TECHNICAL BULLETIN

SANITARY CONTROL AND SURVEILLANCE OF FIELD WATER SUPPLIES

HEADQUARTERS, DEPARTMENTS OF THE ARMY, NAVY, AND AIR FORCE

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Navy Bureau of Medicine and Surgery
Air Force Manual 48-138_IP

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DEPARTMENTS OF THE ARMY, NAVY
AND AIR FORCE
WASHINGTON, DC, 1 MAY 2010

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FOREWORD

Department of Defense Directive 4705.1 designates the Secretary of the Army as the DOD Executive Agent for management of land-based water resources in support of contingency operations. Army Regulation 700-136 sets policy, defines the Army role in tactical operations, and outlines responsibilities for tactical water support. It assigns the Army Surgeon General responsibilities for:

- Establishing water quality standards
- Determining sanitary surveillance requirements
- The technical reviewing and evaluating of water equipment to determine the possible existence of health hazards
- Assisting in the development and review of test protocols for the military use of tactical water purification systems
- Certifying that water is potable before it is distributed for drinking, and providing oversight of operational monitoring to ensure that water quality meets established standards

In partial fulfillment of these responsibilities, the Army Medical Department has coordinated with medical organizations of the other Military Services to produce this multiservice publication to document policy, standards, guidelines, and procedures to ensure that water used by military and supporting civilian personnel for drinking, showers and personal sanitation, and sanitation in the operational environment is of the highest quality possible, and that it is not harmful to human health either in the short or long term. This publication has been prepared under our direction for use by our respective commands and other commands as appropriate.

Army Technical Bulletin Medical[1]
Navy Bureau of Medicine and Surgery[2]
Air Force Manual[3]

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Suggested Improvements. Users of this technical bulletin are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publication and Blank Forms) directly to Office of The Surgeon General, ATTN: DASG-PPM-NC, 5111 Leesburg Pike, Falls Church, VA 22041-3258.

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[1] This bulletin supersedes TB MED 577, 15 December 2005.
[2] This publication supersedes NAVMED P-5010-10, Section II, June 1991.
[3] This publication supersedes AFMAN (I) 48-138, August 2003.

LIST OF TABLES

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PART I
INTRODUCTION AND MULTISERVICE CONSENSUS GUIDANCE

Chapter 1
Introduction

1–1. Purpose

a. This publication provides general instructions and detailed technical guidance and recommendations for the sanitary control and surveillance of land-based field water supplies. Adherence to the guidance and recommendations in this document will help ensure that water produced, treated, and provided by U.S. Military Services and contractors in the operational environment is of the highest quality possible and that it will support and sustain the health and performance of deployed personnel.

b. This publication—

(1) Revises the military (formerly Tri-service) short- and long-term Military Field Water Standards (MFWS) applicable to land-based deployment operations and training exercises. When field water supplies do not meet these standards, preventive medicine (PM) personnel determine the health risk posed to personnel who continue to drink the water and recommend appropriate actions to the commander. For the remainder of this publication, "PM" means Army Preventive Medicine, Naval Preventive Medicine Authority, and Air Force Bioenvironmental Engineer (BEE) and Bioenvironmental Engineering (BE) technician.

(2) Describes PM procedures for recommending raw water sources for treatment and approving treated water for drinking and other activities.

(3) Recommends procedures for PM oversight of operational water quality monitoring and medical surveillance, and practices for ensuring continued acceptable water quality.

(4) Describes procedures for assessing health risks associated with using water that does not meet the minimum standards and guidelines provided herein.

(5) Defines PM roles, responsibilities, and routine actions related to ensuring the quality of water intended for drinking, showering, and personal sanitation during training exercises and in operational environments.

(6) Describes how certain non-PM roles and actions relate to the safety of field water supplies, and recommends methods to minimize field water vulnerabilities to intentional destruction and contamination.

(7) Provides health-related guidance for the management of waste materials resulting from water treatment activities in operational environments.

1–2. References

A list of applicable references is provided in appendix A.

1–3. Abbreviations and terms

The glossary defines abbreviations and terms as they are used in this publication.

1–4. Applicability

This publication—

a. Applies to the Active Army, Navy, Air Force, and Marine Corp; the U.S. Army, Navy, Marine Corps, and Air Force Reserves; Army and Air National Guard; and Department of Defense (DOD) and Military Services contractors and vendors. It incorporates applicable requirements of Department of Defense Instruction (DODI) 6490.03 and Joint Chiefs of Staff (JCS) Memorandum MCM-0028-07.

b. Applies to military, civilian, and contractor personnel concerned with the location, purification, distribution, protection, sanitary control, and surveillance of operational environment water supplies – particularly those intended for drinking, cooking, showering, and personal sanitation.

c. Applies to all phases of training exercises and deployments to ensure that water used for drinking, cooking, sanitation, showers, and personal sanitation supports the health of all personnel and is of the highest quality possible.

d. Must be included as a reference document in all Defense Contracting Management Agency (DCMA), Logistics Civil Augmentation Program (LOGCAP), and other contracts let for provision of field water supplies.

1–5. Technical assistance

Technical assistance related to topics in this publication may be requested from the military and civilian organizations and laboratories listed in Appendix B, in accordance with local command and organization policies, by memorandum, and directly via telephone calls, e-mail messages, or online Web site requests.

1–6. Provisions

This publication relates to three North Atlantic Treaty Organization (NATO) agreements: Standardization Agreement (STANAG) 2136, STANAG 2885, and STANAG 2473. When changes to this publication are proposed that will affect or contradict information in one or more of those agreements, the Army, as the DOD Executive Agent for land-based water resources, will notify the other Military Services and the appropriate NATO Custodian and coordinate recognition of the changes in the appropriate STANAG(s).

1–7. Local supplementation

Much of the guidance in this document is general in nature. Local supplementation by operational command PM organizations to address situations not covered in sufficient detail is encouraged.

Use of trademarked names does not imply endorsement by the U.S. Military Services but is intended only to assist in identification of a specific product.

Chapter 2
Introduction to Field Water Supplies

2–1. General

a. Overview. As an introduction to field water supplies, this chapter highlights certain basic field water terms and concepts that are important in understanding the explanations of the PM field water mission described throughout this document. It describes field water sources, treatment, storage, and distribution systems. It also provides guidance for PM approval for the use of nonpotable water for activities other than drinking, cooking, and brushing teeth.

b. Background. Water is a required commodity for numerous activities in operational environments. The most important of these activities is drinking. Water intended for drinking must be readily available in adequate quantities to prevent dehydration among deployed personnel. Drinking water must be potable or it may produce adverse health outcomes in those who drink it. It must also be palatable so personnel will be willing to drink it in adequate quantities. Water temperature is a critical consideration for palatability; however, capabilities to regulate drinking water temperature in the field may not exist. Commanders must have confidence in the approved drinking water and encourage their subordinates to avoid drinking from unapproved sources that may taste better but may cause illness due to chemical or microbiological contamination.

2–2. Key field water terms and concepts

"The basic concept of tactical bulk water support is to purify water as close to the user as possible" (Joint Publication (JP) 4-03). The following field water definitions and key concepts provide information needed to understand the context of discussions presented throughout this publication. Most are discussed in greater detail later in the document.

a. Potable water.

(1) For purposes of this publication, potable water is treated and disinfected water that has been determined to be safe to drink by PM personnel. Water that has been treated and disinfected to meet potable (drinking water) standards may be considered purified. Thus, Military Services equipment packages that include both water treatment and disinfection capabilities may be called water purifiers. PM personnel review the results of water quality tests that are performed in the field as well as at approved remote laboratories, and compare those results to the appropriate MFWS. If the water meets the standards, the evaluating PM personnel will declare it to be potable and approve it for distribution to personnel for drinking and all other water uses. In the event that PM personnel cannot test reverse osmosis water purification unit (ROWPU)-produced water in a timely manner, Senior Noncommissioned Officers (NCOs) and supervisors of water production systems and operations may distribute the water for drinking and other activities on a provisional basis, as soon as documented operational monitoring (e.g., pH, total dissolved solids (TDS), turbidity, color, taste, odor, and chlorine residual) verifies that the treatment equipment is functioning properly. PM testing and approval should nevertheless be aggressively sought.

(2) In addition to naturally occurring water, host nation water supplies, in most cases, must be treated and/or disinfected before they will be approved as potable.

(3) Two sets of MFWS exist: short-term potability (STP) standards for up to 30 days, and long-term potability (LTP) standards for longer than 30 days. Most of the STP standards parameters can be measured using field water test equipment and kits organic to PM personnel and operations. The Military Services continue efforts to develop field test equipment that will

be able to measure the parameters that cannot be currently measured. Water samples must be sent to approved laboratories to be tested for most of the LTP parameters. Water packaged using military or contract packaging systems in the field must meet the appropriate MFWS. Military- and contractor-produced bottled water, as well as bottled water purchased for military use, must meet Federal bottled water standards and be approved by the U.S. Army Veterinary Services (VS). Applicable standards are discussed below. (See paragraphs 2−2c and d.)

(a) STP standards. For water points producing bulk water during the first 30 days of field operations, treated water is considered potable and will be approved by PM personnel for distribution if it meets the STP standards. Potable water produced at bulk water points in the field must also be disinfected (establishing a free available chlorine (FAC) residual after a 30-minute (min) contact time) at the point of production. The level of FAC residual required depends on the type of treatment employed, the contact time provided, and the method of distribution (see para 2–5).

(b) LTP standards. After 30 days of water production point operation, all shortfalls in equipment and operational monitoring should have been addressed, and water produced after the first 30 days may be approved as drinking water only if it meets the more stringent LTP MFWS which are based on the current U.S. Environmental Protection Agency (EPA) National Primary and Secondary Drinking Water Regulations (NPDWR/NSDWR) established in Title 40, Code of Federal Regulations, Parts 141 and 143 (40 CFR 141 and 40 CFR 143). The FAC residual requirements for the LTP standards are the same as for the STP standards and are explained in paragraph 2-5*b*, below.

(c) Bottled water standards. The STP and LTP standards apply to: military- and contractor-produced field drinking water that is used to fill onsite, remote, or mobile water storage units; water that is pumped through tactical water distribution systems; and water that is bottled or packaged by contractor and military systems and personnel. The requirements for commercially produced bottled water purchased by the military are specified in Military Standard (MIL STD) 3006C, which incorporates the U.S. Food and Drug Administration (FDA) regulations in 21 CFR 129 and 21 CFR 165.

b. Nonpotable water. In the operational environment, water from any untreated or treated source (including bottled water) that has not been tested and determined by the appropriate medical authority to be safe for deployed personnel to drink is considered nonpotable. The water may or may not be truly safe to drink or be suitable for showering and personal sanitation use. PM personnel can recommend authorizing the use of nonpotable water for showers and personal sanitation to a commander after they have evaluated the associated risk and found it to be acceptable. They must test the water to ensure that it meets the criteria listed in chapter 4 and that it has a minimum FAC residual of 1 milligram per liter (mg/L) (or 1 part per million (ppm)) after a 30-min contact time for it to be acceptable for showering and personal sanitation. Personnel must label nonpotable water storage tanks, taps, and spigots that have been approved for showering and personal sanitation with identifying signs such as, “NONPOTABLE WATER. DO NOT DRINK,” or “DISINFECTED NONPOTABLE WATER. DO NOT DRINK – APPROVED FOR SHOWERING (AND/OR PERSONAL SANITATION) ONLY,” as applicable. Additional signs such as “USE ONLY BOTTLED WATER TO BRUSH TEETH” may also be posted as appropriate.

c. Palatable water. Palatable water is water that is pleasing to the senses. Palatability is evaluated in terms of temperature, color, taste, and odor, and acceptable levels for these parameters are included in the STP and LTP MFWS. Water may be palatable and yet not be potable – it may look and taste good, but still have the potential to cause sickness. On the other hand, potable water may not taste, look, or smell good. The goal of military water systems is to provide adequate quantities of drinking water that it is both potable and palatable.

d. Multiple barrier approach. The Military Services employ a typical "multiple barrier approach" to provide safe drinking water for personnel in operational environments. The approach uses five barriers to water contaminants that could cause adverse health effects if they are in drinking water: 1) source water selection and protection, 2) water treatment, 3) disinfection, 4) proper operation and maintenance of storage and distribution systems, and 5) operational water quality monitoring with PM oversight. Weaknesses in one or more barriers increase the risk that contaminants may pass into the treated water, while conversely strengthening a single barrier reduces the overall risk. In operational environments, the Military Services rely heavily on robust and proven treatment and disinfection barriers to make up for potential weaknesses in the other barriers that may be imposed by geographical, situational, and operational constraints.

e. Other terms. Definitions of other terms related to field water supplies are provided in the Glossary. After consulting the definitions of terms in the Glossary, if you have questions, contact any of the Military Services points of contact (POCs) listed in Appendix B for additional information and assistance.

2–3. Field water sources

a. General. Two kinds of water sources may be found in the field: raw water sources that must be treated and/or disinfected prior to use, and water that has already been treated and is approved for use by PM or VS personnel. The former include above and belowground natural bodies of water and host nation water supplies that are considered raw water for our purposes, while the latter includes VS-approved commercial bottled water that is produced in or delivered to the area of deployment.

b. Raw water sources.

(1) General. Raw water may be available from many different sources in the field including surface water (rivers, streams, ponds, lakes, rain, ice, snow, seas, and oceans), ground water (wells or springs), and in some cases, from municipal water treatment systems located in the deployment area. Given a choice, it is important to select the raw water with the best quality available as a source for any water treatment system. Military doctrine dictates that water from all raw water sources and host nation municipal drinking water systems, regardless of how clean it may appear, is nonpotable until it is shown to meet the appropriate MFWS, and/or is approved by PM personnel for drinking. In many modern military operations, locally produced bottled water may be readily available. It likewise must be approved by VS to be sure it is safe to drink. Several factors need to be considered when evaluating, comparing, and selecting different water sources for drinking water production.

(2) Surface water. Surface-water sources that the U.S. Military water treatment equipment can treat include rivers, streams, lakes, ponds, seas, and oceans. These sources are usually more readily available than other sources, and are generally capable of supplying adequate quantities of water for all purposes. However, such sources may contain pathogenic microorganisms and may be contaminated with chemicals or radioactive substances. A few common sources of those kinds of contaminants include urban and agricultural runoff, industrial waste discharges, landfill leachates, septic tank effluents, and raw and treated sewage outfalls. When drawing water from a surface-water source, the intakes should be screened and carefully positioned in the body of water to avoid areas of likely contamination.

(3) Ground water. Ground-water sources in the field include existing wells and springs, and wells constructed by military engineers or local contractors. Some ground-water sources may be used for drinking without additional treatment after the water quality has been confirmed by PM and it has been disinfected (2 mg/L FAC, 30-min contact time). Ground-water flow generally follows local topography; therefore, latrines, septic tanks, and maintenance areas should be positioned at least 30 yards (yd) downgradient from any ground-water sources used to produce drinking water. Drainage from these facilities should flow away from any water sources to prevent contamination.

(4) Host-nation municipal water systems. Partially or completely intact host nation municipal water systems are sometimes available for use as water sources during deployments. Despite the ease of access and possible presumption that the water in these systems has been treated and is potable, the water in them is by military doctrine considered nonpotable until PM personnel have inspected the systems, tested the water, and approved it for use. These types of water sources may appear appealing to use without providing additional treatment. However, the local water treatment methods may be less than adequate, inconsistent, and unreliable, and the water may be contaminated after it has been treated through broken water lines or cross-connections in the storage and distribution systems that are not readily visible. Even if the local population appears healthy, they may have developed resistance to microbiological contaminants and tolerances for chemical impurities in their water through long periods of exposure. The same contaminants could cause acute adverse health effects in unacclimated personnel, which would reduce unit readiness and could have adverse long-term health effects. Further, the threat of intentional contamination of the local drinking water system by disgruntled individuals or terrorist groups must be considered. It is important to note that most military water treatment systems employ reverse osmosis membranes (ROMs) that are sensitive to chlorine, so if chorine-containing municipal water is to be treated with one of those systems, the water needs to be dechlorinated prior to treating it to avoid damaging membranes.

c. Commercial bottled water. Commercial bottled water is drinking water that is sealed in bottles, packages, or other containers by commercial (nonmilitary) interests. It may or may not have been treated prior to bottling, but should have been tested and determined to be potable. U.S. Army VS personnel approve commercial bottled water for use by military personnel both inside and outside the Continental United States (CONUS and OCONUS). They inspect bottling facilities and test the water to ensure compliance with the acceptable manufacturing practices and sanitation standards in MIL STD 3006C. A list of VS-approved bottled water sources worldwide is published by the U.S. Army Veterinary Command (VETCOM) in the DOD Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement ("the Directory"), which is available at: http://vets.amedd.army.mil/vetcom/directory.htm. The Directory can be searched by food item, vendor name, or vendor location. In searching the Directory, it should be noted that bottled water can be classified by several different names, some of which include "bottled water," "bottled potable water," and "bottled drinking water." Logistics personnel ensure that sources of commercial bottled water distributed in the field are listed in the Directory or have otherwise been properly approved by VS personnel. PM personnel verify that sources are approved, test and monitor bottled water stored at depots and distribution points, and encourage proper storage and product rotation. If necessary, PM personnel can extend the expiration dates of bottled water lots in 30-day increments after they have tested it to ensure it is still potable (see paragraph 4−14*d*).

d. Packaged field water. Field-produced drinking water sealed in small containers such as pouches or bottles may be referred to as packaged or bottled field water. Packaging of water in the field by military assets or contractors is a method of field water storage and distribution, and is addressed in paragraph 2–6*b*.

2–4. Bulk field water treatment

a. General. Water treatment consists of one or more processes that act as barriers to (or remove) unwanted impurities or contaminants in (from) drinking water. Disinfection is a water treatment process that kills or inactivates pathogenic microorganisms in the water. Water that is treated and disinfected is sometimes referred to as purified water. The purpose of water treatment is twofold: to reduce the concentrations of health-related contaminants in the water to levels that will make the water potable, and to improve its aesthetic characteristics to render it palatable. Typical field water treatment processes include straining; chemical addition; coagulation; sedimentation; various kinds of filtration including multimedia, cartridge, microfiltration, and ultrafiltration; reverse osmosis (RO); carbon adsorption; and ion exchange. Currently, most of the water purification systems in the U.S. Military Services employ ROMs to provide the ultimate barrier to chemical, microbial, organic, and radiological contaminants. When functioning properly, the ROMs remove essentially all pathogens and reduce the concentrations of many dissolved chemicals of concern. Military RO water treatment systems employ chemical addition and filtration systems ahead of the RO cartridges to remove impurities that can rapidly clog the ROMs. The systems also have post RO cartridges of ion exchange and carbon filters that can be connected when necessary to remove certain chemicals that may pass through the ROMs. These mobile water treatment systems are collectively called ROWPUs. They were designed to treat fresh and sea water, removing salt from the latter, using high-pressure sea-water ROMs.

b. Water treatment. Military water treatment specialists establish sites and setup and operate ROWPUs, water storage facilities, and distribution systems. They also monitor these systems to ensure that the quality of the produced water does not deteriorate and that the security and proper operation of the water systems continue. Military water treatment systems currently in the inventory are described below.

c. Military ROWPUs. ROWPUs are generally used during deployments to treat field water because they can reliably and consistently produce potable water from fresh, brackish, and seawater sources. The Marine Corps has a non-RO water treatment unit, the Lightweight Medium Tactical (LMT) freshwater purification unit, for treating only fresh water. It is a diatomaceous earth-based filtration system. Table 2–1 lists the military water treatment units and their respective production capacities using salt and fresh water sources, excluding the LMT. The listed units may be operated in the operational environment by either military personnel or civilian contractors. Military ROWPUs are multiprocess systems that will remove all waterborne infectious microorganisms such as parasites, bacteria, and viruses. The ROMs' chemical removal/rejection capabilities are more variable (see para 2–4*e*). In general, rejection of simple salts exceeds 98 percent or better, while rejection of small (low molecular weight) organic substances may be less than 50 percent. Some inorganic materials, such as weak acids (hydrogen cyanide, for example), may also be poorly removed. When there is a threat of contamination by highly toxic materials such as chemical warfare (CW) or nuclear agents, ROWPU product water is passed through activated carbon and ion exchange filters to ensure contaminant removal. This additional treatment is also effective against most toxic industrial chemicals (TICs). A properly setup and operating ROWPU with these additional treatment units attached will produce safe drinking water from nearly any raw water source. No other individual pieces or combinations of field water treatment equipment will remove as wide a range of inorganic and organic contaminants as completely as ROWPUs. Types of military field water treatment units are described below.

Table 2–1
Military water purification equipment designations and capacities in gallons per hour

Unit	Salt Water	Salt Water TDS Design Basis	Fresh Water
LWP	75 gph	60,000 mg/L	125 gph
600 GPH ROWPU	450 gph	30,000 mg/L	600 gph
TWPS	1,200 gph	60,000 mg/L	1,500 gph
3,000 GPH ROWPU	2,000 gph	30,000 mg/L	3,000 gph
150,000 GPD ROWPU	120,000 gpd	30,000 mg/L	150,000 gpd

Legend:
LWP = lightweight water purifier; gph = gallons per hour; ROWPU = reverse osmosis water purification unit; TWPS = tactical water purification system; gpd = gallons per day; TDS = total dissolved solids; mg/L = milligrams per liter

(1) The 125-gph LWP is used to purify water for small military units and detachments, Special Operations Forces, and temporary medical facilities during a range of contingency operations. The LWP provides a more mobile, further-forward deployed water production capability than other ROWPUs. The LWP incorporates many of the contamination barriers mentioned above, with its ultrafilter membrane pretreatment distinguishing it from other ROWPU process designs. Figure 2–1 illustrates the basic water treatment processes employed on the LWP.

(2) The 600-gph trailer-mounted ROWPU incorporates many of the contaminant barriers mentioned above and is used for the production of potable water from fresh, brackish, and seawater sources. Its functional equipment consists of various pumps and hoses, intake screens, chemical feeds, multimedia and cartridge filters, and a bank of ROM vessels. Figure 2–2 illustrates the basic water treatment processes of the 600-gph ROWPU. The 600-gph ROWPU is being replaced by the 1,500-gph TWPS.

(3) The 1,500-gph TWPS is contained within an International Organization for Standardization (ISO)-compatible flatrack and is transportable by the load handling system or palletized load system trucks. The 1,500-gph TWPS provides a means for producing a safe, reliable supply of potable water to support current and future forces. The water treatment processes employed by the TWPS are similar to those illustrated in figure 2–1 for the LWP with the exception that the ultrafiltration membrane is replaced by a microfiltration membrane in the pretreatment system.

(4) The 3,000-gph ROWPU is similar to the 600-gph ROWPU in terms of treatment processes but has a larger capacity. It is contained in a special 8-ft by 8-ft by 20-ft ISO container with an overpack. The 3,000-gph ROWPU is mounted on a standard 30-ft military trailer and can be shipped aboard U.S. Air Force aircraft. Detailed descriptions of the equipment and operations of the 600-gph and 3,000-gph ROWPUs are available in Field Manual (FM) 10–52–1.

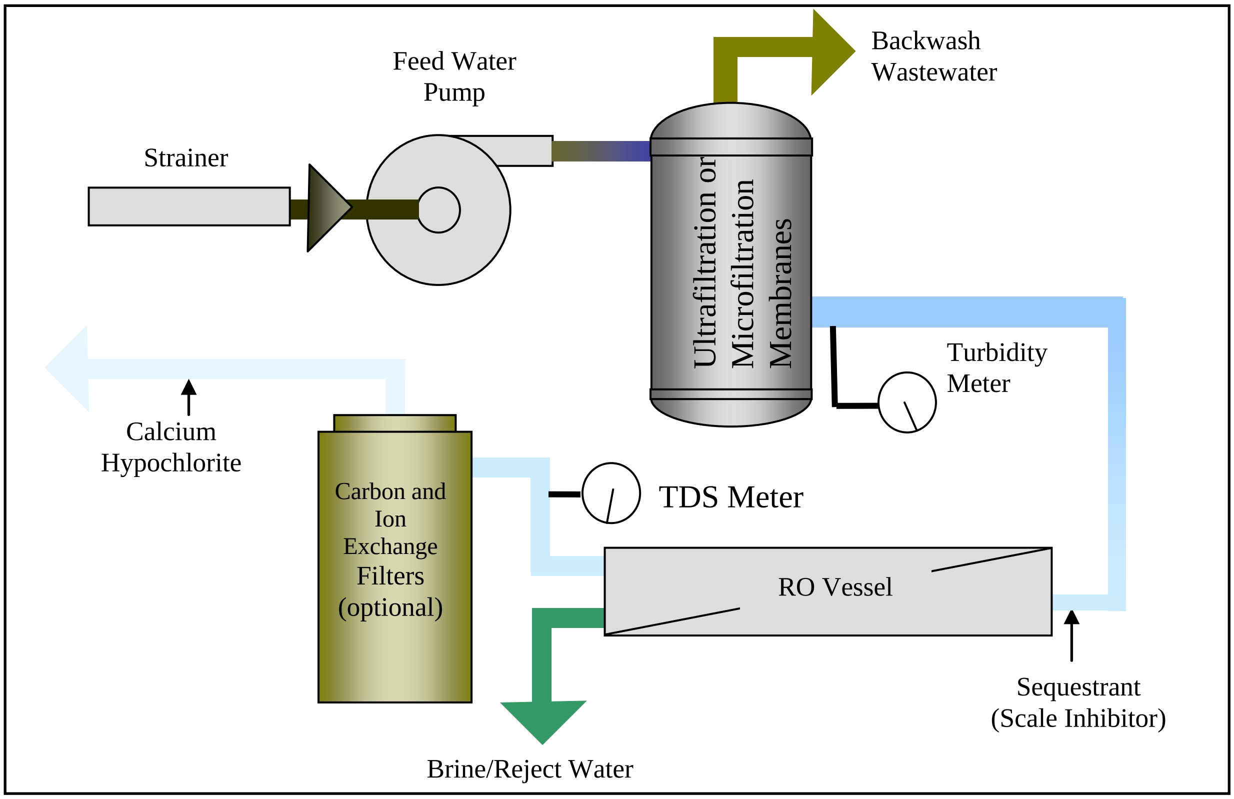

Figure 2–1. LWP and TWPS ROWPU water flow diagram

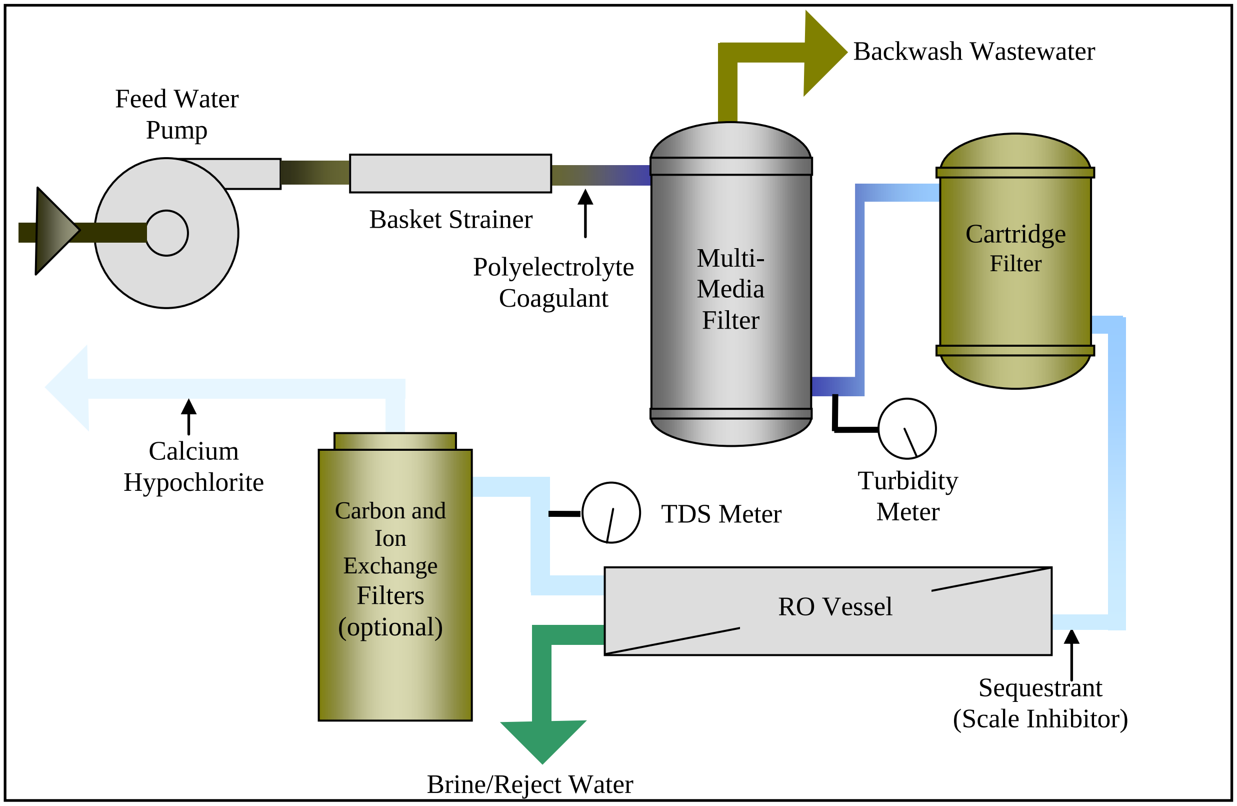

Figure 2–2. 600-gph and 3,000-gph ROWPUs water flow diagram

(5) The 150,000-gpd skid- or barge-mounted ROWPU is designed to operate on seawater and is not specifically designed to reduce the presence of chemical or biological agents or radioactive byproducts. However, a 90 to 95 percent chemical, biological, radiological, and nuclear (CBRN) agent reduction capability is inherent in its operation.

d. Commercial/contractor-operated water treatment systems in the field. Commercial contractors are frequently engaged to produce water for deployed personnel in the operational environment through the DCMA, the LOGCAP or via individual contractor-owned and -operated (COO) systems. Those contractors may operate military ROWPUs or they may setup and operate their own water treatment equipment and systems. Contractor water treatment systems may be different from military systems. They may not be mobile, and may be larger or smaller than military systems. They may also use lower pressure membranes if they are not required to desalinate seawater, but they must produce water that meets the MFWS in this publication. The contract between the government and the contractor must specify the details of the required treatment and quality of the end product to ensure that contractor-produced potable water is as good as water produced by military ROWPUs and military operators. Appropriate-level PM assets should participate in developing contracts for water production in the field to ensure that all necessary requirements are addressed in the contract documents.

(1) Contractors that produce water for military use during deployments using nonmilitary treatment equipment must have documentation that the chemicals and materials they use have been appropriately tested and certified to current NSF International (NSF)/American National Standards Institute (ANSI) Standards 60 and 61. Systems which employ ultraviolet (UV)

radiation for disinfection must also be tested and certified to NSF/ANSI Standard 55. Contractors will provide the certification documents and/or copies thereof to PM personnel on request.

(2) PM personnel have surveillance or oversight responsibilities for COO water treatment systems that produce drinking water and/or water used for showering and personal sanitation in their area of operations (AO). Contractors who operate water systems must provide PM personnel with information that allows them to assess the capabilities and effectiveness of their water collection, treatment, storage, and distribution operations. Required information includes system and specific equipment manufacturers' names and model numbers; manufacturers' specifications, operating procedures, and parameters; maintenance procedures and frequencies; and operational monitoring and testing parameters, procedures, and frequencies.

e. ROM removal capabilities.

(1) General.

(a) Osmosis is a process in which water passes through a semipermeable membrane (that is, a membrane that obstructs the passage of salt or other materials dissolved in the water). The direction of water passage is from the dilute solution side of the membrane to the concentrated side. For example, if a living cell is immersed in distilled water, the cell swells—sometimes to the bursting point—as water flows in through the cell membrane. If, on the other hand, the same cell is immersed in a saturated salt solution, water flows out and the cell is dehydrated. Road salt kills vegetation by that mechanism.

(b) Applying pressure to the concentrated solution side of a membrane reverses this osmotic process. This principle enables the construction of semipermeable membrane devices that will extract pure—or nearly pure—water from solutions of salt and other dissolved materials. The process is somewhat analogous to distillation, except that physical pressure provides the driving force instead of temperature. Military and commercial ROWPUs contain semipermeable membranes in their ROM elements and cartridges.

(c) There are many different kinds of ROMs, and their abilities to remove impurities from water differ. Generally, the higher the pressure required to force water through the membrane, the "tighter" the membrane is, and the more efficient it is at removing impurities. Another way to say that is the higher the required operating pressure, the smaller the impurity that will be rejected by the membrane. Also, the higher the pressure required and the tighter the membrane, the lower the flux or flow of purified water that passes through the membrane. Low pressure membranes have a greater flux than high pressure membranes; on the other hand, their removal rates of impurities are not as good. Low-pressure membranes can produce drinking water that meets military standards from fresh water. Consequently, most COO water treatment systems use them. As long as the water they produce meets the applicable standards for the intended use, they are acceptable.

(2) Removal of simple salts.

(a) Military ROWPUs were designed to operate at high pressures and produce potable water from seawater or brackish water that has a high concentration of dissolved salts, the principal component of which is sodium chloride (common table salt). Other seawater constituents include salts of magnesium, calcium, and potassium, as well as salts of bromine, sulfur (in the form of sulfate), and carbon (in the form of carbonate and bicarbonate). Military ROWPUs use seawater membranes that remove 98 to 99 percent of the sodium chloride and at least that much of the other sea salts. Said another way, 1 to 2 percent of the original salt concentration will pass through these membranes. Ordinary seawater contains about 3.5 percent

(35,000 mg/L) sea salts, so the product water from sea water should contain 350 to 700 mg/L dissolved salts. This is more salt than is present in most municipal drinking water systems, but it is below the military LTP standard of 1,000 mg/L. Note that if the seawater contains more than 3.5 percent salts, as is the case in the Persian Gulf, the ROWPU still removes just 98 to 99 percent. If the seawater contains 6 percent (60,000 mg/L) salts, the product water would contain 600 to 1,200 mg/L and may taste slightly salty. At the other extreme of salt content, when ROWPUs are used to purify fresh water (with a salt content of less than 1,500 mg/L), the product water may contain almost no salts, and may taste quite flat.

(b) As stated above, ROWPU membranes are designed and manufactured to remove sea salts. Other chemicals are also removed, and their removal efficiencies must be determined experimentally for the particular membrane, for each chemical, and for the particular operating conditions (temperature, pH, pressure) under which the membrane will be used. Table 2–2 presents some typical salt rejection information for commercial membranes similar to those used in the ROWPUs. Many new membranes, tailored for specific purposes, are available commercially. Some of these membranes may give significantly improved salt rejection and may provide greatly altered selectivity.

Table 2–2
Rejection of select salts by typical seawater ROMs[1]

Salt	Rejection, percent
Sodium chloride	98 -99.7
Magnesium chloride	98
Calcium chloride	99
Magnesium sulfate	99
Sodium bicarbonate	98
Sodium nitrate	93
Sodium fluoride[2]	98

Notes:
[1]Filmtec, spiral wound, thin-film composite polyamide membrane. Percentages provided by the manufacturer for pure solutions of each salt; they are not applicable to mixtures of salts.
[2]Fluoride rejection is pH-dependent: about 75 percent at pH 5, 50 percent at pH 4, 30 percent at pH 3.5, and 0 percent at pH <3.

(3) Inorganic chemicals. Most inorganic salts are removed to the same extent as sodium chloride by military ROWPUs; however, some are not removed that well. As shown in table 2–3, 99 percent of nickel, copper, cadmium and Arsenic (+5) salts, and 96 to 97 percent of lead and chromium salts present in the source will be removed, but a lower percentage of Arsenic (+3) and mercury salts will be removed. Small differences in removal percentages may not seem like much of a difference, but a process that removes only 90 percent of a pollutant leaves 10 times as much of the pollutant in the product water as one that removes 99 percent. Removal efficiency is good for iron and manganese, but these metals may cause excessive fouling of the membranes because when they are removed they may stay in contact with the membrane. Many common heavy metals found in polluted waters (lead, mercury, cadmium, arsenic, and chromium in particular) are highly toxic. While the ROWPU may remove these metals well enough to meet health standards, it is still important to select the best raw water source available. This

places increasing importance on the role of PM personnel in the process of water point site selection.

Table 2–3
Rejection of heavy metal salts by typical ROMs

Salt	Rejection, percent
Nickel sulfate	99
Copper sulfate	99
Arsenic (+5) salts	99
Arsenic (+3) salts	69 and lower
Cadmium salts	99
Lead salts	97
Mercury salts	37-78
Chromium (+6) salts	97
Chromium (+3) salts	96

(4) Organic chemicals.

(a) Removal of organic materials may depend on size (that is, molecular weight), structure, and functional group[1] (see table 2–4). Natural organic materials in water (lignins, tannins, and fulvic substances) are essentially all removed, as are carbohydrates, proteins, and amino acids. Rejection of contaminants from industrial sources varies greatly. Removal efficiency is poor for low molecular weight alcohols such as methyl, ethyl, propyl, and isopropyl alcohol, as well as for most low molecular weight solvents including chlorinated solvents. In general, short-term removal improves with increasing molecular weight, but it may be deceptive. Some organic contaminants that show good short-term removal in bench-scale tests may leak through the membrane in days or even hours. For example, removal of lindane may fall from an initial 97 percent removal to only 85 percent after 24 hours. Weak organic acids of low molecular weight (acetic acid and its simple derivatives, propionic acid and butyric acid) are poorly removed.

