the trailer.

8-7. Storage equipment

Maneuver and support units are equipped with a variety of water storage equipment including canteens, 5-gallon water cans, lightweight collapsible pillow tanks (LCPT), collapsible fabric drums, and 400-gallon water trailers. Large quantities of water are stored by water supply companies in collapsible tanks ranging in size up to 50,000 gallons.

8-8. Field showers

Field shower equipment consists of pumps, heater unit, generator, portable eight-head shower unit, tentage, and vehicles. Water storage tanks are used for storing potable water or for treating and storing nonpotable fresh water available onsite. Preventive medicine personnel should inspect shower operations on a routine basis using DD Form X343.

8-9. Personnel decontamination station

Field shower equipment can be modified for use as a personnel decontamination station. Water used for personnel decontamination will be disinfected, and have at least a 5 mg/L chlorine residual maintained in the decontamination water during its use.

8-10. Water distribution and waste management system (WDWMS)

The WDWMS is composed of three modules: the Water Distribution Set, Hospital, Deployable Medical System (DEPMEDS); the Wastewater Management Set, Hospital, DEPMEDS; and the Wastewater Augmentation Set, Hospital, DEPMEDS. The WDWMS is the primary means for the receipt and storage of bulk potable water, and for wastewater management for the DEPMEDS hospital under tactical conditions. The total capacity of each WDWMS is dependent on the size of fabric tanks assigned and used (usually between 18,000 and 20,000 gallons per day).

Section II. WATER TESTING KITS

8-11. Water quality analysis set, preventive medicine (WQAS-PM)

The WQAS-PM (NSN 6630-01-367-9402) consists of five individually packaged colorimetric test kits and a spectrophotometer. This kit is issued to Army preventive medicine units, and can be used in the field or at remote sites. It can determine the amount of free acidity, chlorides, dissolved oxygen, fluorides, ferrous, ferric, and total iron, ammonia nitrogen and nitrate nitrogen, pH, turbidity (using Fulton turbidity units or FTUs), zinc, and sulfate. New versions of the kit contain additional test kits for arsenic, cyanide, magnesium, and an updated chloride and sulfate test. The range of detection for each parameter is listed in table 8-1. While some of the tests provided cannot detect contamination down to the applicable field water standard, the test should still be performed to determine if any gross contamination is present.

8-12. Water quality analysis set, purification (WQAS-P)

The WQAS-P (NSN 6630-01-365-5588) contains electronic test equipment to perform turbidity (using NTUs), pH, temperature, and total dissolved solids, and a colorimetric FAC test. It also contains the M272 chemical agents water testing kit. Detection levels for each parameter are also listed in table 8-1. The WQAS-P is issued to water purification units and to preventive medicine units, and replaces the old water quality analysis set - engineer (WQAS-E, NSN 6630-00-140-7820).

8-13. M272 chemical agents water testing kit

The M272 test kit (NSN 6665-01-134-0885) uses test tubes and chemical-coated tickets that change color when levels of the various agents are present in the water sample. It can test for hazardous levels of lewisite, nerve, cyanide, and mustard agents. Each test is a color change that indicates threshold or danger concentrations of the agent. The detection levels for each agent are listed in table 8-1 and are the concentrations reliably detected. As with the WQAS-PM, some of the tests provided cannot detect contamination down to the applicable field water standard. The test should still be performed to determine if any gross contamination is present.

8-14. Microbiological water testing kit

This test kit (NSN 6665-00-682-4765) consists of equipment and an incubator to perform total coliform testing of water samples.

Section III. EQUIPMENT CLEANING, SANITIZING, AND DECONTAMINATION

8-15. Water container cleaning

a. General.

(1) During noncombat emergencies when working in containers large enough to accommodate a person, workers will adhere to standards for working in confined spaces set by the NIOSH Publication No. 80-106. These standards are presented in 29 CFR 1910.1146. In general, continuous atmosphere monitoring and forced ventilation before and during entry, safety harnesses with attached safety extraction lines, self-contained breathing apparatus, and at least two support personnel outside the confined space, are all required for safe entry into a confined space.

(2) Table 8-2 provides the nomenclature for ordering equipment cleaning and sanitizing supplies.

b. Preparation. To prepare the water container for cleaning, personnel performing the cleaning will--

(1) Remove rust from interior surfaces using a non-abrasive, non-chlorinated cleanser and a nonmetallic scouring pad or brush.

(2) Thoroughly rinse the interior of the container and discard the contents.

Table 8-1. Water testing kit capabilities

	WQAS-PM	Test strips	WQAS-P	WQAS-E	M272
<u>Physical Properties</u>					
Free Acidity (mg/L)	0 - 500	--	--	--	--
Total Acidity (mg/L)	0 - 500	--	--	--	--
Dissolved Oxygen (mg/L)	0.2 and above	--	--	--	--
Turbidity	0 - 500[1]	--	0 - 150[2]	5 - 200[3]	--
pH	4 - 10	--	2 - 12	3 - 10	--
TDS (mg/L)	--	--	10-50,000	0-50,000	--
Temperature (Degrees C)	--	--	0 - 48	--	--
	Color (Color Units)		--	--	--
	0 - 100	--			
<u>Chemical Properties</u>					
Arsenic (mg/L)	--	0.1 - 3.0	--	--	--
Cyanide (mg/L)	--	1.0 - 30	--	--	--
Magnesium (mg/L)	--	10 - 120	--	--	--
Chloride (mg/L)	1,000-20,000	500 - 3000	--	0 - 1500	--
Sulfate (mg/L)	0-150	400 - 1600	--	0 - 3000	--
Nitrate nitrogen (mg/L)	0-30	--	--	--	--
Ammonia Nitrogen (mg/L)	0 - 2.0	--	--	--	--
Fluorides (mg/L)	0 - 2.0	--	--	--	--
Ferrous Iron (mg/L)	0 - 2.0	--	--	--	--
Ferric Iron (mg/L)	0 - 10.0	--	--	--	--
Total Iron (mg/L)	0 - 2.0	--	--	--	--
Zinc (mg/L)	1.0 - 20.0	--	--	--	--
<u>Chemical Agents</u>					
Hydrogen Cyanide (μg/L)	--	--	--	--	20,000
Lewisite (μg/L)	--	--	--	--	2,000
Mustard (μg/L)	--	--	--	--	2,000
Nerve Agents (μg/L)	--	--	--	--	20

[1] Fulton Turbidity Units (FTU)
[2] Nephelometeric Turbidity Units (NTU)
[3] Jackson Turbidity Units (JTU)

Table 8-2
Nomenclature for ordering equipment cleaning and sanitizing supplies

NSN Identifier	Item
7920-00-061-0038	Brush, Scrub, Plastic Item used to scrub the interior surfaces of water purification, storage, and distribution equipment.
7920-00-753-5242	Pad, scouring, type II, 6 X 9 ½ X 1/4 in
7930-00-205-0442	Scouring Powder, 14 oz can Item used to clean steel and aluminum surfaces of water purification, storage, and distribution equipment.
7930-00-899-9534	Dishwashing Compound, 5 gal bottle Item used to prepare a soap solution for cleaning equipment.
6810-00-242-4770	Calcium Hypochlorite, Technical, 3-3/4 lb bottle
6810-00-255-0471	Calcium Hypochlorite, Technical, 6 oz bottle
6810-00-255-0472	Calcium Hypochlorite, Technical, 100 lb drum
6810-00-598-7316	Sodium Hypochlorite, 5 gal bottle
6850-00-270-6225	Chlorination Kit, Water Purification Item used to disinfect water and to prepare a sanitizing solution for equipment.
6810-00-264-5896	Carbon, Activated, Technical, 10 lb pail
6810-00-264-6575	Carbon, Activated, Technical, 50 lb drum Item used to neutralize bad tastes and odors in water.

(3) Prepare a soap solution by adding 1/3 canteen cup of dishwashing compound to 10 gallons (38 L) of hot water <u>or</u> 3-1/3 canteen cups of dishwashing compound to 100 gallons (380 liters) of hot water.

c. Cleaning procedures. Personnel performing the cleaning will--

(1) Thoroughly wash the interior surfaces of the equipment with the soap solution.

(a) For 5-gallon cans, add 1 gallon (3.8 L) of the soap solution, shake vigorously for 1 minute, and drain.

(b) For larger containers, scrub the interior surfaces with a long-handled brush.

(c) Clean the filling and discharge pumps, pipes, valves, and spigots by drawing soap solution through them.

(2) Rinse the container and apparatus twice with warm (120 °F (49 °C)) water to completely remove the soap solution.

(3) Drain the rinse water through the discharge apparatus and discard the rinse water.

d. Sanitizing requirement. After cleaning, sanitize the container with a 100 mg/L chlorine solution as discussed in paragraph 8-16.

e. Petroleum containers. Tankers, trailers, drums, 5-gallon cans, or other containers previously used for storage or distribution of petroleum products will never be used for storage or distribution of potable water.

8-16. Equipment sanitizing

a. General. All equipment used to store and distribute potable water will be sanitized with a 100 mg/L chlorine solution after the equipment has been cleaned.

b. Preparation.

(1) Construct a seepage pit or sump into which the waste chlorine solution and rinse waters will be discharged. Waste chlorine solution should not be discharged into bodies of water or into sanitary sewers. Chlorine can kill aquatic organisms in the water and bacteria in sewage which are necessary for waste degradation. Seepage pits should be located at least 100 feet from an existing water source such as a stream, lake, or well. The dimensions will vary greatly due to soil type and water table elevation. For a silt and loam soil, a 1,000-gallon volume of wastewater requires a seepage pit 7 x 7 x 7 feet, backfilled with gravel. A 5 x 5 x 5 foot pit backfilled with gravel will adequately handle up to 400 gallons.

(2) Prepare a sanitizing solution of 100 mg/L chlorine.

(a) Using calcium hypochlorite, add ½ ampule to 5 gallons of potable water, <u>or</u> add 6 ampules to 100 gallons of potable water.

(b) Using liquid bleach, add ½ of a meal ready to eat (MRE) spoonful to 5 gallons of potable water, <u>or</u> add 7 MRE spoonfuls to 100 gallons of potable water.

c. Sanitizing procedures.

(1) When sufficient quantities of water are available, fill the container with the sanitizing solution. Close the manhole covers or ports. Allow the solution to remain in the container for 60 minutes.

(2) If sufficient quantities of water are not available, apply the sanitizing solution by spraying or brushing it with a clean, nonmetallic brush on the interior surface to include ports and manholes. Add additional solution to the tank to clean the discharge and pumping apparatus. The solution must remain in contact with the surfaces for 60 minutes and may require reapplications of the solution every 10 minutes to keep surfaces wet.

(3) Rinse the equipment and apparatus twice with potable water.

(4) Drain the rinse water through the discharge apparatus and appropriate distribution pumps, hoses, and nozzles.

(5) If the equipment is not to be used for a long period of time, open all ports and manholes, remove the drain plug (if any), and allow to dry.

(6) When dry, store the equipment per guidance in the appropriate technical manual.

8-17. Equipment decontamination

a. General.

(1) Organized decontamination. The NBC defense company or detachment (Army, Navy) or the Equipment Decontamination Team (Air Force) performs large-scale NBC decontamination operations.

(2) Unit decontamination. The unit NBC officer or noncommissioned officer (NCO) will supervise unit decontamination.

b. Field expedient decontamination. Water purification and supply personnel and unit field sanitation teams regularly work with an effective chemical and biological agent decontaminant, calcium hypochlorite. They can use this chemical for decontamination of equipment surfaces by following the procedures described below.

(1) Preparation.

(a) Construct a soakage pit or sump into which the decontamination waste and rinse water can be discharged. Seepage pits should be located at least 100 feet from an existing water source such as a stream, lake, or well. The dimensions will vary greatly due to soil type and water table elevation. For a silt and loam soil, a 1,000-gallon volume of wastewater requires a seepage pit 7 x 7 x 7 feet, backfilled with gravel. A 5 x 5 x 5 foot pit backfilled with gravel will adequately handle up to 400 gallons.

(b) Wear a rubber apron and rubber gloves over MOPP gear, and prepare a 3 percent solution of chlorine by adding 3 canteen cups of calcium hypochlorite to 6 gallons (23 L) of water.

(2) Decontamination procedures.

(a) Apply the solution to the exterior of the equipment or container using brushes or brooms. One gallon (3.8 L) of the solution should cover 8 square yards (7 square meters). The decontamination solution must remain in contact with the surface for at least 30 minutes and may have to be reapplied occasionally to keep the surface wet.

(b) Thoroughly wash the surface with potable water.

(c) Test the water stored in containers with the M272 kit to determine if the water was contaminated. If not, rechlorinate the water to 5 mg/L or at a higher level if prescribed by the command surgeon.

(d) If the water is contaminated with a detectable level of chemical agent which exceeds the standards in table C-1, water purification sections should retreat the water using appropriate methods such as the NBC treatment units provided with both the 600-gph and 3,000-gph ROWPU. Individual units should procure a new supply of potable water from approved sources.

CHAPTER 9

WATER FROM OTHER SOURCES

9-1. Bottled water

a. Bottled water is sealed in bottles, packages, or other containers by a commercial (non-military) source for human consumption, including bottled mineral water. There are recognized occasions where packaged water or bottled water may be used until tactical water purification, storage, or distribution assets become available to the commander and are established. Once available and established, commanders should maximize their tactical water equipment usage to sustain the force.

b. Bottled water in support of DOD personnel and operations will be obtained from military-approved sources. A list of approved sources can be found in Veterinary Command (VETCOM) Circular 40-1. Overseas MACOM's will provide their own directory for outside continental United States (OCONUS) establishments as described in AR 40-657/ NAVSUPINST 4355.4F/MCO P10110.31G. The VETCOM website [http://domino1.hcssa.amedd.army.mil/vetcom.nsf] contains updated information on VETCOM Circular 40-1 as well as links to the OCONUS directories.

c. Veterinary service personnel will inspect bottling facilities to ensure compliance with acceptable sanitation standards which impact on the final product. Representative bottles of the finished product will be randomly obtained at the time of each inspection and sent to the appropriate laboratory for microbiological and chemical analyses. The details and frequency of bottling and facility inspections will be in accordance with 21 CFR 103.35, 21 CFR 129 (for continental United States (CONUS) facilities), and AR 40-657/NAVSUPINST 4355.4F/MCO P10110.31G. Table C-4 lists the water quality standards applicable to bottled water. Food establishments and distributors meeting these requirements and approved as sources of supply for bottled water can be found in the USAREUR Circular 40-657 for each major command.

9-2. Tactically-packaged water

a. Packaged water is produced and packaged by the military for military use. Packaged water will conform to the updated field water quality standards listed in table C-2. In addition, all tactically-packaged water will be ROWPU treated, and will contain at least 1 mg/L free-available chlorine at the time of packaging. An inspection of the packaging operation will be conducted prior to the start of purification and packaging operations using DD Form X342.

b. Packaged water should be stored in a clean, covered, well ventilated area and maintained at temperatures between 35 °F (2 °C) and 84 °F (29 °C).