(b) Again, it is important to select the least-contaminated source water available for treatment because of the uncertainty in efficiency of rejection of industrial organics. Surface waters immediately downstream from municipal or industrial outfalls should be avoided, and outfalls from petrochemical complexes would be of particular concern.

(5) CBRN agents. RO removal of CBRN agents from water has received only limited investigation (see table 2–5). One study indicates that the biotoxins, such as ricin, are reduced below detection limits by membranes similar to those in the ROWPU. Other studies

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[1] A functional group is a group of atoms within a molecule that is responsible for certain properties of the molecule and reactions in which it takes part. Organic compounds are frequently classified according to the functional group or groups they contain. For example, methanol, ethanol, and isopropanol are all classified as alcohols since each contains a hydroxyl functional group.

Table 2–4
Typical rejection of some organic chemicals by ROMs as reported in the literature

Chemical	Rejection, percent
Aldehydes and Alcohols	
Formaldehyde	35
Methanol	25
Ethanol	65
Isopropanol	90
Sucrose (cane sugar)	99
Acids	
Acetic acid	60-90
Fluoroacetic acid[1]	98-99
Phenol	56-87
Benzoic acid	87-92
Solvents	
Trihalomethanes	50-80
Chloroethylenes	15-90
BTEX (benzene, toluene, ethylbenzene, and xylenes)	15-90
Chlorobenzene	40-50
Herbicides	
Atrazine	96
Alachlor	98
Linuron	98

Note: [1]Rodenticide; extremely toxic to humans

Table 2–5
Rejection of CBRN agents by ROMs

Agent	Rejection, percent
T-2	100
Microcystin	100
Ricin	100
Saxitoxin	100
GB	>99
VX	>99
BZ	>99
Hydrogen cyanide	<25[1]
^{131}I	>95
^{85}Sr	>99
^{134}Cs	>98

Note: [1]@ pH $\leq$ 8.5

indicate better than 99 percent removal for chemical agents and 95 percent or better removal for certain radioactive chemicals (nuclear agents). However, it is also known that radioactive materials eventually damage ROMs. Furthermore, it can be assumed that membranes exposed to a constant CBRN challenge will eventually pass larger concentrations of organic chemical agents (but not most biotoxins).

(6) Parasites, bacteria, and viruses. For the most part, ROMs have not been specifically tested for removal of bacteria, viruses, and parasites such as *Giardia or Cryptosporidium* cysts. Based on size exclusion, an undamaged and properly operated ROM will remove a significant percentage (up to 100 percent) of all microbiological organisms. However, due to loading rate limitations on membrane units, disinfection must still be provided to ensure the complete absence of viable harmful pathogenic organisms in the treated water. Thus, the ROWPU is an effective barrier to waterborne pathogens. However, it is still important to avoid source water that may contain human or other animal wastes and to disinfect the ROWPU product water in order to provide a measurable FAC residual for operational monitoring and PM surveillance purposes and some protection against accidental post-treatment contamination by pathogenic microorganisms.

2–5. Bulk field water disinfection

a. Disinfection is usually the last process and final treatment barrier to microbiological contaminants in water treatment systems. Disinfection involves exposing the water to an oxidant for a specific period of time to kill or inactivate pathogenic microorganisms that were not removed by the preceding treatment processes. The disinfectant may also oxidize certain chemical contaminants that passed through the previous treatment steps. A secondary purpose for disinfecting military drinking water is to provide a measurable disinfectant residual in storage and distribution systems as a sentinel to post-treatment contamination and to prevent/minimize biofilm growth.

b. The preferred military water disinfectant is chlorine. The most common chemical issued to the military for bulk water disinfection is calcium hypochlorite that is approximately 68 to 70 percent FAC. It is added to water and allowed to remain in contact with the microorganisms in the water for a specified period of time (usually 30 min). Other disinfectants might be encountered in the field, available locally, and/or used by contractors. These include chlorine gas, sodium hypochlorite (unscented bleach), chlorine dioxide, bromine, chloramines ozone, and UV radiation. While ozone and UV radiation are excellent disinfectants, they do not provide a measurable residual as a sentinel for post-treatment contamination or for control of microbiological regrowth like chlorine does, and so are not as desirable for use in the field as those that provide a measurable residual. Ozone generators and UV lamps also require power sources, and the UV lamps are fragile. PM support should be sought if it becomes necessary to evaluate or determine the adequacy of disinfectants other than chlorine. Chlorine disinfection, FAC residual requirements, and dose calculations are presented below.

(1) Chlorine disinfection.

(a) Chlorine is the disinfectant normally specified for military use. Chlorine gas, liquid sodium hypochlorite (unscented bleach), calcium hypochlorite (HTH), and electrolytically produced chlorine solutions are sources of chlorine that can be used to disinfect water. Chlorine is the only widely accepted chemical that destroys organisms in water and leaves an easily detectable residual. No other disinfectant has been shown to be as acceptable or adaptable for field potable water treatment operations. A low-level or nonexistent FAC residual in bulk-

produced drinking water may result from inadequate disinfection procedures, subsequent contamination, or both. The sudden disappearance of normal chlorine residuals in a water system or storage container may indicate that contamination has occurred.

(b) The most important variables in the effectiveness of chlorine disinfection of drinking water are the chlorine dose, demand, residual concentration, and contact time after the demand has been exceeded. The chlorine dose is the amount of chlorine added per unit volume of water and is usually expressed in ppm or its equivalent mg/L. The chlorine demand is the amount of chlorine per liter of water that reacts with inorganic and organic matter, including microorganisms, and is no longer available for disinfection. After the demand is completely satisfied, any remaining chlorine will be free chlorine that is available to be measured as a residual. The residual chlorine will react with any contaminants that subsequently get into the water as well as prevent regrowth of inactivated bacteria in any storage and distribution system that may be in use.

(c) Raw water contaminants that are normally rejected by the ROMs which would reduce the effectiveness of chlorine as a disinfectant if they were to pass through the membranes include:

(i) The type and density of organisms present (viruses, bacteria, protozoa, helminthes, or others) and their resistance to chlorine. Vegetative bacteria and viruses are the most susceptible to chlorine disinfection, whereas the cysts or oocysts of the protozoa *Entamoeba histolytica*, *Giardia lamblia*, and *Cryptosporidium parvum* are the most resistant.

(ii) The concentrations of chemical compounds containing oxidizable substances, ammonia, or organic matter that exert a chlorine demand.

(iii) The suspended solids concentration (measured as turbidity). In addition to exerting their own chlorine demand, suspended solids can surround microorganisms and protect them from contact with the chlorine.

(d) The effectiveness of chlorine disinfection can also be influenced by variables that are affected little, if at all, by the ROWPU treatment. They include—

(i) Mixing. Adequate mixing of the chlorine into the water is needed to ensure direct contact with the target microorganisms. The chlorine 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.

(ii) Contact time. It takes time for the chlorine to react with and inactivate pathogenic microorganisms. Lower FAC residual concentrations require longer contact times to achieve the same level of disinfection. For a given FAC residual, an increase in contact time will improve the level of disinfection.

(iii) Water pH. As the pH of the water increases from 5 to 9, the form of the FAC residual changes from hypochlorous acid ($HOCl$ − the most effective form) to the hypochlorite ion (OCl^- − the less effective form). The most effective chlorine disinfection occurs when the pH is between 5.5 and 6.5. The typical pH of ROWPU-treated water is usually in the range of 5.5, which is the most effective pH for chlorine disinfection.

(iv) Water temperature. At lower temperatures, microorganism inactivation tends to be slower. To obtain the same level of disinfection at low temperatures as at higher temperatures, higher chlorine residuals or longer contact times are required.

(2) Chlorine residual requirements. Recommended chlorine residuals for various applications are shown in table 2–6 and described in the paragraphs that follow.

Table 2–6
Recommended field water chlorine residuals

Action/Location	Chlorine Residual	Comments
Potable Water Requirements		
Point of production and initial distribution into storage or transportation containers, or into a distribution system	2 mg/L FAC	After a 30-min contact time
Delivery to secondary storage or distribution containers and systems	1 mg/L FAC	If between 0.2 and 1 mg/L, rechlorinate to 1 mg/L and deliver. If less than 0.2 mg/L, rechlorinate to 2 mg/L and ensure that at least 1 mg/L FAC remains after 30 min
Delivery to unit level storage containers (e.g., water buffaloes, 5-gal containers)	1 mg/L FAC	If between 0.2 and 1 mg/L, rechlorinate to 1 mg/L and deliver. If less than 0.2 mg/L, rechlorinate to 1 mg/L and ensure that at least 1 mg/L FAC remains after 30 min
Filling canteens, personal hydration systems, and other individual-use containers	0.2 mg/L FAC	If less than 0.2 mg/L (or lowest measurable value), rechlorinate to 1 mg/L and ensure that at least 1 mg/L FAC remains after 30 min
Bottled water	No requirement	Must be from VS-approved vendor
Packaged field water – when filling package (pouch, bottle, or other container)	1 mg/L FAC	Use of a lower or no residual after disinfection may be acceptable, but only after VS and/or PM evaluation of equipment, operations, and water quality
Fresh Water Approved for Drinking		
Ground water approved by PM for drinking after only disinfection	2 mg/L FAC	After a 30-min contact time, prior to distribution
Emergency only – Disinfecting natural surface water or well water under the direct influence of surface water for drinking – no other treatment available	5 mg/L FAC	After a 30-min contact time. Alternate emergency treatment is boiling fresh water for 5 min. Where *Cryptosporidium parvum* is suspected to be present in untreated water, boiling is the recommended emergency water treatment method because of the relative ineffectiveness of chlorine and iodine against that organism.
Nonpotable Water for Showers and Personal Sanitation		
Point of production and initial distribution into storage or transportation containers	1 mg/L FAC	After a 30-min contact time
Delivery to intermediate storage or distribution containers and systems	1 mg/L FAC	If used
Deliver to unit level containers	1 mg/L FAC	e.g., shower point storage containers
Recycled water	1 mg/L FAC	See chapter 9 for details

(a) Points of bulk water production.

(i) ROWPU-treated drinking water. Operator personnel are to add sufficient chlorine to ROWPU-treated water at the production site to provide a 2.0-mg/L FAC residual after a 30-min contact time. This applies to both military and contractor-operated systems.

Paragraph 2–5*b*(4), below, describes how to achieve desired FAC residuals in various volumes of water.

(ii) Drinking water treated by other methods. PM personnel should evaluate the system capabilities and operating procedures for drinking water treated by any method other than RO, and recommend a suitable FAC residual and contact time. If the treatment system will remove turbidity, cysts, and spores, and the treated water can meet the STP and LTP standards for the initial and long-term operating periods, respectively, providing 2 mg/L FAC with a 30-min contact time is acceptable. If the treatment system or operating procedures will not effectively remove cysts and spores, the chlorine dosage should achieve the equivalent of 5.0 mg/L FAC residual after a 30-min contact time.

(iii) Shower water. Water intended for human use other than drinking, cooking, or brushing teeth, such as shower water, must have a minimum FAC residual of 1.0 mg/L after a 30-min contact time prior to human contact. It is strongly recommended that neither of these parameters be reduced in the field. TB MED 575 and NAVMED P-5010-4 provide information on sanitation requirements and procedures for recreational waters including natural waters, hot tubs, and swimming pools.

(b) Bulk water issue points. Water purification personnel will ensure that chlorine levels at potable water issue points along tactical distribution systems, at tank farms, and during bulk transport are maintained, so that FAC residuals remain at or above 1.0 mg/L to the best of their abilities. Maintaining at least a 1.0 or greater FAC residual in large storage and distribution systems may require increasing the chlorine levels at bulk water production sites to levels higher than 2.0 mg/L after the required 30-min contact time, or boosting the chlorine residual on location in some cases. If the chlorine residual at the completion of bulk water transport has at least 0.2 mg/L FAC, the water should be rechlorinated to 1.0 mg/L FAC, after which it may be immediately issued for further transportation/distribution or drinking. If the FAC residual falls below 0.2 mg/L, the water should be rechlorinated to achieve a 1.0 mg/L FAC residual after 30 min before it is issued further. At bulk water points where 10,000-gal and larger storage tanks are used and there is not a good way to rechlorinate and mix the water in a tank, a booster chlorinator should be used to bring the FAC residual up to 1.0 mg/L FAC when it is distributed to secondary transportation units, and the water should not be further distributed for at least 30 min thereafter, at which time it should have at least the 1.0 mg/L FAC residual remaining. A booster chlorinator injects chlorine into the water as it flows from the tank and is a quartermaster (QM) issue item.

(c) Unit level. Regardless of the treatment method, at least a 0.2 mg/L FAC residual should be maintained in unit level potable water distribution containers (e.g., 400-gal water trailers, small lightweight collapsible pillow tanks). The intent of this requirement is to provide water that is both potable and palatable. Field sanitation teams (FSTs) should test unit level water supplies for chlorine residuals at least twice daily. PM personnel will also periodically monitor unit water supply FAC residuals. As long as a 0.2 mg/L residual remains in unit-level potable storage containers, water can be issued from those containers for drinking. If the FAC residual falls below 0.2 mg/L in a unit-level storage container, the water in the container should be rechlorinated to raise the residual to 1 mg/L FAC after a 30-min contact time prior to issuing it for drinking.

(d) Chlorine-resistant organisms. Disease-producing organisms such as *Entamoeba histolytica, Giardia lamblia*, and *Cryptosporidium parvum* are resistant to normal chlorine residuals. Military ROWPUs and similar contractor-operated RO systems remove these

organisms completely when they are operating properly; however, as a precaution, in areas where these organisms are prevalent, theater/command and unit surgeons are encouraged to require higher than normal chlorine residuals and/or longer contact times, as well as increased frequencies of chlorine residual measurements. If the only treatment available for fresh water is disinfection, then it is recommended to provide a 2 mg/L FAC residual for 30 min prior to drinking. If *Giardia* or *Cryptosporidium* are known or expected to be present in the source water, at least 5 mg/L for 30 min would be advisable. Individual water purifiers may also be used for short periods when necessary.

(3) Chlorine residual measurement frequencies.

(a) Military and contractor water treatment system operators, water delivery personnel, trained unit personnel, and PM personnel, as appropriate, should measure chlorine residuals at the following times and frequencies, depending on the location and function of the water supply. The measurement times and results should be recorded, reported in accordance with unit and command policy, and be made available for inspecting and assessing by PM personnel.

(i) Potable water purification points: at least every hour of operation (TM 10-4610-240-10; FM 10−52−1 requires ROWPU operators to measure and record the chlorine residual every 30 min during water production operations).

(ii) Bulk potable water distribution points: at times of receipt and bulk loading for further bulk transport or distribution.

(iii) Nonpotable shower and personal sanitation water treatment/chlorination points: at least every hour during water production and at the time of bulk loading for transport.

(iv) Field shower and personal sanitation water storage points: at the time of delivery/receipt and at least two additional times daily (recommend prior to periods of high use).

(b) Trained unit-level personnel should measure chlorine residuals in unit potable water trailers (or other unit bulk water storage facilities) at least twice daily.

(c) Food service personnel should measure chlorine residuals in their water supply prior to beginning food preparations for each meal.

(4) Chlorine dose calculations and measurements. Tables 2–7 and 2–8 provide volumes in drops (dp), milliliters (mL), teaspoons (tsp), tablespoons (tbls), cups (cp), and gallons (gal) of liquid bleach, dry HTH, and a concentrated calcium hypochlorite solution that, when added to the indicated volume of water, will provide the approximate chlorine dose (in mg/L) indicated. The chlorine residual achieved using these values will depend on the chlorine demand exerted by the water that is chlorinated. If there is no chlorine demand, the residual should equal the dose. The greater the chlorine demand, the lower the residual will be. Note that for all chlorine residual concentrations in water, values in ppm are equivalent to values in mg/L (for example, 10 ppm = 10 mg/L).

(5) Conversion factors. Table 2–9 is useful in converting from one unit of measurement to another. It shows equivalent values for common units of measurement. Unit volumes increase from left to right and top to bottom. All volumes on the same horizontal line (row) are equal. So, looking at the “ounce” row in table 2–9, we can see that 1 oz, 444 dp, 30 mL, 6 tsp, and 2 tbls are all equal to each other. Continuing to the right on the same row indicates that 1 oz is also equal to 0.125 or 1/8th cp, 0.063 pints (pt), 0.031 quarts (qt), and so on across the table.

(a) If you need to add 7 mL of bleach to a container of water, but you only have an eyedropper, you can see that each mL contains 15 dp, so 7 mL would be equivalent to 7 x 15, or 105 dp.

Table 2–7
Volumes of 5-percent liquid (typical household) bleach that will provide approximately the indicated chlorine dose when added to the corresponding volume of water

Gallons to be chlorinated	1 mg/L	2 mg/L	5 mg/L	10 mg/L	100 mg/L
5	6 dp	0.75 mL	1.9 mL	3.8 mL	8 tsp
10	0.75 mL	1.5 mL	3.8 mL	1.5 tsp	16 tsp
25	2 mL	3.8 mL	2 tsp	4 tsp	1 cp
36	3 mL	5.5 mL	2.75 tsp	2 tbls	1.25 cp
50	4 mL	1.5 tsp	4 tsp	3 tbls	1.75 cp
100	7.7 mL	3 tsp	3 tbls	5 tbls	3.25 cp
400	2 tbls	4.25 tbls	0.75 cp	1.5 cp	3 qt
500	3 tbls	0.33 cp	1 cp	1.75 cp	1 gal
1000	0.33 cp	0.67 cp	1.75 cp	3.25 cp	2 gal
2000	.66 cp	1.34 cp	3.5 cp	6.5 cp	4 gal

Table 2–8
Volumes of 70-percent available HTH (or solution concentrate[1]) that will provide the indicated chlorine dose when added to the corresponding gallons of water

Gallons to be chlorinated	1 mg/L	2 mg/L	5 mg/L	10 mg/L	100 mg/L
5	0.9 mL	1.7 mL	4.1 mL	8.3 mL	0.25 tsp
10	1.7 mL	3.3 mL	8.3 mL	16.6 mL	0.5 tsp
25	4.1 mL	8.3 mL	20.7 mL	41.4 mL	1.25 tsp
36	6 mL	11.9 mL	29.8 mL	0.9 mL	1.75 tsp
50	8.3 mL	16.6 mL	0.6 mL	0.25 tsp	2.5 tsp
100	16.6 mL	33 mL	0.25 tsp	0.5 tsp	5 tsp
400	0.92 mL	1.9 mL	1 tsp	2 tsp	19 tsp
500	1.3 mL	0.5 tsp	1.25 tsp	2.5 tsp	0.5 cp
1000	0.5 tsp	1 tsp	2.5 tsp	5 tsp	1 cp
2000	1 tsp	2 tsp	5 tsp	10 tsp	2 cp

Note:
[1]The shaded area of the table indicates the volume of a concentrated solution made from dissolving 1 tsp of HTH in a half canteen cup (1½ cups) of water.

(*b*) The values moving down a single column represent how many of the units at the top of the column make up one of the units on the left of the table. For example, proceeding down the column with "**drop**" at the top, there are 15 dp in a mL, 74 dp in a tsp, 3550 dp in a cp, and 56,775 dp in a gal. Similarly, looking at the "**ounce**" column, there are only 0.002 oz in a dp, 0.5 oz in a tbls, and 32 oz in a qt.

(6) Fractions and decimals. Table 2–10 shows the equivalence between common fractions and decimals.

Table 2–9
Equivalent volumes

	drop	mL	tsp	tbls	ounce	cup	pint	quart	liter	gal
drop	1	0.067	0.013	0.004	0.002					
mL	15	1	0.200	0.067	0.033	0.0042	0.0021	0.0011	0.0010	
tsp	74	5	1	0.333	0.167	0.021	0.010	0.005	0.005	0.001
tbls	222	15	3	1	0.500	0.063	0.031	0.016	0.015	0.004
ounce	444	30	6	2	1	0.125	0.063	0.031	0.030	0.008
cup	3550	237	48	16	8	1	0.500	0.250	0.240	0.063
pint	7100	473	96	32	16	2	1	0.500	0.480	0.125
quart	14200	946	192	64	32	4	2	1	0.960	0.25
liter	15000	1000	203	68	34	4.2	2.1	1.06	1	0.26
gal	56775	3785	768	256	128	16	8	4	3.785	1

Table 2–10
Common fractions and their decimal equivalents

Fraction	Decimal
1/16	0.0625
1/8	0.125
3/16	0.1875
¼	0.25
5/16	0.3125
3/8	0.375
7/16	0.4375
½	0.500

Fraction	Decimal
9/16	0.5625
5/8	0.625
11/16	0.6875
3/4	0.75
13/16	0.8125
7/8	0.875
15/16	0.9375
16/16	1.0000

(7) Chlorination formulas.

(*a*) If the volume and/or concentration you are working with are not in the tables above, use the following equations to calculate the volume of required bleach, HTH, or concentrated calcium hypochlorite solution in mL; then use table 2–8 to convert that volume to enable using the best measuring device you have available.

(i) General equations:

$$\text{grams HTH} = \frac{\text{desired mg/L chlorine x gallons to be treated x 3.785 L/gal}}{\text{1,000 mg/g x (\% available chlorine in HTH/100)}}$$

$$\text{mL HTH} = \frac{\text{grams HTH}}{\text{HTH density in mg/L}}$$ (typical density is 2.35 g/mL)

$$\text{mL liquid bleach} = \frac{\text{desired mg/L chlorine x gallons to be treated x 3.785 L/gal}}{\text{1,000 mg/mL x (\% chlorine in bleach/100)}}$$

(ii) For liquid bleach (~ 5 percent available chlorine):

$$\text{mL required} = \frac{\text{desired mg/L chlorine x number of gallons to be treated}}{13.2}$$

(iii) For HTH (~70 percent available chlorine):

$$\text{mL required} = \frac{\text{desired mg/L chlorine x number of gallons to be treated}}{434.6}$$

(iv) For a calcium hypochlorite solution made from adding 1 level tsp HTH to half a canteen cup of water:

$$\text{mL required} = \frac{\text{desired concentration in mg/L x number of gallons to be treated}}{6.04}$$

For example: chlorinating 10 gallons of water with a dose of 5 mg/L chlorine would require the following:

$\frac{5 \times 10}{13.2}$ = 3.8 mL of 5% *bleach*

$\frac{5 \times 10}{434.6}$ = 0.115 mL of 70% HTH, or

$\frac{5 \times 10}{6.04}$ = 8.3 mL of concentrated *hypochlorite solution* made from 1 level tsp HTH in half a canteen cup (1 ½ cups) of water.

(*b*) If your measuring device is not as precise as the number you come up with, it is generally advisable to round the calculated number up to ensure you get at least the dose you intended to provide. For water destined for drinking, it is particularly important to provide a 30-min contact time after adding the chlorine and mixing, then to test the water to ensure the desired FAC residual has been achieved.

2–6. Bulk field water transportation, storage, and distribution

a. Unit-size and larger systems.

(1) Standard equipment and systems. After field drinking water is produced, determined to be potable, and approved for release by PM personnel, it may be used for drinking water and any other purpose immediately. The water may be stored and distributed locally or it may be transported and stored and distributed nearer to operational forces. Several storage and distribution items/systems that are in the inventory provide flexibility to planners in providing water to deployed personnel. They need to be kept clean and serviceable to protect the water they carry or store from contamination.

(2) Nonstandard equipment and systems. Locally acquired trucks and trailers and containers of all sizes are frequently used to transport and store drinking water in the field. Nonstandard transportation equipment and containers are generally acceptable as long as they are in good condition, have never been used to transport or store petroleum products such as fuels, pesticides, or other toxic substances, and if the water-contact surface materials are nontoxic. The best way to ensure that the materials are nontoxic is to verify that they are listed in NSF/ANSI Standard 61. Information about currently certified coatings (paints) can be obtained from technical POCs listed in Appendix B for additional information. If the information is not obtainable, samples of water that has remained in the storage tanks for 24 hours can be collected and forwarded to an appropriate laboratory for advanced water testing (AWT) to determine if there are any toxic leachates.

b. Packaged field water. The Military Services may seal PM-approved drinking water in containers such as plastic pouches or bottles for distribution. The packaging systems may be operated by military or contract personnel using military-owned or contractor-owned packaging equipment. The requirements for treatment, disinfection, and PM surveillance of packaged field water at the point of production are the same as for bulk drinking-water operations. Chlorine residuals remaining in the treated water after disinfection (should be 2 mg/L FAC after 30 min) may be reduced or removed immediately prior to packaging the water if the procedure is approved by PM personnel. VS has the responsibility to evaluate, test, and approve Military Services water bottling equipment, systems, and processes, and PM has the responsibility for medical surveillance of the quality of water as it is produced and after it is in bottles and packages in bulk storage.

2–7. Individual/emergency field water treatment and disinfection

a. Doctrinal procedures. Quantitative water quality standards do not apply in emergencies, or to water treated by individuals in emergency situations or during operations when water from a military-approved water supply is not available. In those situations, individuals should select the best quality water available, which may be bottled water from an unapproved source, host nation tap water, a natural water source, or a puddle of water. Water from unapproved sources should always be disinfected prior to drinking it, by boiling, by using issued iodine tablets or Chlor-Floc® as described in FM 21−10/MCRP 4−11.1D, or by using Marine Corps authorized Individual Water Purification System (IWPS). The purchase and use of commercial individual water purification devices is generally discouraged, although some guidance is provided for those who are inclined to do so. (Chlor-Floc® is a registered trademark of Control Chemical, D/B/A Deatrick and Associates Inc., Alexandria, Virginia.)

b. Commercial products.

(1) Availability and risk. Many commercial off-the-shelf (COTS) individual water purifiers (IWP) are available for purchase to military units and personnel. They are convenient, and will generally improve the quality and palatability of raw water found in the operational environment. Individuals and commanders sometimes receive or purchase these devices from vendors and use them in lieu of approved military devices and disinfectants to support missions where neither bottled nor bulk potable water supplies are available. While some testing has been performed, many of the COTS devices have not been tested or evaluated by the Military Services to determine their abilities to meet military mission requirements, and their use may increase the potential that personnel will unknowingly drink nonpotable water. Commanders who authorize the use of COTS water purification devices should also require their personnel to disinfect the

water they produce using doctrinal methods of disinfection (iodine tablets, chlorine compounds, or boiling) prior to drinking the water to ensure the water is pathogen-free.

(2) COTS IWP evaluations. NSF International testing protocol NSF P-248 contains procedures to assess the ability of IWPs to reduce waterborne pathogens. The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) has conducted technology-based reviews and some direct pathogen reduction testing of COTS IWPs based on NSF P-248. The results of the evaluations are available for review at http://usachppm.apgea.army.mil/WPD. The reviews contained on the Web site are directed primarily at the pathogen reduction capabilities of the devices. Only the units clearly identified as such on the Web site have been tested to see if they meet P-248 requirements. In some cases, the combination of a COTS filter and a COTS disinfectant may meet NSF P-248 pathogen reduction requirements. As COTS IWPs that meet the requirements of NSF P-248 are identified, they will be indicated as having met the requirements on the Web site. When they are available, IWPs that have been shown in third party testing to meet the requirements of P-248 should be purchased and used in lieu of devices that have not been tested or that have been tested and do not meet the protocol requirements. Additional information and assistance in selecting IWPs is available from USACHPPM at water.supply@.amedd.army.mil. Military Service members should not assume that an IWP has been tested or approved by the military just because it has a National Stock Number (NSN).

c. Military Service-approved individual water purification procedures.

(1) Calcium hypochlorite. Calcium hypochlorite is a white granular or powdered chemical. When fresh, it typically contains 68 to 70 percent by weight available chlorine. It is commonly referred to as HTH and is frequently used as a disinfectant in swimming pools. Calcium hypochlorite may be obtained through Army supply channels in 6-oz bottles (NSN 6810–00–255–0471). The volumes of calcium hypochlorite that will provide specific mg/L doses when dissolved in different volumes of water are presented in paragraph 2–5, above. The procedures for disinfecting water in a canteen using calcium hypochlorite ampules are described in FM 21–10/MCRP 4-11.1D. After filling a canteen, or personal hydration system, or other container with the cleanest water available, add the appropriate amount of calcium hypochlorite or calcium hypochlorite solution. Close the container and shake it vigorously for a few seconds. Slightly loosen the closure and tip the container to allow leakage around closure. Tighten the closure again and wait 30 min before drinking the water.

(2) Chlor-Floc. Chlor-Floc is an emergency disinfectant mixed with a settling aid that helps remove dirt and other suspended particles from water by flocculation and sedimentation. If it is available, it should be used when the water to be treated is cloudy or discolored and the operational situation is such that the treatment bag can remain motionless for the required settling period and can then be filtered. The Chlor-Floc treatment kit (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 adds 8 mg/L of chlorine to 1 qt of water. Newer Chlor-Floc kits contain 3 packages of 10 powder sachets (NSN 6850-01-573-5068) in place of the packages of tablets. All other components and the treatment steps remain the same.

(a) Use Chlor-Floc with the provided water treatment bags as follows:

(i) Add 1 qt of water to the water treatment bag (provided in the kit). The bag will be about half full. A different clean container can be used if the water treatment bag is not available.

(ii) Using the guide provided in the instructions, and shown in table 2-11 below, add one or two tablets / powder sachets of Chlor-Floc to the water in the bag.

(iii) Fold the bag top tightly three times and fold the tabs in.

(iv) Shake the bag for about 1 min or until the tablet(s) or powder dissolves completely.

(v) Let the bag sit for 3 min.

(vi) Swirl the water in the bag for 30 seconds.

(vii) Let the bag sit for either 7 min or 15 min based on the water temperature, as described in the instructions and shown in table 2-11 below.

(viii) If the water is still cloudy, add an additional half tablet or one-half powder sachet and repeat beginning with step (iv).

(ix) Being careful not to disturb the settled material, pour the clear water above the settled material through the cloth filter (provided in the kit) into a clean canteen or other container. Avoid pouring settled material onto the filter cloth. Do not drink the water from the treatment bag without filtering it. If the filter cloth from the kit is unavailable, a clean cotton t-shirt can be used.

(x) Rinse the filter and treatment bag with treated water so they can be reused. Always filter the water through the same side of the filter cloth.

Table 2−11
Chlor-floc tablet or powder sachet addition instructions

Water Temperature	**Number of Tablets / Powder Sachets Per Volume**			**Waiting Period for Step vii**
	1 qt (1 L)	**70 oz (2 L) bladder**	**100 oz (3 L) bladder**	
77°F (25°C)	1	2	3	7
58°F (15°C)	1	2	3	15
50°F (10°C)	1	2	3	15
41°F (5°C)	2	4	6	15

(b) Use Chlor-Floc with hydration system reservoirs in the following manner:

(i) Personal hydration systems require additional tablets / powder sachets based on the volume of water they hold. When using 70- and 72-oz (2 L) reservoirs double the number of tablets described in the instruction, and when using 100- and 102-oz (3 L) reservoirs triple the number of tablets / sachets.

(ii) Fill a separate clean container with the amount of water to be treated. Never add Chlor-floc tables or powder sachets directly to the hydration system.

(iii) Follow instructions (a)(ii)-(a)(ix) above, and add the treated water to the hydration system.

(3) Marine Corps IWPS. Marine Corps System Command has fielded the IWPS to be used for emergency disinfection of an unapproved water source. The IWPS includes a 3-liter hydration bag, and Mountain Safety Research, Inc. (MSR)/CamelBak in-line hollow fiber and charcoal filters (NSN 4610-01-542-3842) to be used in conjunction with the MSR MIOX Pen. The MIOX Water Purifier (Pen) is a miniaturization of the MIOX capital equipment used for treatment of municipal water. The manufacturer’s operating instructions must be followed

exactly to ensure adequate disinfection. Generally, the device operates by converting a small amount of a salt-brine solution to a concentrated mixed-oxidant solution through electrolysis. The primary component of the mixed oxidant is chlorine. However, it has been shown to be more effective than similar strength chlorine solutions. The concentrated brine solution is mixed into the water to be treated, and the FAC level is measured. If the level of FAC is adequate, an appropriate contact time is provided before drinking the water. Each purifier uses two 3V lithium camera batteries, common salt, and a tiny electrolytic cell. The purifier will treat approximately 200 liters of water on one set of batteries. Its NSN is 4610-01-513-8498 (www.msrgear.com. Users of the IWPS must strictly follow all operating and maintenance procedures.

(4) Iodine tablets. Iodine water purification tablets (NSN 6850–00–985–7166) are intended to disinfect water contained in small containers such as canteens or water jugs. The tablets are composed of an iodine compound and are available through the Federal Supply System in bottles of 50 tablets. The tablets are subject to deterioration in storage. They must be inspected for signs of physical change before they are used; otherwise, they may not disinfect the water. Iodine tablets that are completely yellow or brown, that stick together, or crumble easily are no longer effective and must not be used. Iodine tablets in good condition will be solid and steel gray in color. The procedures for disinfecting small quantities of water with these tablets are as follows:

(a) Water in canteens.

(i) Fill the canteen with the cleanest, clearest water available.

(ii) Add two iodine tablets to each 1-qt canteen full of water, or four tablets to 2-qt canteens. Tincture of iodine, 2 percent, may be used in place of the tablets. Five drops of the liquid are equivalent to one iodine tablet.

(iii) Put the cap on the canteen. Shake the canteen to dissolve the tablets.

(iv) Wait 5 min. Loosen the cap slightly and tip the canteen over to allow leakage around the canteen threads.

(v) Tighten the cap and wait an additional 25 min before drinking.

(b) Water in 5-gal containers.

(i) Fill a 5-gal container with the cleanest, clearest water available.

(ii) Dissolve 40 iodine tablets in a canteen cup full of water to disinfect any type of water. Add this solution to the 5-gal container of water and agitate the solution.

(iii) Place the cap on the container loosely. Wait 5 min and then agitate the container vigorously to allow leakage to rinse the threads around the neck of the can.

(iv) Tighten the cap and wait an additional 25 min before using the water for any purpose.

(c) Personal hydration systems.

(i) Use four iodine tablets for 70- or 72-oz water reservoirs and six for 100- or 102-oz reservoirs.

(ii) Allow 30 min of contact time before drinking the water.

(iii) If the water to be treated is cloudy or discolored, either double the dosage or use Chlor-Floc in a separate container.

(5) Chlorine bleach.

(a) When calcium hypochlorite is not available for disinfection of bulk supplies, commercial household chlorine bleach (unscented sodium hypochlorite) can be used in its place. Household bleach is normally a 5 percent or 50,000 mg/L chlorine solution. Add two drops of

bleach per quart of water to be disinfected and let it stand for 30 min before drinking. If a dropper is not available, wet a cloth or stick with bleach and allow it to drip into the water.

(b) Use four drops from a standard 10-milliliter (mL) dropper for a 70-oz reservoir, and six drops for the 100-oz reservoir. Mix the added bleach in the reservoir water and let it stand for 30 min before drinking it.

(c) For larger volumes of water, see paragraph 2–5*b*(4), above, for the amounts of bleach needed to disinfect larger volumes of water. Always allow at least 30 min for contact time.

(6) Boiling. Boiling is an expedient means of disinfecting small quantities of water when no other means is available. To be effective in killing most disease-producing organisms, the water must be held at a rolling boil for 5 min at sea level. At sea level, water boils at 212 °F or 100 °C. However, the boiling temperature decreases by about 1 °F for every 500-ft increase in elevation and 1.1 °C per 1,000-ft increase. To achieve the same microbiological kill at higher elevations, the water must be boiled for longer periods. Hence, the command surgeon may prescribe longer boiling times at higher altitudes and in areas where certain heat-resistant organisms are prevalent. Boiled water must be kept in a covered, uncontaminated container since boiling does not impart any residual disinfectant. Where *Cryptosporidium parvum* is suspected to be present in untreated water, boiling is the recommended emergency water treatment method because of the relative ineffectiveness of chlorine and iodine against that organism.

2–8. Potable and nonpotable water uses

Potable water should be used for nearly all military water-requiring activities if it is available. From a military health perspective, potable water must be used for all activities in which there is a significant risk to a Military Service members’ well-being from doing otherwise. These include drinking, cooking, brushing teeth, shaving, and making ice that contacts food. Potable water should also be used for showering because of exposure to cuts and scratches, incidental ingestion, and breathing of volatile or aerosolized material, all of which may allow contaminant entrance into the body. However, disinfected water of less than drinking water quality may be used for showering, personal sanitation, personnel decontamination, and heat casualty cooling, after an appropriate health risk assessment of the proposed water supply is performed by PM personnel and the action is approved by the commander, as shown in table 2–12. With the medical and command approval caveat in mind, water of a given quality may be used for activities on the same level with and below it on the table. Activities in table 2–12 that do not involve potential human ingestion or contact do not require medical approval, and are shown for completeness and information purposes only. PM personnel tasked with performing a health risk assessment for the purpose of approving lower quality water for an activity that should use potable water should contact higher-level PM assets for assistance as needed.