Water should be packaged and distributed within 30 days of production. Packaged water is considered potable for immediate consumption as long as a measurable chlorine residual exists. Packaged water will be tested for the presence of coliform bacteria as specified in paragraph 9-3. If microbial testing cannot be accomplished, the presence of measurable chlorine residual in packaged water will be adequate to issue packages as potable water to units.

9-3. Microbiological testing of bottled or packaged water

a. Preventive medicine personnel will conduct microbiological testing of bottled and packaged water. Each lot of bottled or packaged water should be tested upon receipt at a central storage facility, warehouse, port of entry, or other theater area issue point. Sampling will also be accomplished every 30 days at major storage sites and end user locations until the lot is exhausted. This allows the shelf life of bottled and packaged water to be extended in 30-day increments, provided testing is done as required. Water may continue to be issued during the 24-hour period that coliform analysis is being conducted. If found to be unsafe for consumption, all recipients of the subject lot will be notified and provided disposition instructions accordingly.

b. Total coliform testing will be performed using the membrane filter technique, or by the defined substrate method, such as the commercially available "Colilert®" and "Colisure™" tests. One percent of the total number of bottles or packages for each lot shall be tested up to a maximum of 10 samples. Samples shall be collected randomly throughout the lot.

c. If any sample is coliform positive, use of that lot should be suspended pending immediate resampling to confirm coliform presence. The resampling should be accomplished on one percent of the remainder of the lot up to 10 samples. If the confirmation resampling is positive for coliforms, the lot should not be used for potable purposes. Units to which the lot had been issued, if any, should be notified and provided disposition instructions accordingly. Depending on the availability of water, bottles containing water that is coliform positive may be issued for personal hygiene, laundry, or other nonpotable uses, or the water may be used for drinking if treated with chlorine, iodine tablets, or Chlor-Floc.

d. Each lot of bottled water will be visually inspected every 30 days at major storage sites and end user locations until the lot is exhausted. The bottle will be inspected for cracks in the cap and bottle and also to determine if the water has become cloudy. If the water in any of the bottles appear cloudy, they shall not be issued for drinking without additional treatment. Depending on the availability of water, bottles containing cloudy water may be issued for personal hygiene, laundry, or other nonpotable uses. The water may be used for drinking if treated with chlorine, iodine, or Chlor-Floc.

e. Bottled and packaged water should not be stored in direct sunlight. It should be stored in shaded, well ventilated areas, and in boxes which keep the packages upright. Bottled and packaged water should be rotated on a "first in - first out" basis. Bottled water stored in direct sunlight for more than 5 days should be visually inspected according to paragraph d above prior to issue.

9-4. Host nation water

a. Water provided by a host nation or treated by host nation field purification methods should comply with NATO (STANAG 2136), Quadripartite (QSTAG 245), or other multi-national agreements as applicable. STANAG 2136 and QSTAG 245 standards are listed in tables C-1 and C-2.

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b. Water may also be obtained from established host nation municipal drinking water systems during training and wartime. All water produced from existing facilities will be considered unsafe until evaluated by preventive medicine personnel and determined potable by the command surgeon. Such sources purify water by the same methods many U.S. municipal water systems use. These sources are considered fixed-installation sources rather than field water sources; therefore, established field water standards are not applicable.

c. In countries where DOD maintains a military presence, Environmental Final Governing Standards may be in place that dictate specific water quality standards for municipal water systems. These standards should be used if available. If Final Governing Standards do not exist, drinking water from OCONUS municipal sources should meet the OEBGD standards for drinking water. The OEBGD standards are very similar to U.S. public drinking water standards provided in table C-5. They can be used to compare water quality of municipal sources that will be used in a field environment.

APPENDIX A

REFERENCES

A-1. Army regulations

AR 40-5	Preventive Medicine
AR 40-657/ NAVSUPINST 4355.4F/ MCO P10110.31G	Veterinary/Medical Food Inspection and Laboratory Service
AR 200-1	Environmental Protection and Enhancement
AR 310-25	Dictionary of U.S. Army Terms
AR 700-135	Mobile Field Laundry and Bath Operations
AR 700-136	Tactical Land Based Water Resources Management in Contingency Operations

A-2. Navy standards

OPNAVINST 5090.1B	Environmental and Natural Resources Program Manual
BUMEDINST 6240.10	Standards for Potable Water
MIL-HDBK 1005/7	Water Supply Systems
NAVMED P-117	U.S. Navy Manual of the Medical Department
NAVMED P-5010	Manual of Naval Preventive Medicine
NAVMED P5010-1	Food Service Sanitation
NAVMED P-5010-5	Water Supply Ashore
NAVMED P-5010-6	Water Supply Afloat
NAVMED P-5010-7	Wastewater Treatment and Disposal Ashore and Afloat
NAVMED P-5010-9	Preventive Medicine for Ground Forces

A-3. Marine Corps regulations

MCO P5090.2	Environmental Compliance and Protection

A-4. Air Force instructions

AFI 32-1067	Water Systems
AFI 32-7041	Water Quality Compliance
AFI 41-106	Medical Readiness Planning and Training
AFI 48-119	Environmental Surveillance Programs

A-5. Technical bulletins (medical)

TB MED 81/ NAVMED P-5052/ AFP 161-11	Cold Injury
TB MED 288	Medical Problems of Man at High Terrestrial Elevations
TB MED 507/ NAVMED P-5052/ AFP 160-1	Prevention, Treatment, and Control of Heat Injury
TB MED 530	Food Service Sanitation

A-6. NATO standardization agreements*

STANAG 2136	Minimum Standards of Water Potability in Emergency Situations
STANAG 2885	Emergency Supply of Water in War

A-7. Quadripartite standardization agreement*

QSTAG 245	Minimum Requirements for Water Potability (Short and Long Term Use)

A-8. Prescribed forms

DD Form X340	Water Source Reconnaissance Report
DD Form X341	Potable Water Container Inspection
DD Form X342	Water Point Inspection Report
DD Form X343	Shower/Decontamination Point Inspection

A-9. Referenced form

DA Form 1713-R	Daily Water Production Log--ROWPU

*Copies of these items are available through the DOD Single Stock Point, 5810 Tabor Avenue, Philadelphia, PA 19120-5099.

APPENDIX B

ARMY, NAVY, AND AIR FORCE LABORATORIES OR AGENCIES AND AREAS SERVED

Laboratory or agency	Area served
Commander USACHPPM Direct Support Activity - North Fort George G. Meade, MD 20755-5225	Connecticut, Delaware, District of Columbia, Northern Kentucky, Indiana, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia
Commander USACHPPM Direct Support Activity - South Fort McPherson, GA 30330-5000	Alabama, Arkansas, Florida, Georgia, Southern Kentucky, Louisiana, Mississippi, Oklahoma, Puerto Rico, South Carolina, Tennessee, Central and Eastern Texas
Commander USACHPPM Direct Support Activity - West Fitzsimons Army Medical Center Aurora, CO 80045-5001	Alaska, Arizona, California, Colorado, Idaho, Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri,

Laboratory or agency	Area served
Dakota, Oregon, Washington, Wisconsin,	Montana, Nebraska, Nevada, New Mexico, North South Dakota, Western Texas Utah, Wyoming
Commander USACHPPM - Pacific APO San Francisco 96338-5008	Hawaii, Japan, Korea, Okinawa, Philippines, Thailand, and all other Far East areas
Commander USACHPPM - Europe ATTN: Preventive Medicine CMR 402 APO AE 09180	Europe, Asia, and Africa
Commander USACHPPM ATTN: MCHB-TS-EWS Aberdeen Proving Ground, MD 21010-5422	Worldwide
Commander Armed Forces Medical Intelligence Center ATTN: AFMIC-GH-MIC Fort Detrick Frederick, MD 21701-5004	Worldwide support for medical intelligence, environmental health threats, and known areas of contamination
Armstrong Laboratory 2402 E Drive Brooks AFB, TX 78235-5114 Analytical Support: AL/OEA Radioanalytical Support: AL/OEBA Technical Support: AL/OEB	Worldwide
Kadena Air Base Detachment 3, Armstrong Laboratory Unit 5213 APO AP 96368-5213	Pacific/Far East
Officer in Charge NAVENPVNTMEDU 2 1887 Powhatan St. Norfolk, VA 23511-3394	Atlantic Region

Laboratory or agency	Area served
Officer in Charge NAVENPVNTMEDU #5 Box 368143 3035 Albacore Alley San Diego, CA 92136-5199	Pacific Coast Region
Officer in Charge NAVENPVNTMEDU #6 Box 112, Bldg. 1535 Pearl Harbor, HI 96860-5040	Pacific Region
Officer in Charge NAVENPVNTMEDU #7 PSC 825, Box 295 FPO AE 09627-2003	Mediterranean Region
Commanding Officer Navy Environmental Health Center 2510 Walmer Avenue Norfolk, VA 23513-2617	Support to listed labs and Worldwide

APPENDIX C

WATER QUALITY STANDARDS

There are several sets of standards directly or indirectly applicable to drinking water quality in a military field environment. The tables in this appendix identify the current standards for each parameter within each set of standards. The applicability and use of each set of standards are discussed further in chapter 2.

Table C-1. Short-term field water quality standards (less than 7 days)

	U.S. Tri Service (June 1996)		QSTAG 245 (Sep 1985)	STANAG 2136 (Sep 1995)
CONSUMPTION RATE	5 L/Day	15 L/Day	5 L/Day	5 L/Day
<u>Physical Properties</u>				
Color (Color Unit)	50	50	--	50
Odor (TON)	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
<u>Chemical Properties</u>				
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
<u>Microbiological</u>				
Coliform (#/100 mL)	0	0	1	1
Virus (#/100 mL)	--	--	1	1
Spores/Cysts (#/100 mL)	--	--	1	1
<u>Chemical Agents</u>				
Hydrogen Cyanide (mg/L)	6	2	--	--
BZ (Incapacitants) (μg/L)	7	2.3	--	--
Lewisite (arsenic fraction) (μg/L)	80	27	--	--
Sulfur Mustard (μg/L)	140	47	200	200
Nerve Agents (μg/L)	12	4	20	20
T-2 Toxins (μg/L)	26	8.7	--	--
<u>Radiological</u>	8 μCi/L	3 μCi/L	--	--

Table C-2. Long-term field water quality standards (less than 1 year)

CONSUMPTION RATE	U.S. Tri Service (June 1996) 5 L/Day	U.S. Tri Service (June 1996) 15 L/Day	QSTAG 245 (Sep 1985) 5 L/Day	STANAG 2136 (Sep 1995) 5 L/Day
Physical Properties				
Color (Color Unit)	15	15	15	15
Odor (TON)	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)	0	0	1	1
Virus (#/100 mL)	--	--	1	1
Spores/Cysts (#/100 mL)	--	--	1	1
Radiological (μCi/L)	0.1	0.05	0.06	2.2 Bq/mL

Table C-3. Water quality standards for nonconsumptive uses

Water Quality	Uses Include
Potable water	a. Mess operations such as food washing b. Personal hygiene such as shaving, brushing teeth, helmet baths, and comfort cooling c. Medical treatment d. Photoprocessing for quality control e. Ice production for food preservation and cooling f. Water hose and pipeline testing and flushing
Disinfected nonpotable fresh water	a. Centralized hygiene such as field showers b. Decontamination of personnel c. Retrograde cargo washing d. Heat casualty body cooling e. Graves registration personnel sanitation f. Well development
Nonpotable fresh water	a. Vehicle coolant b. Aircraft washing c. Pest control d. Field laundry e. Concrete construction f. Well drilling
Seawater	a. Vehicle washing* b. Electrical grounding c. Fire fighting d. Nuclear, biological, and chemical (NBC) decontamination of material

*Seawater may lead to significant corrosion of some mechanical parts. Consider nonpotable fresh water if available.

*Table C-4. Bottled water standards**

Contaminant	Maximum Contaminant Level (mg/L)
Inorganic Contaminants	
Aluminum	0.2
Antimony	0.006
Arsenic	0.05
Barium	2
Beryllium	0.004
Cadmium	0.005
Chloride	250
Chromium	0.1
Copper	1
Cyanide	0.2
Iron	0.3
Lead	0.005
Manganese	0.05
Mercury	0.002
Nickel	0.1
Nitrate (as N)	10
Nitrite (as N)	1
Total Nitrate/Nitrite (as N)	10
Phenols	0.001
Selenium	0.05
Silver	0.1
Sulfate	250
Thallium	0.002
Total Dissolved Solids	500
Volatile Organic Contaminants	
Benzene	0.005
Carbon tetrachloride	0.005
o-Dichlorobenzene	0.6
para-Dichlorobenzene	0.075
1,2-Dichloroethane	0.005
cis-1,2-Dichloroethylene	0.07
trans-1,2-Dichloroethylene	0.1
1,1-Dichloroethylene	0.007
Dichloromethane	0.005
1,2-Dichloropropane	0.005
Ethylbenzene	0.7
Monochlorobenzene	0.1

Table C-4. Bottled water standards (cont.)*

Contaminant	Maximum Contaminant Level (mg/L)
Volatile Organic Contaminants (cont.)	
Styrene	0.1
Tetrachloroethylene	0.005
Toluene	1
1,2,4-Trichlorobenzene	0.07
1,1,1-Trichloroethane	0.2
1,1,2-Trichloroethane	0.005
Trichloroethylene	0.005
Total Trihalomethanes	0.1
Vinyl chloride	0.002
Xylenes (total)	10
Pesticide Contaminants	
Alachlor	0.002
Atrazine	0.003
Carbofuran	0.04
Chlordane	0.002
2,4-D	0.07
Dalapon	0.2
Dibromochloropropane (DBCP)	0.0002
Dinoseb	0.007
Diquat	0.02
Endothall	0.1
Endrin	0.002
Ethylene dibromide (EDB)	0.00005
Glyphosate	0.7
Heptachlor epoxide	0.0002
Heptachlor	0.0004
Lindane	0.0002
Methoxychlor	0.04
Oxamyl (Vydate)	0.2
Polychlorinated biphenyls (PCBs)	0.0005
Pentachlorophenol	0.001
Picloram	0.5
Simazine	0.004
2,4,5-TP (Silvex)	0.05

Table C-4. Bottled water standards (cont.)*

Contaminant	Maximum Contaminant Level (mg/L)
<u>Pesticide Contaminants</u> (cont.)	
Toxaphene	0.003
Benzo(a)pyrene	0.0002
Di(2-ethylhexyl)adipate	0.4
Di(2-ethylhexyl)phthalate	0.006
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
2,3,7,8-TCDD (Dioxin)	3E(-8)