Table 2–12
Typical uses of different classes/qualities of water in the field and associated caveats

Water Class/Quality	Acceptable Activities
Class I – Potable **a. ROWPU Treated Water** **b. Bottled Water** **c. Packaged Field Water** **d. Approved Municipal Water** **e. Approved Ground Water**	a. Drinking water b. Brushing teeth c. Showers and personal sanitation[1] d. Dining facility operations e. Ice production for food preservation and cooling f. Medical treatment g. Potable water hose and pipeline testing and flushing
Class II[2] **a. Disinfected[3] Filtered[4] Fresh Water** **b. Disinfected[3] Fresh Water** **c. Treated Shower and Laundry Water[5]**	a. Decontamination of personnel[1] b. Heat casualty body cooling[1] c. Well development d. Graves registration personnel sanitation e. Retrograde cargo washing
Class III – Not Potable **a. Untreated Fresh Water**	a. Vehicle coolant b. Aircraft washing c. Pest control d. Field laundry e. Concrete construction f. Well drilling
Class IV[6] – Not Potable **a. Brackish Water** **b. Seawater**	a. Vehicle washing b. Electrical grounding c. Fire fighting d. Chemical, biological, radiological, and nuclear (CBRN) decontamination of materiel e. Dust control[7]

Notes:
[1]Permission to use other than potable water for these activities requires a risk assessment by PM assets and approval by the commander.
[2]For some surface and ground water sources, class II a and II b waters may meet short- and/or long-term potability standards, and may be used for drinking water, with PM and command approval. Such use would require a 2 mg/L FAC residual after a 30- min contact time prior to distribution.
[3]For nonpotable water, disinfected means having at least a 1 mg/L FAC residual after a 30-min contact time and at the time of use.
[4]Fresh water that has been filtered through multimedia filters, microfilters, or ultrafilters, and possibly RO concentrate water from fresh water treatment operations, depending on its quality, may be disinfected and used in lieu of or in preference to disinfected fresh water, with PM and command approval.
[5]Applies to Force Provider operations only, and has specific treatment and operational monitoring requirements specified in a 2004 Office of The Surgeon General memorandum and USACHPPM Information Paper (IP) 31-027.
[6]Brackish and seawater are minimally acceptable and may lead to significant corrosion if used; therefore, fresh water should be used if possible. ROWPU brine from seawater desalination operations may not be used.
[7]Use of nondisinfected water or any kind of wastewater, treated or not, for dust suppression requires the approval of the area medical authority, and is dependent on the quality of the water and on the potential it poses for human contact with pathogenic microorganisms.

Chapter 3
Predeployment Planning

3–1. General

a. Overview. PM personnel should participate in predeployment planning and preparation of the plan to provide field water during deployments. This may include the use of completed or participation in initial environmental baseline surveys (EBSs) and/or occupational and environmental health site assessments (OEHSAs) (see DODI 6490.03). For PM personnel, predeployment planning includes determining detailed support requirements and using medical and nonmedical strategic and tactical intelligence to develop an estimate of the PM mission and requirements. Predeployment preparation includes assisting in preparation of the operational environment and conducting strategic-level coordination.

b. Background. During the predeployment phase of the operations process, PM personnel assist commanders and logistics personnel in planning and preparing the field water medical support mission. PM participation is important because it helps ensure successful execution of the field water support mission. Organizations from the three Military Services that can provide technical support during this phase are listed in appendix B.

3–2. Predeployment planning

a. Commanders are responsible for integrating operational, engineering, and logistics, force protection, and force health protection (FHP) planning in predeployment phase functions. To do this effectively, commanders rely on their staffs to provide them with detailed requirements based on planning factors and estimates of resource capabilities. PM personnel provide detailed field water medical support requirements. They also review contracts for water treatment, storage, and distribution to ensure that sanitary control and surveillance of the water supplies are covered adequately, and if not, they recommend appropriate changes/additions to be made. For the field water support mission, strategic-level coordination includes addressing issues such as: prepositioned water support equipment, national-level water resource agreements, host nation water resource support, threats to host nation water sources and water supplies, and theater infrastructure including support base and water supply point locations. Staff-level PM personnel provide assistance and consultation to commanders and staffs based on medical and nonmedical intelligence information, an estimate of PM needs for field water, and their own experience.

b. Prepositioned water support equipment may require inspection and assessment to determine its functional and sanitary condition.

c. National-level water resource agreements and host nation water resources support may require PM input on water quality requirements and procedures for effective sanitary control and surveillance. Preliminary field water vulnerability assessments (Air Force - FWVA) or field water system vulnerability assessments (Army - FWSVA) may be important in that coordination. See chapters 11 (Air Force) and 17 (Army) for details. Naval personnel should refer to chapter 17 for guidance for field water vulnerability assessments.

d. Theater infrastructure development, including support base and water supply point locations, should consider PM recommendations on managing risk based on medical and nonmedical intelligence. Also consider threat information contained in preliminary FWVAs.

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Chapter 4
Deployment Operations

Section I
Raw Water Source Selection

4–1. General

a. PM personnel perform a number of important field water missions during deployment operations. They help engineering and logistics personnel choose and establish water supply points by assisting in water source selection. They perform water source reconnaissance surveys and conduct onsite water testing to characterize raw water sources to assist in finding the highest quality source available. Once the source is selected, they may collect raw water samples and submit them for advanced water testing. These water quality tests may need to be repeated periodically throughout a deployment if the water source quality might be affected by natural, accidental, or intentional contamination.

b. PM personnel evaluate water treatment systems and operations routinely (see table 16–1 for Army-recommended frequencies) and as driven by events throughout periods of deployment. They evaluate systems onsite through interviews with operators, inspections, sampling, and water testing. They evaluate water quality through onsite testing and by sending samples to laboratories with advanced analytical capabilities. They compare the test results to the MFWS and Military Exposure Guidelines (MEGs) for water and perform health risk assessments for parameter concentrations that exceed the standards and guidelines. Based on the results of their assessments, they recommend actions to commanders that will preserve and protect the health of deployed personnel.

4–2. Raw water source reconnaissance surveys

PM personnel provide medical intelligence and information to engineering and logistics planners during predeployment planning to help them identify and select the best water sources to use for field water production. However, the accuracy of the intelligence concerning those sources needs to be physically confirmed after arriving in the deployment AO. Final selection of a raw water source requires an onsite source water reconnaissance survey and raw water characterization (RWC) which includes both onsite testing and submission of water samples for AWT.

4–3. Raw water source sanitary surveys

a. General. A properly staffed reconnaissance team includes engineering, logistics (typically water purification personnel) and PM personnel, as well as intelligence and security personnel. PM personnel perform water source reconnaissance surveys and RWC testing as described below. Typically, water purification personnel also survey the site and perform their own set of water tests. These actions help them evaluate the suitability of the site, the treatability of the raw water source, and what needs to be done for the initial setup of the water purification equipment.

b. Water source sanitary survey. PM personnel examine the proposed water source and the surrounding area for existing and potential sources of pollution and evidence of contamination. If it was not gathered during predeployment planning, information on potential sources of contamination in the area should be obtained from the National Center for Medical

Intelligence (NCMI), USACHPPM Global Threat Assessment Program (GTAP), and the World Health Organization (WHO). Table 4–1 illustrates some items PM personnel should consider when surveying and comparing water sources. The source water may have been contaminated accidentally or deliberately through chemical or biological spills or from industrial pollutant discharges. If visible evidence of contamination such as dead fish, rotting vegetation, oil film or sheen, floating or submerged garbage, or discharges from industrial areas is observed, a different source should be considered. If that is not possible, control measures must be implemented to minimize existing or potential exposure to contamination. Actions to control or improve the raw water quality or to minimize the amount of contaminated water that reaches the ROWPU intake screen include, but are not limited to, building flow diversion structures, suspending the intake screen 8 to 12 inches (in) below the water surface, and keeping the screen off of the bottom.

Table 4–1
Raw water source reconnaissance considerations

Parameter	Considerations
Water quantity	Is the source permanent or intermittent, depending on season, temperature, or other factors (human controls such as dams)? The greater the source flow and volume, the lesser the impact from added toxic substances (intentional or accidental).
Pollution sources nearby or geographically located so that runoff/discharge may reach the source by surface runoff or subsurface movement	Landfills; agricultural and livestock wastes; industrial discharges; petroleum refineries, distribution, or storage systems; domestic sewage discharges
Visible evidence of contamination	Dead fish or vegetation, excessive algae growth, oil slicks/sludge, or strange-colored soil or surface residues
Potential for contamination from accidents or hostile action	Upstream industrial facilities with significant quantities of toxic industrial chemicals; toxic industrial chemical transportation routes in upstream watershed area; upstream area controlled by hostile forces
Information from local populations	Smells, tastes, health effects and/or endemic water-borne diseases

c. Host nation municipal water system as a source. Where a host nation municipal water system is identified as a potential water source for deployed personnel, even though there may be what appears to be an adequate water treatment system in place, it must be considered a raw water source until it is approved by PM personnel for drinking or other uses that would normally require the water to be treated. The PM mission is to identify and assess the potential health risks of this water source. PM personnel will conduct a sanitary survey of the identified municipal source, treatment, and distribution system, and test the water at the point proposed as the source for the military water system. The team should assess the performance and overall condition of the municipal treatment and distribution system that will serve as the water source, and conduct as thorough an analysis and assessment as the tactical mission will allow. The potential for accidental or intentional contamination of the water system by hostile individuals or groups should be considered, and the results should be recorded in the vulnerability assessment report. To be considered for use as drinking water without additional treatment, the water must meet the STP standards for the first 30 days of use, and the LTP standards thereafter. To be considered for use as nonpotable shower and personal sanitation water, the water must meet the criteria described in paragraph 4–6*e*. For any of these uses, without additional treatment, the commander must be willing to accept the health risk presented by the vulnerability assessment. If a decision is made to use the water without additional treatment, it should be tested and monitored for the appropriate field water standards. If a decision is made to treat the water with a ROWPU, the presence or potential presence of a chlorine residual in the municipal supply to be treated must be considered, and adequate precautions must be taken to ensure that any chlorine is removed ahead of the ROMs, as the ROMs currently available for ROWPUs are sensitive to and may be compromised by chlorine in the water.

4–4. Raw water characterization testing

a. General. During the raw water source reconnaissance survey, PM personnel will conduct RWC testing to evaluate the raw water source from a health-risk standpoint. They might also collect water samples and package and send them to a rear-area laboratory for advanced analysis as part of an EBS or OEHSA. PM personnel use the onsite test results to identify and recommend the highest quality raw water sources. In cases where a lower quality raw water source must be used, they assess health risks due to source quality and make recommendations to mitigate those risks. Water purification personnel use their organic water test equipment to evaluate the suitability of the source for purification and to determine initial purification equipment settings.

b. RWC procedures. Water samples collected for testing should be representative of the overall raw water source. For surface waters, samples should be obtained from a location at least 8 to 12 in below the surface at the point where the influent screen will be placed. For local municipal distribution systems, samples should be collected from the tap or hydrant from which the water will be drawn for treatment. Taps and hydrants should be flushed to a point of consistent clarity and temperature, if possible, before collecting samples from them.

c. RWC parameters and test kits. PM personnel will normally perform RWC testing for the following parameters: pH, turbidity, TDS, temperature, color, arsenic, cyanide, and the CW agents (hydrogen cyanide, lewisite, sulfur mustard, nerve agents). The M272 water test kit is used to detect water contamination by chemical agents. It is currently the best available agent detection kit. Coliform testing is not normally a part of the RWC tests.

d. RWC test results. The RWC test results are used to characterize raw water sources, to determine their treatability, to establish initial water treatment equipment settings, and to evaluate water treatment system performance by comparing the RWC test results with treated water test results. PM personnel should evaluate the treatment system performance in order to identify potential treatment limitations and assess health risks; and they should discuss any concerns they have with the personnel who operate the water purification equipment. RWC test results need not meet the STP or LTP standards, or be compared to MEGs, since they all apply to treated water. In some cases, the RWC results may meet the STP or LTP standards (such as when characterizing a municipal water system or a ground-water source). The water will still likely need to be treated and must be disinfected, tested, and verified by PM personnel to be potable before it can be used for potable purposes.

Section II
Field Water Standards and Guidelines

4–5. General

a. Medical support mission. The goal of the overall mission of medical support to field drinking water supplies is to ensure that the drinking water distributed to deployed personnel is, from a health perspective, every bit as good as the water they drink at their home duty station. That goal is achieved by PM personnel through: 1) inspecting and evaluating water sources and purification, storage and distribution systems and procedures; 2) reviewing military and contractor operators' qualifications; 3) providing oversight of operator water quality control and quality assurance monitoring; and 4) performing medical surveillance of distributed water supplies. Items 3 and 4 are executed by performing field and laboratory water quality tests and comparing the test results to operators' test results and to established military water quality standards and guidelines. This publication establishes the LTP standards described below as military doctrine to support meeting the goal. Generally, ROWPU-treated water will meet the LTP standards. However, for situations early in a deployment – specifically the first 30 days – when water purification points and distribution systems are being established, the STP standards apply as the minimum acceptable water quality standards.

b. Operator qualifications. Field water purification systems may be either military or commercial systems, and they may be operated by military personnel or contractors. Military personnel are given military training which they must pass in order to receive a diploma and be qualified to operate various military water purification systems. PM personnel should check with the NCO in charge of water production sites they inspect and ensure that the military operators have had the appropriate required specialty training. Likewise, civilian contractor operators should be adequately trained and educated in water treatment operations and specifically trained and certified, if applicable, to operate the equipment and systems for which they are responsible. The requirements that contract water system operators be appropriately trained and/or certified should be written into all contracts for such services and operations. PM inspections of contractor-operated water production and distribution facilities and systems should include determining that the operators have had the appropriate training and are appropriately certified.

c. MFWS. The MFWS consist of short- and long-term drinking water standards with no reference to the amount of water ingested each day.

(1) The STP standards are designed to prevent acute illness and support mission readiness. Most of the STP standards can be tested for using field test equipment. Samples must be collected and delivered to a DOD-approved laboratory capable of performing the required tests for those contaminants or properties that cannot be adequately evaluated using field test equipment. ROWPU-treated water that meets the STP standards may be used for drinking water (including packaged field water) during at least the first 30 days of deployment, and for all other activities identified in table 2–11 indefinitely, without adverse health effects.

(2) Beyond 30 days, the LTP standards apply for bulk potable water production sites and for military packaged field water. In practice, deployed personnel usually drink commercially bottled water in deployments at least until adequate military or contract water treatment and distribution systems, including bottling and packaging systems, are established. Federal water quality standards for commercially bottled water are presented along with the LTP standards and discussed in paragraph 4-6*c*.

d. Field water quality risk assessment tool. USACHPPM Technical Guide (TG) 230 contains water MEGs that may be used to assess potential acute and chronic adverse health risks for personnel who drink water that contains TIC contaminants that either exceed or do not have LTP standards. The water MEGs are, with few exceptions, equal to or less conservative than corresponding LTP standards; however, the MEGs include many chemicals that do not have LTP standards. The MEGs also address different drinking durations (7-day, 14-day, and up to 1 year) and drinking rates (5 and 15 liters per day) than the MFWS.

4–6. Military field water standards

a. Emergency drinking water standards. Drinking water standards do not apply when personnel are cut off from supply lines and military-approved water is not available. In such cases, each individual should select the clearest, cleanest water with the least odor available, and treat the water by boiling or using iodine tablets, Chlor-Floc dry calcium hypochlorite, household bleach (sodium hypochlorite solution), or the Marine Corps-approved IWPS. COTS individual water purifiers should be tested according to the NSF Protocol P-248. Commanders should discourage the indiscriminate use of untested and unapproved COTS IWPs. Similar guidance applies for using nonstandard COTS unit-size purifiers or purification systems. Contact the applicable technical POCs in appendix B for guidance.

b. STP (30-day) MFWS.

(1) *General*. The STP MFWS are presented in table 4–2. The STP standards are set at levels at which some sensitive individuals might experience adverse short-term health reactions, but overall unit performance and mission accomplishment should not be jeopardized. For some STP parameters, the allowable levels are based on direct toxic effects. For others, they represent points where the water may become so unpalatable that personnel will choose to become dehydrated rather than drink it. As contaminant concentrations become increasingly greater than the STP standards, a corresponding increase in the number of personnel experiencing adverse effects will likely be observed, and the severity of the effects may intensify. The complete approach used to develop the standards is described in the report, “Evaluation of Military Field-Water Quality,” (Daniels, 1990). Guidelines for evaluating the potential adverse effects for many of these parameters are presented in chapter 8.

Table 4–2
Short-term potability military field water standards

Parameter	30-day Standard (mg/L)[1]
Physical properties	
Color	15 CU
Odor (PM evaluation and customer response)	Acceptable
pH	5 – 9 pH units
TDS	1000
Temperature	15 – 22 °C
Turbidity	1 NTU
Chemical properties	
Arsenic	0.02
Chloride	600
Cyanide (as free cyanide)	2.0
Magnesium	30
Sulfate	250
Microbiological properties	
Total Coliforms	0 CFU/100 mL
Escherichia Coli	0 CFU/100 mL
Chemical warfare agents	
Hydrogen cyanide	2.0[2]
BZ (incapacitants)	2.3[2] (µg/L)
Lewisite (as arsenic)	27[2] (µg/L)
Sulfur mustard	47[2] (µg/L)
Nerve agents[3]	4[2] (µg/L)
T-2 toxins[3]	8.7[2] (µg/L)
Radiological	
Gross alpha and/or beta activity[4]	0.05 (µCi/L)

Legend:
mg/L = milligrams per liter; CU = color unit; TDS = total dissolved solids; NTU = Nephelometric turbidity unit; CFU/100 mL = colony forming units per 100 milliliters; µg/L = micrograms per liter; µCi/L = microcuries per liter
Notes:
[1]Units are in mg/L unless indicated otherwise.
[2]These values apply for up to 7 days exposures only. It is not anticipated that personnel would remain in an area where water is contaminated with agent longer than 7 days.
[3]See paragraph 4–11*e*.
[4]Drinking water contaminated at this level has the potential to expose individuals to approximately 8 roentgen equivalent man (rem) of radiation to the gastrointestinal tract. These exposures should be documented and accounted for in individual Unit's Radiation Exposure Status (RES) and Operational Exposure Guidance (OEG).

(2) *Military microbiological standards (short and long term) for field drinking water*. The military standards for microbiological water quality are presented in table 4–3. They apply to drinking water systems regardless of the length of time they have been in operation. They include total coliforms as a monitor of operating system integrity and possible environmental and sample handling contamination. It does not necessarily represent potential

pathogen contamination to the extent that the presence of *E. coli* does. The presence of *E. coli* is a very strong indicator of fecal contamination and, therefore, warrants more concern. Details are provided in the notes for table 4–3.

Table 4–3
Military microbiological field water standards (short and long term)

Total Coliform (TC)		***E. Coli***		**Interpretation and PM Action**
Absent	**Present**	**Absent**	**Present**	
X		**X**		**Green** : Water safe for drinking
	X	**X**		**Amber**: Caution; OK to drink, but repeat tests, take remedial action if results confirmed.
	X		**X**	**Red**: Water is unsafe to drink. Stop distribution. Inform operators and medical authority/commander.
X			**X**	**Gray**: Testing error: retest

Notes:

Green – Total Coliforms Absent, and *E. Coli* Absent (-/-). These are the expected results. They indicate that the water treatment and disinfection systems are performing properly. Document the results, and no further action is required.

Amber – Total Coliforms Present, but *E. Coli* Absent (+/-). Results indicate either a possible breakdown in the treatment and/or disinfection system or contamination of the sample during collection that has resulted in environmental contamination. Warfighters can drink it, but caution is advised. Carefully sample and retest the water, and if the results are (+) again for TC, recommend that quartermaster or engineer personnel take action immediately to confirm that the treatment system is working properly, and to fix any problems that are identified. After remedial action(s) are completed, retest the water. Continue investigating and applying remedial actions until (-) TC results are obtained.

Red – Total Coliforms Present, and *E. Coli* Present (+/+). Results indicate fecal matter contamination and possible breakdown of the treatment and/or disinfection systems. It could also be the result of contamination of the sample. The water must be considered unsafe to drink until the problem is identified and corrected. Immediately notify the water treatment system operators and the Surgeon/Commander and recommend personnel notification, increasing the chlorine dose, issuing personal water container disinfection orders, and/or discontinuing use of the water as appropriate to the situation. Perform confirmatory sampling and analysis. Report the confirmatory results to the system operators and the Surgeon/Commander. If the confirmatory results match the initial sample results (+/+), recommend continuing the previous actions until the problem is resolved. If the second test results are (-/-) or (-/+), remove the restrictions and follow the guidance for Green or Amber conditions, respectively.

Gray – Total Coliforms Absent, and *E. Coli* Present (-/+). Results indicate that there was a problem with the testing, since *E. Coli* would be expected to show up as TC also. Examine the testing materials for expiration dates and cleanliness, and carefully repeat the sampling and testing. If the condition persists, use new testing materials.

c. LTP (>30 days) MFWS.

(1) The military LTP standards are listed in table 4–4. The LTP standards are based on the EPA NPDWR and NSDWR. They are applicable to military- and contractor-operated water purification systems that have been operating for more than 30 days. They apply to

treated drinking water whether it is in storage; distributed by pipes, vehicles, or trailers; or packaged and distributed by military or contractor systems and personnel.

Table 4–4
Long-term potability military field and bottled water standards

Property/Contaminant	Military LTP Standards (mg/L)[1]	FDA Standards for Bottled Water (mg/L)[1]
Physical Properties		
Turbidity	1 NTU	5 NTU
Odor	Acceptable	3.1 TON
Color	15 CU	15 CU
pH	6.5-8.5	-
Total dissolved solids	500	500.0
Disinfectants		
Chloramines (as Cl_2)	4.0	4.0
Chlorine (as Cl_2)	4.0	4.0
Chlorine dioxide[2] (as ClO_2)	0.8	0.8
Disinfection Byproducts		
Bromate[2]	0.010	0.010
Chlorite[2]	1.0	1.0
Haloacetic acids-five (HAA5)	0.060	0.060
Total trihalomethanes (TTHMs)	0.080	0.080
Inorganic Chemicals		
Aluminum	0.2	0.2
Antimony	0.006	0.006
Arsenic	0.010	0.010
Asbestos[2] (fibers >10 micrometers)	7 MFL	-
Barium	2	2
Beryllium	0.004	0.004
Cadmium	0.005	0.005
Chloride	250	250.0
Chromium (total)	0.1	0.1
Copper	1.0	1.0
Cyanide (as free cyanide)	0.2	0.2
Fluoride	4.0	(depends on whether natural or added, and varies w/temp- see 21 CFR 165)
Iron	0.3	0.3
Lead	0.015	0.005
Manganese	0.05	0.05
Mercury (inorganic)	0.002	0.002
Nickel	-	0.1
Nitrate (as nitrogen)[3]	10	10
Nitrite (as nitrogen)[3]	1	1
Selenium	0.05	0.05

Property/Contaminant	Military LTP Standards (mg/L)[1]	FDA Standards for Bottled Water (mg/L)[1]
Silver	0.10	0.10
Sulfate	250	250.0
Thallium	0.002	0.002
Total nitrate plus nitrite	-	10
Zinc	5	5.0
Organic Chemicals		
1,1,1-Trichloroethane	0.2	0.20
1,1,2-Trichloroethane	0.005	0.005
1,1-Dichloroethylene	0.007	0.007
1,2,4-Trichlorobenzene	0.07	0.07
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	0.0002
1,2-Dichloroethane	0.005	0.005
1,2-Dichloropropane	0.005	0.005
2,4,5-TP (Silvex)	0.05	0.05
2,4-D	0.07	0.07
Alachlor	0.002	0.002
Atrazine	0.003	0.003
Benzene	0.005	0.005
Benzo(a)pyrene (PAH)	0.0002	0.0002
Carbofuran	0.04	0.04
Carbon tetrachloride	0.005	0.005
Chlordane	0.002	0.002
Chlorobenzene (mono)	0.1	0.1
cis-1,2-Dichloroethylene	0.07	0.07
Dalapon	0.2	0.2
Di(2-ethylhexyl) adipate	0.4	0.4
Di(2-ethylhexyl) phthalate	0.006	-
Dichloromethane	0.005	0.005
Dinoseb	0.007	0.007
Dioxin[2] (2,3,7,8-TCDD)	$3x10^{-8}$	$3x10^{-8}$
Diquat	0.02	0.02
Endothall	0.1	0.1
Endrin	0.002	0.002
Ethylbenzene	0.7	0.7
Ethylene dibromide	0.00005	0.00005
Glyphosate	0.7	0.7
Heptachlor	0.0004	0.0004
Heptachlor epoxide	0.0002	0.0002
Hexachlorobenzene	0.001	0.001
Hexachlorocyclopentadiene	0.05	0.05
Lindane	0.0002	0.0002
Methoxychlor	0.04	0.04
o-Dichlorobenzene	0.6	0.6

Property/Contaminant	**Military LTP Standards (mg/L)[1]**	**FDA Standards for Bottled Water (mg/L)[1]**
Oxamyl (Vydate)	0.2	0.2
p-Dichlorobenzene	0.075	0.075
Pentachlorophenol	0.001	0.001
Phenols[2]	-	0.001
Picloram	0.5	0.5
Polychlorinated biphenyls (PCBs)	0.0005	0.0005
Simazine	0.004	0.004
Styrene	0.1	0.1
Tetrachloroethylene	0.005	0.005
Toluene	1	1
Toxaphene	0.003	0.003
trans-1,2-Dichloroethylene	0.1	0.1
Trichloroethylene	0.005	0.005
Vinyl chloride	0.002	0.002
Xylenes (total)	10	10
Radiological		
Gross alpha particle activity (excluding radon and uranium)	15 pCi/L	15 pCi/L
Gross beta particle and photon emitter activity	4 mrem/yr	4 mrem/yr
Tritium[2,4]	0.27 µCi/L	-
Combined Ra-226 and Ra-228 activity[2]	5 pCi/L	5 pCi/L
Uranium	30 µg/L	30 µg/L
Microorganisms		
E. coli (CFU/100 mL)	0 (P/A)	0 (MF or MPN)
Total coliforms (CFU/100 mL)	0 (P/A)	4 and 1 (MF)[5]
Viruses	TT	N/A
Giardia	TT	N/A
Cryptosporidium	TT	N/A

Legend:
LTP = long-term potability; FDA = U.S. Food and Drug Administration; mg/L = milligrams per liter; NTU = nephelometric turbidity units; TON = threshold odor number; CU = color units; MFL = million fibers per liter; µg/L = micrograms per liter; pCi/L = picocuries per liter; mrem/yr = millirems per year; µCi/L = microcuries per liter; CFU/100 mL = colony forming units per 100 milliliters; P/A = presence/absence; MF = membrane filter method; MPN = most probably number method; TT = treatment technique (i.e., adequate filtration and disinfection); N/A = not applicable; MCL = maximum contaminant level; WHO = World Health Organization

Notes:
[1]Units are in mg/L unless noted. For analytes in water, units of mg/L are equivalent to parts per million (ppm).
[2]Parameter is neither in the field test kit nor in the 40-mL AWT suite, but must be specifically requested and sampled for if contamination is suspected.
[3]Infants below the age of 6 months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.
[4]Although the current water test kits do not include a test for tritium, current procedures do call for tritium testing in special cases (such as if source water is taken downstream from a nuclear facility). The WHO standard shown has been adopted as the LTP standard.
[5]Not more than one of the analytical units in the sample shall have 4.0 or more CFU/100 mL, and the arithmetic mean shall not exceed 1 CFU/100 mL. MPN method has other requirements – see 21 CFR 165.110 for details.

(2) The Army VS is responsible for inspecting and approving bottled water facilities and operations for all Military Services. VS personnel use MIL STD 3006C as the basis for approving or disapproving bottled water facilities for military use. Appendix K of the standard specifically addresses bottled water and soft drink plants. The standards and inspection criteria in MIL STD 3006C incorporate the FDA standards for manufacturing procedures and quality of bottled water, and are applicable to bottled water produced both CONUS and OCONUS for multiservice procurement. The military-adopted FDA bottled water standards are shown in table 4–4. They are nearly identical to the military LTP standards.

d. NATO drinking water standards.

(1) NATO STANAG 2136 establishes the minimum acceptable quality for water that is produced by one NATO nation and provided to another during NATO operations. It establishes standards for water potability for emergency and routine situations. Operational monitoring and testing requirements are also specified, and STANAG 2136 should be reviewed and complied with when providing water to other NATO nations' forces. Water produced by U.S. military forces that meets the LTP MFWS should be acceptable to other NATO nations in terms of water quality.

(2) Water purified by any NATO member nation during multinational deployments is expected to be of a quality that will meet STANAG 2136 requirements. Variances with the agreement must be documented and provided to nations receiving the water. The receiving nations can evaluate the variances and either accept the water or find another water source. USACHPPM and the Navy and Marine Corps Public Health Center (NMCPHC) maintain contact and coordinate standards updates with the STANAG 2136 Working Group during annual custodial meetings.

e. Disinfected fresh and disinfected filtered fresh water for nonpotable use. The basic quality requirements for these waters, when used for nonpotable water activities shown in table 2–11, are presented in table 4–5. The presumption is that the exposure to the water and any contained impurities is almost exclusively through contact, and that little or none of the water is ingested. When samples of these waters are submitted for AWT, PM personnel perform a health risk assessment for each parameter that exceeds an MFWS or MEG. In performing the risk assessments, the assessors acknowledge that the exposure is primarily contact with skin, and therefore includes minimal ingestion, inhalation, and eye contact.

Table 4–5
Disinfected fresh and disinfected filtered fresh water guidance for nonpotable uses

Parameter	Requirement
pH	6.5 – 10 pH units
TDS	< 1500 mg/L
Turbidity	< 1 NTU if filtered; < 10 NTU if not filtered
FAC residual	1 mg/L after 30-min contact time, and maintained until the water is used

4–7. Military exposure guidelines

In addition to the contaminants addressed by the MFWS, numerous industrial chemicals potentially capable of producing immediate or delayed adverse health effects in some individuals could be present in treated water. PM personnel identify the presence of these contaminants in field water through the Continued Water Quality Surveillance (CWQS) Program for treated water. They periodically collect samples from field drinking water supplies and submit them, usually to a remote laboratory, for AWT or specific analyte testing. The analytical results from AWT or special testing are compared to USACHPPM TG 230 water MEGs to assess the potential health risk from any chemicals identified, and to use as a basis for making risk-mitigating recommendations to commanders. More than 600 chemicals have water MEGs assigned, most of them for drinking 5 and 15 liters per day for less than 7 days, 7 to 14 days, and 1 year. The MEGs are published in USACHPPM TG 230, which is updated periodically and posted on the USACHPPM Web site at http://www.chppm.com (under Resources—USACHPPM Technical Guides). In addition to listing the MEGs, USACHPPM TG 230 contains discussions of risk assessment methods and toxicological data associated with the chemicals of concern, the caveats and uncertainties associated with the development and use of MEGs, example scenarios, and sample risk assessments.

4–8. Radioactivity

Field water supplies may be contaminated by a nuclear weapons detonation, radiation dispersal devices, or “dirty bombs.” More likely are industrial or natural radiological sources upstream or within the aquifer of a water source. Contaminated particles are generally insoluble, but may remain suspended in the water or settle out and later be resuspended by natural or mechanical actions and drawn into raw water intake systems. The MFWS for radiation are designed to limit the amount of radioactive substances taken into the body through drinking water. The short-term standard shown in table 4–2 is designed to protect against performance degradation during a period up to 30 days. The long-term standards in table 4–4 were derived from the WHO standards. If the radioactivity in the water is above the respective guidance levels, PM personnel should contact qualified experts such as those at USACHPPM, U.S. Air Force School of Aerospace Medicine (USAFSAM), and NMCPHC or consider alternative water sources or additional testing prior to allowing its use, particularly for drinking.

4–9. Comparing results to standards and guidelines

PM personnel must compare the results of tests performed on field water supplies to the appropriate standards and guidelines to evaluate whether the water quality is acceptable. These standards and guidelines include the STP and LTP standards and the water MEGs. When field water standards or MEGs are exceeded, PM personnel evaluate the potential risk of the excessive contaminant(s) to personnel and make recommendations to the appropriate medical or command authority to mitigate possible adverse health effects. The risk assessment method is described in detail as it applies to field water contaminants in USACHPPM TG 230. (Note: While results from testing samples of raw and other nonpotable waters may be compared to STP and LTP standards and MEG values, the comparisons are only used for evaluating and documenting the sampled water quality; they are not used to evaluate health risks from drinking the water, since raw and nonpotable waters are not to be consumed.)

Section III
Bulk Field Water Sampling and Testing

4–10. Bulk water production points

a. STP and initial PM approval. As soon as possible after field water treatment and disinfection operations at a water production point are fully functional as determined by the water treatment system operators, they should notify the appropriate PM element. PM personnel inspect the water treatment system and test the treated water using field test equipment to ensure that it meets STP standards. At the same time, the inspecting and testing PM personnel should collect and submit raw source water samples (if it hasn't already been done) as well as treated water samples for initial LTP testing. If the field test results confirm that the water meets the STP standards, the testing PM personnel will declare the water potable for short-term usage, and approve it for distribution for drinking and all other uses. It takes PM personnel approximately 24 hours after inspecting the site and collecting water samples to complete the field testing and initially approve a water production point. PM or unit personnel should document the test results and approval in the Defense Occupational and Environmental Health Readiness System - Environmental Health (DOEHRS-EH), the DOD-approved system for documenting and archiving all occupational and environmental health surveillance (OEHS) efforts. If the required functionality has not been incorporated in DOEHRS-EH, or access to the system is not available, STP results should be submitted and entered into the Deployment Occupational and Environmental Health Surveillance (DOEHS) Data Portal and, if required, into other Military Service-specific data collection systems for review and archiving. Data and information that is entered into DOEHRS-EH does NOT have to be submitted via the DOEHS Data Portal.

b. LTP and AWT. Advanced water testing is required to confirm LTP (the water quality acceptable for >30 days consumption) for production points that operate longer than 30 days. AWT procedures are described in paragraph 4–11*c*(2), below. The procedures involve PM onsite testing and collecting and submitting water samples to in-theater or remote laboratories that have the capabilities to test for the LTP standards shown in table 4–4. (Note: If a water production site has been approved for potable water distribution under the STP standards and samples for LTP testing have been collected and submitted, but the results are not received before the 30th day of operation, production and distribution may continue under the STP approval until the test results are received, with PM recommendation and permission from the local medical authority and unit commander.)

c. Follow-on testing and approval. PM personnel should test product water using field test equipment at established potable water production points periodically, at the frequencies shown in table 4–6, as the overall mission permits. PM personnel should retest product water in the field to ensure at least continued short term potability whenever there is a significant change in the quality of the source water (for example, after a major rainstorm) and after work is performed on the treatment system (in the case of a ROWPU, for example, ROM cleaning or replacement, multimedia filter maintenance, or prefilter replacement). The frequency of recurring testing should also be increased based on ongoing composite/operational risk management (C/ORM) of the safety of the water supply system. Consideration should be given to doubling, tripling, or quadrupling the routine testing frequencies as dictated by the perceived risk, the mission, and the tactical situation.

Table 4–6
Recommended frequencies for periodic PM testing of potable water production, storage, and distribution systems

Parameter	Sampling Frequency				Recommended test method
	ROWPU water production points	Distribution systems[3]	Stand-alone storage[4]	Bottled/ packaged field water	
Coliforms[1] (total and *E. coli*)	Weekly/monthly	Monthly	Weekly/ Monthly	Monthly[5]	P/A
TDS[1]	Weekly/monthly	-	-	-	TDS meter
Chlorine residual[1]	Weekly/monthly	Weekly	Daily	-	DPD test
Temperature[1]	Weekly/monthly	Monthly	-	-	Thermometer
pH[1]	Weekly/monthly	Monthly	Daily	-	pH tester/ phenol red test
Color/odor[1]	Weekly/monthly	-	-		Color disk
Turbidity[1]	Weekly/monthly	-	-	Monthly/ visual	Turbidimeter
Arsenic	Quarterly	-	-	-	Test strips
Cyanide	Quarterly	-	-	-	Test strips
Magnesium	Quarterly	-	-	-	Titration/test strips
Chloride	Quarterly	-	-	-	Test strips
Sulfate	Quarterly	-	-	-	Test strips
Radiological	Quarterly	-	-	-	Laboratory analysis
AWT[2]	Semiannually/ annually	Semiannually/ annually	-	Event-driven	Laboratory analysis
Chemical agents	Threat-related[6]	-	-	-	M272 chemical agent test kit

Legend:
TDS = total dissolved solids; P/A = presence/absence; DPD = N,N- diethyl-p-phenylenediamine;
AWT – advanced water testing
Notes:
[1]These parameters should be monitored weekly during the initial phase of field operations, and monthly as the theater matures and the water system is stabilized.
[2]AWT samples are collected using the deployment field water sample kit available from USACHPPM, described in para 4-12, and submitted to a fixed facility laboratory for analysis.
[3]Where a host nation distribution system or the tactical water distribution system (TWDS) is used.
[4]Includes representative sampling of water buffalos, Hippos, and other storage tanks not connected to or part of a distribution system (e.g., 10 percent).
[5]See para 4-14*d* for detailed information.
[6]See table 4−7.

4–11. Physical, chemical, and biological testing

a. General water sampling considerations. Water samples should always be as representative of the bulk raw or treated water being sampled as possible. Appropriate chemical and environmental preservation techniques should be used and prescribed holding times and temperatures met. Care should always be taken to avoid contaminating the water sample or collection vessel during the sampling procedure. This is particularly important for bacteriological samples. Source water samples should be collected as close as possible to the actual water intake screen or structure. Water purification system product water samples should be collected from a point where the disinfectant (chlorine) has had at least a 30-min contact time prior to sampling. Treated water samples collected for microbiological testing must be dechlorinated (typically using sodium thiosulfate or sodium bisulfite) at the time of sample collection to halt the bactericidal action of residual chlorine.

b. STP (30-day) potability testing. PM personnel use organic water testing equipment and reagents to perform initial and repeated onsite testing of purified water. Recommended frequencies after initial testing for select water testing parameters are shown in table 4–6. They perform tests for the all of the STP parameters listed in table 4–2 that their field equipment can detect at the level of the standards. They also perform presence/absence testing for total coliforms (TC) and *E. coli*. The M272 chemical agent water testing kit is used to screen raw water supplies for the presence or absence of chemical agents. It does not need to be used to test treated water unless raw water tests indicate the presence of chemical agents. Radioactivity, BZ, or T-2 mycotoxins, for which there are STP standards, must be evaluated from samples provided to laboratories with advanced testing capabilities. Military Service-specific water testing equipment used by field PM elements together with the detection limits and detectable concentration ranges can be found in their respective sections.

c. Initial LTP (>30-days) potability testing.

(1) General. LTP testing is required to evaluate the suitability of treated water to be used for drinking water for longer than 30 days. Field water test equipment available to most PM personnel in the field cannot detect all of the parameters at the levels established in the LTP standards. The additional parameters must be evaluated at a laboratory with AWT capabilities.

(2) AWT procedures. To ensure the quality of analytical results from AWT in support of LTP testing, EBSs, and OEHSAs, PM personnel must follow correct procedures for: collecting water samples; documenting sample data, including field test results; shipping samples for advanced testing; and archiving the results.

(a) Collecting water samples for AWT.

(i) PM personnel collect and submit treated water samples to a higher level laboratory for partial or complete AWT initially when a water purification point is established, whenever meeting LTP standards needs to be verified, and otherwise, semiannually. The frequency may be extended to annually after the first year if the water supply system is robust and well established, with the approval of the area medical authority. It is very important to properly label and identify the samples so laboratory personnel will handle and test them appropriately, and personnel who may evaluate the results have the proper understanding on which to base their evaluations.

(ii) USACHPPM provides deployment water sampling kits complete with all the necessary sample containers, supplies, sampling instructions, and field data sheets for correct documentation to minimize the errors that can lead to invalid results. Kits for both treated and raw water are available, and the kit should be used for the type of water to be sampled. The kits and procedures for using them are described in paragraph 4–12, below.

(iii) Personnel who collect samples for AWT must test the water onsite at the time they collect the samples using their field water test equipment. They should test the water for its pH, temperature, conductivity, turbidity, FAC residual, and TDS concentration, as well as for the presence of TC and *E. coli*. They record the results of these tests on the sample information sheet that comes with the sample kit (or make one up if necessary) and ensure that it accompanies the samples to the laboratory.

(b) Shipping samples for AWT. After collecting and packaging samples for AWT, PM personnel are responsible for ensuring the samples are properly shipped, together with complete and correct documentation, to an appropriate laboratory (preferably the one the sample kit came from). Typically, this is the final action that field PM personnel are responsible for in AWT procedures. Prior to shipment, personnel must coordinate with the selected laboratory to ensure that the laboratory is aware of the numbers and types of samples, as well as the approximate arrival date so they will be prepared to accept them. USACHPPM provides details regarding the use of their specific sample kits and analytical laboratory services.

(c) AWT sample results. All AWT results from testing treated water, whether from EBSs, OEHSAs, or CWQS, should be used to assess and control health risks through the C/ORM process. AWT analyses include the MFWS and some of the 600-plus MEG parameters listed in USACHPPM TG 230. The analytical methods used for AWT must be sensitive enough to be able to measure the lowest MEG value for each analyte listed in USACHPPM TG 230. Because AWT samples must be shipped to advanced laboratories for testing, it may be several weeks from the time samples are collected until the results are received. If a more rapid turnaround time is required, PM personnel must coordinate with the USACHPPM Deployment Environmental Surveillance Program (DESP) to see if the sample analysis and reporting can be expedited.

d. CWQS.

(1) DODI 6490.03 requires the implementation of deployment OEHS including documentation of, as nearly as possible, all occupational, environmental, and chemical, biological, radiological, nuclear, and high energy explosive (CBRNE) warfare exposures to deployed personnel. To accomplish this for field water, in addition to initial LTP testing of treated water (including bottled/packaged field water) to approve it for distribution beyond 30 days of operation, the LTP tests should be repeated periodically for all drinking water supplies in a deployment area throughout the deployment to monitor the continued quality of the water and identify any trends such new or increasing concentrations of parameters that indicate a reduction in treated water quality.

(2) Collection and submission of a single set of representative AWT samples for each water supply in an AO may suffice for some deployments; however, additional sampling will be required if the drinking water supplies are used for longer than 6 months, or if contaminants are identified in the initial sampling that pose potential health risks. PM personnel will determine the need for additional testing after reviewing the results of the first set of analyses for each water supply. Further, whenever the water source quality changes (for example, due to flooding or a spill upstream) or when the treatment system is modified or shut down and then restarted, additional AWT samples should be considered as part of CWQS. The procedures for collecting and submitting CWQS samples are the same as for AWT, described in paragraph 4–11*c*(2)(a).

e. Chemical agent testing. Water purification system operators use M272 test kits to test water for CW agents in accordance with table 4–7. PM personnel should likewise use the M272 kit to conduct water tests for chemical agents, if there is threat or intelligence information suggesting possible contamination, as part of RWC and STP testing. The M272 kit detection limits are not as low as the MFWS concentrations. Its test results are employed as gross-level clearance indicators, and should be used on raw water first, because the concentrations in the raw water, if there are any, will be greater and easier to detect than in treated water. Once water purification operations have started, the reject/brine stream from the ROWPU can also be used to test for chemical agents. Because of the membrane rejection capabilities for chemical agents and the volume reduction of the raw water stream, the agents will be concentrated in the brine stream and thus easier to detect. CBRNE filters are a component of all currently fielded water purification systems. If CBRNE contamination is a concern, or if contaminants are identified at any stage in water source or treatment system evaluations, water purification personnel will immediately connect the CBRNE filters. The MFWS for chemical agents shown in table 4–2, above, are only for drinking water used for 7 days or less. There are no 30-day or long-term agent standards, because it is anticipated that an alternate water source would be found as soon as possible if chemical agents were discovered in the source water being used.

Table 4–7
Frequency of chemical warfare agent and radioactivity testing of source water by water purification personnel according to threat and MOPP level[1]

Threat level	MOPP level	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

Legend:
MOPP = mission-oriented protective posture
Note:
[1]Extracted from FM 10–52–1.

f. Shower and personal sanitation water. When disinfected fresh or disinfected filtered fresh water is approved for centralized showers and other activities identified with asterisks in table 2–11, the water must be tested by the producing organization to ensure it has at least a 1 mg/L FAC residual when delivered to storage facilities for use. The date, time, and results of testing should be recorded and readily available for PM personnel to review during routine inspections. Unit-level PM-trained personnel should also test the stored water daily, unless the water is delivered and used completely each day. In cases where the number of storage containers makes the specified testing impractical, water producers and PM personnel should develop a periodic test schedule, such as testing some percentage of the containers daily, that provides adequate assurance that the water in all of the storage containers always has the required FAC residual. Personnel may seek higher level PM guidance for assistance in determining an appropriate sampling plan and schedule if necessary.

4–12. Deployment field water sampling kits

a. The USACHPPM deployment field treated water sampling kits were developed as reduced-volume field-expedient screening tools for PM personnel to collect and submit treated water samples for AWT. The kits are specifically designed for sampling treated water sources (to include host nation municipal water or bottled water) to meet DOEHS and OEHSA requirements. The raw water kits are larger, and can also be used to sample surface and ground-water sources for EBSs. Full size sample kits are also available for performing full volume EPA sampling. Regardless of which sampling kit is used, it is imperative for field personnel to clearly identify the type of water they are sampling, whether it is raw or treated surface water or ground water, and if treated, whether by ROWPU or by some other method.

b. The treated water kits contain appropriately prepared and pre-preserved small sample containers to properly collect treated water samples to ensure that the laboratory can analyze the water for the MFWS and some of the MEGs parameters (some limited field preservation is necessary). They were specifically designed to accommodate military logistical requirements by minimizing volume and weight. The reduced kit size and sample volume also reduce the levels of quality assurance and quality control measures employed, resulting in somewhat less confidence in the analyses than if full volume samples were collected.

c. The treated water sample kits are generally shipped to units from USACHPPM-Headquarters or USACHPPM-Europe (USACHPPM-EUR) and include sets of 40- and 125-mL bottles with the necessary preservative chemicals in the sample bottles and packing material. Each kit also includes instructions that provide step-by-step procedures for collecting and shipping the water samples to a supporting laboratory. It is important that all directions be followed explicitly, including staying within the appropriate shipping times and temperatures to the extent possible. Collecting one set of samples usually takes half an hour or less. The samples are analyzed for most of the LTP standards plus select MEG parameters to determine if they are present at or above the standards or guidelines. The other kits are larger but are similarly provided with preservatives, where necessary, and written instructions.

d. Field personnel must follow the instructions that come with the sampling kits precisely to ensure their proper use and submission to an appropriate support laboratory. If this is not done correctly, some or all of the analytical results for the chemical parameters will be invalid. It is important to coordinate with the receiving laboratory if different from the one the sampling kit came from prior to shipping the samples to it to ensure that it can perform all the desired analyses using the sample containers in the kit. The USACHPPM-Headquarters laboratory has developed procedures for accurately analyzing the samples from its kits, and achieving the necessary detection levels, as has USACHPPM-EUR for its sampling kits. Other laboratories may not be able to accommodate the treated water kits' reduced sample sizes, so prior coordination with analytical laboratories other than USACHPPM's is essential. Finally, ALL SAMPLES MUST BE ACCOMPANIED BY A CORRECTLY FILLED OUT DA Form 7577 (Treated Water Sampling Field Data Sheet). Instructions for filling out this data sheet are on the reverse side of DA Form 7577.

4–13. Documenting field water sampling and testing

a. Documenting the samples.

(1) If a sample kit comes with instructions for labeling the containers, they should be followed. The USACHPPM sampling kits include field data sheets for documenting critical sample information. Personnel who collect samples for AWT must accurately complete a field

data sheet and return it with each sample set and kit. Other laboratories have similar instructions with their sample collection kits. The information requested is extremely important to laboratory personnel and others who may have to assess the potential health risk associated with drinking the water if a standard or MEG is exceeded in the sample.

(2) If no instructions accompany the sampling containers, the following general guidance should be followed. Samples should be labeled in such a way that the test results can be accurately traced back to the time, location, and specific water that was sampled. Labels need to identify whether the water in the sample container is raw/untreated water, treated water, wastewater, or something else. Each sample should be given a unique sample number, and a log kept relating each sample number to its collection location and the analytes it was collected to evaluate. Any preservatives added to the samples need to be identified. The date, time, and location of the sampling event, a drawing of the location if it is a raw water source, and grid coordinates should be recorded if they are available. If the sample is of treated water, identify the water source and type of treatment – provide model and serial numbers of the treatment equipment components if available. The more information provided the better, as long as it is clear and easy to understand.

b. Documenting the results.

(1) All results of onsite and remote laboratory water testing must be documented and stored so as to be retrievable if a question arises. Accurate and complete results of all water tests are critical for their proper and accurate evaluation. A hard copy of the test results should be given to the supervisor of the operation or area sampled, one retained by the sampler, and one each passed up the medical and operational chains of command in accordance with current local/theater policies.

(2) Test results should also be entered into DOEHRS-EH. If the required functionality has not been incorporated, or access to the system is not available or at or near the field water sampling/testing location, test results should be submitted (electronic or hard copy) and entered into the DOEHS Data Portal and/or other Military Service-specific data collection systems.

4–14. Bottled and packaged field water sampling and testing

a. Commercial bottled water for military issue. Military medical personnel must approve all bottled drinking water sources before they are used by deployed personnel. Army VS personnel inspect and approve commercial bottling facilities to ensure compliance with acceptable sanitation standards. They submit source and product water samples to an accredited laboratory for testing according to 21 CFR 165 prior to initial approval. Army VS personnel also perform periodic sanitary inspections of approved CONUS and OCONUS bottling facilities according to MIL STD 3006C. During these sanitary inspections, they collect samples from randomly selected bottles of treated water and submit them to an accredited laboratory for complete microbiological and chemical analyses. Continued approval and military use of the facilities' bottled water product is contingent on satisfactory sanitary inspections and acceptable analytical results. The VS should ensure that all analytical results from testing bottled water samples are documented and uploaded to DOEHRS-EH if possible, or if not, provided to the USACHPPM Environmental Surveillance Integration Program (ESIP) for archiving in the DOEHS Data Portal.

b. Military and contractor-produced packaged field water. As a result of improvements in mobile water packaging equipment and the changes in the MFWS implemented with this edition of TB MED 577, the requirements for these systems is very similar to the requirements for commercial operations.

(1) *Packaging equipment and process*. The raw and treated water must be tested, and the packaging equipment and process must be inspected, and both approved by PM personnel.

(2) *Water quality for packaging*. Packaging is merely a form of distribution of treated water. As such, all the water quality requirements for the water production operations are the same as described for bulk water treatment in paragraph 4–6. The water must meet either STP or LTP standards, depending on the length of time the system has been in operation and meet the microbiological standards for TC and *E. coli*.

(3) *Chlorine residual requirements*. The chlorine residual in the ROWPU or contractor-operated water treatment system product water must have the required 2 mg/L FAC residual after 30 min (or equivalent 60 mg-min/L concentration-time (CT)). However, the chlorine residual for the water when it is sealed in packages or bottles may be reduced, as determined by PM personnel, after carefully evaluating the treatment system and the packaging equipment operations. The water may be able to be dechlorinated prior to packaging to reduce the chlorine residual or completely eliminate it. Contact PM technical support for guidance and assistance.

c. Storage and shelf life of bottled and packaged field water.

(1) *General*. Bottled and packaged field water should not be stored in direct sunlight because the light and warmth support bacterial growth in the water. Bottles and packages of water should be stored in shaded, well-ventilated areas and in boxes which keep the caps elevated. Stored bottled/packaged field water should be used on a first in, first out basis, to keep the holding time as short as possible.

(2) *Commercially bottled water*. Commercially bottled water usually has a labeled shelf life of 1 year or more. It may continue to be stored and issued indefinitely beyond its expiration date, if necessary, as long as PM or VS personnel test representative samples of lots as described below, and approve the expiration date/shelf life extensions.

(3) *Packaged field water*. The initial approved shelf life or expiration date for these packages/bottles, unless prescribed otherwise by PM or VS personnel, is 30 days from the date of production. Shelf life or expiration dates may not be printed on packaged field water containers or labels. However, at least the production date should be on the bottle, package, or label. Expiration dates may be extended indefinitely in 30-day increments by PM or VS inspectors as described below.

d. PM surveillance requirements for bottled and packaged field water. The following procedures are guidelines for a conservative PM bottled water quality surveillance program. They can be easily modified to apply to packaged field water. When bottled or packaged field water is a significant percentage of the total force drinking water, the procedures can be very daunting in terms of personnel, time, and in-theater travel. PM leaders should consider the time requirements and operational risk resulting from fully implementing these procedures, and modify them as necessary to optimize the trade offs among operational risk, health risk if contamination goes unobserved, and time requirements, to provide adequate bottled water quality surveillance without unnecessarily detracting from other important PM missions.

(1) *Procedures.* Logistics personnel may begin issuing bottled and packaged field water received from or produced at VS-approved facilities/sources upon receipt. However, PM personnel should test representative samples of bottled water for quality, initially and periodically, at storage and distribution facilities in the deployment area. A representative sample is defined as 1 percent of the total number of bottles, up to a maximum of 10 bottles, randomly selected from a lot. A lot may be identified by a number on the bottles or labels, or

all bottles of a brand with the same production date may be considered a lot. PM personnel should—

(a) Inspect shipments of commercial bottled water upon delivery/receipt in theater, prior to distribution to storage and issue points, for damage, leakage, clarity, expiration, and potential tampering. They should perform visual observations and field testing of representative samples of each brand for TC and *E. coli*.

(b) Inspect shipments for damage, leakage, clarity, expiration, and potential tampering, upon receipt at ports of entry, central storage facilities, warehouses, and other theater distribution points, and perform TC and *E. coli* analyses on each lot of OCONUS- and CONUS-produced bottled water, and on military-produced packaged field water.

(c) Similarly inspect each lot of bottled and packaged field water at major storage sites and end user locations, and test for TC every 30 days until the lot is exhausted. This procedure will allow expiration dates to be extended in 30-day increments as necessary.

(2) *Methods and results*.

(a) Total coliform and *E. coli* testing may be performed using any EPA-approved testing method, including the membrane filter technique, Colilert® and Colisure®. Dated copies of the inspections and testing results should be maintained by the inspecting PM authority and by the facility manager, and copies should be made available to subsequent PM/VS inspectors. PM personnel should ensure that all inspections and testing results are documented and entered into DOEHRS-EH if possible, or if not, provided to the USACHPPM ESIP for archiving into the DOEHS Data Portal. (Colilert® and Colisure® are registered trademarks of IDEXX Laboratories, Inc., Westbrook, Maine.)

(b) If the water in any of the bottles is cloudy, tampering is suspected, or coliform positive samples are identified, the nearest veterinary detachment will be notified immediately, and issue from the suspicious lot will be suspended pending investigation of the matter and/or immediate resampling to confirm coliform presence. In the case of coliform-positive samples, a representative sample of the suspect lot should be retested. If the confirmation results indicate the presence of coliforms, the lot should not be used for potable purposes. In all cases of suspected nonpotable bottled or packaged field water, the notified veterinary detachment will initiate appropriate suspension of issue and recall actions. If no other sources of drinking water are available, bottled or packaged field water lots that have tested positive for coliforms may be issued for drinking, along with stern guidance that iodine, Chlor-Floc, unscented chlorine bleach or boiling water must be used to disinfect the water prior to drinking it.

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Chapter 5
Redeployment and Post Deployment Actions

5–1. Redeployment. A number of tasks and actions need to be completed by PM personnel at the conclusion of their deployment. These tasks and actions are important to the health of Soldiers, Sailors, Airmen, and Marines because exposure to environmental health threats may have acute, chronic, or latent effects. The tasks and actions performed will assist in providing OEHS continuity. PM personnel should:

a. Brief the personnel of the unit that are replacing their unit concerning ongoing water-related issues and actions, and transfer all original water data and reports to them.

b. Ensure that all raw occupational and environmental health (OEH) water data has been submitted according to command policy for documentation and archiving.

c. Perform OEHSA and EBS final water sampling as required by the command.

5–2. Post deployment. Typical post-deployment tasks that PM personnel should perform with respect to the field water mission include—

a. Monitoring, sampling, and testing.

(1) Provide guidance on field water site/area restoration, including the removal and disposal of waste (see FM 4–02.17 and other Military Service-specific guidance).

(2) Perform the necessary water sampling to ensure site/area in question is restored.

b. Health surveillance.

(1) Provide water sample collection locations and test results to health care providers so they may continue to provide health surveillance and reporting on units redeployed from an AO or theater of operations (TO).

(2) Provide necessary input to unit leaders regarding water studies, sampling, inspections, and exposures so they can complete medical surveillance reports.

(3) Ensure all OEH sample results are analyzed for potential medical follow-up, and ensure the necessary sample information is included as appropriate in lessons learned and future operational reports.

(4) Notify health care providers concerning personnel exposures to contaminated water if appropriate.

(5) Ensure PM health care providers address OEH concerns related to the review of responses on the DD Form 2796 (Post Deployment Health Assessment), and document these concerns in the individual’s health or medical record.

(6) Develop OEHS-related lessons learned and after action reports (AARs), and input into the DOEHS database for archiving.

c. Risk communication.

(1) Provide water-related issues for inclusion in post deployment medical debriefings risk communication material and participate in post-deployment medical debriefings and risk communication sessions.

(2) Conduct and document medical debriefings and submit these briefings to the DOEHS Data Portal for archiving.

d. Reporting and archiving.

(1) Ensure that all field water quality analytical results, with appropriate context information, risk assessments, and corrective actions are documented and uploaded into

DOEHRS-EH if possible, or if not, provided to the USACHPPM ESIP for archiving via the DOEHS Data Portal.

(2) Provide AARs and lessons learned for submission through the chain of command to the DOEHS Data Portal.

(3) Prepare AARs and include significant exposures/events/issues. These reports should address specific water issues and be provided to the operations and intelligence communities, to the Military Services health surveillance centers, and to the Armed Forces Health Surveillance Center.

(4) Develop and forward FHP lessons learned, AARs, and lessons learned reports to the appropriate U.S. Combatant Command (COCOM), Joint, and Military Services lessons learned portals, the appropriate Military Services lessons learned center, and to the DOEHS Data Portal.

(5) Prepare an AAR and a joint lessons learned report that address significant issues and findings with equipment, doctrine, tactics, techniques, and procedures. Submit copies to the Joint Lessons Learned Repository and Center for AMEDD Lessons Learned. Lessons learned should use the doctrine, organization, training, manpower, leadership and education, personnel, and facilities (DOTMLPF) format with evaluation impacts requirement, and shortfalls.

PART II
REFERENCE MATERIAL

Part II of this document provides general and detailed technical guidance and reference material that may be useful to PM personnel during deployment operations. This part—

- Discusses military/nonmilitary bulk field water storage systems.
- Describes field water test equipment typically used in the field.
- Provides techniques for cleaning, sanitizing, and decontaminating field water equipment.
- Discusses how to manage waste from field operations.
- Describes illnesses caused by water contaminants, and provides tools and directions for assessing the risks of some of the more common contaminants.

Chapter 6
Bulk Field Water Storage and Distribution

6–1. Military bulk field water storage systems

a. Potable water storage and distribution system (PWS/DS). The PWS/DS is the primary means for the receipt and storage of bulk drinking water and for issue to combat forces under tactical conditions. The PWS/DS is intended for use in arid environments by both direct and general support water units. The total capacity of each PWS/DS is dependent on the number and size of fabric tanks assigned and used. Each PWS/DS can distribute water to and receive it from hose lines and tank trucks. The PWS/DS can deliver water to tank trucks, water trailers, forward area water point supply systems (FAWPSS), or small unit containers such as 5-gal cans. The systems operate on a modular concept; that is, any combination of storage tanks may be used collectively or individually, as connected tanks can be valved off at either their input or output valves. More information on the PWS/DS is available in TM 10–4610–237–12 and TM 10–4610–242–13.

b. 3,000-gal onion tank. The 3,000-gal onion tank is a highly mobile, easily transportable, manually inflatable/collapsible fabric water tank. Packaged, the tank is 23 in x 28 in x 42 in and weighs 130 pounds (lb). Filled with water, the tank is 56 in x 148 in x 94 in and weighs 25,020 lb. More information on the 3,000-gal tank is available in TM 5–5430–213–13&P.

c. Load handling system (LHS) water tank rack (Hippo). The Hippo is compatible with the Army's LHS and consists of a 2,000-gal, hardwall water tank rack with a stainless steel interior and a recirculation water pump. The Hippo may be mounted on or dismounted from its prime mover and when mounted, can move water whether it is filled, partially filled, or empty. The Hippo performs individual and bulk water distribution. The current equipment for bulk distribution, the semitrailer-mounted fabric tank (SMFT), cannot distribute potable water at the unit level and has limited tactical mobility. Because of these shortcomings, the SMFT cannot support emerging operational concepts. The Hippo meets the Army's critical need for a mobile, flexible, hardwall water distribution system for current and future forces.

d. Forward Area Water Point Supply System. The FAWPSS is a portable, self-contained, gas- or diesel-operated unit that dispenses potable drinking water to troop units. The FAWPSS employs a 125-gal/min centrifugal pump to distribute water from combinations of 500-gal water storage and dispensing drums attached two at a time. Quick-disconnect couplings connect the drums to the pump. The drums provide water to the pump, which pumps water through hoses and valves to four distribution nozzles. More information on the FAWPSS is available in TM 10–4320–346–12&P.

e. SMFT. SMFTs are used to transport only drinking water. The assembled unit consists of a collapsible tank with a pressure gauge, end fittings, tie down straps, emergency repair items, hoses, and tools. These large rubberized tanks can be mounted on the bed of an empty flatbed trailer, filled with water, and driven by truck from origin to destination. Because the fabric tank must be emptied completely at its destination and is unstable with partial loads of potable water, the SMFT is truly an "all or nothing proposition." The flatbed trailer that hauls the SMFT also lacks off-road mobility and, therefore, cannot deliver water far forward. The SMFT has no pumps. The 3,000-gal SMFTs are used by direct support water supply units to deliver water to major users that have no organic transportation capable of retrieving needed water supplies directly from the water points. The 5,000-gal 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. More information on the 3,000- and 5,000-gal SMFTs is available in TM 5–5430–213–13&P and TM 5–5430–212–13&P, respectively.

f. Tactical water distribution system (TWDS). The TWDS is a highly mobile water distribution system. It consists of pumping stations, 6-in diameter fabric pipes, storage assemblies, and distribution points. It is designed to distribute water for distances up to 10 miles on level terrain. More information on the TWDS is available in TM 10–4320–317–13.

g. 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 gal).

h. 800-gal unit water pod system (Camel). The 800-gal Camel was under development at the time this publication was prepared. It will replace the M107, M149, and M1112 series water trailers. It sits on an M1095 trailer which allows for better transportability on and off the road than its predecessors, using the Family of Medium Tactical Vehicles Truck. The Camel was designed to be towed either full or partially full, and will be outfitted with a water pump, hose reel, and filling station. Chillers are also being developed for future addition to the package.

i. 400-gal water trailer. The Army employs the M149A2 and M1112 water trailers to distribute drinking water to field units. The M149A2 water trailer with a stainless steel tank replaced the M149 and M149A1 fiberglass tank water trailers. The M1112 is a newer eight-wheeled water trailer with a cylindrical stainless steel tank and a wider footprint which makes it more stable during movement. More information on the M149A2 and M1112 water trailers is available in TM 9–2330–267–14&P and TM 9–2330–397–14&P, respectively. PM concerns with these trailers are presented in USACHPPM IP 31–035. The Camel, an 800- or 900-gal steel tank water trailer, will replace the existing water trailers on a one-for-two basis, when it is fielded.

j. 5-gal water can. Five-gal cans, NSN 7240–00–089–3827, are part of the unit water storage and distribution capabilities. Replacement lids are available as NSN 7240–00–089–7312.

k. Individual water storage equipment. Individually carried water storage devices include 1- and 2-qt canteens and personal hydration systems. Most personal hydration systems hold 45 to 100 oz of water. More information on personal hydration systems is available in USACHPPM IP 31–037.

6–2. Nonmilitary water storage and distribution systems

a. Contractor-provided systems. U.S. contractor-provided storage containers and distribution systems and appurtenances must comply with all applicable FDA requirements and regulations for approved food contact surfaces. Appropriate documentation of inspections, testing, and certification of materials, equipment, supplies, and operator training and certification must be available for inspection by PM personnel.

b. Host nation-provided equipment and supplies. PM personnel should work with host nation personnel to determine as best they can that the materials used in potable water transportation, storage, and distribution systems meets NSF, American Water Works Association, or EPA criteria and standards, where applicable, in every situation. Host nation-certified materials may be evaluated by reviewing and comparing the certification requirements to applicable U.S. standards and criteria, if possible. Recycled containers such as storage tanks or tank trucks that have been used to store or carry products other than potable water should be carefully evaluated. Samples of water stored in the proposed-use containers for 24 hours to several days may be collected and analyzed for contaminants by AWT-capable laboratories. Anything that has previously been used to store petroleum, oil and lubricant products, pesticides, herbicides, or other toxic materials, must not be used to carry potable water.

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Chapter 7
Cleaning, Disinfection, and Decontamination of Field Water Equipment

7–1. Cleaning and disinfection

a. Supplies. NSNs and nomenclatures for ordering cleaning supplies is provided in table 7–1.

Table 7–1
Nomenclature for ordering equipment cleaning and sanitizing supplies

NSN	Item description
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 in x 9.5 in x ¼ 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, 3.75-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

b. Personal hydration systems

(1) *Manufacturers' recommendations*. Under ideal conditions, manufacturers suggest the following basic steps for cleaning personal hydration systems:

(a) Remove the reservoir (water bladder) from the cloth pack.

(b) Clean the reservoir with mild soap and hot water by scrubbing the inside with a bottlebrush.

(c) Air dry the reservoir leaving the top opened.

(d) Fill the reservoir with water and add 2 tsp of baking soda to remove odors. Let it sit overnight. Rinse thoroughly and air dry.

(e) Sanitize the reservoir with water and 2 tsp of liquid bleach. Let it sit for 30 min. Rinse thoroughly and air dry. Run the water/bleach cleaning solution through the tube and scrub it with a long pipe cleaner, a flexible wire covered with cloth, or one of the specially made brushes. Be careful not to puncture the tube.

(f) Machine wash the cloth pack in cold water with a mild detergent, and let it air dry. You may also hand wash the pack in a field environment.

(g) Dry the pack thoroughly and completely before storing. This is the safest way to store the pack.

(2) *Reservoir bite valve maintenance*. A primary source of potential contamination is the delivery tube bite valve. To properly clean the valve, first pull the valve off of the tube

end. Alternatively, if you just want to clean debris out of the diaphragm core, the valve body may be left on the tube's end. Second, grasp the rib at the valve's face and roll it backwards. This exposes the core piece with the slit opening. Third, pull the core off of the ribbed post. Then clean the valve parts with a cotton swab or toothbrush and some soapy water. Finish by rinsing all parts thoroughly and repositioning the valve core on the center post of the valve body. Then roll the outer sleeve forward again to complete the job.

c. 5-gal water can. The general cleaning procedures for a 5-gal water can are:

(1) Add 1 gal of the soap solution. Shake the can vigorously for 1 min and then drain the solution out of it. Drain some of the solution through the spigot to clean it.

(2) Rinse the can at least twice with warm water to remove the soap solution. Ensure to rinse clean water through the spigot.

(3) Sanitize the can prior to filling it with drinking water.

d. Hard-wall water storage containers larger than 5 gal (e.g., water trailers, Hippos, fiberglass/plastic storage tanks). A disinfection solution can be used in more than one container. Planning to disinfect several containers consecutively, moving the solution from one container to another, can conserve both chemicals and water.

(1) *Steel containers*. Prior to general cleaning, rust and mineral deposits should be removed from metal tanks.

(a) Rust. DO NOT use a mechanical grinder or sanding device to remove rust. These devices will degrade the surface of the tank and cause more rust. To remove the rust in a stainless steel tank, clean the rusted areas with water and scouring powder (NSN 7930–01–423–1147) and a nonmetallic, nylon brush (NSN 7920–00–061–0038). Be sure to flush the tank thoroughly with clean water.

(b) Mineral deposits. Mineral deposits on the bottom of the tank can be removed by adding enough vinegar (NSN 8950–01–079–3978) to the tank to cover the mineral deposits, letting it sit for 5 hours, and then emptying and flushing the tank with clean water.

(2) *General cleaning procedures for all containers.*

(a) Clean the outside of the water container with water and a stiff brush (soap is recommended, but is optional). (Note: For the 400-gal water trailer, remove the drain plug located beneath the rear portion of the water trailer, and elevate the front of the trailer so the water will flow toward the drain.)

(b) Prepare a soap solution by adding 1/3 cup of liquid detergent to 10 gal of hot water.

(c) Thoroughly wash the inside surfaces of the water container with the soap solution and a long handle scrub brush such as the one identified by the NSN 7920–00–061–0038.

(d) Clean the valves and spigots by flushing the soap solution through them. Drain the container by removing the drain plug.

(e) Rinse the container and spigots twice with potable water (preferably warm water) to completely remove the soap solution.

(f) Disinfect the container prior to filling it with drinking water.

(3) *Disinfecting method 1*. This method may be used where both water and the required amount of chemicals are plentiful.

(a) Fill the container full of water with a 100-mg/L chlorine concentration (see chapter 2 for how to make a 100-mg/L solution). Do not add calcium hypochlorite granules directly to the water in metal containers. The chemical may not dissolve before contacting the

metal, and it becomes very corrosive as it sits on the bottom of the container and dissolves. Always dissolve the required amount of chemical in a bucket or other smaller container of water and then add the resulting solution to the water in the container to be disinfected.

(b) Mix or slosh the solution around so it contacts all the surfaces.

(c) Run some of the solution through the valves and spigots.

(d) Keep all interior surfaces wet with the solution for at least 60 min.

(e) Drain the disinfecting solution into a sanitary sewer or other approved location (not into a lake, stream, or storm drain). Local requirements may require dechlorination prior to discharging. In this case, contact higher level PM support for assistance.

(f) Rinse the container and spigots twice with potable water.

(4) *Disinfecting method 2*. Use this method if either water or the required chemicals are in short supply.

(a) Prepare 5 gal of water with a 100-mg/L chlorine concentration.

(b) Using a long-handled brush, stick, or rod with a cloth secured to the end (or some other method), swab the interior walls of the tank every 10 min or as often as necessary to keep the walls wet with the solution for 1 hour.

(c) Run some of the solution through the valves and spigots.

(d) Drain the accumulated solution from the container into a sanitary sewer or other approved location (not into a lake, stream, or storm drain). Local requirements may require dechlorination prior to discharging. In this case, contact higher level PM support for assistance.

(e) Rinse the container and spigots twice with potable water.

(5) *Alternative procedures*. Less corrosive but more labor intensive and time consuming options employ 10 mg/L chlorine residuals and a 24-hour contact time in lieu of the 100 mg/L and 1-hour contact time recommended in methods 1 and 2 above.

(6) *Specific guidance for the Hippo*.

(a) Ensure valve E, the tank's primary drain valve, is closed. Do not drain the tank if there is water in it. Drain any water in the plumbing by opening valves A, B, and C. Close the valves.

(b) Fill the tank full of potable water.

(c) Mix the required amount of chemical in water in a separate container. Use 4 gal of 5-percent unscented liquid (typical household) bleach or 2 cups of 70-percent HTH to acquire the 100 mg/L chlorine residual. For HTH, stir the mixture vigorously until the granules dissolve. Some granules may not dissolve completely. Allow the solution to sit for 1 min to allow the particles that did not dissolve to settle to the bottom.

(d) Slowly pour the solution into the tank. Do not pour the granules that did not dissolve into the Hippo tank. Properly discard granules that did not dissolve. Mix the solution with the water in the tank by starting the engine and putting the Hippo system in the "recirculation mode." Allow the water to circulate for 5 min.

(e) Run the disinfectant solution through the plumbing, valves, and spigot.

(i) With the Hippo in the "recirculation mode" slowly open valve A to bleed the air out of the plumbing. Close the valve when water runs out.

(ii) Repeat this procedure for valves B and C. This will pack the lines with the disinfectant solution.

(f) Run the disinfectant solution through the hoses on the hose reel and the filling station.

(i) With the Hippo in the "recirculation mode" reel out the hose from the hose reel to reach outside of the Hippo cabin.

(ii) Assemble the filling station and connect it to the end of the hose.

(iii) Open valve D. Open the valves on the filling station to bleed the air out of the line and flush the valves. Flush each valve for 30 seconds and then close the valves. This will pack the lines with the disinfectant solution.

(g) Shut off the engine and maintain this condition for 1 hour now that the tank, plumbing, hoses, and filling station are wet with the disinfecting solution.

NOTE

If more than one Hippo will be disinfected, position the next Hippo to be cleaned close enough to the disinfected Hippo so that the disinfectant solution can be pumped into the next Hippo.

(h) Drain the disinfectant solution from the plumbing and hoses into an approved drain location. Drain the tank into an approved drain location or pump the solution into the next Hippo to be disinfected.

(i) Rinse the interior of the tank to include the walls, high level sensor, vents, and the water level gage components thoroughly with potable water using a hose. Do not enter the tank.

(j) Rinse the plumbing, valves, spigot, and the hoses on the hose reel with potable water.

(i) Fill the tank 1/4 full with potable water.

(ii) Start the engine and put the Hippo system in the "recirculation mode."

(iii) Partially open valve A to flush out the plumbing. Close the valve after flushing for 15 seconds. Repeat this procedure for valves B and C.

(iv) Open valve D. Open each of the valves on the filling station one at a time to flush out the disinfecting solution in the lines.

(v) Close the valves on the filling station after flushing for 15 seconds.

(k) Shutdown the engine. The system is now sanitized and ready to be put into operation.

WARNING

The hose on the hose reel and the filling station valves may still be pressurized.

(l) Open the valves on the filling station to release the pressure in the lines before disassembling.

(m) Pack up, drain, or setup the system based on mission requirements.

(7) *Storage*. If the disinfected water container is not going to be used for 30 days or longer, upon completion of disinfection, open all faucets, valves, drain plugs, and manhole covers, and allow the tank to air dry. This is a very important step to avoid severe corrosion during periods of non-use. After it is completely dry, close it up and repeat the cleaning and disinfection procedures prior to using it.