*Source: 21 CFR 165, Bottled Water - Quality Standards, 1 April 1996

*Table C-5. U.S. EPA public drinking water standards**

Parameter	Maximum Contaminant Level	Maximum Contaminant Level Goal	Units
Organics			
Benzene	0.005	0	mg/L
Carbon tetrachloride	0.005	0	mg/L
o-Dichlorobenzene	0.6	0.6	mg/L
para-Dichlorobenzene	0.075	0.075	mg/L
1,2-Dichloroethane	0.005	0	mg/L
cis-1,2-Dichloroethylene	0.07	0.07	mg/L
trans-1,2-Dichloroethylene	0.1	0.1	mg/L
1,1-Dichloroethylene	0.007	0.007	mg/L
Dichloromethane	0.005	0	mg/L
1,2-Dichloropropane	0.005	0	mg/L
Ethylbenzene	0.7	0.7	mg/L
Monochlorobenzene	0.1	0.1	mg/L
Styrene	0.1	0.1	mg/L
Tetrachloroethylene	0.005	0	mg/L
Toluene	1	1	mg/L
1,2,4-Trichlorobenzene	0.07	0.07	mg/L
1,1,1-Trichloroethane	0.2	0.2	mg/L
1,1,2-Trichloroethane	0.005	0.003	mg/L
Trichloroethylene	0.005	0	mg/L
Total Trihalomethanes	0.1	--	mg/L
Vinyl chloride	0.002	0	mg/L
Xylenes (total)	10	10	mg/L
Benzo(a)pyrene	0.0002	0	mg/L
Di(2-ethylhexyl)adipate	0.4	0.4	mg/L
Di(2-ethylhexyl)phthalate	0.006	0	mg/L
Hexachlorobenzene	0.001	0	mg/L
Hexachlorocyclopentadiene	0.05	0.05	mg/L
2,3,7,8-TCDD (Dioxin)	3E(-8)	0	mg/L
Alachlor	0.002	0	mg/L
Atrazine	0.003	0.003	mg/L
Carbofuran	0.04	0.04	mg/L
Chlordane	0.002	0	mg/L
2,4-D	0.07	0.07	mg/L
Dalapon	0.2	0.2	mg/L
DBCP	0.0002	0	mg/L
Dinoseb	0.007	0.007	mg/L
Diquat	0.02	0.02	mg/L

Table C-5. U.S. EPA public drinking water standards (cont.)*

Parameter	Maximum Contaminant Level	Maximum Contaminant Level Goal	Units
Organics (cont.)			
Endothall	0.1	0.1	mg/L
Endrin	0.002	0.002	mg/L
Ethylene dibromide (EDB)	0.00005	0	mg/L
Glyphosate	0.7	0.7	mg/L
Heptachlor epoxide	0.0002	0	mg/L
Heptachlor	0.0004	0	mg/L
Lindane	0.0002	0.0002	mg/L
Methoxychlor	0.04	0.04	mg/L
Oxamyl (Vydate)	0.2	0.2	mg/L
PCBs	0.0005	0	mg/L
Pentachlorophenol	0.001	0	mg/L
Picloram	0.5	0.5	mg/L
Simazine	0.004	0.004	mg/L
2,4,5-TP (Silvex)	0.05	0.05	mg/L
Toxaphene	0.003	0	mg/L
Inorganics			
Arsenic	0.05		mg/L
Fluoride	4	4	mg/L
Asbestos	7	7	MFL
Barium	2	2	mg/L
Cadmium	0.005	0.005	mg/L
Chromium	0.1	0.1	mg/L
Mercury	0.002	2	mg/L
Nitrate (as N)	10	10	mg/L
Nitrite (as N)	1	1	mg/L
Selenium	0.05	0.05	mg/L
Antimony	0.006	0.006	mg/L
Beryllium	0.004	0.004	mg/L
Cyanide	0.2	0.2	mg/L
Nickel	0.1	0.1	mg/L
Thallium	0.002	0.0005	mg/L
Lead	0.015	0	mg/L
Copper	1.3	1.3	mg/L

Table C-5. U.S. EPA public drinking water standards (cont.)*

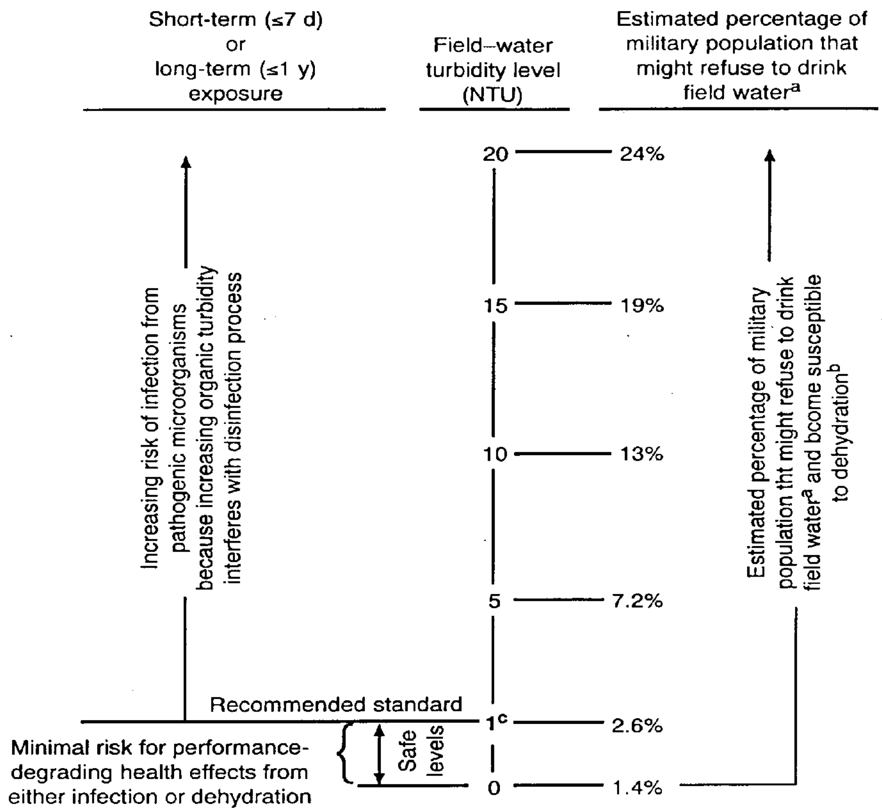
Parameter	Maximum Contaminant Level	Maximum Contaminant Level Goal	Units
Radionuclides			
Gross alpha activity	15		pCi/L
Radium 226, pCi/L	20		pCi/L
Radium 228, pCi/L	20		pCi/L
Combined Radium 226/228	5		pCi/L
Beta activity, mrem	4		mrem
Strontium 90	8		pCi/L
Tritium	20000		pCi/L
Secondary (Aesthetic) Standards			
Aluminum	0.05 - 0.2		mg/L
Chloride	250		mg/L
Color	15		C.U.
Copper	1		mg/L
Corrosivity	>0		LSI
Fluoride	2		mg/L
Foaming Agents	0.5		mg/L
Iron	0.3		mg/L
Manganese	0.05		mg/L
Odor	3		TON
pH	6.5 - 8		
Silver	0.1		mg/L
Sulfate	250		mg/L
Total dissolved solids	500		mg/L
Zinc	5		mg/L

*Source: 40 CFR 141, National Primary Drinking Water Regulations, July 1996

APPENDIX D

HEALTH EFFECTS SUMMARY TABLES

The figures in this appendix are designed to help military personnel identify the health risks associated with drinking water consumption that does not meet the tri-service field water quality standards. More detailed information on each parameter is contained in chapter 7.

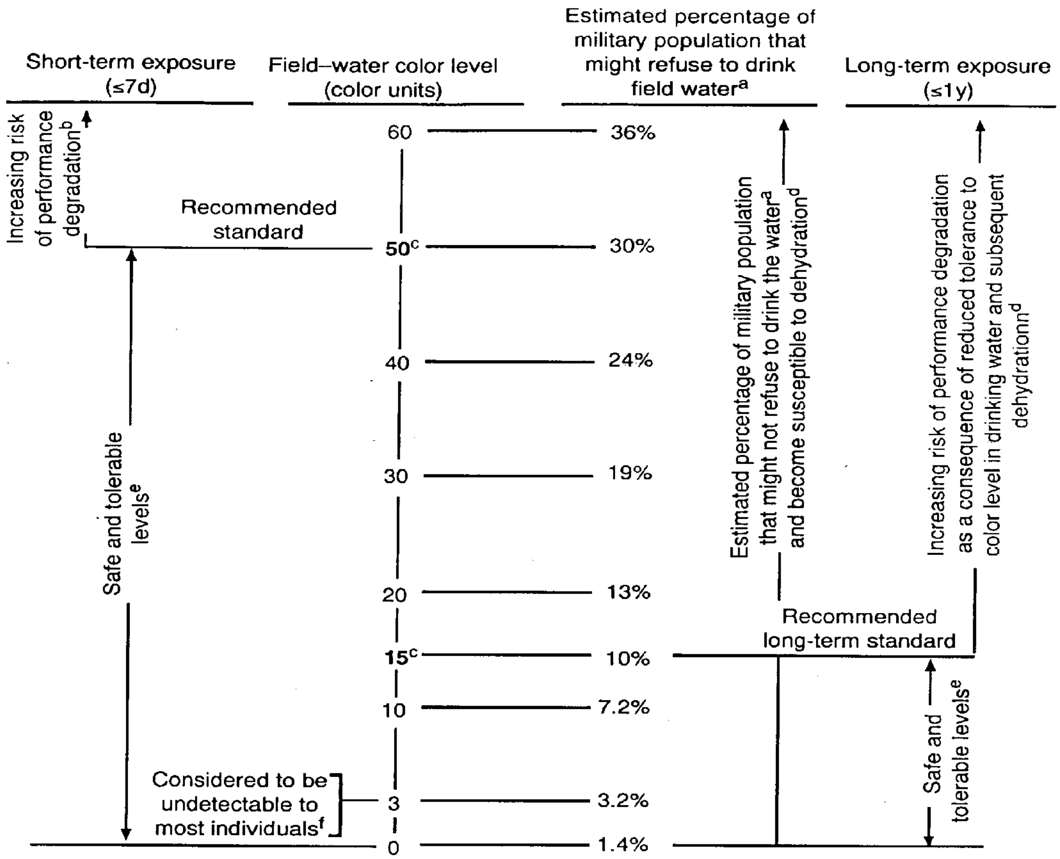


[a]For any combination of color , turbidity, and odor values:
MP= 1.1 + 0.575(c) + 1.15(T) + 0.115(S), where MP = percent of military population that might refuse to drink field water and thereby become susceptible to the performance-degrading effects of dehydration; C = color units; T= nephelometric turbidity units (NTU); and S = threshold odor number (TON). Estimates presented are computed on the basis of zero color units (C) and a TON (S) of three.

[b]Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[c]Because turbidity is an organoleptic property of water (i.e., appearance), the recommended field-water-quality standard for both short- and long-term exposure is applicable to any consumption rate, including ones of 5 and 15 L/d.

Figure D-1. Health-effects summary for turbidity with color absent (i.e., zero) and a threshold odor number (TON) equal to three



[a] for any combination of color, turbidity, and odor values:
MP= 1.1 + 0.575(c) + 1.15(T) + 0.115(S), where MP = percent of military population that might refuse to drink field water and thereby become susceptible to the performance-degrading effects of dehydration; C = color units; T= nephelometric turbidity units (NTU); and S = threshold odor number (TON). Estimates presented are computed on the basis of zero turbidity (T) and a TON (S) of three.

[b] Performance degradation results from decreased tolerance to color level in drinking water and subsequent dehydration

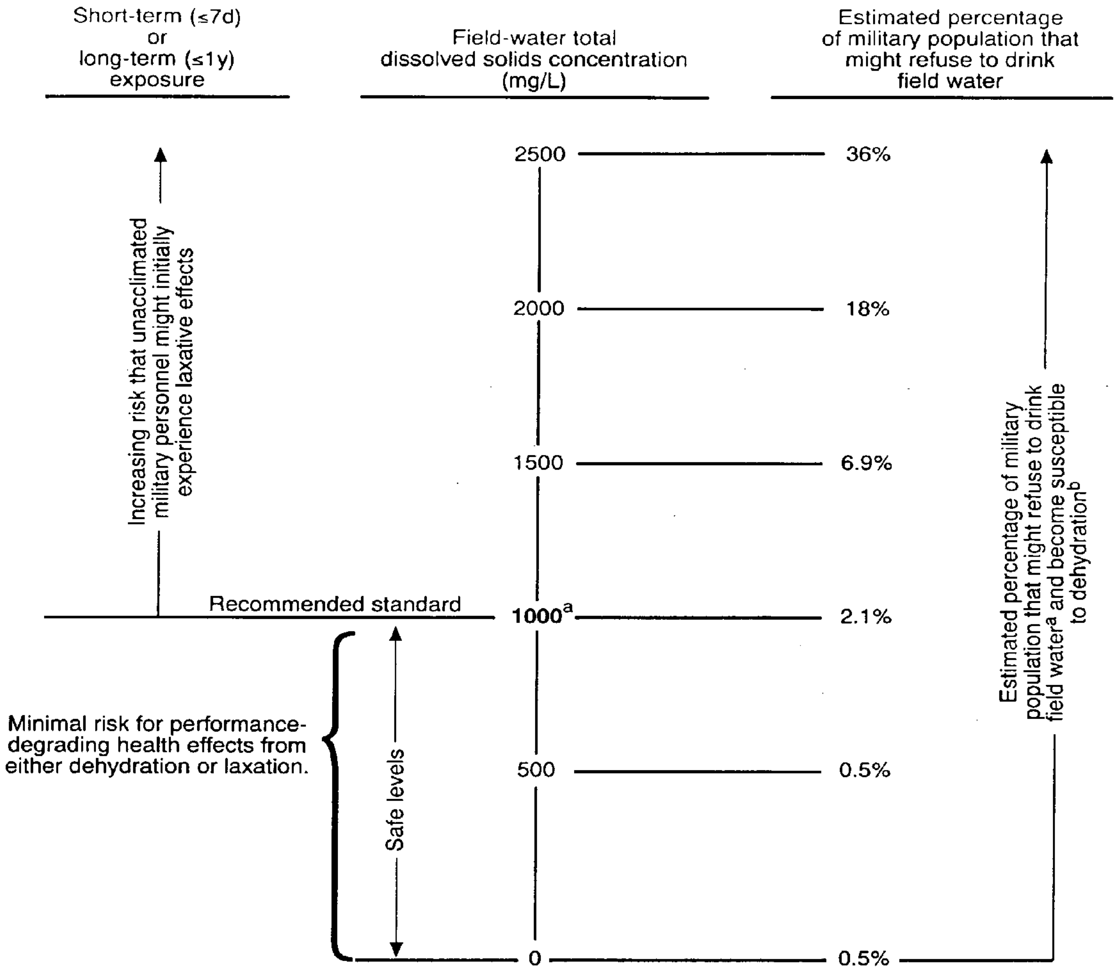
[c] Because color is an organoleptic property of water (i.e., appearance), the recommended field-water-quality standards are applicable to any consumption rate, including ones of 5 and 15 L/d.

[d] Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium and heat stroke

[e] Safe and tolerable color levels are ones that should not impact the performance of military personnel, but which may
require acclimation.

[f] The U.S. Environmental Protection Agency cites evidence indicating that a color level of three color units will not be detectable to many individuals.