7–2. Decontamination

Water purification and supply personnel and unit level PM representatives regularly work with calcium hypochlorite which is an effective chemical and biological agent decontaminant. They can use this chemical to decontaminate equipment surfaces by following the procedures described below.

a. Preparation.

(1) 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 ft from an existing water source such as a stream, lake, or well. Greater distances may be required if hydrogeological conditions include highly fractured rock. The dimensions will vary greatly due to soil type and water table elevation. For a silt and loam soil, a 1,000-gal volume of wastewater requires the construction of a 7-ft x 7-ft x 7-ft seepage pit backfilled with gravel. A 5-ft x 5-ft x 5-ft pit backfilled with gravel will adequately handle up to 400 gal. Seepage pits are described in FM 21–10/MCRP 4-11.1D.

(2) Determine the surface area of the equipment to be disinfected. See table 7–2 for the surface areas of selected equipment.

Table 7–2
Approximate exterior surface areas of select equipment

Equipment	Area (square ft)
400-gal water trailer	90
FAWPSS:	-
Pump	16
500-gal drum	63
Distribution components	48
TWPS	1280
LWP	40
Camel	200
Hippo	1024

(3) Determine the amount of decontamination solution required. One gal (3.8 L) of decontamination solution should cover 8 square yd (7 square meters). One square yd equals 9 square ft.

(4) Wear a rubber apron and rubber gloves over MOPP gear, and prepare a 5-percent (50,000 mg/L) solution of chlorine (– straight unscented household bleach may be used for this application).

b. Decontamination procedures.

(1) Apply the solution to the exterior of the equipment or container using brushes or brooms. The decontamination solution must remain in contact with the surface for at least 30 min and may have to be reapplied occasionally to keep the surface wet.

(2) Thoroughly wash the surface with potable water and allow to air dry.

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Chapter 8
Water Contaminant Health Effects

8–1. Introduction

a. University of California Lawrence Livermore National Laboratory (LLNL), Livermore, California, supported by the U.S. Army Medical Research and Development Command, Fort Detrick, Maryland, conducted a study entitled, “Evaluation of Military Field-Water Quality,” which was completed in May 1990. This study resulted in the development of a priority list of water contaminants of concern including three physical properties (turbidity, color, and total dissolved solids); seven chemical constituents (chloride, magnesium, sulfate, arsenic, cyanide, lindane, and metabolites of algae and aquatic bacteria); more than twenty waterborne pathogenic microorganisms; and five warfare agents (hydrogen cyanide, radioactivity, organophosphate nerve agents, mycotoxin T-2, and lewisite). After these constituents and agents were identified, the risks associated with exposure were evaluated and recommendations for standards that would preclude Soldier performance degradation were developed. The recommended standards were based on 5 and 15 liters per day (L/d) drinking rates for short-term (up to 7 days) and long-term (<1 year) exposure. Risks were assessed for healthy males and females, 18 to 55 years old, with no predisposing physical or mental factors that would exacerbate health effects. The recommended standards were derived for drinking water with a single constituent of concern in it. Health effects summaries and potential Soldier performance degradation associated with contaminants in excess of the recommended standards are presented throughout this chapter. These summaries and associated graphs should help PM personnel estimate health risks associated with the various contaminants.

b. Readers should note that the recommended standards illustrated in this chapter stem from the LLNL study described above and may differ from the current MFWS. Since the LLNL study was performed, the Services have adopted water quality criteria that mirror the EPA NPDWR and NSDWR (the MFWS described in chapter 4). This should not detract from the usefulness of the illustrations as they are designed to show the sliding scale nature of water constituents and health effects. When an MFWS is exceeded, the health effects summary for that contaminant can be used to evaluate the risk associated with drinking the water.

8–2. Physical characteristics and chemical constituents of water

Specific physical characteristics and chemical constituents of water determine whether water is potable as well as palatable. If any of the parameters are excessive, the water may not be desirable or safe to drink. Both situations can significantly impact the health of personnel and the ability of a unit to complete its mission.

a. Turbidity and color.

(1) General. Turbidity and color are physical attributes of natural water that generally make it uninviting to drink. The presence of color and turbidity may or may not represent direct health risks. Historically, the three primary health risks stemming from turbidity and color remaining in treated field-water supplies centered on 1) individuals’ refusal to drink the water and their subsequent dehydration, 2) obtaining water from unapproved, more aesthetically pleasing, but contaminated supplies, and 3) microbial contamination protected by particulate matter creating turbidity. Clearly, drinking contaminated water that looks and tastes good reduces individual readiness when those who drink it become sick with acute waterborne illness. As the percentage of personnel in a unit who drink contaminated water increases, the health threat becomes a medical threat, and unit readiness and effectiveness are compromised.

The effects of dehydration are initially more subtle, yet will result in significant performance degradation and thereby potentially jeopardize mission accomplishment. The debilitating effects of dehydration progress in sequence from discomfort, to weariness, to apathy, to impaired coordination, to delirium, and finally to heat stroke.

(2) *Turbidity.* The relationship between turbidity and water rejection has been documented through the use of action-tendency scales that are used to attempt to quantify behavioral responses to stimuli. The relationship illustrated in figure 8–1 is direct with the percentage of personnel refusing to drink the water increasing with increased turbidity. The STP and LTP standards for turbidity are 1 NTU where an estimated 2.6 percent of personnel might refuse to drink the water for short- and long-term uses (5 and 15 L/d drinking rates). Turbidity levels greater than 1 NTU may make the water appear slightly cloudy and can interfere with disinfection. This is particularly true when the turbidity is caused by organic matter. Achieving turbidity less than 1 NTU will improve the efficiency of disinfection for most pathogenic microorganisms. *Giardia* and *Cryptosporidium*, two organisms that are resistant to disinfection, can only be guaranteed eliminated by filters that reduce turbidity to less than 0.1 NTU. Fortunately, RO-treated product water has very low turbidity if the ROMs function properly and the water is clear and free of disease-producing organisms. Providing a 2 mg/L FAC residual and a 30-min contact time after RO treatment provides additional assurance that the water is microbiologically safe to drink.

(3) *Color*. The LLNL recommendations for color were the same for 5 and 15 L/d drinking rates at 50 color units (CU) for short term and 15 CU for long term. Color levels greater than 50 CU for short term and exceeding 15 CU for long term make the water undesirable. These levels also increase the risk of dehydration from reduced water intake, even though they are not associated directly with adverse health effects. Figure 8–2 shows that at the indicated short- and long-term levels, 30 percent and 10 percent of personnel, respectively, might refuse to drink the water and either become dehydrated or seek another source of water.

b. TDS. Total dissolved solids include inorganic salts and small amounts of organic matter that are dissolved in water. The principal constituents are usually the cations calcium, magnesium, sodium, and potassium; and the anions carbonate, bicarbonate, chloride, sulfate, and, particularly in ground water, nitrate (from agricultural use). As with color and turbidity, the primary health concerns related to field drinking water with TDS concentrations greater than the MFWS are the risks of water rejection and the associated consequences of the personal choices described above. Figure 8–3 provides a health-effects summary for the range of TDS concentrations. From the graph, about 2 percent of a military population (MP) might refuse to drink water containing the LLNL-recommended TDS standard of 1,000 mg/L and thereby choose dehydration or another water supply. At TDS concentrations above 2,800 mg/L, about 50 percent of the exposed MP might refuse to drink the water.

c. Taste and odor. Taste and odor are called “organoleptic” properties. These properties affect the palatability of water and, like the constituents discussed above, can encourage voluntary dehydration or the use of unapproved sources. Taste and odor may be naturally occurring, in which case a military or contract ROWPU should remove them, or they might be

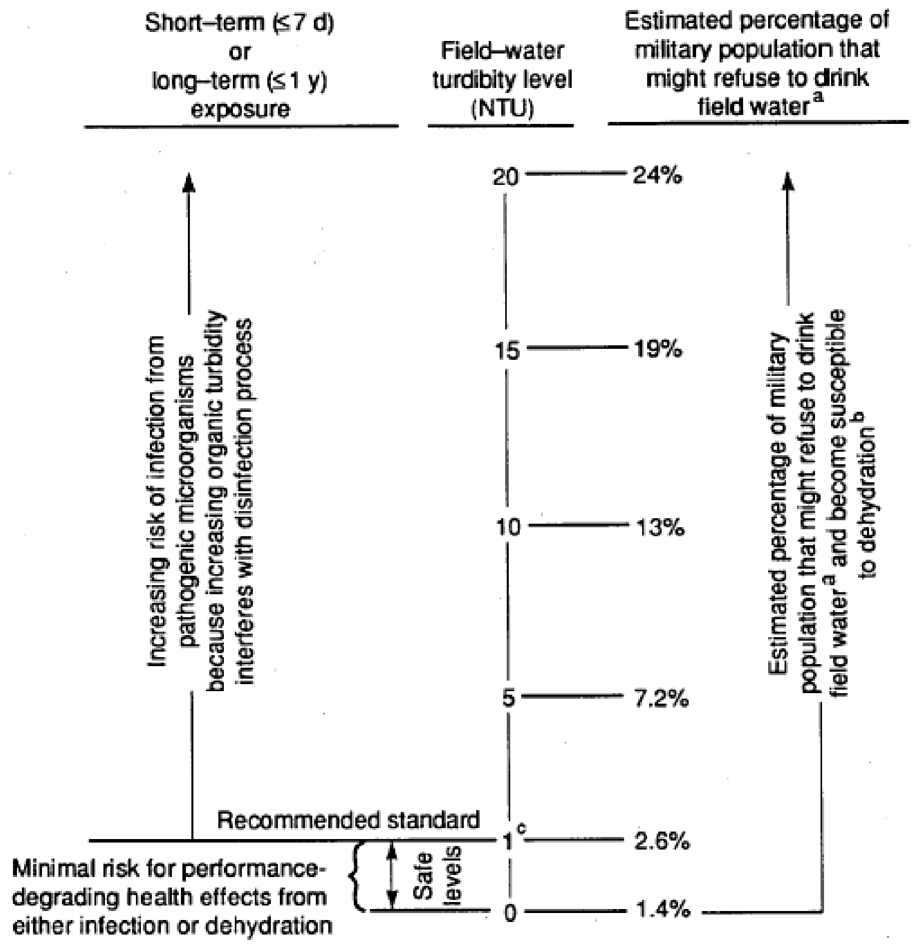

Figure 8–1. Health-effects summary for turbidity with color absent (= zero) and threshold odor number equal to three

Notes:

[a] For any combination of color, turbidity, and odor values: military population (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 drinking rate, including ones of 5 and 15 L/d.

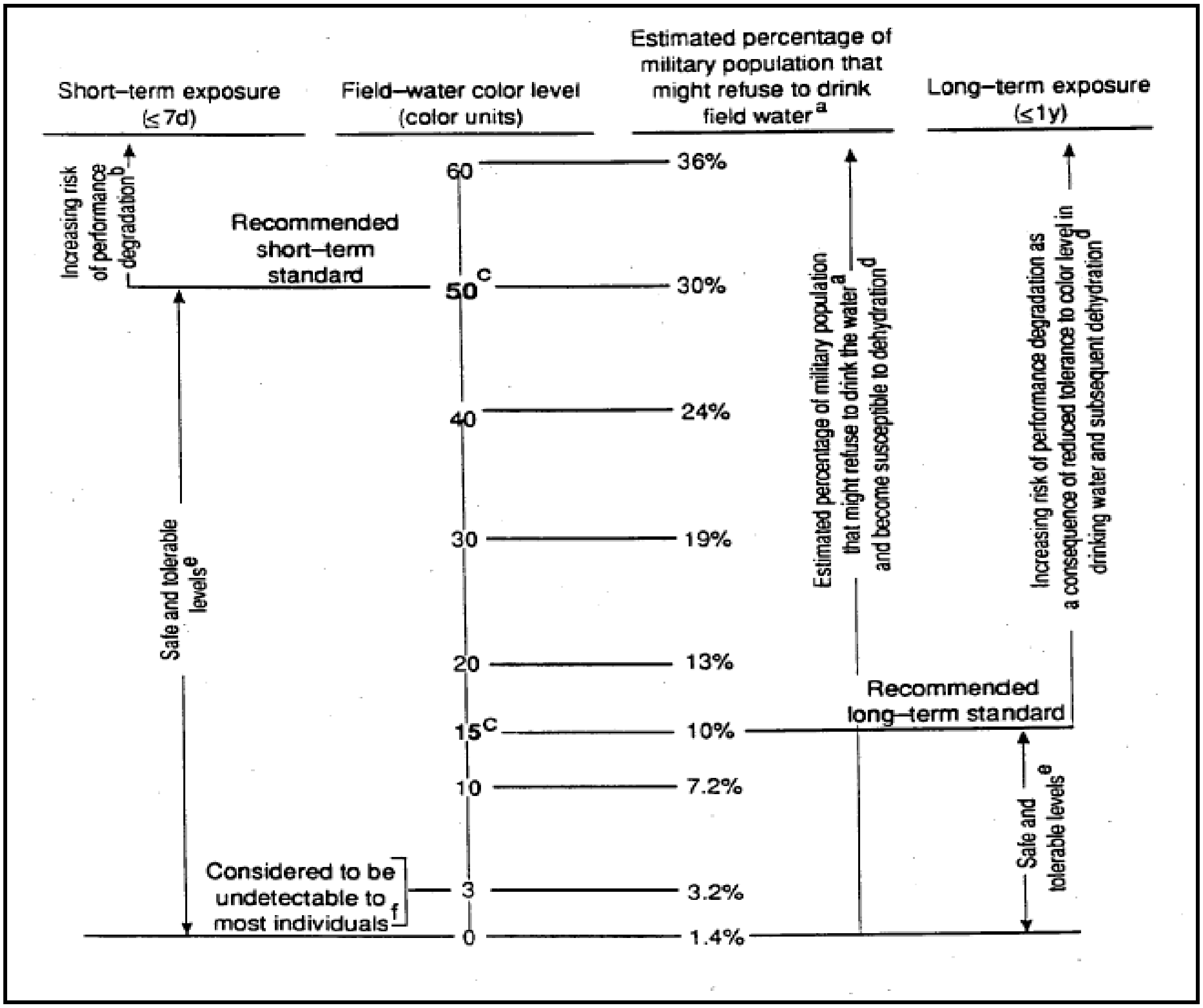

Figure 8–2. Health-effects summary for color with turbidity absent (= zero) and threshold odor number equal to three

Notes:

[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 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 all drinking rates, including 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 may require acclimation.

[f] The EPA cites evidence indicating that a color level of three color units will not be detectable to many individuals.

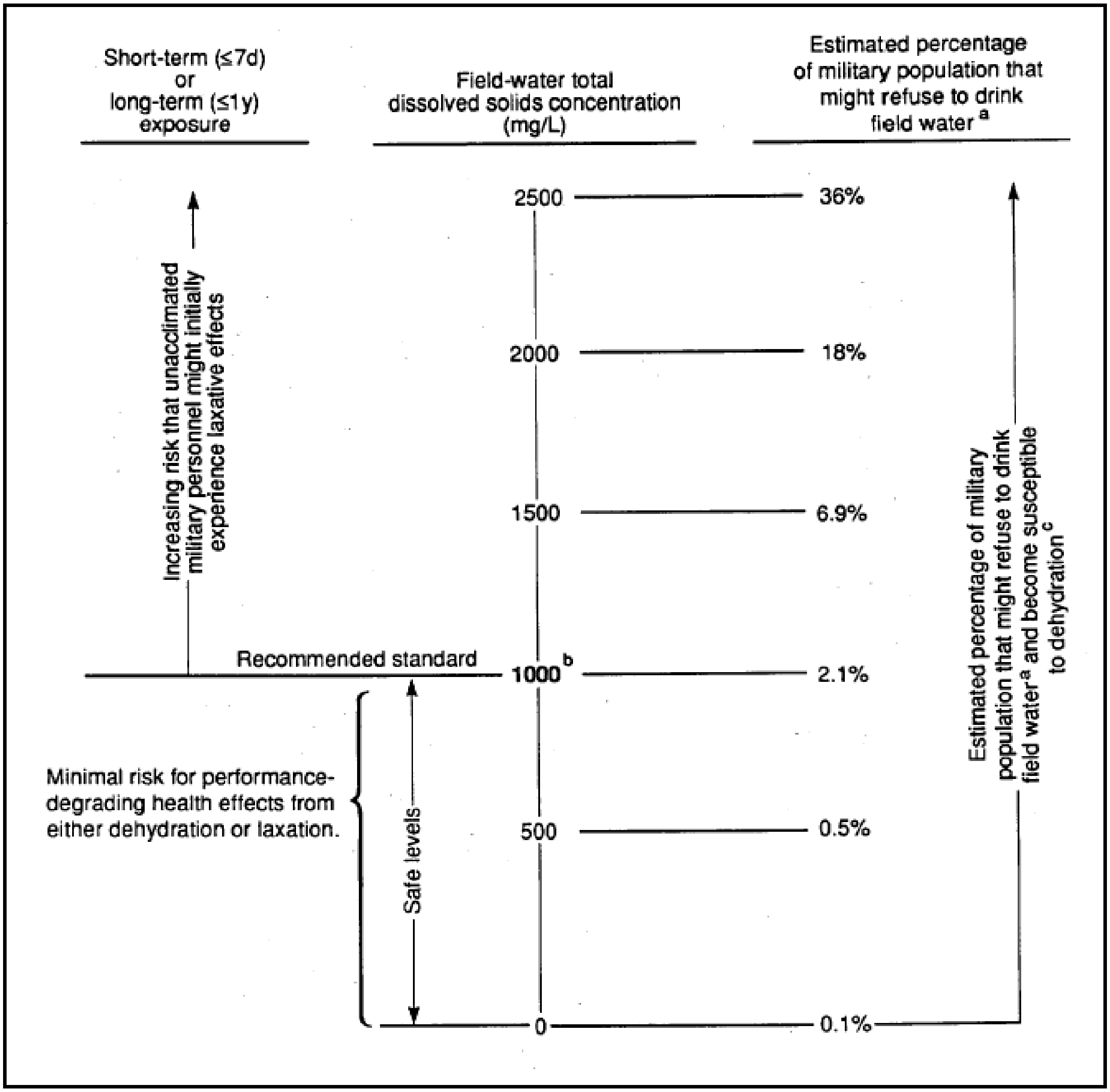

Figure 8–3. Health-effects summary for TDS

Notes:

[a] Determined using the z-score for Action-Tendency ratings and a table of values for the standard normal distribution.

[b] 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 all drinking rates, including 5 and 15 L/d.

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

imparted to the water by the treatment processes. The most common in military water supplies are the well-known taste and odor attributed to high chlorine residuals. The standard method for determining odor involves multiperson panels of testers who have been trained in the method. It is highly unlikely that such a body of testers would be found in the operational environment. Rather, PM personnel must smell the water and make personal judgments as to its odor acceptability, and then follow up by monitoring customer comments and complaints. The best water is water that produces no detectable odor. Where high chlorine residuals are employed, the odor of chlorine may be the most prominent odor from the water. Keeping chlorine levels as low as possible while providing adequate disinfection, and chilling the water whenever possible, will reduce objectionable tastes and odors associated with chlorine residuals.

d. Temperature. The palatability of all water is greatly enhanced by cooling it. Whether or not mobile chillers are available, water trailers and other containers (such as bottles of water) in hot regions should be shaded to keep water as cool as possible. Five-gal water cans can be covered with an insulating jacket (NSN 7240-01-119-4956) to help maintain an acceptable temperature in either hot or cold regions.

8–3. Waterborne diseases

Waterborne diseases are a threat to nearly all international travelers, including deployed personnel. They take on extra significance in military environments where their effects may cause mission failure. Most agent-specific waterborne diseases discussed are considered reportable. Providers who diagnose these infections are required to report them in a timely manner to aid in outbreak investigation/prevention. Current information on the requirements and procedures for reporting are available from the Armed Forces Health Surveillance Center at: http://afhsc.army.mil/Reports.asp. The following subparagraphs provide information about waterborne pathogens and testing procedures that could be present in drinking water due to inadequate water treatment or poor sanitation conditions and the illnesses they cause. Many of the organisms are carried in the feces of warm-blooded animals, and they could be present in untreated water sources, especially surface-water sources. Individual pathogenic organisms are generally difficult to detect in water samples. Therefore, treated water is tested for the presence of indicator coliform bacteria, which, if detected, signal potential water contamination and the presence of pathogenic organisms. PM personnel conduct presence/absence tests for TC and *Escherichia coli (E. coli*) bacteria in treated water. Total coliforms indicate environmental contamination, and *E. coli* presence verifies the contamination is of a fecal origin.

There are no relatively simple field tests for measuring the specific concentration of any of the variety of infectious organisms. Particularly in the case of viruses and some parasites, analysis can be extremely difficult and require very large amounts of water, essentially becoming an impossible task in the field. Tests are available that can determine gross contamination of water such as Eclox™, Microtox®, and various other sentinel indicators (Eclox™ is a trademark of Severn Trent Services, Fort Washington, Pennsylvania; Microtox® is a registered trademark of Strategic Diagnostics Inc., Newark, Delaware). However, they have obvious limitations, such as pinpointing specifically what type of contamination is occurring. Until such tests are available for determining the concentration of specific infectious organisms in field water, the membrane-filter technique or other test methods, such as Colilert, that can detect the presence of total and fecal coliforms should be used to determine the presence of coliform organisms in water. The effectiveness and reliability of the treatment and disinfection operations of a unit is important. This is especially true in developing countries where there is a high level of acquired immunity, and concentrations of pathogenic organisms are likely to be higher. With proper water treatment and disinfection, along with operational monitoring and PM oversight, a reasonably safe water supply may be supplied to personnel in the field.

a. 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. Approximately 50 million cases of invasive *E. histolytica* disease occur annually, resulting in up to 100,000 deaths, with expression of disease varying with geographic location. The incubation period is commonly 2 to 4 weeks but can range from several days to 120 days. Infectivity continues through the period of cyst passing which may last several years. Cysts may remain viable for weeks or months in an approximately moist environment outside the body. The cysts may survive for as long as 48 hours at 20 °C to 25 °C on foods and have been found to remain viable in sewage and natural surface water at 4 °C for 1 month. The infectious dose has been shown to be as low as 2,000 to 4,000 cysts. The primary reservoirs for *E. histolytica* are humans. Transmission is via the fecal-oral or person-to-person route or through ingestion of contaminated food or water. Additionally, flies can spread cysts. Susceptibility is general.

b. Campylobacteriosis. The majority of all *Campylobacter* infections are caused by the bacterium *C. jejuni*, causing fever, abdominal cramps, nausea, vomiting, and diarrhea that is often bloody and typically lasts 1 week. *Campylobacter* is widely distributed, is generally regarded as the most common bacterial cause of gastroenteritis in the world, and is a common cause of traveler's diarrhea. The primary reservoirs are wild and domestic animals, particularly birds. Illness usually occurs 2 to 5 days after exposure, but onset can range from 1 to 10 days. Transmission through contaminated water or ice is a recognized source of infection, as well as ingestion of contaminated food and contact with infected animals, particularly cats and puppies. *Campylobacter* and related organisms grow best in an atmosphere containing 5% to 10% oxygen and are thus considered microaerophilic and grown at 37 °C; however, *C. jejuni* grows best at 42 °C. Owing to their small size (0.3 to 0.6 µm in diameter) and motility, *Campylobacter* and related organisms pass through 0.45- or 0.65- µm filters. The infectious dose is very small – fewer than 500 bacteria. Generally, cases tend to occur sporadically rather than in outbreaks. All age groups are at risk, but infants and young adults are at higher risk of infection. Immunocompromised individuals that contract Campylobacteriosis are at risk of developing sepsis. In some cases, infection leads to Guillain-Barre syndrome which is a temporary paralysis typically requiring intensive care. On average, there are approximately 100 fatalities in the U.S. resulting from *Campylobacter* infections each year.

c. 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 after onset if untreated. This intestinal disease is abrupt and produces profuse watery stools without strain, tenesmus, or prominent abdominal pain, rapidly followed or sometimes preceded by vomiting. It produces severe dehydration in a matter of a few hours and can cause circulatory collapse. Cholera occurs mainly in Asia, Africa, Latin America and parts of the Mediterranean, but it also presents some risk worldwide largely to those living in poverty. The majority of cases have occurred in Africa since the mid-1990s. Humans are the main reservoirs for *V. cholerae*, and there is evidence supporting the idea that there are environmental reservoirs such as copepods and other zooplankton. The disease is transmitted primarily by ingesting contaminated food or water. Large outbreaks have occurred from fecal contamination of water supplies and street vendor supplied food. Eating naturally contaminated, undercooked shellfish has also transmitted cholera. The infectious dose associated with ingesting contaminated water is 10^3 to 10^6 organisms. The incubation period can be from a few hours to 5 days, but is usually 2 to 3 days. The contagious period continues until a few days after recovery, though a carrier state may persist for several months. Susceptibility is variable, and, in endemic areas, most persons acquire strain-specific antibodies by early adulthood. Presently, the manufacture and sale of the only licensed cholera vaccine in the United States has been discontinued. Cholera vaccines have offered only brief and incomplete immunity. There is no current military requirement for the cholera vaccine.

d. Cryptosporidiosis. Cryptosporidiosis is an infection caused by the *Cryptosporidium parvum* oocyst, which is most often transmitted through the feces of a number of carrier organisms such as cattle, other domestic animals, and humans. The occurrence is worldwide with higher rates of infection occurring in underdeveloped countries. *Cryptosporidium* is ubiquitous; all surface-water supplies are considered to be contaminated with the parasite. Infection with this organism is not easily detected unless looked for specifically. The incubation period is not precisely known, but 1 to 12 days is the likely range with an average of about 7 days. The infectious dose is estimated to be very low–approximately 30 to 100 oocysts. People with intact immune-system 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. Immunocompromised individuals are at greater risk of contracting cryptosporidiosis and are more likely to develop severe, life-threatening symptoms.

e. Diarrhea. Most cases of travelers' diarrhea worldwide are caused by C*ampylobacter*, certain strains of *E. coli,* and some noncholera *Vibrio*. These bacteria are often involved in cases of waterborne diarrhea as well. These bacteria may be spread by food or other routes as well as by water. The acute onsets of nausea, fever, vomiting, abdominal pain, and diarrhea occurs after an incubation period of about 2 to 5 days. The acute illness is usually limited to 3 to 5 days or less.

f. Escherichia coli (E. coli) O157:H7. The bacterium *E. coli* serotype O157:H7 produces Shiga toxin(s); infected individuals exhibit acute bloody diarrhea and abdominal cramping lasting about 1 week. The incubation period ranges from 2 to 8 days. Little is known about susceptibility and immunity; the infectious dose is very low. *E. coli* O157:H7 is transmitted via ingestion of contaminated food (especially ground beef) and water, swimming in contaminated water, and person-to-person transmission. Cattle are the primary reservoirs of *E. coli* O157:H7. It is a recognized disease in North America, Europe, South Africa, Japan, the southern cone of South America, and Australia along with various other enterohemorrhagic *E. coli* serotypes. Its importance is not well recognized in the rest of the world.

g. 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. They can be found in any locale, even arctic waters. As with amebiasis, most cases are asymptomatic. Ingestion of only one cyst may be enough to cause illness. A distinguishing feature after an incubation period of 7 to 21 days, acute cases may present with abdominal cramps, flatulence, diarrhea (begins with profuse and water diarrhea that turns greasy and foul smelling), and fatigue. If untreated, passage of cysts may continue for 3 months or, rarely, longer. The reservoirs for *Giardia* include humans and domestic and wild animals. *Giardia* is transmitted via the fecal-oral route, especially ingestion of fecally contaminated food or water, person-to-person transmission by way of institutional environments (for example, daycare centers), and sexual activity. The cysts may also be transmitted to humans from animals.

h. Legionellosis. Both Legionnaires' disease (LD) and Pontiac Fever are caused by the bacteria *Legionella*. Approximately 46 species and 70 serogroups have been identified with *L. pneumophila* accounting for over 90 percent of LD documented in the U.S. While Pontiac Fever is primarily a flu-like, self-limiting illness, LD is a debilitating, pneumonia-like illness (fever, chills, cough, muscle aches, headache) that can be very severe. The incubation period for LD is 2 to 10 days, and as little as several hours to 2 days for Pontiac Fever. *Legionella* is transmitted via inhalation of contaminated aerosol (as from showers and faucets) or aspiration of contaminated water. The infectious dose is unknown. *Legionella* bacteria thrive in water temperatures between 32 °C and 45 °C, so they can commonly be found in significant numbers in hot water systems that maintain tap temperatures below 50 °C or hot water tanks with temperatures set below 60 °C. Although persons of any age can contract LD, those most at risk are middle-aged or elderly individuals, smokers, individuals with chronic lung disease, and immunocompromised persons. Pontiac Fever can affect any individuals. Legionellosis occurs worldwide. The true occurrence is difficult to determine, and it is suspected to be vastly underreported. Most reporting comes from industrialized countries. This is most likely because they have reporting systems in place as well as ecological niches that act as reservoirs that support *Legionella* such as hot water plumbing systems.

i. Leptospirosis. Leptospirosis is a bacterial disease contracted through skin contact with surface water contaminated with urine from infected animals. *Leptospira* penetrate the skin readily through abrasions or mucus membranes. The 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 in urban, rural, industrialized, and developing areas. Individuals exposed to river, canal, stream, and lake water contaminated with domestic and wild animal urine as well as tissues and urine of infected animals are at greatest risk. These groups include military troops, veterinarians, sewer workers, campers, and sportsmen. Wild and domestic animals are reservoirs, particularly rats, swine, cattle, dogs, and raccoons. The primary mode of transmission is dermal exposure, especially through abraded skin. To a lesser extent, contaminated food or inhalation of contaminated aerosols can spread leptospirosis. The incubation period is 4 to 19 days, most commonly 10 days. Infected persons may excrete *Leptospira* in the urine for 1 to 11 months after the acute illness.

j. Metabolites of cyanobacteria (bluegreen algae) and related aquatic bacteria. Cyanobacteria produce two different types of toxins: neurotoxins and hepatotoxins. Symptoms may include abdominal pain, nausea, vomiting, diarrhea, fever, muscle, and joint pain. Dermal contact may produce skin irritation that eventually produces a rash. The primary mode of transmission is ingestion of contaminated water, but dermal contact in waters where there is a cyanobacteria bloom can also cause illness. Cyanobacteria are found worldwide, particularly in polluted, stagnant surface waters. The main reservoirs are stagnant water, sediments, and soil. Drinking water standards have not been established for most of the toxic substances associated with cyanobacteria in algal blooms. However, the WHO has set a drinking water standard of 1.0 µg/L total microcystins for lifetime exposure. Use of an algaecide to eliminate the algal mass in order to obtain drinking water may be inadvisable, because killing algae releases toxins. Furthermore, the chemical nature of these contaminants makes chlorination ineffective against them. RO treatment is effective at removing tastes, odors, and health-risk contaminants associated with algae.

k. Noroviruses. The term "norovirus" is the recently-approved official genus name of the group of viruses also known as "Norwalk-like viruses," caliciviruses, or small round-structured viruses. The incubation period is usually 24 to 48 hours, although symptoms can appear as early as 12 hours, and the illness generally lasts 24 to 60 hours. Symptoms include nausea, vomiting, watery diarrhea and abdominal cramps, and occasionally low-grade fever. Noroviruses are very common and occur worldwide. They are extremely contagious and are spread primarily via the fecal-oral route, via contaminated food or water or spreading directly from person to person. Infections may also be spread via environmental or fomite contamination. There is also evidence that norovirus infections may be spread from inhalation of aerosolized vomitus particulates. The infective dose is unknown but is assumed to be low. It is unlikely individuals can build immunity to norovirus due to the wide genetic variety of noroviruses; any immunity appears to be strain-specific and generally only lasts a few months. Waterborne outbreaks of norovirus have often been traced to sewage contamination of wells and recreational water.

l. Salmonellosis. Salmonellosis is a bacterial disease caused by enterobacteriaceae of the genus *Salmonella*. The incubation period is usually 6 to 72 hours and typically lasts 12 to 36 hours. Symptoms include fever, abdominal cramps, and diarrhea that may be bloody; the illness generally lasts 4 to 7 days. In some cases, the diarrhea may become so severe that the infection progresses to sepsis (that is, it passes to the bloodstream) which could lead to death if not treated. Although any person is potentially at risk of contracting salmonellosis, the immunocompromised as well as infants and the elderly are at greater risk of severe disease. Salmonellosis occurs worldwide but is reported more in North America and Europe most likely due to better reporting systems in those areas. The majority of *Salmonella* cases in the United States are caused by two serotypes: *S. typhimurium* and *S. enteriditis*. Domestic and wild animals are reservoirs as well as humans. The infective dose varies depending on several variables, including the serotype involved and patient characteristics, but can be as low as 15 to 20 bacteria. Transmission routes are contaminated food, water, and contact with infected animals.

m. Schistosomiasis. Schistosomiasis is a disease that is contracted simply by being in contact with water containing schistosomes. Three blood flukes, *Schistosoma mansoni*, *S. japonicum*, and *S. haematobium*, are the major species that cause human disease. Each of these species has a specific geographic distribution and affects 200 million people worldwide. *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 occurrence of schistosomiasis in specific geographic areas: the presence of the specific snail intermediate host and the lack of sanitary disposal of human feces. Humans are the primary reservoirs for *S. mansoni* and *S. haematobium*; humans and various domestic animals are the potential reservoirs for *S. japonicum*. After maturation within the body, adult flukes can cause intestinal or urinary tract complications. Symptoms from *S. japonicum* and *S. mansoni* infections include diarrhea, abdominal pain, and enlarged liver. If an infection is caused by *S. haematobium*, symptoms include painful urination and changes in urinary frequency. The incubation period lasts 4 to 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.

n. Schistosome dermatitis (cercarial dermatitis). Also a form of Schistosomiasis known as swimmer's itch, it is caused by the larvae of certain schistosomes of birds or mammals that may penetrate the human skin and cause 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. The larvae are found worldwide and the disease has been reported in many European and American locations.

o. Shigellosis. Known also as bacillary dysentery, shigellosis is an infection of the distal small intestine and colon. It is characterized by diarrhea accompanied by fever, nausea, and sometimes vomiting. Humans are the principal reservoir for the disease. The severity of the illness is a function of the patient’s age and state of nutrition, the size of the infecting dose, and the serotype of the organism. Shigellosis is endemic in both tropical and temperate climates. It is found worldwide, and outbreaks tend to occur in poor areas where basic sanitation is lacking. The disease is spread through direct and indirect human contact via the fecal-oral route, ingestion of contaminated food or water, and transference of *Shigella* from feces to food surfaces by flies. The infectious dose is 10 to 100 bacteria and the incubation time is 1 to 7 days. Persons infected remain capable of spreading the disease until *Shigella* is no longer present in the feces (usually within 4 weeks of the onset of the illness). Susceptibility is general.

p. Typhoid. Typhoid fever, the most 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 at a rate of 21 million cases and 200,000 deaths annually but is not common in industrialized countries. The period of incubation usually lasts 1 to 3 weeks. Infectivity continues from the first week through convalescence. Susceptibility is general. Humans are the primary reservoirs for *S. typhi*. The infective dose varies depending on several variables, including the serotype involved and patient characteristics, but can be as low as 15 to 20 bacteria. Transmission of the illness occurs from ingesting contaminated food or water. People living in poverty and unsanitary conditions in developing countries are at greatest risk of contracting typhoid fever.

q. Viral hepatitis A (viral hepatitis). Caused by the hepatitis A virus, viral hepatitis ranges from a mild illness lasting 1 to 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. Viral hepatitis occurs worldwide, particularly on the Indian subcontinent, North Africa, parts of Eastern Europe, and Asia, and tends toward cyclic recurrences. The incubation period can be 15 to 50 days but is more commonly 28 to 30 days. Maximum infectivity occurs during the latter half of the incubation period until after the first week of jaundice. Susceptibility is general. Although unknown, it is assumed the infective dose is 10 to 100 virus particles. Humans are the main reservoir for the hepatitis A virus. Transmission is through direct and indirect person-to-person contact, as well as ingestion of fecally contaminated food or water and swimming in sewage-contaminated surface waters. Although water is an important means of transmitting hepatitis A, contaminated food tends to account for the majority of cases.

8–4. Chemical contamination

a. BZ. BZ is a hallucinatory chemical with unpredictable effects at high doses. These effects, which may include changes in heart rate or blood pressure, weakness, disorientation, and delirium are not observed in subjects ingesting BZ in water at levels equivalent to 7 µg/L when drinking up to 5 L/d or 2.3 µg/L when drinking as much as 15 L/d for up to 7 days. Figure 8–4 summarizes the health effects for BZ in field water. Because BZ is considered a less viable threat today than a decade ago, and because there is no available field detection capability, BZ is under consideration to be eliminated from the MFWS.

b. Chloride. Although chloride might produce laxative effects at concentrations exceeding 600 mg/L, the health effects of greatest concern for MPs exposed to elevated concentrations of chloride ion in field water are not direct. Rather, they are associated with dehydration and use of unapproved sources by personnel who reduce their ingestion of treated field water because of its poor taste. Figure 8–5 summarizes the chloride concentration-related health risks. Only about 2 percent of an MP 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.

c. Cyanide and hydrogen cyanide.

(1) *Cyanide*. 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. Headache, breathlessness, weakness, palpitation, nausea, giddiness, and tremors are typical symptoms of acute exposure. Safe concentrations of cyanide in field drinking water are estimated to be 6 mg/L for personnel drinking 5 L/d and 2 mg/L for personnel drinking 15 L/d, regardless of the length of time they will drink it. Figure 8–6 shows the basis for these standards. The higher the cyanide concentration rises above the safe levels, the greater the risk that many of the exposed military personnel will develop symptoms that can be performance degrading or lethal. Drinking 5 L/d of water with cyanide concentrations of 24 to 48 mg/L may cause metabolic acidosis, as might drinking 15 L/d with cyanide levels at 8 to 16 mg/L; and drinking water with cyanide concentrations greater than 48 mg/L for 7 days or 16 mg/L for longer than 7 days may result in life-threatening toxicity.

(2) *Hydrogen cyanide*. Hydrogen cyanide, also referred to as hydrocyanic acid and prussic acid, is used in some common industrial practices and as a chemical agent. Its effects are the same as those described for cyanide, above, and the recommended standards to prevent performance-degrading effects are the same.

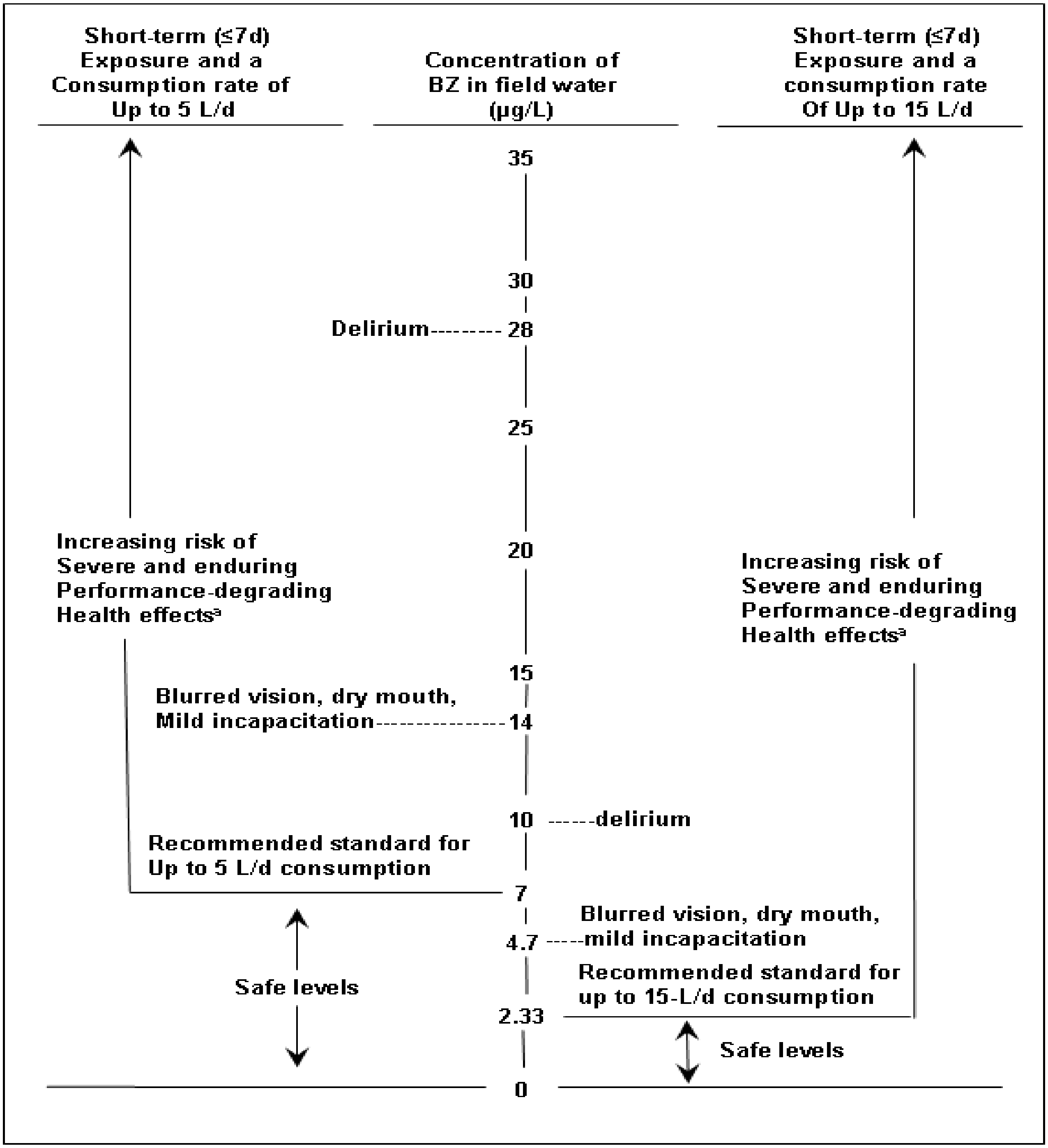

Figure 8–4. Health-effects summary for BZ

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

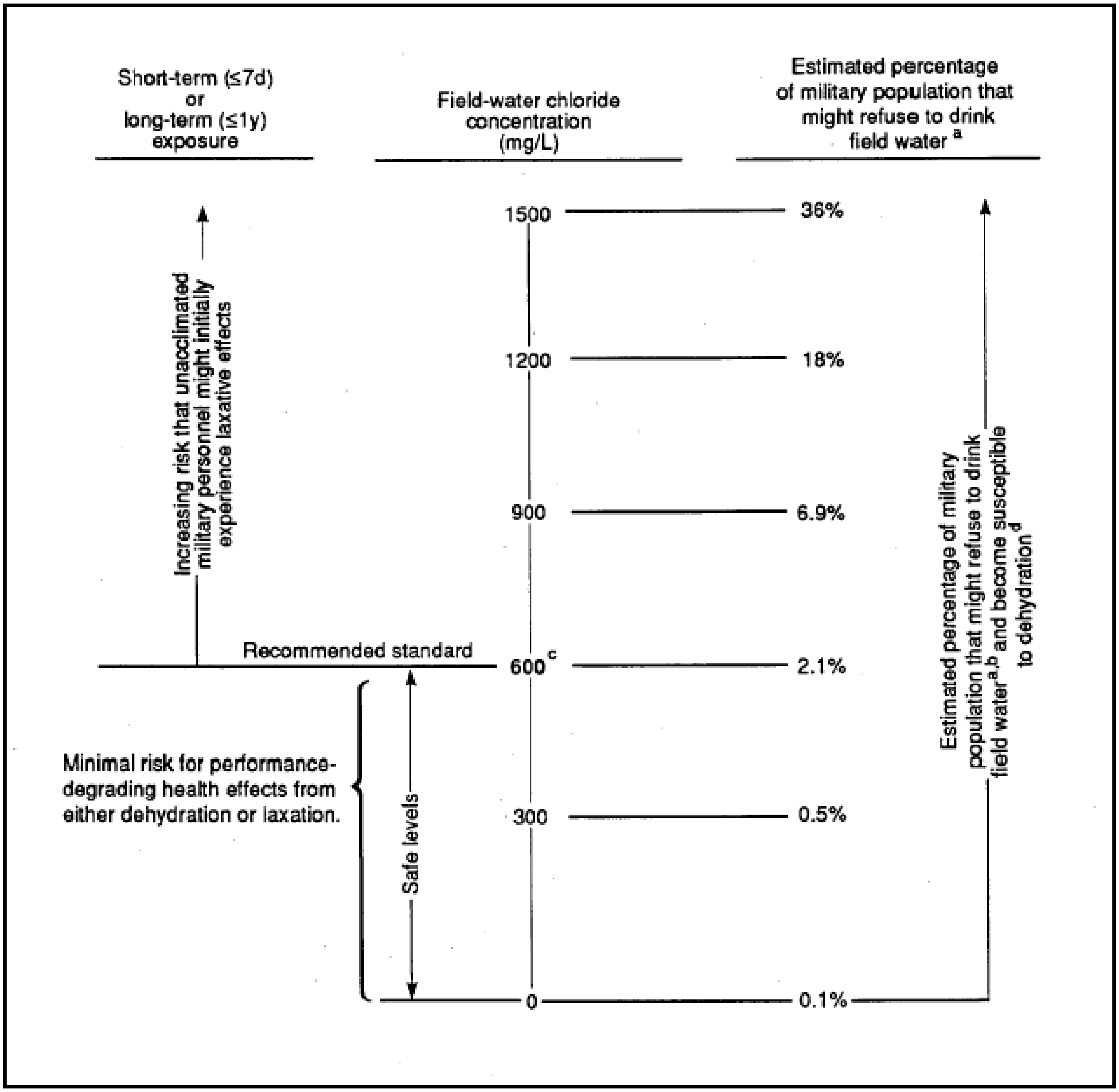

Figure 8–5. Health-effects summary for chloride

Notes:

[a] Determined using the z-score for Action-Tendency ratings and a table of values for the standard normal distribution.

[b] Estimates are made assuming chloride ion constitutes 60 percent 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).

[c] 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 drinking rates of both 5 and 15 L/d.

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

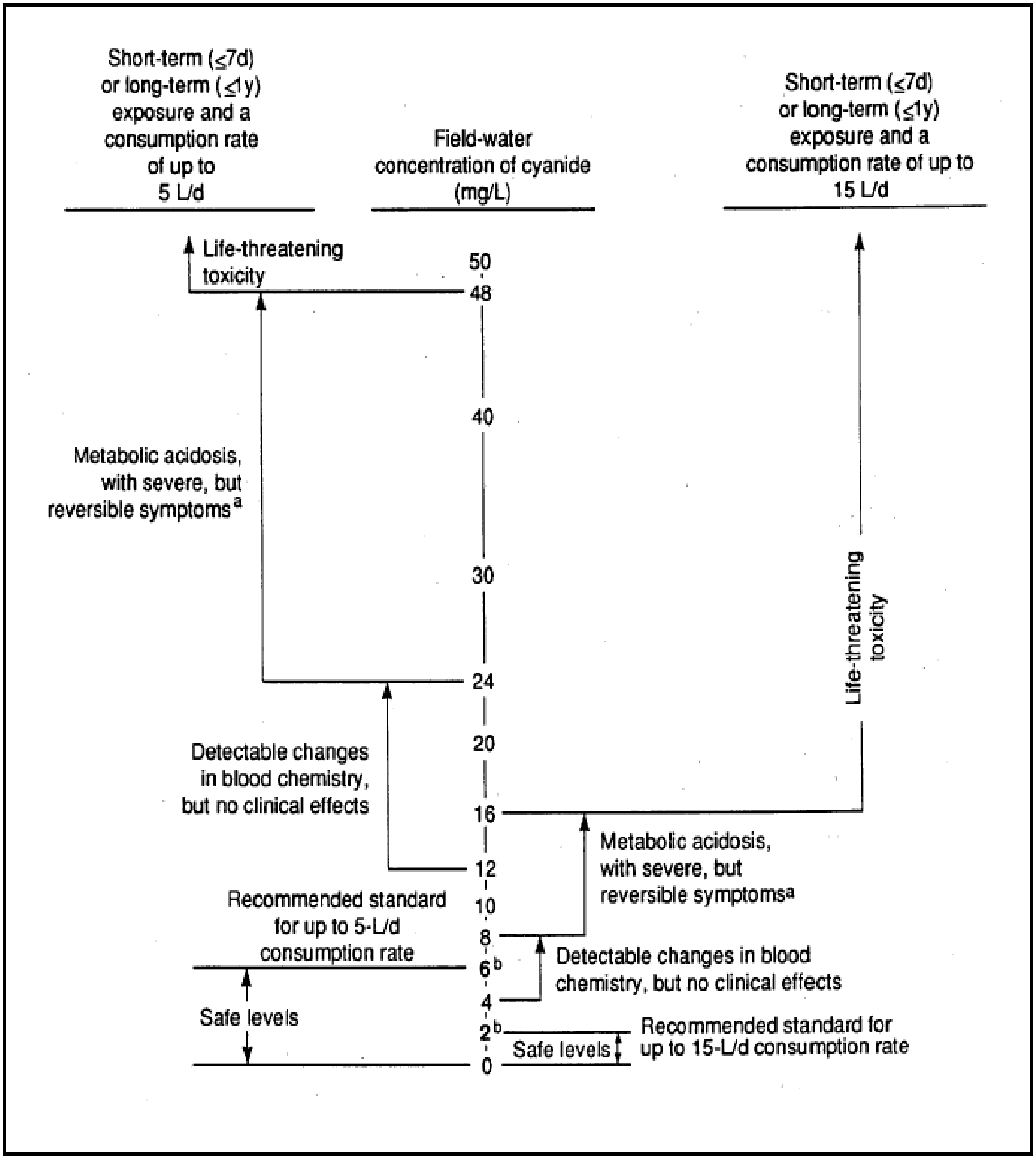

Figure 8–6. Health-effects summary for cyanide and hydrogen cyanide

Notes:

[a] Symptoms of acute cyanide toxicity can include headache, weakness, palpitation, nausea, giddiness, and tremors.

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

d. Lewisite and arsenic. Lewisite is a man-made arsenic-based warfare (threat) agent manufactured in limited quantities. While ingestion of lewisite can cause gastrointestinal (GI) injury and may be lethal, it breaks down rapidly into other constituents one of the most persistent and toxic being arsenic. Arsenic is also naturally occurring and can exist in many forms in water. Generally speaking, organic forms of arsenic are more toxic than inorganic forms. Reports of human exposure to inorganic arsenic via ingestion include several in which the arsenic was ingested via drinking water. Where exposures are high enough to cause observable health effects, several different organ systems are affected including the circulatory, GI, integumentary (skin), nervous, hepatic, renal, and immune systems. 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 GI 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 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 acute and chronic effects. Figure 8–7 summarizes arsenic health effects. For exposure periods of up to 7 days, the standards are based on a daily dose of 1.5 milligrams per day (mg/d), and for exposure periods up to 1 year, the standards are based on a daily dose of 0.32 mg/d. The up to 7-day doses translate to total arsenic concentrations of 0.3 mg/L (for 5 L/d), 0.1 mg/L (for 15 L/d), while the 1-yr doses result in 0.06 mg/L (for 5 L/d) and 0.02 mg/L (for 15 L/d). The recommended arsenic-based standards for lewisite are 0.08 and 0.027 mg/L for 5 and 15 L/d ingestion rates, respectively, corresponding to lewisite concentrations of 0.22 and 0.075 mg/L (note that only short-term standards apply). These standards were developed from the daily dose of the arsenic fraction of lewisite that showed no effects from ingestion by rabbits. Figure 8–8 summarizes lewisite health effects. Unfortunately, the proportion of the exposed MP that could be affected by performance-degrading symptoms at concentrations above recommended safe levels cannot be estimated from the available data.

e. Magnesium. Figure 8–9 summarizes the performance-degrading health risks stemming from elevated levels of magnesium leading to dehydration caused by acute laxative action. Synergism between laxative-producing solutions such as chloride, magnesium, and sulfate may be important but cannot be addressed quantitatively because of a lack of data. Field-water quality standards are based on a single dose of 480 mg of magnesium ions prescribed clinically to induce laxative effects in fasting individuals (that is, a group that is more sensitive to saline laxatives than are nonfasting individuals). The derived field-water quality standards for 5 and 15 L/d intake rates are 100 and 30 mg/L of magnesium, respectively, for either short- or long-term exposure. It is presumed that higher levels of magnesium would be associated with increasing incidences of laxative effects, which could lead to performance-degrading dehydration, but the severity of these effects and the percentage of population that would experience them cannot be estimated from available data.

f. Mustard. Sulfur mustard, a blistering agent, may be used in any of three formulations: distilled mustard, thickened mustard, or an impure mixture containing 60 percent distilled mustard. All formulations are only slightly soluble in water. Based on animal studies, acute effects, such as nausea or GI upset, are not expected to occur following ingestion of water

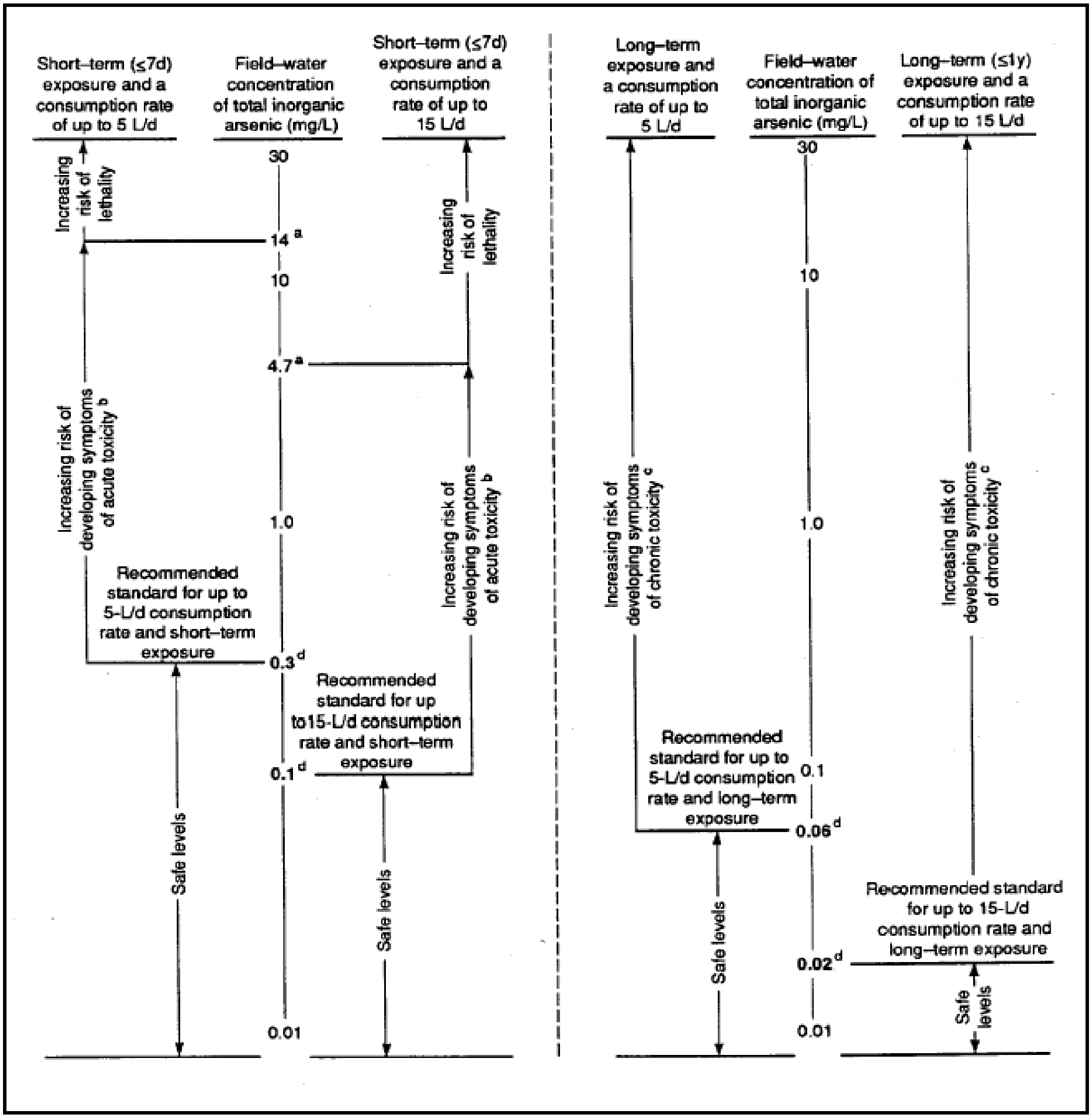

Figure 8–7. Health-effects summary for arsenic

Notes:

[a] Concentration corresponding to an increasing risk of lethality was calculated based on a single, oral does 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 water intake rate and exposure period.

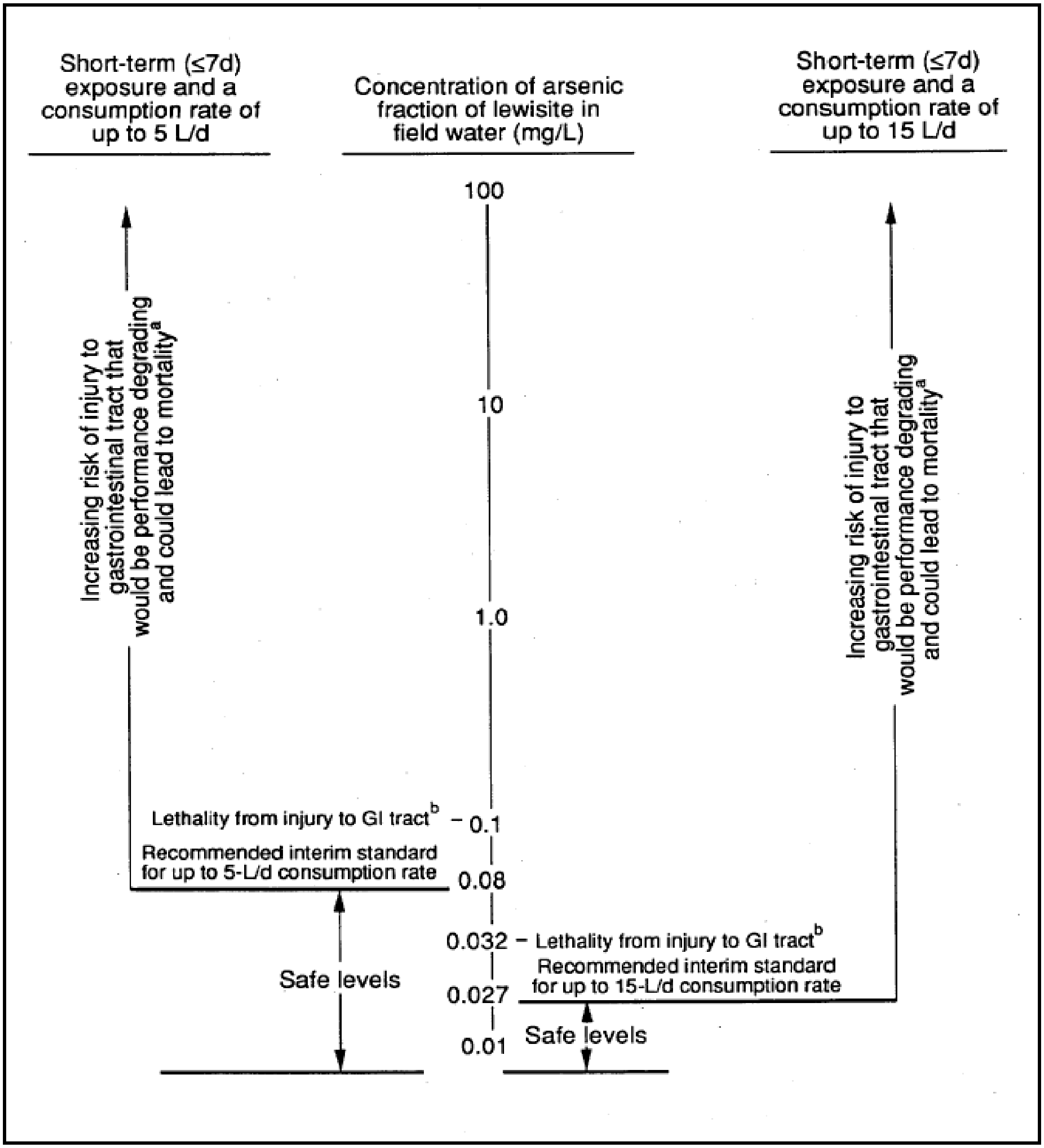

Figure 8–8. Health-effects summary for lewisite

Notes:

[a] Based on extrapolation from effect of doses above the no observable effect level (NOEL) for rabbits.

[b] Based on lowest dose reported to produce mortality in rabbits (0.07 mg/kg x 0.1 x 70 kg/(5 or 15) L/d).

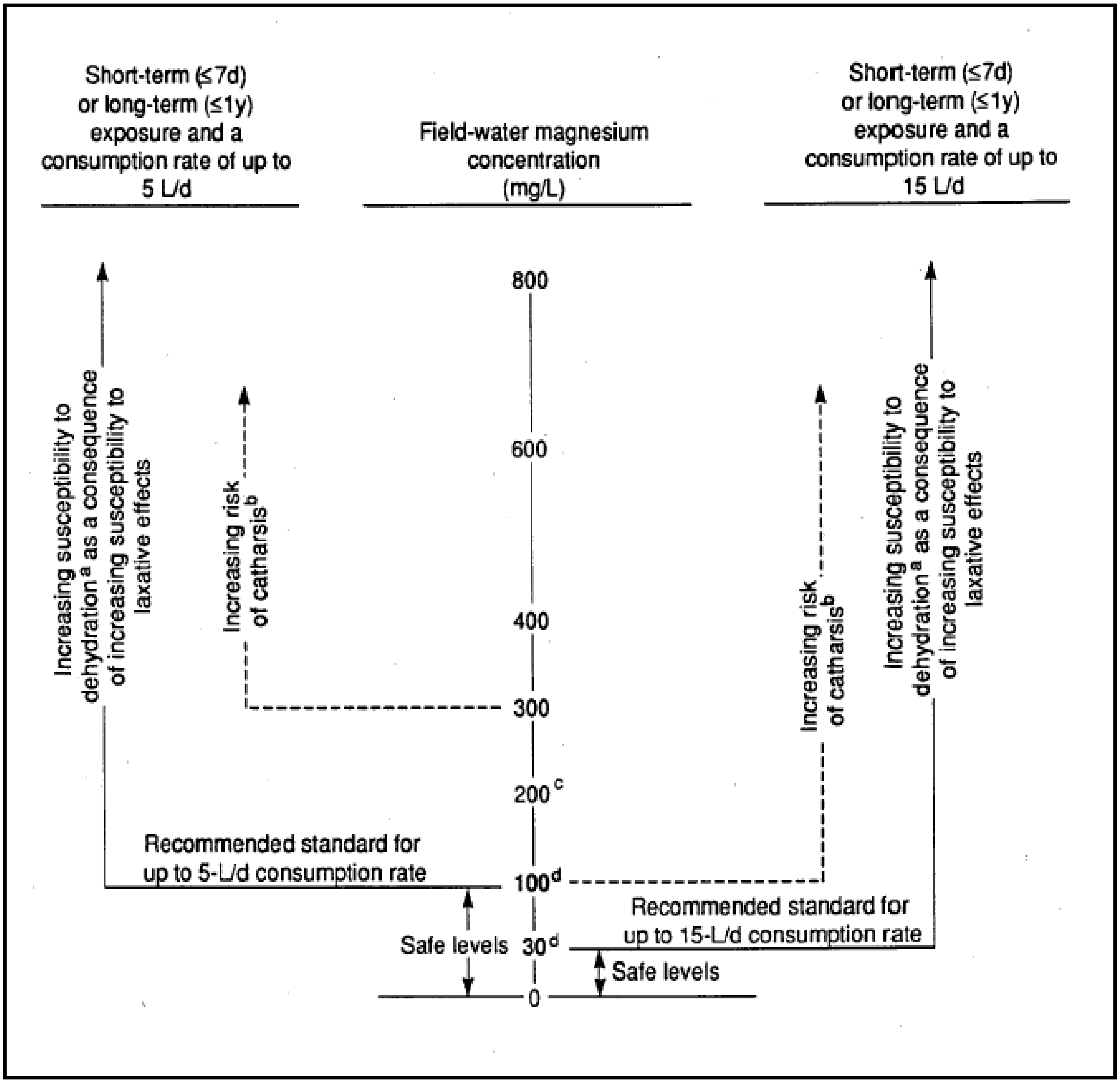

Figure 8–9. Health-effects summary for magnesium

Notes:

[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 (MgSO4* 7H20), effects include semi-fluid or watery evacuation in 3 hr or less. Doses lower than 15 g produce laxative effects with a longer latency period.

[c] Although many individuals would perceive the water to have an inferior taste, a few individuals might consider it drinkable 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 water intake rate and exposure periods up to either 7 d or 1 y.

containing 140 μg/L (5 L/d intake rate) or 47 μg/L (15 L/d intake rate) for up to 7 days, provided no other toxic compounds are present. Sulfur mustard is a known human carcinogen, and the cancer risk, based on established acceptable concentration, water intake, and specified duration is 1 in 100,000 people exposed.

g. Organophosphate (OP) nerve agents. Concentrations of OP nerve agents, including the CW agents GA, GB, and VX, in field water at concentrations greater than the recommended standards can produce performance-degrading health effects that include abdominal cramps, vomiting, diarrhea, and headache. Sufficiently high levels ingested over the course of a 7-day period may even lead to death. The concentration of OP nerve agents at which some performance degradation 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 exposures lasting up to 7 days is no less than 12 μg/L for an intake rate of 5 L/d and 4 μg/L for an intake rate of 15 L/d. 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. Figure 8–10 summarizes the basis for these standards.

h. Sulfate. Adverse health effects stemming from ingesting levels of sulfate ions greater than the recommended standards also result from the risk of dehydration caused by acute laxative action. Figure 8–11 summarizes these effects. This dehydration can cause significant performance degradation, but the relationship between sulfate concentrations in drinking water and laxative effects is poorly documented. Field-water quality standards are based on a single dose of 1,490 mg sulfate ions prescribed clinically to induce laxative effects in fasting individuals (that is, a group that is more sensitive to saline laxatives than would be nonfasting individuals). The derived field-water quality standards for 5 and 15 L/d intake rates are 300 and 100 mg/L of sulfate, respectively, for either short- or long-term exposure. It is presumed that higher levels of sulfate would be associated with increasing laxative effects, which can lead to performance-degrading dehydration, but the severity of these effects and the percentage of population experiencing them cannot be estimated from available data.

i. Trichothecene (T–2) mycotoxin. Mycotoxins are naturally occurring substances produced by fungi as a secondary metabolite that typically affords the organism survival benefit (for example, penicillin). Thus, many of the toxins produced are pathogenic to animals and humans. More than 300 mycotoxins are reportedly produced by some 350 species of fungi. T–2 mycotoxin is the only one of them known to have been used as a biological warfare (BW) agent. T–2 is nonvolatile, relatively insoluble in water, and highly soluble in ethanol, methanol, and propylene glycol. The toxin is highly heat stable and resistant to UV light destabilization—two important factors when considering it as a BW agent. The first performance-degrading effects to occur after ingestion of concentrations of T–2 mycotoxin in field water greater than the recommended standards are nausea and vomiting as shown in figure 8–12. On the basis of data from clinical trials where cancer patients were treated with a chemotherapeutic agent considered analogous to T–2 mycotoxin, the mildest symptoms would be associated with concentrations just above the short-term (less than 7 days) interim exposure limit of 26 μg/L for a water intake rate of 5 L/d and 8.7 μg/L for a water intake 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.

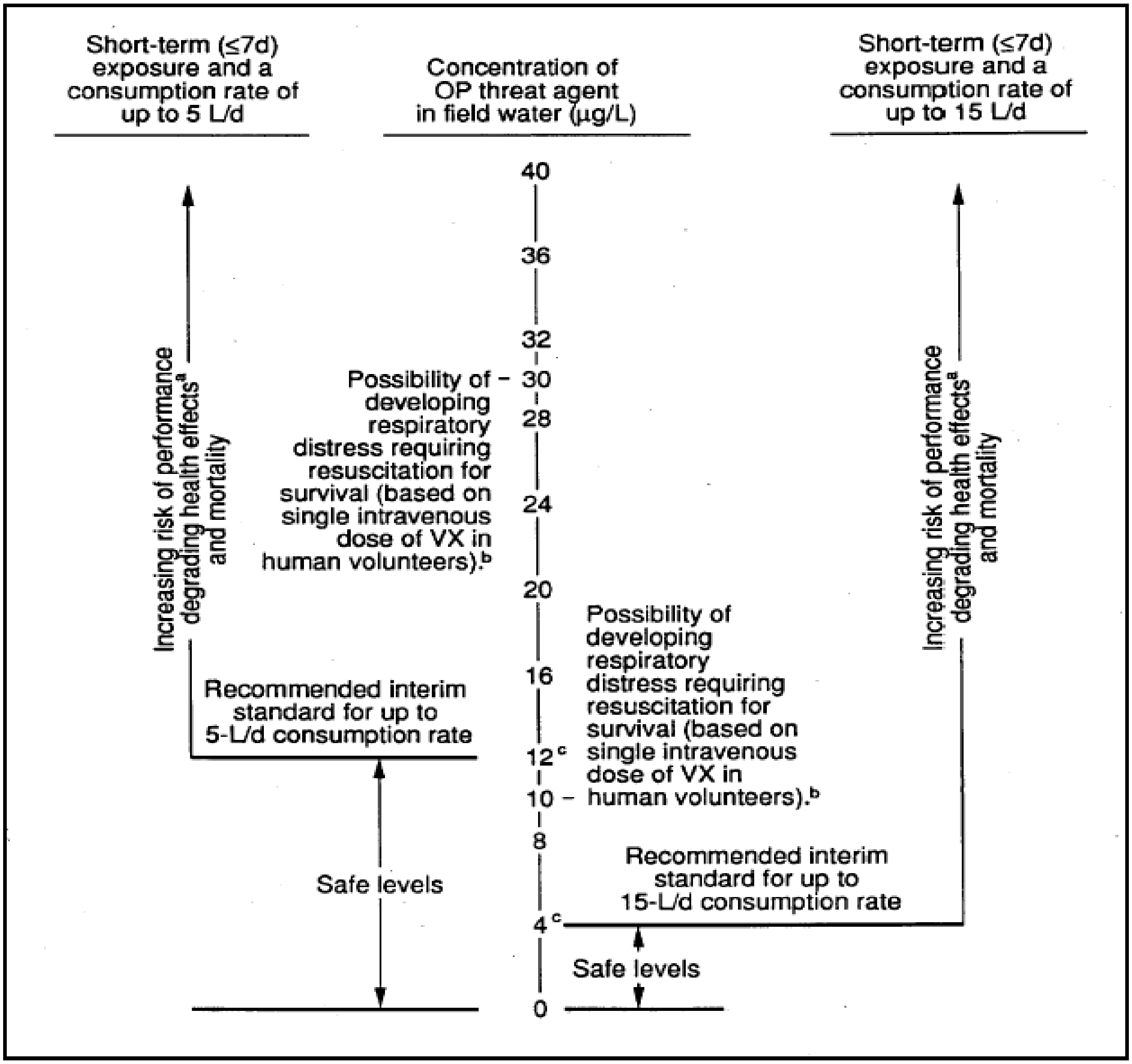

Figure 8–10. Health-effects summary for organophosphate (OP) nerve agents

Notes:

[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 lasing up to 7 d.

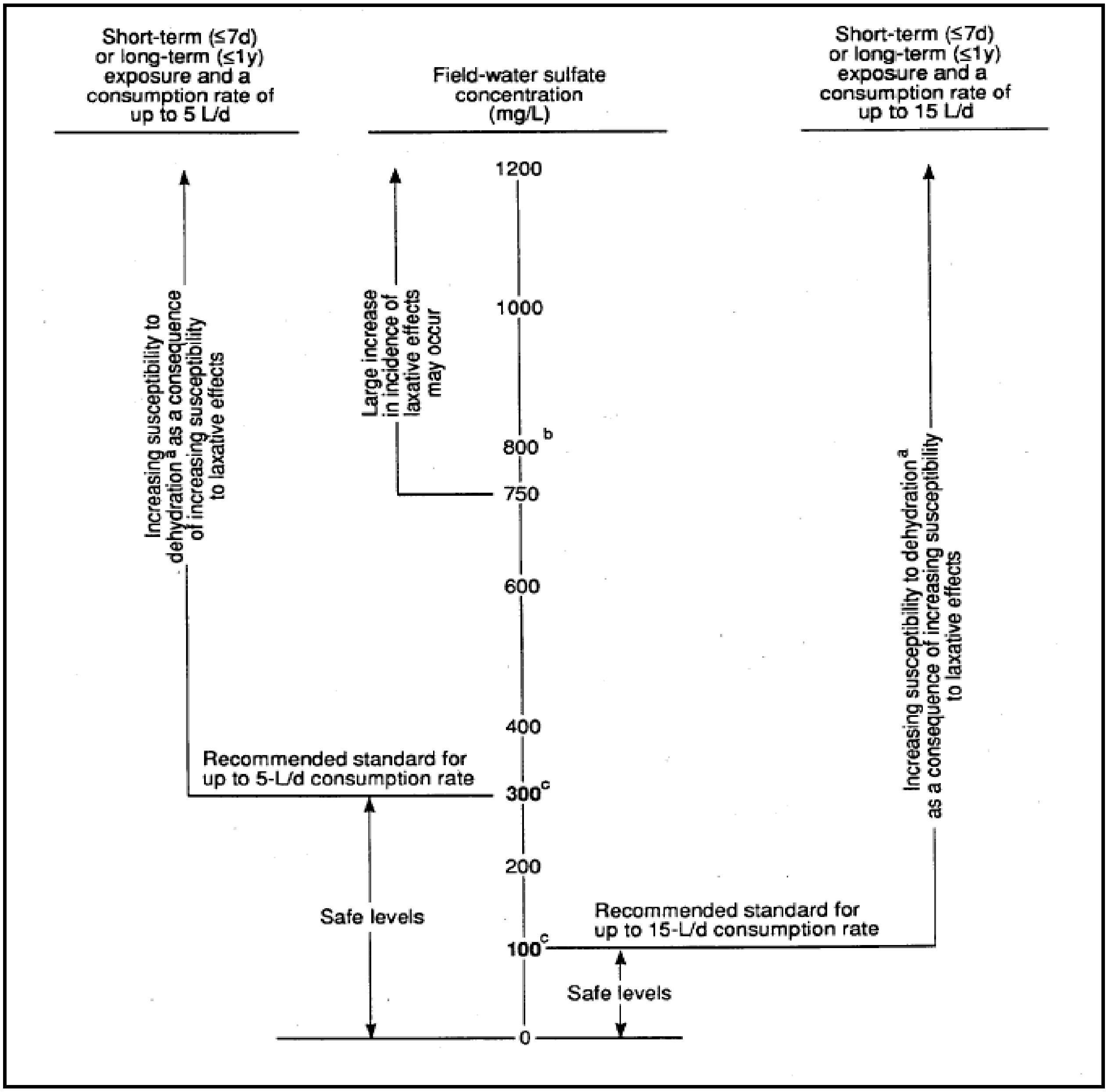

Figure 8–11. Health-effects summary for sulfate

Notes:

[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 drinkable 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 intake rate and exposure periods up to either 7 d or 1 y.