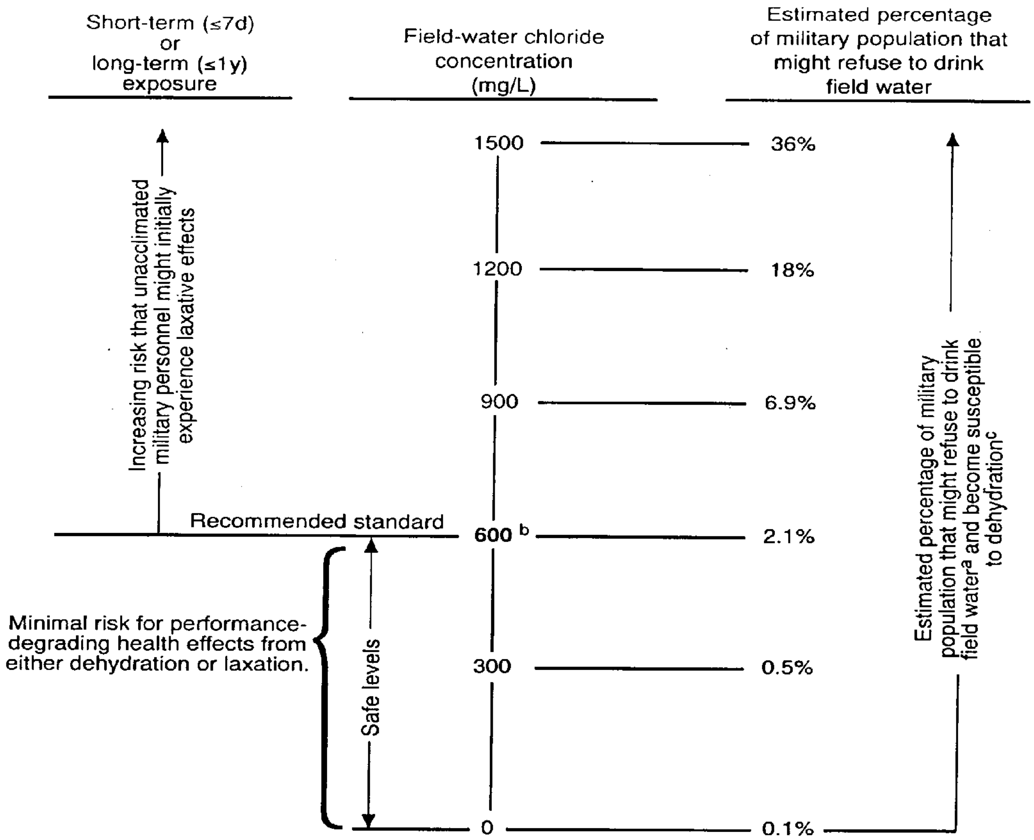
Figure D-2. Health-effects summary for color with turbidity absent (i.e., zero) and a threshold odor number (TON) equal to three



[a]Because total dissolved solids at concentrations less than or equal to 1000 mg/L are only organoleptically of concern (i.e., affect taste), the recommended field-water-quality standard for both short- and long-term exposures is applicable to any consumption rate, including ones of 5 and 15 L/ d.

[b]Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium and heat stroke.

Figure D-3. Health-effects summary for total dissolved solids (TDS)

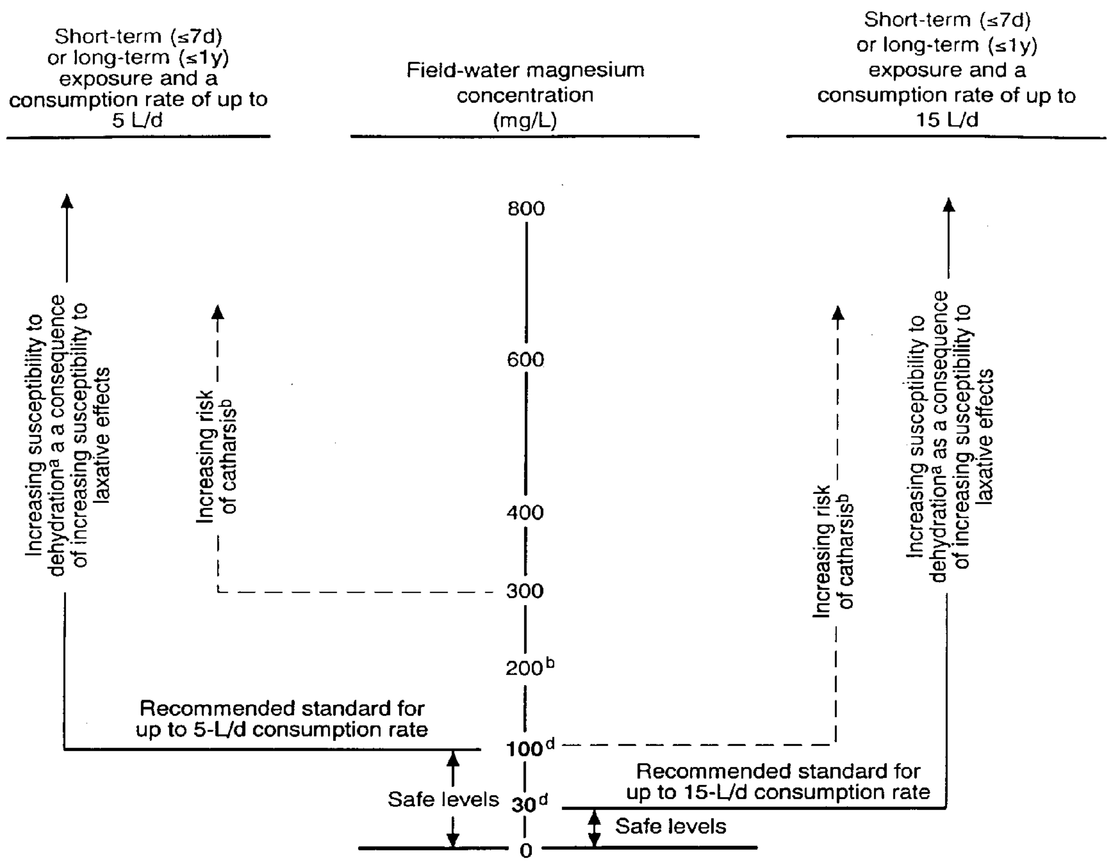


[a]Estimates are made assuming chloride ion constitutes 60% of total dissolved solids (TDS) concentration because sodium and chloride ions are considered to be the predominant constituents of the TDS content of most field waters, particularly seawater processed through the reverse osmosis water purification unit (ROWPU).

[b]Because chloride ions at concentrations less than or equal to 600 mg/L are only organoleptically of concern (i.e., affect taste), the recommended field-water-quality standard for both short- and long-term exposures is applicable to any consumption rate, including ones of 5 and 15 L/d.

[c]Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

Figure D-4. Health-effects summary for chloride



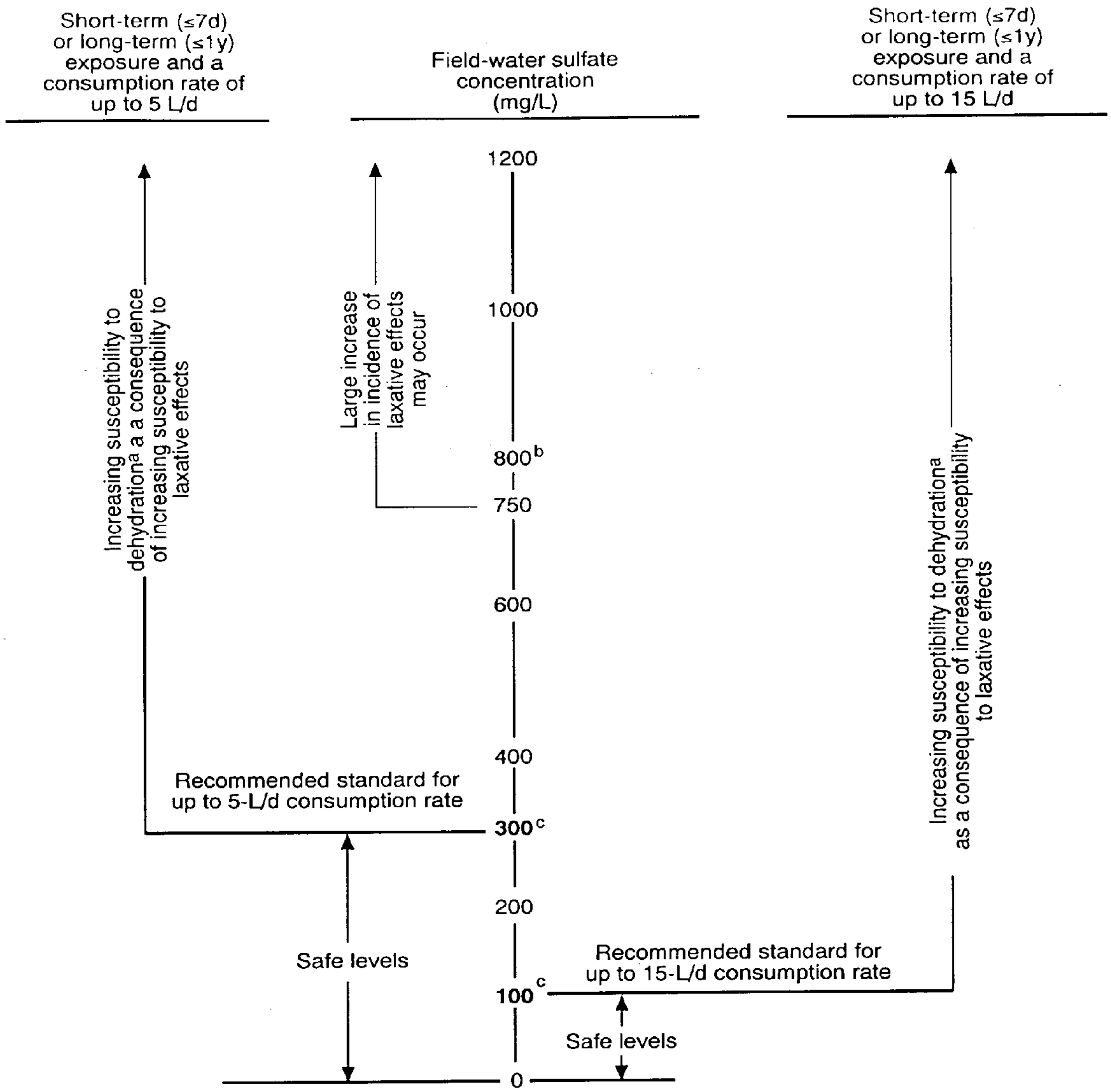
[a]Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[b]Based on a laxative dose of 15 g of epsom salts ($MgSO_4 \cdot 7H_2O$), effects include semifluid or watery evacuation in 3 h or less. Doses lower than 15 g produce laxative effects with a longer latency period.

[c]Although many individuals would perceive water to have an inferior taste, a few individuals might consider water consumable and for them taste alone might not be an effective warning of laxative effects.

[d]Recommended field-water-quality standard for magnesium-ion concentration for indicated daily consumption rate and exposure periods up to either 7 d or 1 y.

Figure D-5. Health-effects summary for magnesium

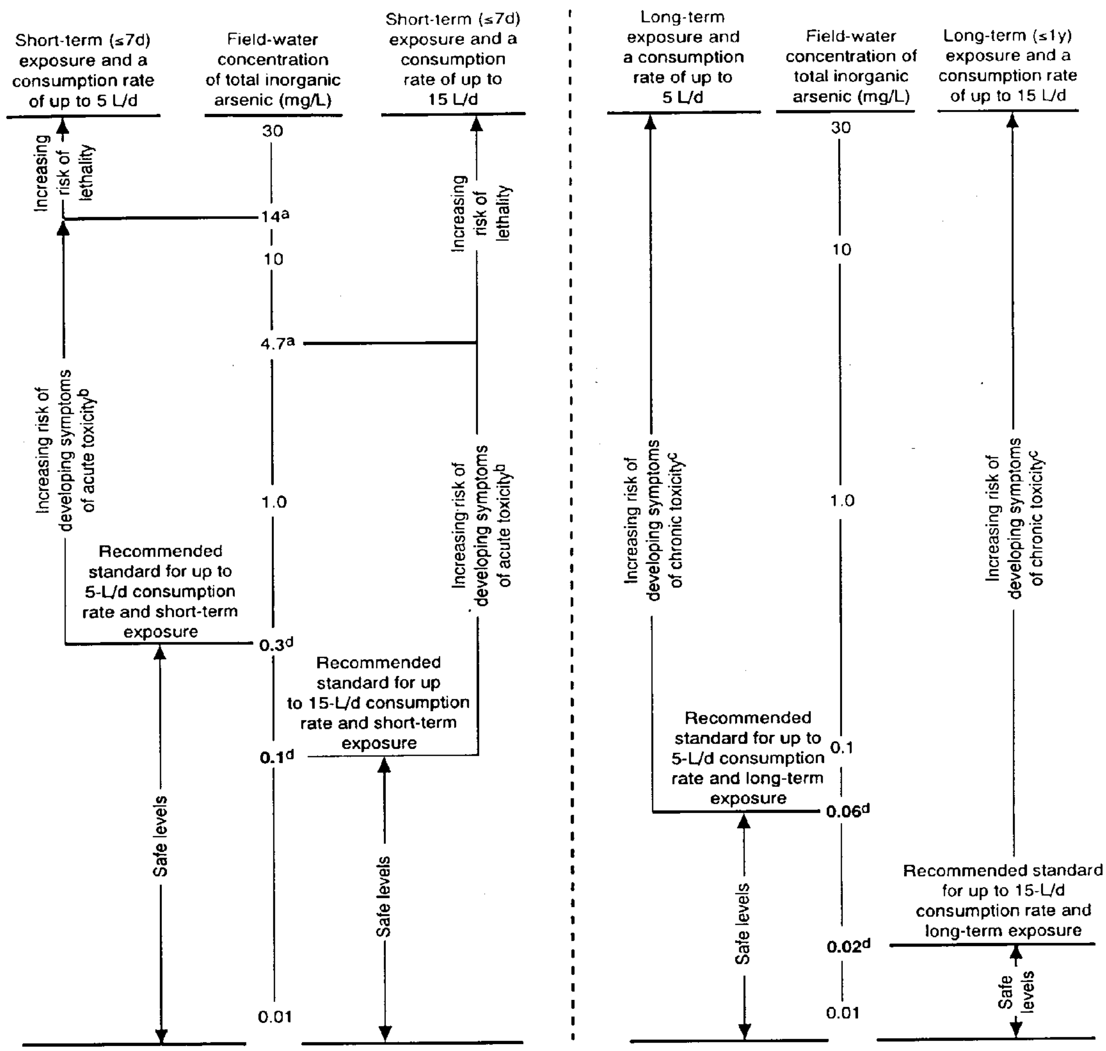


[a]Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[b]Although many individuals would perceive water to have an inferior taste, a few individuals might consider water consumable and for them taste alone may not be an effective warning of laxative effects.

[c]Recommended field-water-quality standard for sulfate-ion concentration for indicated daily consumption rate and exposure periods up to either 7 d or 1 y.

Figure D-6. Health-effects summary for sulfate



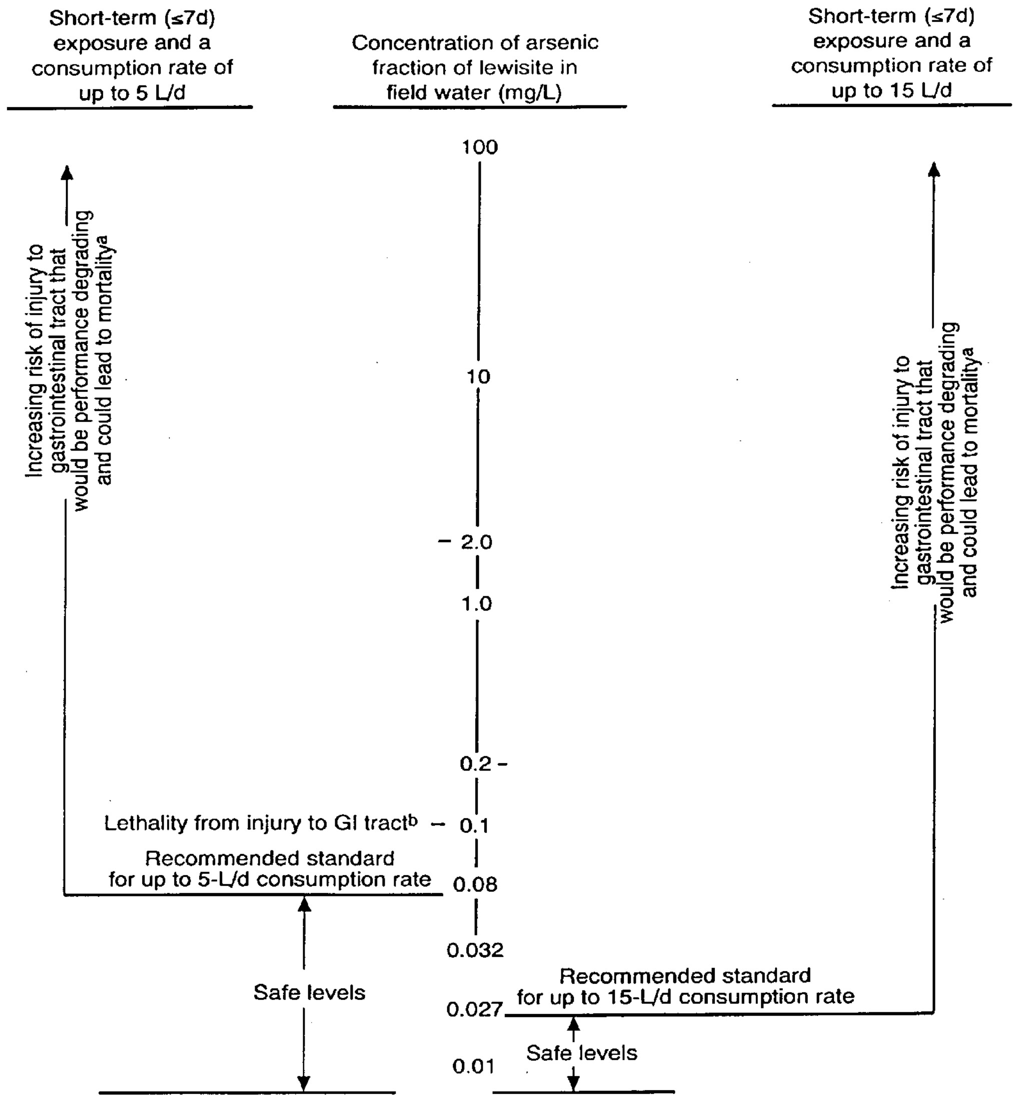
[a]Concentration corresponding to an increasing risk of lethality was calculated based on a single, oral dose of 70 mg of arsenic.

[b]Symptoms of acute arsenic toxicity may include edema, nausea, vomiting, headache, and abdominal pain.

[c]Characteristic symptoms of chronic arsenic toxicity include skin effects (pigmentation changes, keratosis and skin cancer), gastrointestinal problems, peripheral vascular disease, and neurological changes.

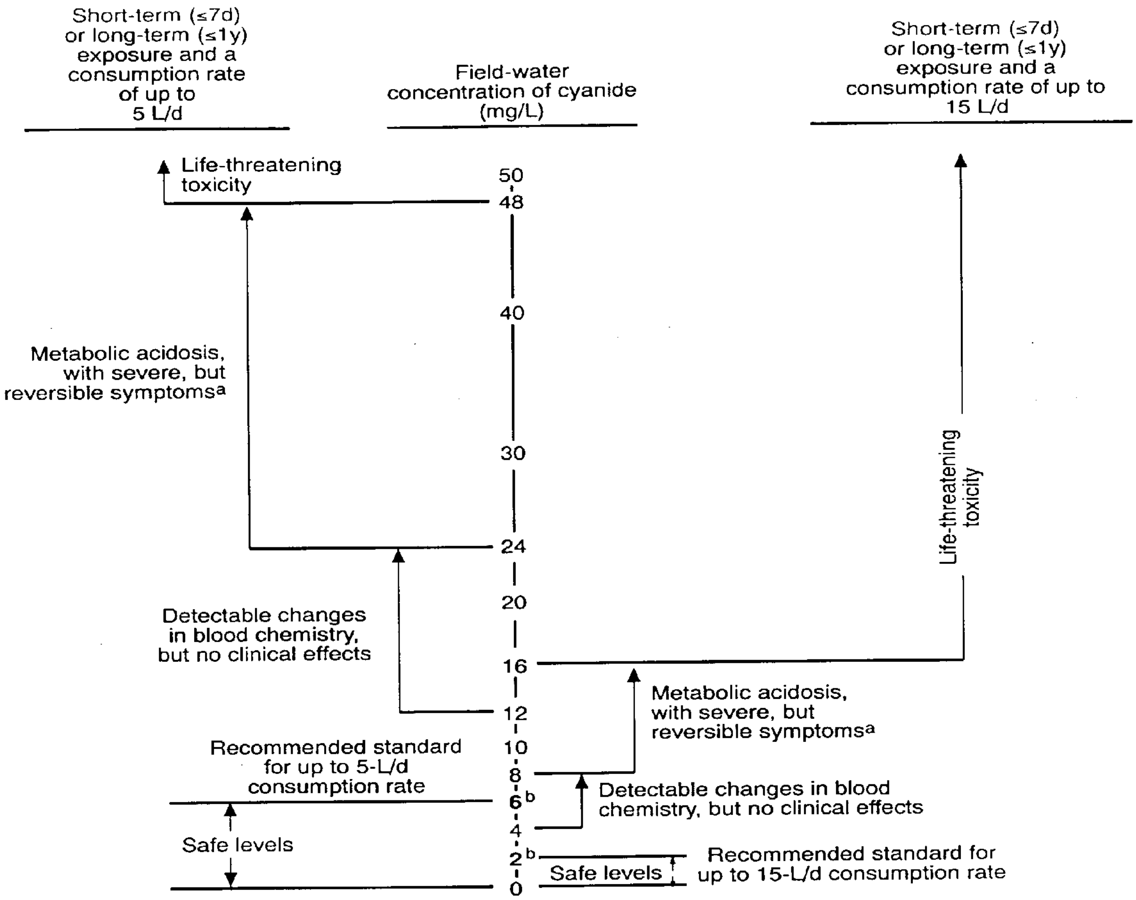
[d]Recommended field-water-quality standard for indicated daily consumption rate and exposure period.

Figure D-7. Health-effects summary for arsenic



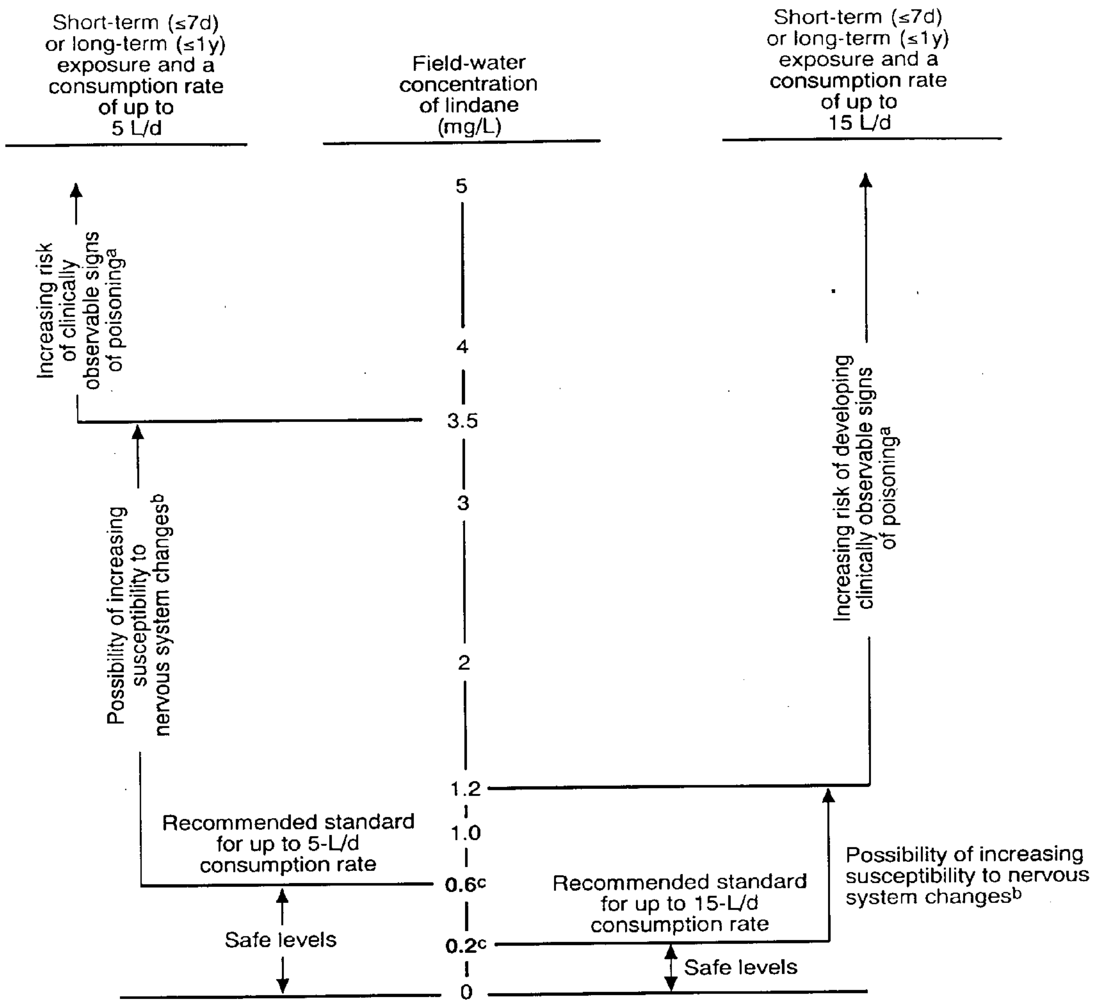
[a]Based on extrapolation from effect of doses above NOEL for rabbits.

Figure D-8. Health-effects summary for lewisite



[a]Symptoms of acute cyanide toxicity can include headache, weakness, palpitation, nausea, giddiness, and tremors.
[b]Recommended field-water-quality standard for indicated daily consumption rate and exposure period.

Figure D-9. Health-effects summary for cyanide and hydrogen cyanide

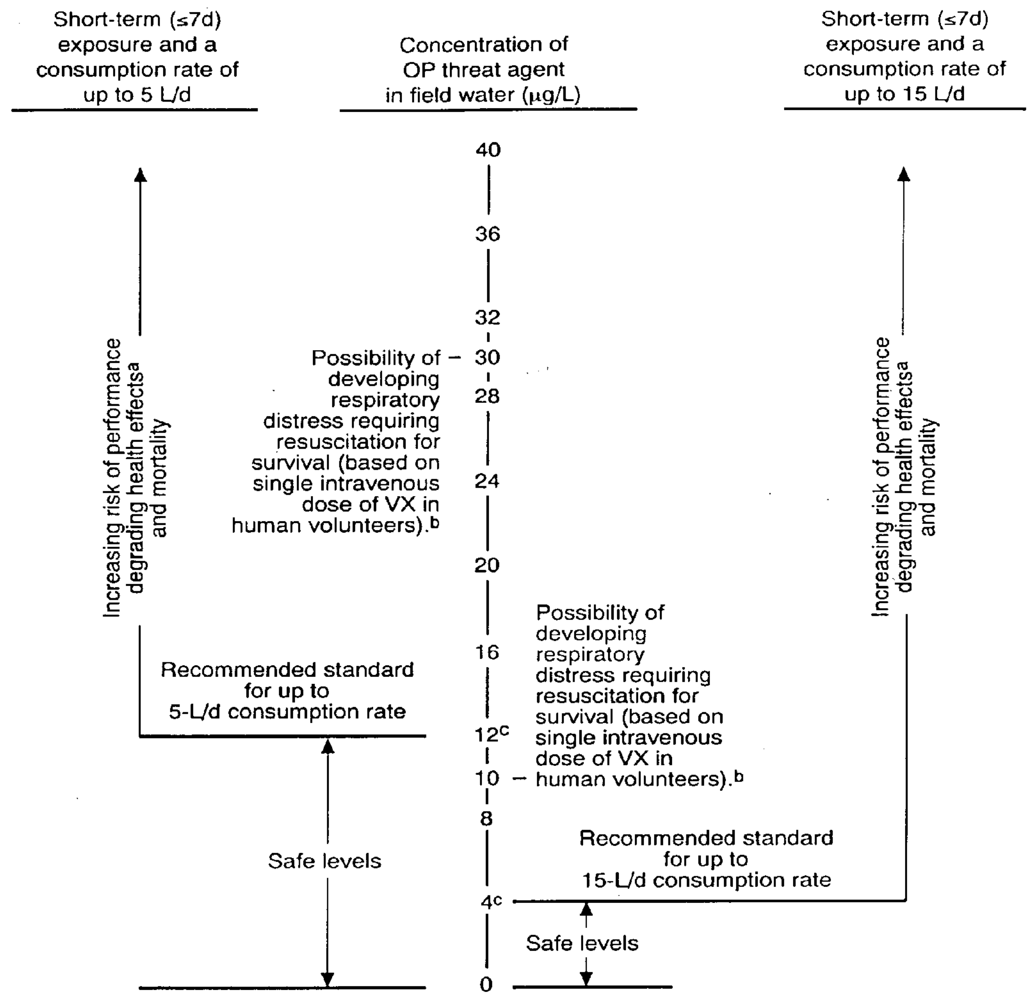


[a]Based on extrapolation to humans from a minimal-effects dose reported in a lifetime feeding study of laboratory animals and the application of a 10-fold safety factor.

[b]Evidence from long-term feeding studies of laboratory animals indates that low doses of lindane may be associated with subclinical effects on the nervous system.