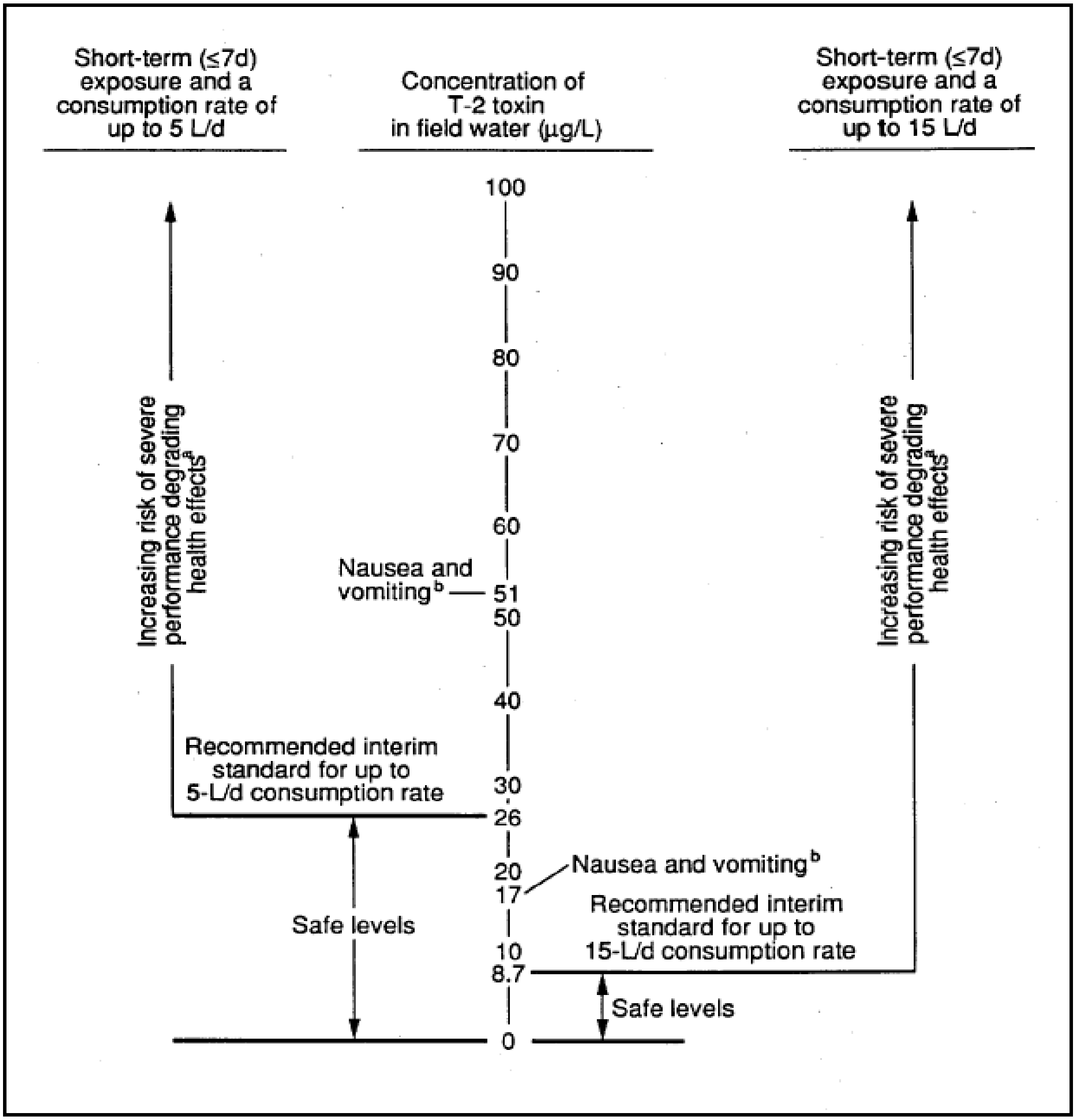

Figure 8–12. Health-effects summary for trichothecene mycotoxin, T–2

Notes:

[a] Potentially performance-degrading health effects may include nausea, vomiting, diarrhea, generalized burning erythema, and mental confusion according to studies 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.

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Chapter 9
Water Recycle and Reuse

9–1. General

The concepts of water recycle and reuse have not been widely practiced in the field. However, in areas where water supplies are few and demand is high, recycle and reuse of water may be necessary to efficiently use as much of natural water that may be available as possible. Gray or black water is not permitted to be directly recycled or reused for drinking, cooking, or brushing teeth water consumption. Recycling or reusing RO reject water or gray water for showers and other Class I and Class II activities shown in Table 2–11 that do not require potable water <u>do</u> require PM approval to safeguard the participants.

9–2. Considerations for water recycle and reuse

a. Conservation. Water will not be recycled or reused for activities that require potable water. In addition, no water will be recycled or reused when chemical or biological agents or nuclear weapons have been used. As a result of these restrictions, the only way to provide adequate amounts of potable water in water-short areas is to conserve supplies. Conservation includes minimizing spillage when transferring water from one container to another, covering open tanks to reduce evaporation and contamination by dust, and reducing waste. Equipment modifications which can help conserve water supplies include spring-loaded faucets in sinks, spring-loaded or pull-chain shower head valves, and water-conserving shower heads. For portable bath units that do not have individual valves on shower heads, leaders can limit personnel shower durations to reduce water usage.

b. Recycle. Recycling wastewater involves using it again in the process that generated it, usually by treating it and returning it to the beginning of the operation. Reject water from ROWPU operations and gray water from showers and laundries can, under certain circumstances, and only when approved by the area medical authority, be treated and recycled in ROWPU and shower or laundry operations, respectively. RO reject water may be recycled and run through the ROMs either internally or externally. Shower and laundry wastewater (gray water) may be collected, treated, disinfected, and pumped back to the shower or laundry unit. While shower and laundry gray water recycling equipment may include RO and produce water that meets drinking water standards, it may not be used for drinking water, but only recycled and used as shower or laundry water.

c. *Reuse.* Reusing water involves using it again for a different purpose than it was originally used, such as in laundry operations having rinse water reused as wash water in the wash cycle, and in some field feeding operations where the final rinse water becomes initial rinse water, and the initial rinse water becomes the dish washing water.

9–3. Treatment

a. Field expedient treatment. Batch treatment for recycling can be accomplished with onion tanks and onsite treatment processes. Advice of water treatment experts should be obtained to plan and implement treatment systems. A physical/chemical treatment system might include coagulation, sedimentation, filtration, and the addition of powdered activated carbon. Reverse osmosis treatment would be desirable. Disinfection will be required in all cases of recycling involving any kind of human contact with the water, including contacting clothing laundered in recycled water.

b. Military-approved recycle systems. Automated laundry recycle systems have been developed, tested, and approved for use in Force Provider units, and shower water recycle systems are currently undergoing testing for use in the field. These systems have/will have specific operating instructions, product water quality standards, and water quality monitoring requirements. PM personnel should ensure that such systems are monitored according to the instructions and that the quality of the water produced is within the defined criteria specific to each system. PM personnel must have access to the treatment systems, operating manuals, and operator-performed test data, and be allowed to test the recycled water to provide medical oversight of the recycle operations.

9–4. Recycled gray water standards

a. Purpose. The purpose for establishing standards for recycled water is to protect the health of personnel, including prevention of skin and eye irritation from recycled shower water.

b. General standards. These standards represent the acceptable range or maximum allowable limit for each constituent.

(1) pH: 5 to 9
(2) Turbidity: 1 NTU
(3) Hardness: 500 mg/L
(4) TDS: 1500 mg/L
(5) Coliforms: absent
(6) FAC chlorine residual: 1 mg/L after 30 minutes.

c. Specific standards. Standards have been developed for recycling shower and laundry gray water to shower facilities in Army Force Provider transportable base camp systems. They are described in USACHPPM IP 31-027, “Criteria for Recycle of Gray Water for Shower Use,” and implemented in Army Surgeon General Memorandum DASG-PPM-NC, 13 August 2004. They represent good guidance for any field laundry and shower recycle operations.

9–5. Operational monitoring

Personnel operating recycling equipment perform operational monitoring to control the process involved. Assistance in determining the operational monitoring requirements can be obtained from PM Detachments or higher level PM assets. Water recycled for operations involving personal contact should be tested hourly for adequate chlorine residual.

Chapter 10
Management of Wastes Produced During Field Water Operations

10–1. General

a. Background. When operating in a field or garrison environment, commanders must comply with EPA, state, 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 must coordinate with the appropriate environmental office to determine how to legally dispose of wastewater and other treatment wastes. Outside the U.S., commanders must meet wastewater disposal requirements by coordinating with the appropriate Installation Management Agency, Area Support Group and/or base support battalion, or local command engineer.

b. Procedures.

(1) *Regulated discharges.* In cases where a discharge permit has been secured, the commander of the QM unit responsible for water supply will comply with the permit to prevent contamination of the receiving water body. In cases where a permit has been denied, the QM unit's designated representative 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 (WWTP). Such action will also involve coordination with the chief of the WWTP.

(2) *Unregulated discharges.* If a discharge permit is not required, the water purification section chief will take precautions to avoid contaminating any receiving body of water. Wastewater should be discharged according to paragraph 10–2.

10–2. Wastewater management

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. Dischargers, with close coordination, support, and representation by the installation's environmental office, must apply for and obtain a site-specific NPDES permit (or State equivalent) or general NPDES permit. These permits set limits for discharges. Water purification operations must meet these limits.

(2) Foreign countries have their own rules and regulations on disposal of wastes as well as ambient water quality criteria. Usually, the host nation Final Governing Standards (FGS) and the host nation standards contain these requirements. If FGS have not been developed, then the DOD Overseas Environmental Baseline Guidance Document (OEBGD) should be consulted. Planners must always consult and coordinate with the appropriate environmental office or equivalent organization prior to operations to determine the requirements for discharges.

b. Wastewater generation.

(1) ROWPU operations produce three separate waste streams that must be managed. They include the brine, the filter backwash, and wastewater from cleaning ultrafiltration membranes, microfiltration membranes, or ROMs. The TWPS and the LWP do not use multimedia filters but generate a backwash wastewater stream which is more dilute in suspended solids than the 600-gph and 3,000-gph ROWPUs. In addition to these "real" waste streams, the

chlorinated product water may also have to be disposed of as wastewater if it is not issued to personnel to drink (the case in some training exercises).

(2) The amount of wastewater generated will depend on the source water quality and operational practices. However, table 10–1 shows the typical volumes that can be used as a basis for planning. Rinse waters generated after performing chemical cleaning operations have not been included in the table. For fresh water sources, approximately 50 percent product water and 50 percent brine is produced. If the water source is brackish to saline, approximately 35 percent product water and 65 percent brine is generated. Generally, the multimedia filters on the 600-gph and the 3,000-gph ROWPUs are backwashed every 20 hours of operation or when the pressure loss across the filters rise more than 5 lb per square inch above the initial readings and when the ROWPUs are shut down. Approximately 1,000 gal of backwash wastewater is produced during a 13-min backwash cycle. The TWPS and LWP microfiltration and ultrafiltration membranes are automatically backwashed every 15 min. Because of the frequent backwashing on these newer systems, the wastewater is more dilute in suspended solids than the backwash wastewater generated by the 600- and 3,000-gph ROWPUs.

Table 10–1
Wastewater production guidelines for various ROWPU systems

ROWPU unit	Source water	Raw water flow rate (gph)	Product water (gph)	Brine (gph)	Backwash (gal/cycle)	ROM cleaning (gal)	Ultra filter (UF)/micro filter (MF) cleaning (gal)
600-gph	Fresh	2000	900	1100	1000	350	0
	Brackish/Sea	2000	600	1400	1000	350	0
3,000-gph	Fresh	6000	3000	3000	1000	350	0
	Brackish/Sea	6000	2000	4000	1000	350	0
TWPS	Fresh/Brackish	4200	1500	1750	240	260	260
	Sea	4200	1200	2050	240	260	260
LWP	Fresh/Brackish	300	125	90	20	40	40
	Sea	300	75	140	20	40	40

(3) Water treatment operators clean the UF, MF, and ROMs based on indicators of system performance. The source water quality will directly affect how often the multimedia filters will need to be backwashed and the frequency of UF, MF, and ROM cleaning. Operators clean the membranes by circulating citric acid, a detergent, or hypochlorite solution through the membrane vessels. The cleaning process generates various quantities of wastewater for each ROWPU.

(4) As an example, assume you are operating a 600-gph ROWPU for 20 hours each day at an intake rate of 2,000 gph. Also assume you will have to backwash the multimedia filter twice daily because the source water is a fairly muddy river and the operators do not anticipate having to clean the RO units during the operation. From table 10−1, for this example, the estimated daily waste and water production would be—

(a) Total daily flow = 2,000 gph x 20 hr/d = 40,000 gpd

(b) Water production = 900 gph x 20 hr/d = 18,000 gpd

(c) Brine production = 1,100 gph x 20 hr/d = 22,000 gpd
(d) Backwash waste = 2 cycles/d x 1,000 gal/cycle = 2,000 gpd

(5) These are the numbers one would use to begin coordinating with the appropriate office/individual to ensure that the operation complies with applicable legal requirements to discharge. Note that if all of the treated water is not used up, the water that remains will have to be discharged as a waste too. If the operators collect the brine water and use it to backwash the multimedia filter, the volume of brine that needs to be disposed of would be reduced by 2,000 gpd in the example above.

c. Brine (RO reject water) management. The contaminants present in the reject water include most of the contaminants that are in the source water, but they are at different concentrations. The concentrations of various contaminants in the brine water vary depending on the particular pretreatment filtration employed (600- and 3,000-gph brines are somewhat more concentrated than TWPS and LWP brines). The suspended solids concentration is less than that of the raw water because they are removed by the pretreatment filtration systems. However, the dissolved solids, alkalinity, metals, and chloride concentrations in the brine are as much as two times their respective concentrations in the source depending on the ROM flux and contaminant rejection rates, since they are not generally removed by pre-RO filtration and are rejected by the ROMs. Protozoan cysts and nearly all bacteria are removed by the TWPS and LWP pretreatment filters, but not the 600-gph or 3,000-gph prefilters. Hence, brine microorganism concentrations are equal to or greater than the raw water concentrations for the 600-gph and 3,000-gph ROWPUs, but much less for the TWPS and LWP brines. The phosphate concentration is greater in the brine than in the raw water when sodium hexametaphosphate (600-gph ROWPU) is added during the treatment process. Four options may be considered for brine disposal.

(1) Return the brine to the raw water 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 that is returned to the source should be discharged at least 50 yd downstream from the raw water intake for flowing sources, and as far as possible from the intakes for standing bodies of water. For training exercises, each discharge site should be evaluated by the local regulatory authority to determine if a permit is required.

(2) Discharge the brine to a WWTP. This includes disposal to a sewer line and discharge directly to the plant. Most brine can be treated without difficulty at a WWTP. However, there is a possibility that elevated metals concentrations in the brine could upset biological processes at the WWTP, so coordination with the WWTP operator prior to discharging to the system is strongly recommended. This is more of a concern in brackish or saline sources with high TDS content.

(3) Discharge the brine to the ground. In lieu of other options, the standard field wastewater disposal method, a soakage pit or trench (see FM 21–10/MCRP 4-11.1D), is an alternative in many areas except where high ground-water tables exist. Other options include evaporation ponds in arid areas and various conventional land treatment methods applicable to the local climate. 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 and the negligible impact on the source.

(4) Blend the brine and product water and then dispose of it using one of the three methods above. 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 because of the contaminant concentrations and extra product water is available, the two can be blended to dilute the constituent concentrations. The controlling authority may then allow the blended solution to be returned to the source, discharged to a WWTP, or discharged to the ground. To dilute the brine to a concentration low enough to discharge would require most of the product water.

(5) ROWPU brine/concentrate will not be used for any human contact activities regardless of its quality, unless specifically authorized by the local medical authority and commander, with a supporting risk assessment performed by appropriate-level PM personnel. If RO reject water is authorized by the designated command element and used, its use will be curtailed as soon as a better water supply is available.

d. Filter backwash management.

(1) *Multimedia filter backwash.* The potentially high total suspended solids concentrations in the filter backwash water from the 600- and 3000-gph ROWPUs makes recycling the backwash waters to the raw water sources an unlikely option. For training exercises in CONUS, these backwash waters should be discharged directly to a sanitary sewer manhole, or if that is not possible, they could be collected and hauled to an STP. During deployments, the backwash water should be discharged downstream from the source water intake of a flowing source, or to soaking pits, trenches, or other similar ground-disposal options.

(2) *TWPS and LWP backwash*. Backwash waters from the TWPS and LWP microfilters and ultrafilters have comparatively lower suspended solids levels and may be disposed of in the same manner as multimedia filter backwash. With approval of the local medical authority, they also may be recycled to the raw water source since the suspended solids concentrations are lower than the backwash waters from the 600- and 3,000-gph ROWPUs.

e. Membrane cleaning wastewater management.

(1) The RO, UF, and MF membranes are cleaned with citric acid, detergents, or hypochlorite solutions. For the TWPS and 600-gph ROWPU that use copper-nickel alloy tubing in conveying water, wastewater produced during the citric acid cleaning may contain high levels of copper, nickel, lead, and zinc. The concentrations will diminish over successive citric acid element cleaning cycles for the lifetime of the equipment.

(2) Direct discharge of wastewaters generated during either citric acid, detergent or hypochlorite cleaning cycles to surface waters is unlikely to be allowed because of the high 5-day biochemical oxygen demand, the high or low pH, the presence of hypochlorite, the presence of surfactants, and the high suspended solids in the wastewaters.

(3) As with backwash water, the membrane cleaning solutions should be discharged to a sewer or hauled to a WWTP. For high or low pH wastewaters it may be necessary to adjust the wastewater pH before discharging to the sewer. To reduce the potential impact of the concentrated wastewater on the WWTP processes, it can be discharged to the sewer or WWTP slowly rather than being discharged all at once. The elevated metal content in wastewater generated during citric acid cleaning of new ROWPUs using a copper-nickel alloy tubing in conveying water could negatively impact the biological processes at the WWTP depending on its size in relation to the volume and rate of wastewater discharged to it.

(4) Land disposal methods for wastewater generated during membrane cleaning should not be used.

f. Product water. The amount of product water that personnel drink during an exercise that includes actual or simulated ROWPU water treatment varies from barely any that is produced to nearly all of it. If personnel do not drink it or use it for some other purpose, and it has been treated and chlorinated, permission must be obtained to dispose of it like any other form of wastewater. Optimally, the treated water can be discharged back to the source from which it was taken; however, a permit to do so will likely be required. A permit may or may not be required to discharge to a sanitary or storm sewer or perhaps even to discharge directly on the ground.

g. Operator protective equipment. Material Safety Data Sheets for all chemicals used in water purification should be consulted for safety information and personal protective equipment. Under normal operation, ROWPU operators must—

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

(2) Wear a full face shield when working with membrane cleaning solutions which are severe eye and skin irritants.

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

(4) Wear safety spectacles with side shields or chemical splash goggles with a face shield, and a National Institute for Occupational Safety and Health (NIOSH)-approved dust mask when there is a potential for contaminated water from the ROMs to be aerosolized. The operators can substitute a military chemical protective mask for the NIOSH-approved mask only when there is potential for a CBRNE environment.

10–3. Solid waste management in a nonchemical, biological, radiological, nuclear, and high energy explosive environment

a. Regulatory information.

(1) The Resource Conservation and Recovery Act, reflected in 40 CFR 260–280, defines hazardous wastes and provides regulatory controls for handling and managing 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, RO, UF, or MF membranes and cartridge filters will not meet these criteria and thus will not be considered hazardous. Questions should be directed to the appropriate environmental staff with jurisdiction in the training or operating area. Contact higher echelon PM organizations for additional information.

(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 RO, UF, or MF membranes and cartridge filters. Maintain good housekeeping practices to include containing and collecting spent membranes and cartridge filters in a central location. The spent membranes and cartridge filters may have to be transported back to the U.S. for disposal as recommended in paragraph 10−3*a*(1), above.

b. Disposal. Dispose of spent ROWPU cartridge filters and membranes as solid, nonhazardous wastes according to state, local, and FGS, or the OEBGD, if no FGS exists.

10–4. Chemical, biological, radiological, nuclear, and high energy explosive-contaminated waste management

a. Treatment of CBRNE-contaminated water. Water purification units will normally treat water in an uncontaminated environment only (that is, in an area where the soil and air is not contaminated). CBRNE-contaminated water will be treated only as a last resort if no other source exists. If water must be treated in a contaminated environment (that is, CBRNE weapons have been extensively used on the battlefield and uncontaminated areas are nonexistent), containerize the treated water to prevent further post-treatment contamination. Surface-water sources should be avoided, and ground-water sources should be used if possible.

b. Decontamination. If contaminated source water must be treated, the treatment equipment must be thoroughly decontaminated before it is used again. Chemical corps and PM personnel should be consulted for proper decontamination procedures for the equipment and for protective measures for individuals performing the decontamination.

c. Disposal. Brine and backwash water generated from CBRNE purification operations should only be discharged back to the original source. Brine should be disposed of downstream or away from shore so that it does not increase the contaminant concentrations of the water drawn into the ROWPU for treatment. Discharging the brine to a sump or another surface source would likely contaminate clean soil, ground water, or surface water. The multimedia filter media, cartridge filters, RO/UF/MF membranes, and ion exchange and activated carbon media must all be disposed of as CBRNE-contaminated wastes. Chemical corps and PM personnel should be consulted on the proper procedures for handling and disposal.

d. Radiation safety. If appropriate radiation safety measures are taken, health risks to the operators and the Military Service member 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 their exposure time to a minimum by staying away from the equipment except when it is necessary to make adjustments and by shielding the waste container with whatever is available. Radiation warning signs can be posted, if available, to keep unauthorized personnel away from the purification equipment. Other areas occupied by personnel should be setup well away from the purification operation if possible.

PART III
AIR FORCE-SPECIFIC GUIDANCE

PM personnel from all Military Services are charged with ensuring that the water being provided to the men and women under field conditions meets applicable water quality requirements on a continuous basis. Although the objective is the same for all Military Services, some policies and procedures vary by Military Service due to differences in the roles of stakeholders responsible for operating, maintaining, securing, and providing surveillance for field water systems and supplies. Furthermore, while other Military Services predominantly rely on field water assets common to forward operating bases, the Air Force is more often deployed to locations that are supported by more robust semi-fixed water assets. In these situations, the approach for Air Force sanitary control and surveillance activities (e.g., sanitary surveys and water vulnerability assessments (WVAs)) will not differ significantly from the approach implemented on most Air Force installations that utilize fixed water systems.

Air Force PM personnel should refer to Air Force Instruction (AFI) 48-144 to ensure all applicable surveillance requirements are met. Bioenvironmental engineers and technicians should conduct WVAs using the USAFSAM WVA deployment checklist and protocol outlined in the WVA Guide. The USAFSAM WVA guidance can be found on the knowledge exchange at the following environment, safety, and occupational health (ESOH) Service Web site: https://kx.afms.mil/kxweb/dotmil/kj.do?functionalArea=ESOH. The WVA information can be found under the "Environmental Health" link. In the event that a BEE or BE technician deploys in support of or is co-located with another Military Service, refer to Part IV (Army Specific Guidance) and Part V (Navy and Marine Corps Specific Guidance) of this TB MED for applicable service-specific information and guidance.

Chapter 11
Air Force Roles

11–1. Bioenvironmental engineering

Bioenvironmental engineering−

a. Performs drinking water quality surveillance for the protection of public health and regulatory compliance. Provides data and technical support to physicians and public health personnel investigating potential drinking water-related illnesses. Maintains records of drinking water quality surveillance in accordance with primacy requirements. Ensures laboratories perform analyses using required analytical methods.

b. Ensures a sanitary survey is performed to satisfy the requirements of applicable regulations and standards, using guidance from USAFSAM if appropriate, and recommends measures to be taken to maintain the sanitary quality of the base drinking water system. Ensures special surveys of the drinking water system are conducted as warranted in the event of contamination.

c. Ensures WVAs are completed per guidance (as a minimum using USAFSAM references).

d. Monitors and approves aircraft watering points.

e. Interprets results of water analyses and reports to the medical treatment facility (MTF) commander. In the Central Command (CENTCOM) area of responsibility, provide results to the

U.S Air Forces Central BEE. In other areas of responsibility, provide results to the Air Force Component or Numbered Air Force BEE, per direction.

f. Immediately implements the public notification procedures described when drinking water analysis results indicate a potential public health threat.

g. Assists the Public Affairs Office in the preparation of Public Notifications.

h. Conducts engineering reviews of repairs and modifications to drinking water systems, and determines and conducts sampling, analysis, and monitoring as necessary.

i. Reviews construction and modification plans and drawings to assess and avert potential health hazards that may result from construction or modification. Supports the cross connection and backflow prevention program by classifying health hazards of potential and actual drinking water cross connections.

j. Advises commanders on source water protection opportunities, physical modifications to enhance water treatment and distribution systems, and alternative management practices to meet MFWS and enhance water quality.

k. Maintains drinking water analytical data records in electronic format (e.g., DOEHRS database) and, if applicable, paper.

11–2. Base civil engineer

The base civil engineer–

a. Designs, constructs, operates, and maintains drinking water systems. Coordinates all modifications and repairs to the drinking water systems with the installation BEE.

b. Develops and maintains an adequate supply of safe drinking water for the base populace and protects supplies from unintentional contamination.

c. Conducts drinking water treatment process control monitoring and records drinking water production rates, periodic disinfectant residual, and pH measurements.

d. Ensures a detectable disinfectant residual level is maintained in all parts of the installation drinking water distribution system.

e. Develops local operating instructions to include operational monitoring for process control, sampling and testing procedures, emergency operations, maintenance, and OEBGD requirements.

f. Conducts a cross connection control and backflow prevention program to identify, isolate, and correct cross connections and other potential sources of contamination to the water supply system.

g. Corrects distribution system deficiencies identified through internal assessment or monitoring and keeps records of corrective actions.

h. Notifies BE of any unusual events affecting the water distribution system that could result in changes to water quality and potability including line breaks, new connections, distribution system maintenance (e.g., cleaning of reservoirs, storage tanks, and bladders), water treatment plant repairs, and chlorine application problems. Works closely with BE to bring the distribution system back on line.

i. Coordinates contingency support plans and base recovery actions pertaining to drinking water systems with BE and optimizes the use of BE and civil engineering resources.

j. Assists BE in developing and maintaining a sampling, analysis, and monitoring plan.

11–3. Public Health Office

The Public Health Office−

a. Ensures public Air Force facilities are evaluated for proper sanitation (e.g., showers and restrooms).

b. Employs evaluators who discuss any sanitation problems with and provides a legible copy of the site visit report to the site supervisor, who in turn advises the division chief responsible for the facility of any substantive findings.

c. Provides copies of unsatisfactory reports to the MTF commander and then to the installation commander.

d. Coordinates with Medical Services to decide when to reevaluate failed facilities.

11–4. U.S. Air Force School of Aerospace Medicine

The USAFSAM−

a. Provides technical consultations regarding safe drinking water quality, provides analytical services to BEE in garrison and deployed, and provides a contracting mechanism to execute projects related to drinking water monitoring and health risk surveillance.

b. Provides specialized field surveys and studies to assist installations with drinking water quality issues.

c. Provides guidance to installations on collection and preservation of drinking water samples, sampling equipment, instruments, methods, calibration, and interpretation of results concerning drinking water.

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PART IV
ARMY-SPECIFIC GUIDANCE

Chapter 12
Army Levels of Preventive Medicine Support

12–1. Composition and function
Army PM support is organized into five levels based on level capability, rather than echelon or location in the operational environment. The TO contains four of the levels of support, which would extend rearward in a linear theater, but may be almost anywhere in the current asymmetrical operational environment. The fifth level is located in the CONUS. In the TO, PM support is tailored and phased to: enhance mission requirements, counter the medical threat, and provide PM support as far forward as the tactical situation will permit. Level II PM resources are organic to medical companies in the brigades, divisions, and corps. PM resources providing levels III and IV PM support consist of the deployable units listed in table 12–1. They are employed on an area basis to provide the utmost benefit to the maximum number of personnel in the AO. Staff sections within each level of PM support, less level I, provide medical intelligence and information, the medical threat, and the PM estimate of the situation to the surgeon or the command. They also ensure that essential information on the medical threat and PM measures are integrated into operation plans, operation orders, and briefings. They serve as the focal point for PM reports and analyze water quality and health surveillance data to provide early warning of potential disease threats and to monitor the effectiveness of PM activities in countering the medical threat. Details on each level follow.

Table 12–1
Deployable Army PM units[1]

Type of Deployable Unit	Unit Type Code (UTC) / Standard Requirements Code (SRC)
Medical Detachments – Level III	
Medical detachment, PM (Sanitation) - MF2K	F1XVV / 08498A000
Medical detachment, PM (Entomology) – MF2K	F2XVV / 08499L000
Medical detachment, PM (Sanitation & Entomology) – MRI	FZGGG / 08429A000
Support Units – Level IV	
Area Medical Laboratory PM	FKHGG / 08668A000
Special Medical Augmentation Response Teams	
Nuclear/Biological/Chemical (SMART-NBC)	SMART-NBC
PM (SMART-PM)	SMART-PM
Veterinary (SMART-V)	SMART-V

Note:
[1]See Glossary for acronym definitions.

a. Level I PM support is provided by individual Soldiers, designated unit individuals or elements organic to combat, combat support, and combat service support units (FSTs). Major emphasis is placed on those measures necessary to maintain basic field sanitation and hygiene, protect individuals from the medical threat, and maintain a healthy and fit force.

b. Level II PM technicians (military occupational specialty 68S) and PM officers (area of concentration 67C) provide support at this level. This is the first level of PM support that has medical personnel, typically organic to the unit, specifically trained in PM.

(1) *Brigade-level*. Level II PM support is provided by a PM team, typically an officer and an NCO, organic to the medical company. They can provide basic field sanitation, unit FST training, field screening, and basic onsite water quality testing.

(2) *Division-level*. Division-level PM support is provided by organic PM personnel. Up to three PM teams may exist in the division's organic medical company. These teams can provide basic field sanitation, unit FST training, field screening, and basic onsite water quality testing.

(3) *Corps-level*. The PM section of the Multifunctional Medical Battalion (MMB) provides level II PM support in the Corps area on an area basis. The MMB PM section provides the same basic functions as the division-level PM section. The MMB PM section can backfill or augment division and brigade PM sections as required.

c. Level III PM support is provided by small, mobile PM detachments. They provide technical consultation support on PM issues throughout the TO. The units provide specialized PM support in the areas of medical surveillance, disease-vector identification, environmental engineering, medical threat profile, and health hazard assessment. The detachments can provide basic field water testing. Level III PM assets can augment level II assets as determined at the appropriate command level based on mission requirements.

d. Level IV PM support is provided by the area medical laboratories (AMLs). An AML serves as the theater's source for confirmatory field laboratory analysis. AML personnel also prepare samples for shipment to the CONUS reference laboratories for definitive analysis. The AML has three sections: the endemic disease section, the OEH section, and the nuclear, biological, and chemical (NBC) section.

(1) *Endemic disease section*. This section provides analytical, investigative, and consultative services to assist in the identification of endemic diseases that pose a potential threat to deployed forces (or other populations at risk) in the AO.

(2) *OEH section*. This section monitors and evaluates the OEH hazards to deployed forces and provides medical risk assessment and consultation on associated hazards. Its water testing capabilities are much greater than those of level II PM assets and approach those of a reference laboratory.

(3) *NBC section*. This section provides analytical, investigative, and consultative services to assist in the identification of NBC threat agents in biomedical specimens and other samples from the AO. Capability exists within this section to perform field confirmation of suspected NBC threat agents.

e. Level V PM support is provided by PM units in the CONUS. Home station operations centers, such as U.S. Army Medical Department Activities and U.S. Army Medical Centers in the CONUS sustaining base, will provide technical support for PM issues and support to the force during pre- and post-deployment surveillance. USACHPPM and its subordinate activities provide definitive laboratory analysis, serve as the technical center of expertise, and are the ultimate repository of all medical surveillance data collected within the theater.

12–2. Preventive medicine support to field water operations
The field water-related tasks for each level of PM support are shown in table 12–2. These tasks are described in terms of the deployment phase to which they are applicable following the table.

Table 12–2
Levels of PM support to field water operations

Level	Description	Roles	Tasks
I	Unit FST	Assess local unit treated water supplies.	Inspect water containers and trailers; test unit water supplies for chlorine and add additional chlorine when needed; report problems and concerns to unit commander and supporting PM section (Level II).
II	PM sections of divisions, separate brigades, armored cavalry regiments, and area support medical battalions	Identify/assess medical threats; oversight surveillance of potable water supplies and related contracts; train FSTs; provide commanders with recommendations to minimize adverse health effects arising from water-related risks.	Identify and coordinate with logistical elements for needed PM materials; use field test kits to screen water supplies and certify them as potable; conduct sanitary surveys and perform additional sampling; coordinate with Levels III–V to characterize risks associated with identified water contaminants; recommend C/ORM strategy and courses of action to command elements to minimize health risks.
III	Medical detachments, PM	Augment and support FST and Levels I and II PM personnel and provide unique capabilities.	Collect and analyze samples; conduct epidemiological investigations; provide technical consultation.
IV	AML PM support (normally allocated based on the anticipated medical threat); other military units/ organizations for specific technical support	Augment and support PM Levels II and III, and provide unique capabilities.	Provide more advanced laboratory analytical support and technical consultative services.
V	USACHPPM – resource for technical information, sampling assistance, and laboratory support	Maintain all deployment-related environmental (including drinking water) data; augment and support PM Levels II–IV and provide unique capabilities.	Archive exposure data and provide more advanced laboratory analytical support and technical consultative services regarding health risks and preventive measures.

a. Predeployment. PM personnel work with logistics and operations planners to plan and prepare for deployment. For PM personnel, predeployment planning includes determining detailed support requirements and providing an estimate of PM requirements based on medical and nonmedical intelligence. Predeployment preparation includes assisting in intelligence preparation of the operational environment and conducting strategic-level coordination. Some of the water-related predeployment tasks that PM personnel should perform include the following:

(1) Assist in estimating drinking water requirements based on the location/climate, and the anticipated level, duration, and frequency of operational activities.

(2) Obtain and deliver medical threat information including medical intelligence reports, medical threat products, and briefings (see FM 4–02.17). This includes the use of medical and nonmedical intelligence information to evaluate potential threats to field water supplies such as industrial contamination or endemic diseases.

(3) Assist logistics/engineer personnel in characterizing potential raw water sources and in developing contracts for nonmilitary execution of the field water mission.

(4) Conduct preliminary FWSVAs.

(5) Assist in training unit FSTs in unit-level field water mission tasks (see FM 4−25.12).

(6) Assist in determining the equipment that will be needed to conduct surveillance of field water supplies.

(7) Assist in performing predeployment PM equipment checks for PM units and PM-trained unit personnel.

b. During deployment. PM personnel perform surveys, inspections, and evaluations, collect water samples, and perform sample analyses for military and contractor-operated water supplies. They also provide real-time recommendations and assistance to commanders and unit PM personnel with regard to source selection and treatment, field water testing, water supply inspection and approval, and operational risk assessment and exposure documentation. Typical deployment-phase tasks include—

(1) Using field observations and equipment to perform water source reconnaissance and to screen potential raw water sources based on military or contractor-operated ROWPU or other available treatment system capabilities, to identify and assess health hazards, and to support documentation requirements for EBSs.

(2) Ensuring that proper treatment and disinfection procedures are followed by both military and nonmilitary (contractor) operators.

(3) Confirming that water treated in the field for drinking is potable based on comparing the results of testing to the appropriate MFWS and guidelines.

(4) Performing CWQS by collecting treated water samples, properly labeling and documenting them, sending them to rear-area laboratories for AWT, and then reviewing and taking appropriate actions based on the results of the analyses.

(5) Conducting field inspections to ensure all military and contract field water treatment systems and associated equipment are properly maintained and monitored.

(6) Evaluating AWT analytical results using field water standards and MEGs for water and recommending corrective actions using C/ORM methods as necessary.

(7) Ensuring that all field water supply-related analytical data, risk assessments, and corrective actions are documented and entered into the DOEHS Data Portal or otherwise provided to the USACHPPM ESIP.