[c]Recommended field-water-quality standard for indicated daily consumption rate and exposure periods up to either 7 d or 1 y. Based on human data and the application of a 10-fold safety factor.

Figure D-10. Health-effects summary for lindane

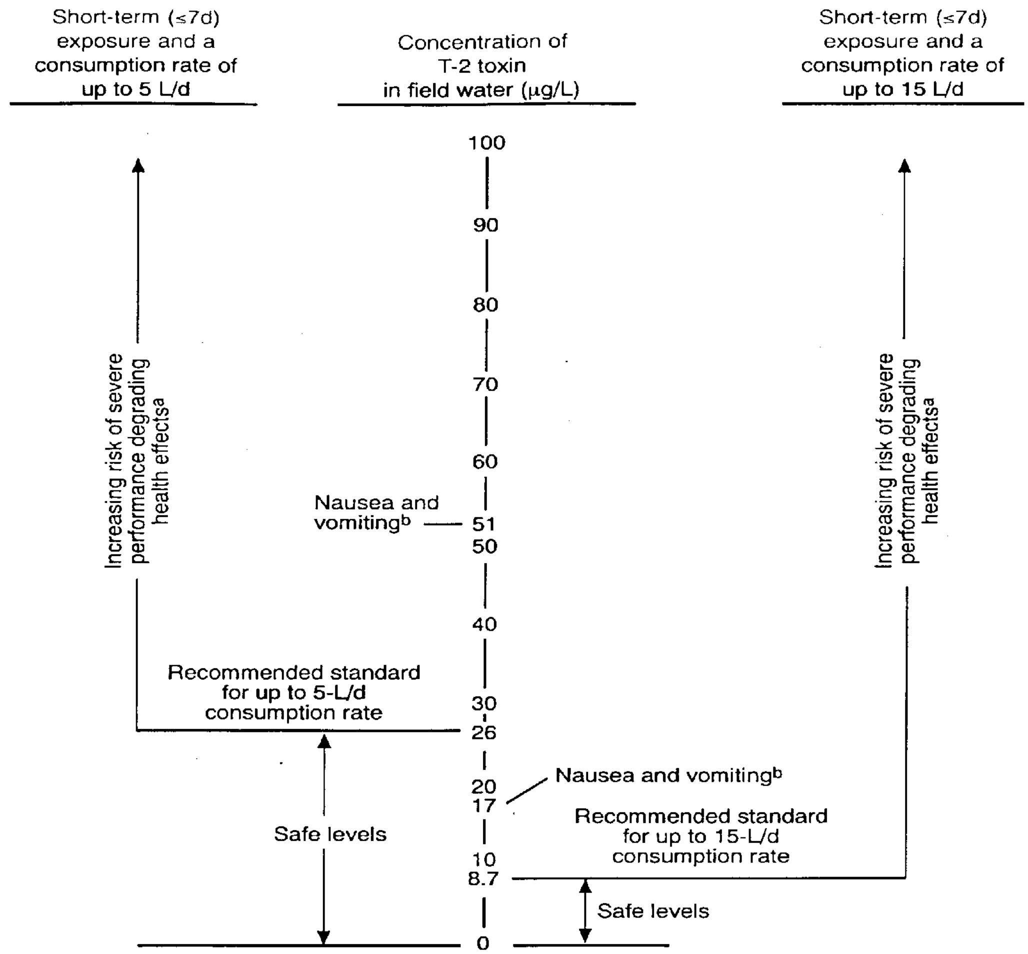


[a]Performance-degrading health effects can include abdominal cramps, vomiting, diarrhea, and headache.

[b]Response considered possible on the basis of a single intravenous dose of VX in humans of 2.12 µg/kg converted to a drinking water concentration. This response and corresponding concentration are presented because lethality data for repeated ingestion of OP threat agents over time are not available for humans. Furthermore, VX is the most toxic OP threat agent when administered intravenously in a single dose to humans, but appears to be less toxic than GD when ingested in several divided doses over time.

[c]Interim standards for OP threat agents are based on the MPC for GD because GD appears to be the most toxic OP threat agent where a total dose from field water is ingested in several drinks separated in time over the course of a day for an exposure period lasting up to 7 d.

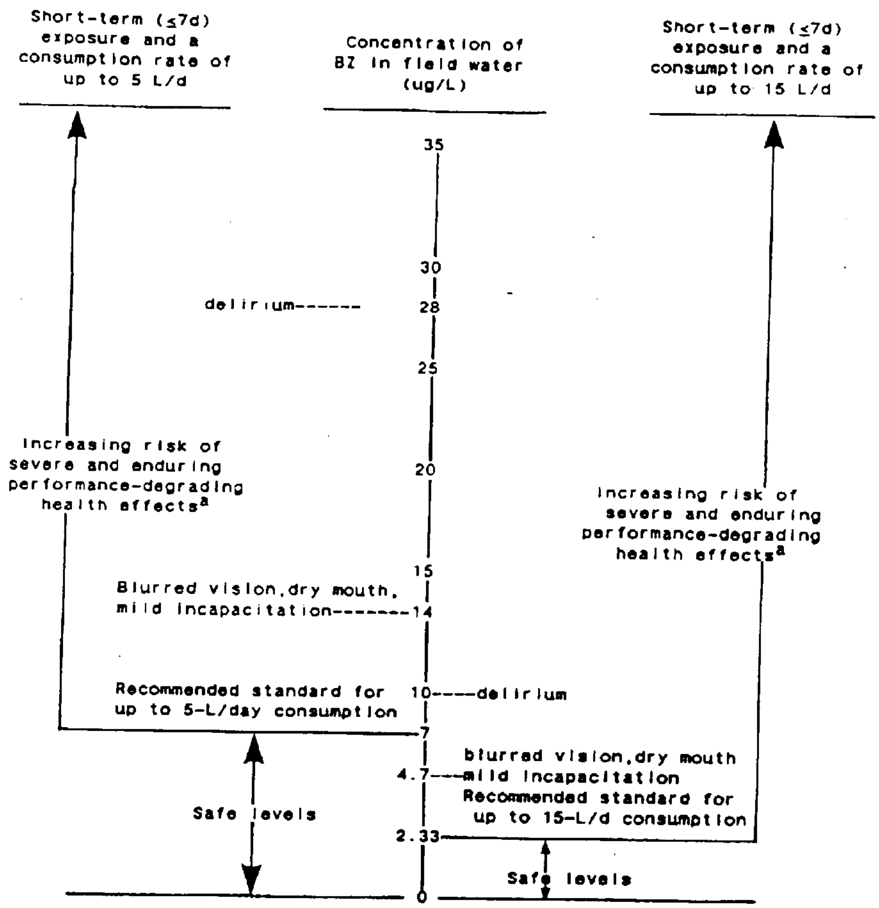
Figure D-11. Health-effects summary for the organophosphorus nerve agents



[a]Potentially performance-degrading health effects may include nausea, vomiting, diarrhea, generalized burning erythema, and mental confusion according to studies with where patients were treated with a chemotherapeutic agent considered analogous to trichothecene mycotoxin, T-2.

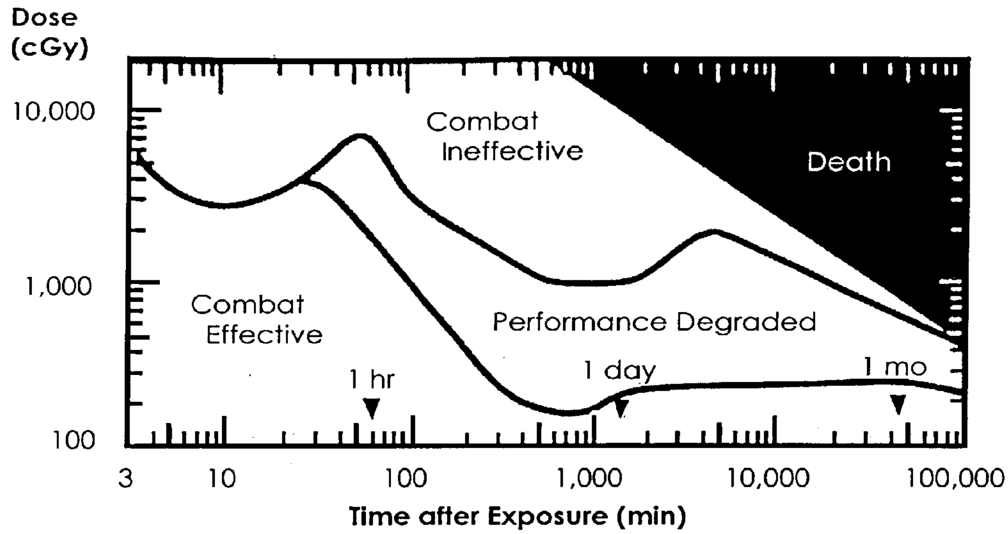
[b]Based on lowest daily intravenous dose of a chemotherapeutic agent considered analogous to T-2 that caused nausea and vomiting in cancer patients. Most severe health effects were reported in cancer patients administered a daily dose of the agent by rapid intravenous infusion for 5 d that was about 30 times greater than the one used to calculate the standards. Therefore, concentrations of T-2 toxin that are 30 times greater than the recommended interim field-water-quality standards are expected to produce the most severe toxic symptoms.

Figure D-12. Health-effects summary for the trichothecene mycotoxin, T-2

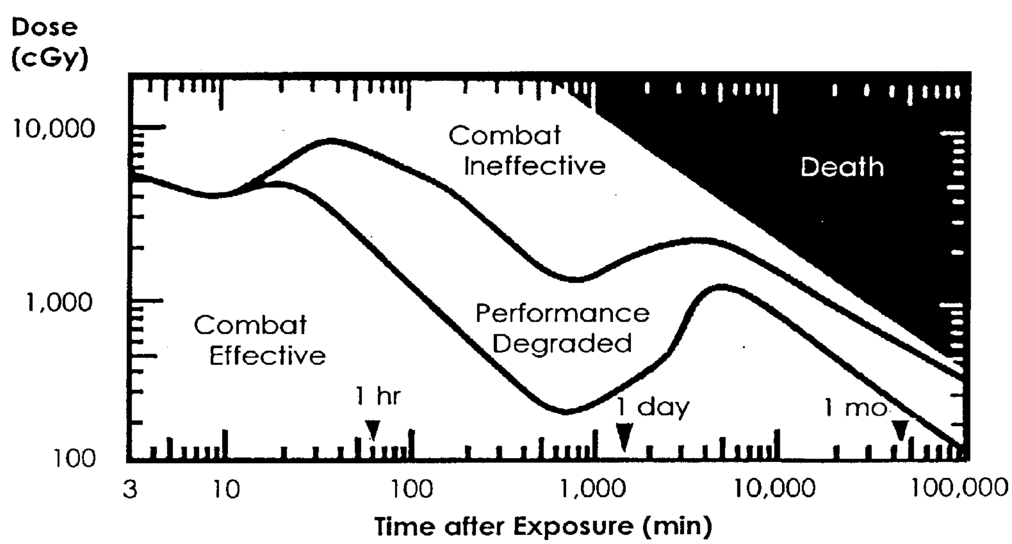


[a]Performance-degrading health effects may include rapid pulse, decreased salivation, blurred near vision, decreased mental performance, poor coordination, restlessness, stupor, hallucinations, delirium.

Figure D-13. Health-effects summary for 3-quinuclidinyl benzilate (BZ) in field water

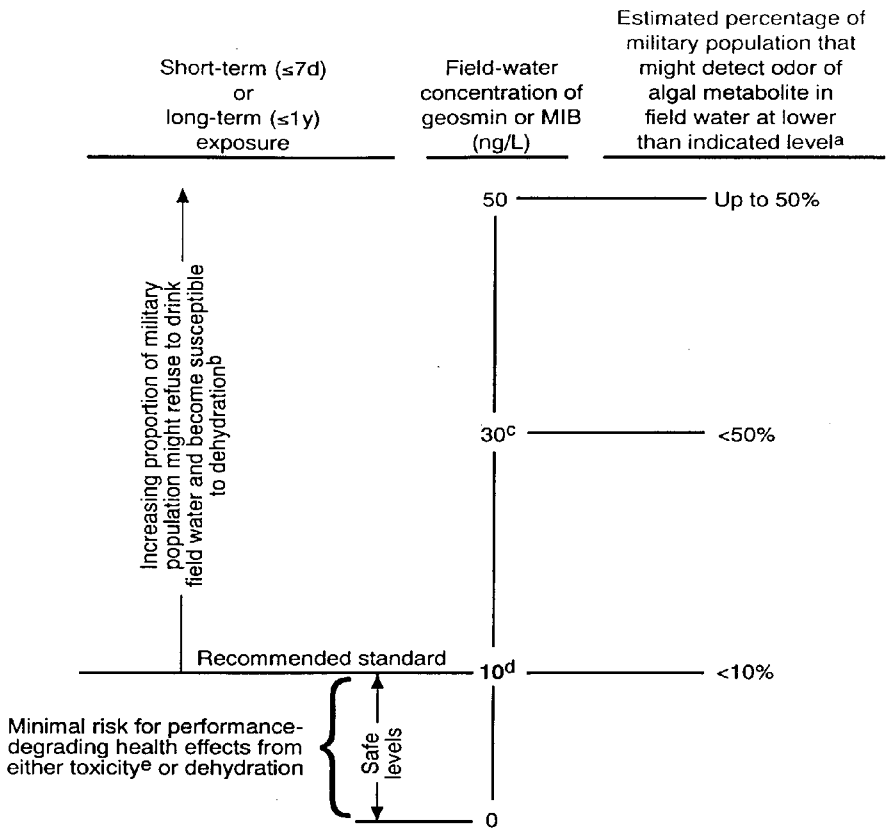


Expected response to radiation for physically demanding tasks.



Expected response to radiation for physically undemanding tasks.

Figure D-14. Risk of death or performance degradation (vomiting) from radiation



[a]Estimates for a military population are based on information available in the literature on the predicted response of the general public to geosmin and MIB in drinking water.

[b]Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[c]The greatest number of complaints from the general public appear to occur at concentrations of geosmin above 30 ng/L. This is not recommended as a standard for military personnel because it has been reported that concentrations of geosmin above 30 ng/L. This is not recommended as a standard for military personnel because it has been reported that concentrations exceeding 10 ng/L may be associated with the presence of toxins released by cyanobacteria (see Volume 4, Part 1).

[d]Because geosmin and MIB affect the organoleptic quality of water (i.e., taste and odor), the recommended field-water-quality standards are applicable to any consumption rate, including 5 and 15 L/d.

[e]Poisoning from toxins released by cyanobacteria is considered unlikely at concentrations of geosmin and MIB less than or equal to 10 ng/L. WARNING: Risk of poisoning from toxins released by cyanobacteria increases at levels above the recommended standard for geosmin and MIB, especially if an algal bloom is present and earthy/musty odors are detectable.

Figure D-15. Health-effects summary for the organoleptic metabolites of algae and associated aquatic bacteria

APPENDIX E

CHLORINE DOSAGE CALCULATIONS

There are two methods for determining the amount of chlorine to add to a given volume of water to produce a desired chlorine residual.

a. Use table E-1 as a guide for determining chlorine dosage based on gallons of water to be chlorinated and the type of chlorine solution to be used.

Example: you wish to produce a 100 ppm (mg/L) chlorine solution in a 5-gallon bucket of water for use during a sanitation wipedown. You use 70 percent available calcium hypochlorite. Using table E-1, you determine you need to add 0.1 ounces of 70 percent calcium hypochlorite to the 5 gallons of water to achieve the 100 ppm solution. Note that you can also use multiples of the values in the table. For example, you need to chlorinate 500 gallons of water to a residual of 3 ppm (mg/L). From table E-1, you note that to chlorinate 500 gallons to a residual of 1 ppm, 1.28 ounces of 5 percent bleach are needed. Since we want three times this residual (that is, 3 ppm), we can triple the amount of chlorine. Thus, you determine you need 3.84 ounces of 5 percent bleach.

b. Calculate the amount of chlorine required using the standards conversion formula below:

$$\text{Pounds of chlorine} = \frac{\text{gallons of water} \times 8.34 \times \text{desired residual in ppm}}{(\text{percent available chlorine}/100) \times 1{,}000{,}000}$$

Example: You need to chlorinate 1,000 gallons of water to a free-available chlorine residual of 5 ppm (mg/L) using 70 percent available solid sodium hypochlorite. How many pounds of sodium hypochlorite do you add to the 1,000 gallons?

$$\text{Pounds of chlorine} = \frac{1{,}000 \times 8.34 \times 5}{(70/100) \times 1{,}000{,}000} = 0.06 \text{ pounds of chlorine}$$

Table E-1. Chlorine dosage calculator

Desired parts per million	1	1	1	1	5	5	5	5	25	25	25	25	50	50	50	50	100	100	100	100	200	200	200	200
Strength of chlorine solution	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%
Gallons of water to be chlorinated	1	1 lb	10	6.7	5	8 lb	3	2 lb	25	41 lb	14 lb	10 lb	50	83 lb	30	20 lb	100	166 lb	59 lb	41 lb	200	333 lb	119 lb	83 lb
50,000	gal	11 oz	oz	oz	gal	6 oz	lb	2 oz	gal	12 oz	15 oz	7 oz	gal	7 oz	lb	14 oz	gal	13 oz	10 oz	12 oz	gal	10 oz	4 oz	7 oz
25,000	2 qt	134 oz	5 oz	3.34 oz	2.5 gal	4 lb 3 oz	1 lb 8 oz	1 lb 1 oz	125 gal	20 lb 14 oz	7 lb 8 oz	5 lb 4 oz	25 gal	41 lb 12 oz	15 lb	10 lb 7 oz	50 gal	83 lb 7 oz	29 lb 13 oz	20 lb 14 oz	100 gal	166 lb 13 oz	59 lb 10 oz	41 lb 12 oz
10,000	25.6 oz	5.5 oz	2 oz	1.34 oz	1 gal	1 lb 11 oz	9.6 oz	6.72 oz	5 gal	8 lb 6 oz	3 lb	2 lb 2 oz	10 gal	16 lb 11 oz	6 lb	4 lb 3 oz	20 gal	33 lb 6 oz	12 lb	8 lb 6 oz	40 gal	66 lb 12 oz	23 lb 14 oz	16 lb 11 oz
5,000	12.8 oz	2.8 oz	1 oz	.61 oz	2 qt	14 oz	4.8 oz	3.36 oz	2.5 gal	4 lb 3 oz	1 lb 8 oz	1 lb 1 oz	5 gal	8 lb 6 oz	3 lb	2 lb 2 oz	10 gal	16 lb 11 oz	6 lb	4 lb 3 oz	20 gal	33 lb 6 oz	11 lb 12.4 oz	8 lb 6 oz
2,000	5.12 oz	1.1 oz	.4 oz	.26 oz	25.6 oz	6 oz	1.92 oz	1.35 oz	1 gal	1 lb 11 oz	9.6 oz	6.68 oz	2 gal	3 lb 6 oz	11 lb 4 oz	13.5 oz	4 gal	6 lb 11 oz	2 lb 62 oz	1 lb 11 oz	8 gal	13 lb 6 oz	4 lb 12.4 oz	3 lb 6 oz
1,000	2.56 oz	.55 oz	.2 oz	.14 oz	12.8 oz	.3 oz	.96 oz	.68 oz	2 qt	13.6 oz	4.8 oz	3.34 oz	1 gal	1 lb 11 oz	9.6 oz	6.72 oz	2 gal	3 lb 6 oz	1 lb 3.1 oz	13.5 oz	4 gal	6 lb 11 oz	2 lb 6.2 oz	1 lb 11 oz
500	1.28 oz	.28 oz	.1 oz		6.4 oz	1.4 oz	.48 oz	.34 oz	1 qt	6.72 oz	2.4 oz	1.67 oz	2 qt	13.5 oz	4.8 oz	3.36 oz	1 gal	1 lb 11 oz	9.54 oz	6.72 oz	2 gal	3 lb 6 oz	1 lb 3.1 oz	134 oz
200	.512 oz	.11 oz			2.56 oz	.56 oz	.2 oz	.14 oz	12.8 oz	2.68 oz	.96 oz	.68 oz	25.6 oz	5.4 oz	1.92 oz	1.35 oz	51.2 oz	10.7 oz	3.82 oz	2.67 oz	102.4 oz	1 lb 6 oz	7.64 oz	5.34 oz
100	.256 oz				1.28 oz	.28 oz	.1 oz	.64 oz	.64 oz	1.35 oz	.48 oz	.34 oz	12.8 oz	2.7 oz	.96 oz	.68 oz	25.6 oz	5.4 oz	1.91 oz	1.35 oz	51.2 oz	10.7 oz	3.82 oz	2.67 oz
50	.13 oz				.64 oz	.14 oz			3.2 oz	.68 oz	.24 oz	.17 oz	6.4 oz	1.4 oz	.48 oz	.34 oz	12.8 oz	2.72 oz	.96 oz	.68 oz	25.5 oz	5.4 oz	1.91 oz	1.34 oz
25	.064 oz				.32 oz				1.6 oz	.34 oz	.12 oz		3.2 oz	.68 oz	.24 oz	.17 oz	6.4 oz	1.36 oz	.48 oz	.34 oz	12.8 oz	2.72 oz	.96 oz	.67 oz
10	.026 oz				.128 oz				.64 oz	.14 oz			1.28 oz	.3 oz	.1 oz		2.56 oz	.56 oz	.192 oz	.14 oz	5.12 oz	1.12 oz	.384 oz	.27 oz
5	.013 oz				.064 oz				.32 oz				.64 oz	.14 oz			1.28 oz	.28 oz	.1 oz		2.56 oz	.56 oz	.192 oz	.14 oz

Materials used are as follows: 5%-sodium hypochlorite (liquid) 25%-chlorinated lime (solid) 70%-calcium hypochlorite (solid) 100%-gaseous chlorine

APPENDIX F

MEASUREMENT OF CHLORINE RESIDUAL AND pH

F-1. General

Currently, the preferred method for measuring chlorine residual in field water supplies is the N,N-diethyl-p-phenylenediamine (DPD) color comparator.

F-2. DPD color comparator procedures

a. Wallace and Tiernan Model U25337.

(1) Place the DPD chlorine color comparator disc in the comparator.

(2) Select two clean comparator sample tubes.

(3) Fill one cell to the 15 mL mark with test water.

(4) Insert the cell into the right-hand cell compartment of the comparator. This cell, when filled to the mark, compensates for color and turbidity.

NOTE: The omission of this step may cause serious errors.

(5) Collect just enough test water to cover the bottom of the second sample cell.

(6) Add two DPD No. 1 tablets to the second sample cell and crush them with the stirring rod. Fill the sample cell to the 15 mL mark with test water and insert it into the left-hand cell compartment of the comparator.

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

(8) Color matching will be completed as soon as possible after the addition of the DPD tablets. The reading should be made within 1 minute; delays of 2 minutes or more can produce incorrect results.

(9) If the color of the indicator tube is between two colors on the chlorine color comparator, the value will be estimated. Choose a value between the readings corresponding to the colors on either side of the indicator color.

(10) When the test has been completed, remove sample cells from the comparator, empty the samples, and wash the cells with clean water.

b. LaMotte-Palin Model LP-8.

(1) Select one clean comparator sample tube.

(2) Rinse the sample tube with part of the test sample, then fill the tube to the mark with sample water.

(3) Add one DPD No. 1 tablet to the test tube and crush the tablet with a glass rod.

(4) Cap the test tube and shake to dissolve the tablet.

(5) Immediately insert the test tube into the comparator.

(6) Hold the comparator about 1 foot away and face a good light source. Match the color of the sample with the color standards in the comparator. Read the value which is expressed in mg/L.

(7) Follow steps (8) through (10) above.

F-3. Precautions

a. General. As with all chemicals, exercise caution in handling DPD tablets. To ensure the greatest accuracy, follow the precautions listed below--

(1) Cleanliness.

(a) Before taking readings, be sure that the color standards in the disk and the plastic tubes are clean.

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

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

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

b. Sample tubes. Color disks are adjusted for sample tubes having a 26-millimeter depth and on the basis of 15 mL of water sample. The graduated mark on the sample tubes is at 15 mL.

F-4. pH determinations

a. Wallace and Tiernan procedure. Measure the pH using the procedure described in paragraph D-2a except that:

(1) Second sample cell is filled to the 15 mL mark.

(2) One dropper full (0.5 mL) of pH indicator solution is substituted for the appropriate DPD tablet.

(3) The pH disk is used instead of the chlorine color disk.

b. LaMotte-Palin procedure. The LaMotte-Palin Phenol Red Indicator Tablet contains Halidex that eliminates the bleaching effect of chlorine or bromine on the pH indicator disk. No additional treatment is required when the halogen level is below 8.0 mg/L.

(1) Rinse the test tube with the sample, then fill it to the mark.

(2) Add one LaMotte-Palin Phenol Red Indicator Tablet, cap, and gently shake to dissolve.

(3) Immediately insert the tube into the comparator to obtain a color match. If the test sample color is in between two standard colors, the midpoint between the two standard values is taken as the value of the sample.

F-5. Equipment

If new equipment kits are needed or available equipment is not adequate, replacement chlorine residual kits should be ordered using the information in table F-1.

Table F-1
Nomenclature for ordering equipment kits

NSN Identifier	Item
6630-01-115-5281	Disk, Color Standard, Free Chlorine, DPD Method, Wallace & Tiernan Company. Item used to modify the existing comparator, NSN 6630-00-087-1838. The kit consists of one color disk for use with DPD reagent, a revised instruction book, a revised plastic-inclosed instruction card, and an instruction sheet on the steps to be taken to modify the existing comparator.
6630-01-044-0334	Comparator, Color, Hydrogen Ion and Residual Chlorine, Wallace & Tiernan Company. Item used in performing pH and chlorine determinations of water in the field. The kit consists of one color comparator with prismatic eyepiece assembly, four rectangular sample cells, one pH reagent bottle, one DPD chlorine color disk, one pH color disk, operating instructions, service data, and carrying case. Replacement item for NSN 6630-00-087-1838.
6630-01-027-3914	Comparator, Color, Hydrogen Ion and Residual Chlorine, LaMotte Chemical Products Co. Item used in performing pH and chlorine determinations in the field. The kit contains two chlorine comparator blocks, one pH comparator block, sample tubes, pH and DPD No. 1, No. 2, No. 3, and No. 4 tablets.
6810-00-087-2340	pH indicator solution. Item used to measure pH when used with pH color disk.
6810-01-044-0315	Chlorine Test Tablet, DPD Method, 100's, Wallace & Tiernan Company. Item used with NSNs 6630-01-027-3914 and 6630-01-044-0334. Comparator to determine chlorine content in water. Item consists of 100 foil-wrapped DPD No. 1 tablets.
6640-00-926-2236	Dropper bottle, pn 893.

Glossary

Section I. Abbreviations

AR	Army regulation
AFI	Air Force Instruction
AFM	Air Force Manual
AFMIC	Armed Forces Medical Intelligence Center
AFOSH	Air Force Occupational Safety and Health
AFR	Air Force Regulation
ALI	annual limits of intake
BOD_5	5-Day Biochemical Oxygen Demand
BZ	3-quinuclidinyl benzilate
$^\circ C$	degrees Celcius
CFR	Code of Federal Regulations
cGy	centiGray
Cl^-	chloride ion
cm	centimeter
CNS	central nervous system
CONUS	continental United States
CWA	Clean Water Act
DE	diatomaceous earth
DEPMEDS	Deployable Medical System
DOD	Department of Defense
DPD	N,N-diethyl-p-phenylenediamine
EPA	U.S. Environmental Protection Agency

°F	degrees Fahrenheit
FAC	free-available chlorine
FAWPSS	forward area water point supply system
FM	field manual
FTU	Fulton turbidity unit
g/L	grams per liter
gph	gallons per hour
gpm	gallons per minute
HD	distilled mustard
HOCl	hypochlorous acid
HT	impure mixture
HTH	high test hypochlorite
ISO	International Standard Organization
JTU	Jackson turbidity unit
kBq/L	kilobacque per liter
kW	kilowatt
L	liter
L/day	liter per day
LCPT	lightweight collapsible pillow tank
m	meter
MCL	maximum contaminant level
MFL	millions of fibers per liter
$mgCl_2$	magnesium chloride
mg/d	milligram per day
mg/L	milligrams per liter
mg^{+2}	magnesium ion
mL	milliliter
MOPP	mission-oriented protection posture
MRE	meal ready to eat
NaCl	salt
NATO	North Atlantic Treaty Organization
NAVMED	Navy Medical
NBC	nuclear, biological, chemical
NCO	Noncommissioned Officer
NIOSH	National Institute for Occupational Safety and Health

NSN	national stock number
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric turbidity unit
OCl-	hypochlorite ion
OCONUS	outside continental United States
OEBGD	Overseas Environmental Baseline Guidance Document
OP	organophosphorus
pCi/L	picocurie per liter
pH	hydrogen-ion concentration
PMCS	preventive maintenance checks and services
POL	petroleum, oil, and lubricant
ppm	parts per million
psi	pounds per square inch
PWS/DS	potable water storage and distribution system
QSTAG	Quadripartite standardization agreement
rad	standard unit of radiation absorb dose
RCRA	Resource Conservation and Recovery Act
rem	standard unit of radiation dose equivalent
RO	reverse osmosis
ROM	reverse osmosis membrane
ROWPU	reverse osmosis water purification unit
SMFT	semitrailer-mounted fabric tank
SO_4^{-2}	sulfate
STANAG	standardization agreement
STP	sewage treatment plant
TB MED	technical bulletin (medical)
TB	technical bulletin
TC	training circular
TDS	total dissolved solid(s)
THD	thickened mustard
TM	technical manual
TSS	total suspended solids
TWDS	tactical water distribution system
μCi/L	micro curie per liter
μg/L	microgram per liter

USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USAREUR	United States Army Europe
VETCOM	Veterinary Command
WBGT	wet bulb globe temperature
WDWMS	water distribution and waste management system
WQAS-E	water quality analysis set, engineer
WQAS-P	water quality analysis set, purification
WQAS-PM	water quality analysis set, preventive medicine

Section II. Terms

Acclimatization
The process by which one becomes accustomed to new environmental conditions.

Command surgeon
The brigade, division, corps, or CINC surgeon, or the Air Transportable Hospital or Air Transportable Clinic surgeon, responsible for providing medical support at the corresponding level concerned.

Dehydrate
To lose water from body tissues.

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

Endemic
A disease or organism that is constantly present to a greater or lesser extent in a particular locality or region.

Field facility
A facility intended to endure long enough to support a local tactical or training operation where a fixed facility is not economically feasible or required operationally.

Field water supply system
An assemblage of collection, purification, storage, transportation, and distribution equipment and personnel which provide potable water to field units during training and combat environments.

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

Fresh water
Fresh water has a TDS concentration of less than 1,500 ppm. Brackish waters are highly mineralized and have a TDS concentration between 1,500 mg/L and 15,000 mg/L. Saltwaters have a TDS concentrations greater than 15,000 mg/L.

Host
A living animal or plant that harbors or nourishes another organism.

Incubation period
The time required between initial contact with an infectious agent and the appearance of the first clinical symptoms of disease.

Installation medical authority
The unit surgeon, command chief surgeon, U.S. Army Medical Center and/or U.S. Army Medical Department Activity commanders, and the Director of Health Services or his or her representative responsible for provision of medical support at the unit, command, or installation concerned.

Maximum contaminant level
The maximum permissible level of a contaminant in water which is delivered to the consumer.

Nonpotable water
Fresh, brackish, or seawater that has not been treated or disinfected and has not been approved for human consumption.

Palatable water
Water that is pleasing in appearance and taste. It is significantly free from color, turbidity, taste, and odor. Also, it is cool and aerated. Palatable water may not be potable.

Pathogenic organism
Any disease-producing organism.

Pollution sources
Sources of pollution such as landfills, industrial and domestic sewage discharges, and fuel oil storage sites.

Potable water
Water that is free from disease-producing organisms, poisonous substances, and chemical or biological agents and radioactive contaminants which make it unfit for human consumption and many other uses. Potable water may or may not be palatable.

Treated water
Water that has undergone processing such as sedimentation, filtration, and disinfection. Does not imply potability until inspected by preventive medicine personnel and approved by the command surgeon.

Vector
An insect or other organism that carries and transmits a pathogenic amoeba, bacterium, fungus, virus, or worm.

Water discipline
Consuming water that has been properly treated, conserving and protecting the potable water supply, and ensuring that potable water does not become contaminated from careless or improper handling.

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

Index

By Order of the Secretary of the Army:

By Order of the Secretary of the Air Force:

By Order of the Secretary of the Navy:

Distribution:
To be distributed in accordance with Initial Distribution Number (IDN) 341783, intended for Active Army, Army National Guard, and U.S. Army Reserve.

Navy:

Air Force:

DRAFT FORMS

NOTE: There are four draft forms on the following pages for your review and comment. These forms are also being sent to Crystal City to be finalized and assigned form numbers.

WATER SOURCE RECONNAISSANCE REPORT

1. DATE *(YYYYMMDD)*

2. TIME OF RECONNAISSANCE

3. RECONNAISSANCE TEAM	(1) NAME *(Last, First, Middle Initial)*	(2) GRADE	(3) ORGANIZATION
a. ENGINEER			
b. PREVENTIVE MEDICINE			
c. WATER TREATMENT OPERATOR			

4. FORWARDED TO *(Name and Organization)*

5. MAP COORDINATES OF WATER SOURCE

6. PHYSICAL PROPERTIES

a. TYPE OF SOURCE	b. QUANTITY	c. COLOR *(Color Unit)*	d. ODOR *(Threshold Odor Number)*

e. TDS	f. TEMPERATURE	g. TURBIDITY (NTU)	h. ph TEST

9. CHEMICAL PROPERTIES *(mg./L)*

a. ARSENIC	b. CYANIDE	c. CHLORINE	d. LINDANE	e. MAGNESIUM	f. SULFATE

10. MICROBIOLOGICAL *(#/ml)*

a. COLIFORM

NEEDS DD 67

11. CHEMICAL AGENTS *(ug/L)*

a. HYDROGEN CYANIDE	b. INCAPACITANTS	c. T-2 TOXINS	d. MUSTARD	e. NERVE AGENTS

12. RADIOLOGICAL *(uCi/L)*

a. RADIOLOGICAL

13. SITE CONDITIONS

a. SECURITY

b. DRAINAGE - SOIL TYPE

c. TERRAIN

d. BIVOUAC

e. DISTANCE TO CONSUMERS	f. ROADS

14. **SKETCH OF AREA** *(Show road net and traffic circulation)*

NEEDS DD 67

POTABLE WATER CONTAINER INSPECTION

1. REPORT DATE *(YYYYMMDD)*		
2. TO	3. FROM	
4. INSPECTION RATING	5. SERIAL NUMBER	6. MAP COORDINATE LOCATION
7. OWNING UNIT	8. MAINTENANCE NCO	9. UNIT REPRESENTATIVE
10. INSPECTING UNIT	11. DATE/TIME GROUP **NEEDS DD 67**	12. INSPECTED BY

SECTION I - WATER TRAILER INSPECTION CRITERIA

	YES	NO
13. CONTAINER EXTERIOR		
a. Marked "POTABLE WATER ONLY"		
b. Clean/good repair		
14. MANHOLE COVERS		
a. Rubber gasket intact		
b. Locking mechanism functions		
c. No rust/Insulation intact		
d. Pressure relief valve operates		
15. DISPENSING SPIGOTS		
a. All spigots function		
b. "T" handle operates easily		
c. Protective box intact		
d. Locking devices function		
16. DRAIN		
a. Plug installed hand-tight		
b. Cracks do not expose fiberglass		
c. Plug/hole threads undamaged		
d. Threads not rusted		
17. CONTAINER INTERIOR: STAINLESS STEEL AND ALUMINUM		
a. Clean/good repair		
b. No rust		
c. Not painted/coated		
d. No cracks/dents exposing polyurethane foam		
18. CONTAINER INTERIOR: FIBERGLASS		
a. Clean/good repair		
b. Cracks/chips less than 10%		
c. Fiberglass exposed		
d. Paint surface not flaking		

SECTION II - WATER TANK TRUCK INSPECTION CRITERIA

19. CONTAINER EXTERIOR		
a. Marked "POTABLE WATER ONLY"		
b. Clean/good repair		
20. MANHOLE COVERS		
a. Rubber gasket intact		
b. Locking mechanism functions		
c. No rust/Insulation intact		
21. DISPENSING VALVES		
a. Valves operate easily		
b. Hose coupling threads undamaged		
c. Dust caps attached to valve ports		
22. TANK INTERIOR		
a. Clean/good repair		
b. No rust		
c. Steel/aluminum not painted		

SECTION III - FABRIC TANK/DRUM INSPECTION CRITERIA		
23. CONTAINER EXTERIOR	YES	NO
a. Marked "POTABLE WATER ONLY"		
b. Clean/good repair		
c. Plugs patches secure		
24. VALVE ASSEMBLY		
a. Check-valve adapter undamaged		
b. Coupler valve operated easily		
c. Dust cap attached to coupler		

SECTION IV - CONTAINER LOCATION (FIELD USE) INSPECTION CRITERIA		
25. SITE CONDITIONS	YES	NO
a. Manholes/ports closed		
b, Soakage pits constructed beneath spigots		
26. WATER CONDITIONS		
a. Chlorine residual adequate (________ ppm)		
b. Procured from: ______________________		

27. COMMENTS AND RECOMMENDATIONS

NEEDS DD 67

28. PREVENTIVE MEDICINE INSPECTOR		
a. PRINTED OR TYPED NAME *(Last, First, Middle Initial)*	b. GRADE	c. SIGNATURE

WATER POINT INSPECTION REPORT

1. REPORT DATE *(YYYYMMDD)*		
2. TO	3. FROM	
4. INSPECTION RATING	5. WATER POINT NUMBER	6. MAP COORDINATE LOCATION
7. OPERATING UNIT	8. TEAM CHIEF	9. UNIT REPRESENTATIVE
10. INSPECTING UNIT	11. INSPECTION DATE/TIME	12. INSPECTED BY

N E E D S D D 6 7

SECTION I - INSPECTION CHECKLIST CRITERIA

	YES	NO
13. SITE CONDITIONS		
a. Adequate drainage		
b. Dust control practiced		
c. Rodent/insect control practiced		
14. BIVOUAC AREA		
a. >100 ft. away/downstream		
b. Latrines >100 yds. away		
c. Handwashing devices present		
d. Garbage control practiced		
15. WATER SOURCE		
a. No visible pollution <2 miles		
b. Water quality analyses performed		
c. Chemical agents present		
16. INTAKE LINE		
a. Intake strainer attached		
b. <4 in. from surface or bottom		
17. EFFLUENT LINE		
a. Backwash water sump present		
b. Sludge sump present		
c. Discharge >25 yds. from intake		
18. LIGHTWEIGHT WATER PURIFIER		
a. Pallet level		
b. Grounding present		
c. D-E filter pressure maintained		
19. ROWPU		
a. Trailer/pallets level		
b. Filter backwash tank full		
c. Grounding present		
d. Separate raw and brine water tanks used		
20. GENERATOR		
a. Grounding present		
b. Fire extinguisher present		
c. Hearing protection used		
d. Sufficient ventilation		
21. OPERATOR PROTECTION		
a. Rubber hip boots used		
b. Long rubber gloves used		
22. OPERATOR MONITORING		
a. WQAS-P chemicals not expired		
b. Water source tested		
c. Treated water tested		
d. Chemical usage recorded		
e. Gauge/meter readings recorded		
f. Chlorine residuals checked hourly		

REPLACES DA FORM 5456, OCT 85, WHICH IS OBSOLETE.

SECTION I - INSPECTION CHECKLIST CRITERIA *(Continued)*

	YES	NO
23. WATER STORAGE		
a. Tanks level		
b. Safety bottom apron used		
c. Open top tanks covered		
d. Tanks clean and sanitary		
e. Capacity sufficient for issue		
24. WATER DISTRIBUTION		
a. Standpipe hose >4 ft. off ground		
b. Hoze nozzle clean, off ground		
c. Operators check containers for cleanliness		
25. RECORDS		
a. Production log maintained		
b. Distribution log maintained		
c. Blank forms sufficient		
26. SUPPLY STORAGE		
a. Fuel and chemicals sufficient		
b. Chemical containers labeled, capped, and dry		
c. Active carbon and calcium hypochlorite stored separately		

SECTION II - PRODUCT WATER ANALYSIS

27. PHYSICAL PROPERTIES	STANDARD	MEASURED LEVEL
a. Color (Color Unit)	15	
b. Odor (Threshold Odor Number)	3	
c. pH	5 - 9	
d. Temperature (Degrees C)	15 - 22	
e. TDS (mg/L)	1000	
f. Turbidity (NTU)	1	
28. CHEMICAL PROPERTIES		
a. Arsenic (mg/L)	0.06	
b. Cyanide (mg/L)	6	
c. Chloride (mg/L)	600	
d. Lindane (mg/L)	0.6	
e. Magnesium (mg/L)	100	
f. Sulfate (mg/L)	300	

29. MICROBIOLOGICAL	STANDARD	MEASURED LEVEL
a. Coliform (#/100 ml)	0	
b. Virus (#/100 ml)	1	
c. Spores/Cysts (#/100 ml)	1	
30. CHEMICAL AGENTS		
a. Hydrogen Cyanide (mg/l)	6	
b. Incapacitants (ug/l)	7	
c. Lewisite (ug/l)	2000	
d. Mustard (ug/l)	140	
e. Nerve Agents (ug/l)	12	
f. T-2 Toxins (ug/l)	26	
31. RADIOLOGICAL		
a. Radiological (Bq/ml)	2.2	

32. COMMENTS AND RECOMMENDATIONS

N E E D S D D 6 7

33. PREVENTIVE MEDICINE INSPECTOR

a. PRINTED OR TYPED NAME *(Last, First, Middle Initial)*	b. GRADE	c. SIGNATURE

SHOWER DECONTAMINATION POINT INSPECTION		1. REPORT DATE *(YYYYMMDD)*
2. TO	3. FROM	
4. INSPECTION RATING	5. SHOWER POINT NUMBER	6. MAP COORDINATE LOCATION
7. OPERATING UNIT	8. TEAM CHIEF	9. UNIT REPRESENTATIVE
10. INSPECTING UNIT	11. DATE/TIME GROUP **NEEDS DD 67**	12. INSPECTED BY

INSPECTION CHECKLIST CRITERIA

	YES	NO
13. SITE CONDITIONS		
a. Adequate drainage		
b. Rodent/insect breeding areas controlled		
c. Separate latrines provided		
d. Latrines adequate ___ Men ___ Women		
e. Handwashing devices present		
f. Garbage control practiced		
14. WATER SOURCE		
a. Nonpotable water chlorinated		
b. Chemical agents present		
c. Radioactivity present		
d. Procured from:		
15. WASTEWATER CONTROL		
a. Drainage ditches adequate		
b. Effluent discharge $\geq$25 yds. downstream		
c. Decontamination waste sump present		
d. Proper sump closeout and marking		
16. INTAKE LINE		
a. Intake strainer attached		
b. $\geq$4 in. from surface or bottom		
17. SHOWER UNIT		
a. Showers/floor clean		
b. Air circulation provided		
c. Nonpotable water sign posted		
18. GENERATOR		
a. Located $\geq$50 ft. from showers		
b. Grounding present		
c. Fire extinguisher		
d. Hearing protection used		
e. Sufficient ventilation		
19. OPERATOR MONITORING		
a. Chlorine residuals checked		
b. Chemical agents present		
c. Radioactivity present		
d. Shower water temperature checked		
20. WATER STORAGE		
a. Tanks level		
b. Safety bottom apron used		
c. Open top tanks covered		
d. Tanks clean and sanitary		
e. Capacity sufficient for issue		
21. RECORDS		
a. Bath and clothing exchange report used		
b. Blank forms sufficient		

INSPECTION CHECKLIST CRITERIA *(Continued)*		
22. SUPPLY STORAGE	**YES**	**NO**
a. Fuel and chemicals sufficient		
b. Chemical containers labeled/capped dry		
c. Activated carbon and calcium hypochlorite stored separately		
23. SHOWER WATER SAMPLES		
a. Chlorine residuals checked		
b. Chemical agents present		
c. Radioactivity present		
d. Shower water temperature checked		

24. COMMENTS AND RECOMMENDATIONS

N E E D S D D 6 7

25. PREVENTIVE MEDICINE INSPECTOR		
a. PRINTED OR TYPED NAME *(Last, First, Middle Initial)*	b. GRADE	c. SIGNATURE