(8) Performing field water system vulnerability assessments.

(9) Assisting commanders with the assessment, oversight, and sustainment training of FSTs (see FM 4−25.12).

(10) Conducting water sampling and analysis, and providing C/ORM assessments and recommendations in response to water supply incidents such as environmental spills and accidental or intentional contamination.

(11) Advising the commander concerning drinking water quality issues and the use of risk communication techniques to inform unit personnel about water quality issues.

c. Postdeployment. Typical postdeployment actions that PM personnel perform with respect to the field water support mission include—

(1) Ensuring that all field water quality analytical results, with appropriate context information, risk assessments, and corrective actions are entered into DOEHRS-EH if possible, or if not, provided to the USACHPPM ESIP for archiving into the DOEHS Data Portal.

(2) Providing guidance on field water site/area restoration, including the removal and disposal of waste (see FM 4–02.17).

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Chapter 13
Army Roles

The following roles apply in the sanitary control and surveillance of the field water supplies for training exercises and for deployed forces in operational environments.

13–1. Army preventive medicine roles in field water supplies

a. Commanders at all levels—

(1) Plan for the sanitary control and surveillance of field water supplies in support of the operational mission.

(2) Protect water inventories from contamination.

(3) Maximize the use of type-classified tactical water treatment, storage, and distribution equipment.

(4) Use tactical water concepts for command post and other training exercises.

(5) Establish and enforce water use discipline.

(6) Ensure, when nonmilitary issue, commercial unit-level or individual water purifiers are used for atypical missions or emergency water supplies, and that such devices are as far as possible Army-approved and determined by the Army Surgeon General to meet Army field drinking water performance standards.

(7) Ensure that unit FSTs are trained, equipped, and employed according to FM 4–25.12, to conduct routine inspections of unit water containers and trailers, daily checks of unit water supplies for chlorine residual, and, when necessary, disinfection (rechlorination) of unit water supplies.

(8) Inform, train, and equip subordinates, and work closely with PM personnel to minimize disease and nonbattle injury resulting from dehydration, drinking contaminated water, and poor personal and unit sanitation and hygiene practices.

(9) Use appropriate C/ORM methods (see FM 5–19 and FM 3–100.12/MCRP 5–12.1C/ NTTP 5–03.5/AFTTP(I) 3–2.34) to integrate water supply-related health risk information into overall mission planning and execution.

(10) Ensure that all results from chemical and microbiological analyses of field water samples are documented and reported to the USACHPPM ESIP.

(11) Use risk communication techniques to disseminate water supply-related health risk information to unit personnel. Trained PM personnel can assist commanders with risk communication.

b. Unit and theater/command surgeons—

(1) Advise commanders and assist them with recognizing the importance of the sanitary control and surveillance of field water supplies in planning operational missions.

(2) Implement or oversee the implementation of PM procedures and instructions required for ensuring the security, adequacy, and quality of field water supplies.

(3) Provide medical oversight of field water supply operations for the prevention of waterborne diseases.

(4) Ensure that results of field water quality analyses which indicate the potential for immediate and acute health threats as well as those that may cause chronic or long-term health effects are documented and reported.

(5) Make recommendations to commanders for applying ORM principles to water supply decisions, including C/ORM-based responses to analytical results of water quality tests.

c. PM unit commanders and PM staff officers—

(1) Advise commanders and combat service support (CSS) personnel in planning for the sanitary control and surveillance of the field water supplies.

(2) Implement PM procedures required for the sanitary control and surveillance of field potable water supplies.

(3) Provide PM oversight of field water supply operations for the prevention of waterborne illness and disease.

(4) Document and forward to USACHPPM for archiving the results of field water quality analyses that indicate the potential for immediate and acute health threats as well as those that may cause chronic or long-term health effects.

(5) As directed, assist commanders in applying C/ORM principles to water supply-related decisions.

d. PM NCOs—

(1) Assist CSS personnel in water source selection by conducting water source reconnaissance surveys.

(2) Assist in certifying purified water as potable.

(3) Conduct sanitary surveys of potable water containers and water points.

(4) Inspect potable water treatment, storage, and distribution equipment.

(5) Test treated water to ensure water quality standards are met and chlorine residual is appropriate.

(6) Inspect field shower points and personnel decontamination stations.

(7) Train and evaluate unit FSTs and Soldiers at all levels in proper field water quality surveillance and sanitation.

e. Unit FSTs—

(1) Coordinate dining facility sanitation, field waste disposal, and personal sanitation inspections to prevent the spread of waterborne disease.

(2) Test unit water supplies for appropriate chlorine residuals when containers are filled, when water arrives in the unit area, and when directed to do so by medical or command personnel.

(3) Add chlorine to unit water supplies using approved methods when chlorine residuals are below required levels.

(4) Inspect water containers and trailers for cleanliness: quarterly in garrison, prior to deployment, and before filling at distribution points. Ensure containers are maintained in a clean and sanitary condition.

(5) Ensure unit has adequate stocks of iodine tablets, bulk chlorination equipment, and other supplies necessary for field water sanitation.

(6) Ensure water trailers and containers are protected from temperature extremes, when feasible, to keep drinking water as cool as possible for palatability.

(7) Train individual Soldiers to perform sanitary control measures for field water supplies.

(8) Request PM assistance to correct or control field water problems that are beyond the capabilities of the unit FST.

f. Individual Soldiers—

(1) Fill canteens and personal hydration systems with Army-approved potable water at every opportunity.

(2) Use only approved methods of disinfection (according to FM 21–10/MCRP 4-11.1D) or commander-approved IWPs when treating raw water supplies for drinking.

(3) Avoid the transmission of disease by keeping personal water containers and unit water supplies clean and secure.

(4) Seek the support of unit FST or local PM personnel to assist in correcting or controlling problems related to drinking water that are beyond individual Soldier capabilities.

13–2. Army preventive medicine roles in the operational environment

This section lists and describes typical tasks that PM personnel should perform to fulfill their field water mission responsibilities during all phases of deployment.

a. Predeployment. PM personnel will work with logistics and operations planners to plan and prepare for deployment. For PM personnel, predeployment planning includes determining detailed support requirements and providing the preventive medicine estimate based on medical and nonmedical intelligence. Predeployment preparation includes assisting in intelligence preparation of the operational environment and conducting strategic-level coordination. Some of the water-related predeployment tasks that PM personnel should perform include the following:

(1) Assist in estimating drinking water requirements based on the location/climate, and the anticipated level, duration, and frequency of operational activities.

(2) Obtain and deliver medical threat information including medical intelligence reports, medical threat products, and briefings (FM 4–02.17, para 4–5a). This includes the use of medical and nonmedical intelligence information to evaluate potential threats to field water supplies such as industrial contamination or endemic diseases.

(3) Assist in identifying and assessing potential field water sources including assessing the quantity, quality, potential health risks, and anticipated treatment and disinfection requirements for all potential and proposed water sources.

(4) Conduct preliminary FWSVAs.

(5) Assist in training unit FSTs in unit-level field water mission tasks.

(6) Assist in determining the equipment that will be needed to conduct surveillance of field water supplies.

(7) Assist in performing predeployment PM equipment checks for PM units and unit FSTs.

b. During deployment. PM personnel will perform surveys, inspections, and evaluations, and will collect samples and perform sample analysis. They will also provide real-time recommendations and assistance to commanders and FST personnel with regard to source selection and treatment, field water testing, water supply inspection and certification, and operational risk assessment and exposure documentation. Typical deployment-phase tasks include—

(1) Using field observations and equipment to perform water source reconnaissance and to screen potential raw water sources based on RO or other available treatment system capabilities, to identify and assess health hazards, and to support documentation requirements for EBSs.

(2) Ensuring that proper treatment and disinfection procedures are followed (see chap 9).

(3) Certifying that water purified at field water purification points is potable based on comparing the results of basic testing to the MFWS.

(4) Initiating CWQS by collecting treated water samples, properly labeling and documenting them, sending them to rear-area laboratories for AWT, then reviewing and taking appropriate actions based on the results of the analyses.

(5) Conducting field inspections to ensure all potable water supply systems and associated equipment are properly maintained and monitored.

(6) Evaluating AWT analytical results using appropriate water MEGs and take any required actions using C/ORM methods.

(7) Ensuring that all field water supply-related analytical data, risk assessments, and corrective actions are documented and provided to the USACHPPM ESIP.

(8) Performing FWSVAs.

(9) Assisting commanders with the assessment, oversight, and sustainment training of unit FSTs.

(10) Conducting water sampling and analysis, and providing C/ORM assessment and recommendations in response to water supply incidents such as environmental spills and suspected tampering.

(11) Advising the commander concerning drinking water quality issues and the use of risk communication techniques to inform unit personnel (see para 4-5*c*).

c. Post deployment. Typical post deployment tasks that PM personnel will perform with respect to the field water support mission include—

(1) Ensuring that all field water quality analytical results, with appropriate context information, risk assessments, and corrective actions are forwarded through command channels to the USACHPPM ESIP for archiving.

(2) Providing guidance on field water site/area restoration, including the removal and disposal of waste (FM 4–02.17).

(3) Conduct a formal and written AAR to identify water quality and support issues such as equipment shortfalls and mission constraints planning assumption validation using the DOTMLPF format.

(4) Conduct a formal and written AAR on the theater FWSVA process.

(5) Review and update standing operating procedures (SOPs) for follow-on deployments and missions. Tie them into DOTMLPF.

(6) Reset/refit/identify and mitigate equipment shortfalls.

13–3. Tabulated Army preventive medicine missions and functions

Table 13–1 describes the functions of various levels of PM support in all phases of deployment. Units can determine what their responsibilities are during each phase of deployment.

Table 13–1
Matrix of field water sanitary control and surveillance actions during deployments

Water Type	Action	Who	Army PM Level	Documentation[1]	Comments
Predeployment Phase					
1	Perform planning and resourcing	1,2,3,4,7	V		
1	Develop a potential source inventory	1,2,3,4,7	V		
1	Initiate Field Water System Vulnerability Assessment (FWSVA)	1,2,3,4,7	V		
2	Inspect treatment, storage and distribution equipment and systems in Garrison	5,6	II, III		A
3	Review OPLANS/OPORDS	5,6,7	II, III		B
1	Establish OEH data recording & archiving standard operating procedures	6	II, III	1	
1	Identify health risks	6	I, II, III	1	
1	Conduct C/ORM training	6	II, III	1	
1	Coordinate for site studies	6	II, III	1	
1	Perform preliminary health risk assessments based on OPLANS/OPORDS	6	II, III	1	
1	Develop preliminary health risk summary	6	II, III	1	
1	Communicate general health risks	6	II, III	1	
1	Identify PM countermeasures	6	I, II, III	1	
1	Conduct predeployment health brief	6	II, III	1	
3	Conduct unit field sanitation team training	6	II		K
4	Provide PPE & training	6,7	II, III	1	
3	Provide water-related input to and prepare to participate in predeployment OEH health site assessments	6,8	II, III	1	
3	Provide water-related input to and participate in health threat briefings	6	II, III	1	
3	Provide water-related input to and participate in developing and implementing health risk communication plan/standard operating procedure	6	II, III	1	
3	Provide water-related input to and participate in developing preliminary deployment health surveillance plan/standard operating procedure	6	II, III	1	
1	Ensure all predeployment activities are documented and reported	6,9	II, III	1	
Deployment: Initial Phase (0-6 days)					
1	Develop and initiate surveillance program	6	II, III	2[2]	
1	Develop PM sampling protocol and criteria	6	II, III	2[2]	
1	Request technical/laboratory assistance	6,10	II, III	2[2]	
3	Identify locations of water and treatment, storage and distribution equipment and systems	5,6,7	II, III	2[2]	
1	Initiate surveillance	6	II, III	2[2]	
1	Initiate risk assessments	6	II, III	2[2]	
1	Employ countermeasures	6	II, III	2[2]	
1	Report/archive surveillance data	6	II, III	2[2]	C
1	Document exposures	6	II, III	2[2]	C
5	Identify and approve sources	6,9	II, III	2[2]	D
2	Inspect treatment, storage, and distribution equipment and systems in the AO	5,6	II, III		A
5	Coordinate bottled water procurement and distribution	5,6,7	II, III	2[2]	
5	Perform bottled water quality surveillance	6,9	II, III	2[2]	C, E

Water Type	Action	Who	Army PM Level	Documentation[1]	Comments
7	Perform raw water source reconnaissance	5,6,7,8	II, III	2[2]	C, F
7	Characterize raw water source	5,6,7	II, III	2[2]	C, G
7	Select raw water source	5,6,7	II, III	2[2]	
9	Approve to use without additional treatment	5,6,7,10	II, III	2[2]	H
8, 11	Perform water purification system setup and evaluation	5,6	II, III	2[2]	G, I
3	Approve/certify water potability	6,10		2[2]	C
10	Perform/review environmental baseline survey [EBS (Water)]and occupational and environmental health site assessment [OEHSA (water)]	6,8	II, III	2[2]	J
11	Evaluate bulk water distribution (portable – trucks, trailers, etc.)	6,11	II. III	2[2]	C
11	Evaluate unit-level water storage/distribution surveillance	6,11	I	2[2]	K
Deployment: Sustaining Phase (day 30 and beyond)					
12	Evaluate depot storage – by lot – recurring surveillance	6	II, III	2[2]	L
1	Link exposure records to medical record	6,10	II, III	2[2]	C
1	Perform or update risk assessments	6	II, III	2[2]	C
1	Communicate health risks	6,10	II, III	2[2]	C
1	Identify unit and personnel/locations	2,6	II, III	2[2]	M
1	Obtain personnel rosters	2,6	II, III	2[2]	N
1	Perform sampling and analysis	6	II, III	2[2]	O
12	Perform periodic water purification system monitoring	6	II, III	2[2]	P
13	Perform periodic bulk water storage / dry water points surveillance	6	II, III	2[2]	P
13	Perform periodic sampling and analysis on unit water storage and distribution points	11	I	2[2]	K
1	Perform or update FWSVA	4,6	II, III	2[2]	C
1	Perform raw water source re-evaluation as necessary	6	II, III	2[2]	Q
1	Document OEHS data summaries on SF 600; file in deployment health record	6,10	II, III	2[2]	R
1	Document all sampling and analysis results	6,10	II, III	2[2]	S
Incident / Event Driven					
1	Confirm an incident occurred	5,6,8,10,12	II, III	2[2]	T
1	Suspend water distribution	5,6,8,10,12	II, III	2[2]	U
1	Confirm water/equipment contamination	5,6,8,10,12	II, III	2[2]	E, U
1	Communicate risk	5,6,8,10,12	II, III	2[2]	U
1	Perform C/ORM evaluation	5,6,8,10,12	II, III	2[2]	V
1	Perform OEHS	6,10	II, III	2[2]	U
1	Request technical assistance (AML, EPICON, SMART Team/Health Surveillance Center)	6,10	IV, V	2[2]	U
1	Report incident findings including all sample results and risk assessments for record	6,10	II, III, IV, V	2[2]	W
Deployment: Redeployment Phase					
10	Perform OEHSA and EBS final sampling	6,8	II, III	2[2]	E, J
1	Provide replacement unit with briefing on issues and actions and transfer all original data and reports	6	II, III	2[2]	X
1	Submit all raw OEH water data: toxic industrial chemicals and materials, and veterinary public health including food and bottled water safety, and any OEH reports not previously submitted	6	II, III	2[2]	Y
Post Deployment Phase					

Water Type	Action	Who	Army PM Level	Documentation[1]	Comments
1	Provide water-related input to and participate in post-deployment medical debriefings and risk communications	6,10	II, III	1[3]	Z
1	Conduct/document medical debriefing	6,10	II, III	1[3]	Z
1	Enter all sample results and risk assessments into DOEHRS-EH if possible, or if not, provide the information to USACHPPM ESIP for archiving into the DOEHS Data Portal	6,10	II, III	1[3]	C, AA
1	Prepare After Action Reports (AARs) and include significant exposures/events/issues	6,10	II, III	1[3]	C, AA
1	Provide AARs to Intelligence and Military Services centers	6,10	II, III	1[3]	C, AA
1	Develop and forward force health protection (FHP) lessons learned to JULLS	6,10	II, III	1[3]	C, AA
1	Ensure all DOEHS surveillance data and reports have been submitted into DOEHRS-EH if possible, or if not, that it has been provided to USACHPPM ESIP for archiving into the DOEHS Data Portal	6,10	II, III	1[3]	C, AA
1	Ensure all AARs and lessons learned reports have been submitted to the appropriate COCOM, Joint, and Military Services lessons learned portals and also to the DOEHS Data Portal	6,10	II, III	1[3]	C, AA

Notes for the indicated column:

Column 1 - Water Type
1 Bottled water, Packaged field water, ROWPU treated water
2 All treatment, storage & distribution equipment & systems to include host nation equipment & systems
3 Bottled water, Packaged field water, ROWPU treated water, treatment, storage & distribution equipment & systems to include host nation equipment & systems
4 Raw/contaminated/untreated water
5 Bottled water
6 Deployment area raw/host nation untreated water
7 Deployment area raw host nation treated water
8 Deployment area raw/host nation treated (unapproved) water
9 Host nation treated
10 Deployment area raw water
11 Military treated/certified water
12 Bottled/packaged field water
13 Military treated/packaged
14 Military treated

Column 3 - Who
1 Preventive medicine planners
2 Personnel (G1)
3 Operations personnel (G3)
4 Intelligence personnel (G2)
5 Quartermaster personnel
6 Preventive medicine personnel
7 Logistics personnel (G4)
8 Engineer personnel
9 Veterinary medicine personnel
10 Surgeon (e.g., Command, Division, Brigade, etc.)
11 Unit Field Sanitation Team
12 Chemical personnel

Column 4 - Documentation

Column Footnotes

[1] Sample test and survey results should be entered into DOEHRS-EH, the DOD-approved system for documenting and archiving DOEHS efforts, if it is available. Users must go to https://doehrs-ih.csd.disa.mil/Doehrs/ to establish a DOEHRS-EH account. If DOEHRS-EH is not available, information should be submitted for archiving and future evaluation to USACHPPM-ESIP for entry into the DOEHS Data Portal. The DOEHS Data Portal is a DOD system maintained and operated by USACHPPM. For submission of unclassified DOEHS data and reports, users can go to https://doehsportal.apgea.army.mil/doehrs-oehs/ to establish an account. COCOM or Military Services Component Surgeons usually submit data and reports to the DOEHS Data Portal. However, personnel at any level can submit unclassified data via e-mail to oehs@amedd.army.mil. Classified surveys and data can only be submitted to the SIPR DOEHS Data Portal. Users must access www.doehsportal.csd.disa.smil.mil/doehrs-oehs/ on the SIPRNET to establish an account. Classified data and reports may also be submitted via the SIPRNET to oehs@usachppm.army.smil.mil. The DOEHS Data Portals contain occupational and environmental data, sampling results, and reports available electronically to health care providers and redeployed personnel. Sampling and analysis results, data, and reports should be readily available electronically to health care providers and redeployed personnel.

[2] Data and reports are provided to affected units and next higher headquarters Surgeon. Data and reports should go up the chain of command to the COCOM. For example, in the Operation Iraqi Freedom theater of operations, reports and data would be provided to Component Commands (i.e., ARCENT, CENTAF, NAVCENT, and MARCENT), to Multinational Division, Multinational Corps-Iraq, and Multinational Force-Iraq to CENTCOM. These commands ensure the data and reports are entered into the DOEHS Data Portal. The Component Commands may provide the data and reports to the Military Services Health Surveillance Centers. Any direct reporting (bypassing the chain of command) to higher headquarters elements by preventive medicine units should be spelled out in operational orders. Sampling and analysis results, data, and reports should be readily available electronically to health care providers and redeployed personnel.

[3] Reports are provided to affected units and next higher headquarters Surgeon. The reports should go up the chain of command to the Commands responsible for training, mobilizing, deploying, sustaining, and reconstituting numbered combat units, (i.e., Forces Command). These Commands ensure the data and reports are entered into the DOEHS Data Portal. They also provide the data and reports to the Military Services Health Surveillance Centers. Sampling and analytical results, data, and reports should be readily available electronically to health care providers and redeployed personnel.

Column entries

1 Unit & parent organization

2 In-Theater data repository

Column 5 - Comments

A - Systems should be inspected and tested during FTXs or in Garrison if FTX-testing is not possible.

B - Ensure if Preventive Medicine, Quartermaster, and Logistics water-related support is adequate in appropriate Annexes. Request necessary revisions.

C - Sampling and analysis results, data, risk assessments, and reports should be readily available electronically to health care providers and redeployed personnel.

D - Sample collection performed. Veterinary Medicine (OCONUS - Preventive Medicine on request)

E - Field testing and sample collection performed as required.

F - Field Testing-Visual (optional Water Quality Analysis Set (WQAS)-PM).

G - Field testing - WQAS-P/ WQAS-PM (-).

H - Host nation-treated water is considered raw water unless approved for drinking by PM.

I - Certify potability. Quartermaster personnel can issue water treated by RO and disinfected prior to PM certification of potability.

J - Sampling collection uses equipment and sampling kits specified or provided by Engineer for EBS. Preventive Medicine assists.

K - Field testing - chlorine residual.

L - Field testing - visual, bacteriological packaged field water quality surveillance is identical to bottled water once it has been packaged.

M - Services are to establish once daily recording and weekly reporting of the location of individuals in theater. Location records help determine the population at risk for occupational and environmental exposures, for any associated medical follow-up required, and for reporting to DOD.
N - Location records help determine the population at risk for occupational and environmental exposures, for any associated medical follow-up required, and for reporting to DOD.
O - Sample collection with Deployment Environmental Surveillance Program (DESP) sample kit.
P - Field testing - monthly WQAS-PM bacteriological.
Q - If source water quality changes revaluation is required.
R - Document periodic occupational and environmental surveillance summaries on an SF 600 for each permanent or semi-permanent basing location and update at least annually. Surgeon will file the occupational and environmental surveillance summaries in the medical records of each individual for which the exposure applies or archive the summaries so that they are readily available electronically to health care providers and redeployed personnel.
S - Sampling and analysis results should be readily available electronically to health care providers and redeployed personnel.
T - Field testing - event driven. Sample collection as required. Initial reports shall be made NLT 7 days after an incident or outbreak. Interim and final reports shall be forwarded NLT 7 days after investigation and report completion.
U - Consult with Surgeon and Veterinary Medicine.
V - Performed by PM unit in theater. Will be reviewed by Military Services Health Surveillance Centers after the fact.
W - Initial reports shall be made NLT 7 days after an incident or outbreak. Interim and final reports shall be forwarded NLT 7 days after investigation and report completion.
X - For continuity of support available data, reports, and information should be provided to follow-on or replacement unit.
Y - Ideally accomplished in theater, but if not possible, data and reports are to be filed NLT 30 days after redeployment of the Military Service PM unit responsible for sampling and report preparation.
Z - Upon arrival at home station.
AA - Data and reports are to be filed NLT 30 days after redeployment of the Military Service PM unit responsible for sampling and report preparation.

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Chapter 14
Army Predeployment Planning and Preparation

14–1. General

a. Detailed field water support requirements.

(1) *Individual drinking water requirements*. In support of the detailed field water support planning process, PM personnel estimate the amount of water that personnel must drink to maintain their health and complete their missions. PM personnel should recommend guidelines for water replacement based on environmental conditions and workload, as described TB MED 507, to determine these estimates.

(2) *Water planning factors*. Logistics planners estimate total water support requirements using water use planning factors that are contained in the U.S. Army Combined Arms Support Command (CASCOM) Potable Water Planning Guide. These factors are based on estimates found in the U.S. Army Quartermaster School approved Water Consumption Planning Factors Study. PM personnel may assist planners in applying the water planning factors to the field water planning process.

(3) *Water quality surveillance requirements*. PM personnel also contribute detailed information on field water quality surveillance requirements, and they estimate the personnel, equipment, and training required to meet those requirements.

b. Intelligence and the estimate of water-related PM needs. During predeployment planning activities, PM personnel provide medical intelligence and information, the medical threat, and an estimate of water-related PM needs to the surgeon or the commander. These information resources assist commanders and logistics planners in predeployment identification of potential water sources, treatment and disinfection methods, operational monitoring and surveillance equipment requirements, and the PM personnel and units required to execute the PM field water mission.

(1) *Medical intelligence*. Medical intelligence is an important resource to PM planners during pre-deployment planning and in preparing an estimate of water-related PM needs. On receipt of notification of a pending deployment, PM planners should immediately coordinate with the NCMI to obtain medical intelligence about potential health threats in the AO. See Appendix B for contact information. NCMI maintains information that is available to military planners on the chemical and biological quality of surface and ground-water sources in major geographic regions. NCMI can provide assessments of endemic waterborne diseases and offers general information on the types of industries located in specific areas and chemicals typically associated with those industries. Note: NCMI accepts information from the field on surface- and ground-water source quality to add to and update available water quality information. Another important information source for PM planners to consult is the multiservice Water Resource Database (WRDB), produced and maintained by the U.S. Army Topographic Engineering Center (TEC). The WRDB provides information on the quality, quantity, and availability of existing water facilities, surface-water supplies, and ground-water resources in areas of the world of interest to the DOD. A water consumption calculator tool is also available to help determine water planning requirements. The WRDB is available on TEC's Intelink-S (http://www.tec.army.smil.mil) and Intelink-TS (http://www.tec.ic.gov) Web sites under "Products Available/Water Resources." A "For Official Use Only" (FOUO) subset of the WRDB is hosted on the TEC NIPRNET with PKI security (http://www.tec.army.mil/pki). Special WRDB analyses, reports, and coverage can be provided or posted upon request.

(2) *Medical threat*. PM personnel obtain and deliver medical threat products and briefings based on medical and nonmedical intelligence information as part of predeployment planning. Prepared medical threat products, including medical threat briefings, are maintained on the USACHPPM Web site at http://chppm-www.apgea.army.mil/mtb/.

(3) *The preventive medicine estimate*. The estimate of water-related PM needs is the basic tool used by the PM planner. The purpose for developing an estimate of water-related PM needs is to provide health risk management recommendations to commanders and other planners. To perform sanitary control and surveillance of water supplies successfully in the field water support mission, PM plans must be well thought out and based on current and relevant information. The estimate of water-related PM needs includes evaluations of the six topics listed in FM 3–0, chapter 5: Mission, Enemy, Terrain and weather, Troops and support available, Time, and Civil considerations (METT–TC). The METT–TC factors provide a framework for identifying risks and estimating resource needs for planning, preparing, and executing operations. A comprehensive sample format for the estimate of water-related PM needs is available in FM 4–02.17.

14–2. Preventive medicine estimate checklist for drinking water

The estimate of water-related PM needs checklist for drinking water addresses the METT–TC (see FM 3–0). Each METT–TC term is explained below.

a. Mission. PM personnel should identify the following when developing the estimate of water-related PM needs and input to the intelligence preparation of the battlefield (IPB) with regard to drinking water quality requirements and the specified mission:

(1) What units will be involved in the operation, what is their manpower strength, and what will they be doing?

(2) What is the mission, and what level of risk is the commander willing to accept?

(3) Where and when will the operation begin, and how long will it last?

(4) What is the plan for supplying drinking water? Will commercially bottled water, packaged field water, ROWPU-treated bulk water be used? If it is commercially bottled water, are approved sources available?

(5) Are there potential biological, chemical, radiological contaminants or endemic waterborne diseases in the projected AO that could adversely affect health?

b. Enemy. The analysis of the enemy includes current information about the enemy's strength, location, activity, and capabilities. Information to gather/consider/address with respect to drinking water threats includes:

(1) Are terrorists, enemy units, local insurgents, or sympathetic local national civilians active in the AO, and do they have the means to target water system components?

(2) Is the enemy known/suspected to possess chemical, biological, or radiological agents that could be used to target water systems?

(3) Is there a potential for residual biological, chemical, or radiological contamination resulting from prior military or industrial activity that could have contaminated potential drinking water sources?

c. Terrain and weather. The terrain and weather may significantly impact the presence and concentrations of various contaminants in surface water, ground water, and water from existing wells. Information to gather includes:

(1) What kinds of industrial activities are/were present in the AO? What chemical, biological, or radiological materials are used by these industries and how/where are they stored? How are industrial wastes handled/disposed?

(2) What kinds of pesticides are used on agricultural lands in the AO?

(3) What potential effects will runoff from the local terrain have on the quality of water sources in the area? Where will it go? What contaminants is it likely to carry?

(4) What are the local weather patterns, and how might they affect the quality of potential drinking water sources?

(5) How will the local weather affect water consumption?

d. Troops and support available. Exposures to contaminants can vary depending on unit employment and individual tasks. Individual training, fitness, and climate acclimation can also affect exposures by influencing the volume of water ingested. Questions to address include—

(1) What efforts will be made to assist deploying personnel to acclimate to the temperature and humidity of the AO?

(2) Are there endemic diseases other than waterborne that could affect individual or unit health and readiness?

(3) Is the PM mission adequately staffed, equipped, and trained to assist in the sanitary control and surveillance of field drinking water supplies?

(4) Will operational units require support from higher level PM resources? Has the necessary request for forces been coordinated?

e. Time available. The severity of the health risk posed by the contaminants in drinking water are proportional to the concentration of the specific contaminants present, the frequency/amount of water ingested and length of time that a water supply is used. The following are specific items that should be investigated during the potential contaminant identification process:

(1) Will more than one drinking water source be used during the operation? Is there any existing water quality data available on the prospective water source? How current is that data?

(2) Will it be necessary to identify/develop alternate drinking water sources to reduce the duration of use of lower quality water supplies? Are such sources available?

f. Civil considerations. Drinking water quality is affected by the customs of local population in the AO and the attitudes/capabilities of their government with respect to public health, sanitation, and environmental protection. The following are specific items that should be investigated when planning deployments:

(1) What are the local practices for handling and disposal of sewage, solid wastes, and industrial wastes?

(2) What infrastructure/technologies are employed within the AO for protecting natural waters from pollution? What is the operational status of the infrastructure and to what extent are pollution control technologies employed?

(3) What environmental protection laws/rules/regulations have been enacted to protect natural waters in the AO, and to what extent are they followed/enforced?

(4) What local practices (community, religious, cultural) affect the local water supply?

14–3. Environmental baseline surveys

a. General. Military engineer-led multidisciplinary teams document existing deployment area environmental conditions, determine the likelihood of present and past site contamination, and identify potential vulnerabilities, including OEH risks. Details of and instructions for conducting EBSs, including the role of PM, are contained in FM 3–100.4/MCRP 4–11B. Initial EBSs, conducted early in the deployment cycle, may include reconnaissance surveys, some onsite testing, and sample collections of air, soil, ground water, and surface water at base camps, assembly areas, logistical supply areas, and enemy prisoner of war camps. Final or closeout

EBSs are performed at the end of the deployment to document any changes that have occurred as a result of deployment operations. The EBS is a tool to help determine whether a site is appropriate for military use, the environmental concerns that should be addressed to ensure effective and safe operations, and whether a site is in compliance with various military, national or foreign environmental compliance requirements and whether deployment operations resulted in environmental degradation in the deployment area.

b. Application to field water supplies. AWT testing of surface or ground water in conjunction with ROWPU source selection, or strictly for the EBS information gathering, is a tool to document that site's water-related environmental conditions. Water samples from existing local or municipal water treatment systems may also be collected and submitted for AWT as part of an EBS at the discretion of the team leader and PM personnel.

c. PM assistance. Task force or combatant command commanders are responsible for EBSs but generally delegate them to engineering units. PM personnel are frequently tasked to assist in the environmental sampling and analysis segment because they have the equipment and experience required to meet the data quality objectives of the EBS. They can conduct the required field tests and collect samples for AWT with organic and equipment supplies obtained from higher-level PM support activities and organizations.

d. AWT sampling considerations. AWT performed in support of EBSs is typically conducted on untreated natural water sources. Since EBS evaluations consider changes in environmental conditions, initial and subsequent samples for AWT must be collected from the same locations using the same sampling techniques and analyzed using the same methods. It is important to document that the samples are raw water, to specify where initial samples were collected (grid coordinates if possible), and then to reference the original test results when evaluating follow-up tests.

14–4. Occupational and environmental health site assessments

a. General. The requirements for OEHSAs are also documented in FM 3–100.4/MCRP 4–11B. They may be performed concurrently with EBSs and as part of preliminary hazard assessments. Their purpose is to identify and document potential environmental exposures that may impact the health of deployed personnel as directed by Presidential Review Directive 5, JCS Memorandum MCM–0028–07, and DOD Instruction (DODI) 6490.03. The focus of OEHSAs is to identify complete or potentially complete exposure pathways at deployment sites that may adversely affect the short- or long-term health of deployed personnel. Like EBSs, OEHSAs will normally involve site reconnaissance and some sampling and analysis to identify contaminants and then to confirm the presence or absence of complete or potentially complete exposure pathways.

b. Application to field water supplies. As with EBSs, OEHSAs document environmental conditions at proposed base camps and other deployment area locations. Like EBSs, they are performed initially and at the end of deployments; therefore, they may include collection and submission of both untreated and treated water samples. OEHSAs may also need to be repeated periodically during a deployment because changes in environmental conditions may affect the health of deployed personnel, and that needs to be documented. From a drinking water perspective, the data and information available from CWQS should satisfy all the requirements of mid-deployment OEHSAs. Exposure pathways and requirements for PM surveillance of recreational waters, which may be of interest when performing OEHSAs, are addressed in TB MED 575. Units expecting to conduct recreational water surveys as part of the OEHS of maritime/combat/diver /swimmer operations or unit recreational use will need to order appropriate media and analytical equipment to conduct quantitative analysis of recreational water supplies in accordance with TB MED 575 and state and Federal regulations and guidance.

c. PM assistance. OEHSAs are a medical responsibility. PM personnel are typically tasked to collect samples for AWT of field water supplies (both raw and treated water) in support of OEHSAs because they have the experience and equipment to conduct the required field tests and collect samples for advanced laboratory analysis. PM personnel (onsite or at higher PM levels) also typically evaluate AWT results, perform risk assessments as needed, and provide C/ORM recommendations to commanders to reduce identified field water supply-related risks.

d. AWT sampling considerations. AWT performed in support of an OEHSA, depending on when it is conducted, may include both raw and treated water. AWT sample kits for both are available from the USACHPPM DESP at both USACHPPM-Headquarters and USACHPPM-EUR. It is important to use the sample kit that corresponds with the type of water to be sampled, and to return it to the laboratory it was obtained from.

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Chapter 15
Army Field Water Test Equipment

15–1. General

During deployments, PM personnel collect raw and treated water samples for onsite and remote laboratory analyses to evaluate water quality. The Army's WQAS-PM has the capability to test for all STP parameters in the field except for radioactivity, BZ, and T-2 Toxins. Table 15–1 shows the detection ranges for the Army WQAS-PM test kits.

15–2. Test equipment in the Army inventory

a. Test equipment currently available through the Army Supply System includes—

(1) *WQAS–P: NSN 6630–01–365–5588*. Water treatment personnel use this kit to conduct operational monitoring of the treatment processes. The WQAS–P is capable of testing for pH, temperature, TDS, turbidity, and chlorine residual. It includes an M272 chemical agent water testing kit which is also available separately. It is designed for ROWPU operators to test raw water during the site selection process that indicate whether or not it is suitable for ROWPU treatment, and treated water to determine whether CBRNE filters are required, and if the ROWPU is operating correctly. The WQAS-P is issued to QM units with the 600-gph and 3,000-gph ROWPUs. Units with TWPSs and LWPs receive similar capability test equipment, but not necessarily the WQAS-P. Operational monitoring should be performed as frequently as necessary to ensure proper equipment performance, water potability prior to issue, and detection of significant changes in source water quality that can affect treatment. The operator's manual for the 600-gph ROWPU (TM 10–4610–240–10) recommends hourly checks of the water quality. The operator and unit maintenance manual for the WQAS–P is TM 10–6630–246–12&P.

(2) *WQAS–PM: NSN 6545-01-507-4313*. Army PM personnel use this kit along with operational monitoring data they get from the treatment system operators to determine if the water meets the STP standards. The set is designed for onsite testing of raw water sources and treated drinking water. The WQAS–PM consists of: the HACH DREL/2400 (2800) Complete Water Quality Laboratory (CWQL), and the Bacteriological Test Kit. A brief summary of each of these is provided below. Two individually packaged colorimetric test kits for arsenic, NSN 6550–01–504–2603 and cyanide, NSN 6515–01–504–9610, and the lead test strip kit, NSN 6550–01–504–8617, are also included. The operator's manual for the WQAS–PM is TM 5–6630–215–12.

(3) *M272 Chemical Agent Water Test Kit, NSN 6665–01–134–0885*. The M272 test kit is used to detect and identify harmful amounts of cyanide, mustard, lewisite, and nerve agents in raw water sources. Quartermaster and PM personnel are required to conduct tests for chemical agents in treated and raw water during CBRNE operations based on MOPP levels. Table 4–7, in chapter 4, contains the recommended test frequencies. The M272 kit consists of 25 containers of reagents, a thermometer and holder, a test bottle, a container of waterproof matches, and instruction cards, enough to do 25 tests for each agent. The presence of chemical agent is detected by distinctive color changes in the detector tubes when levels of the various agents are present in the water sample. Although the cyanide, lewisite, and nerve agent tests cannot detect

Table 15–1
Army field water test equipment detection capabilities

Constituents/characteristics of water (mg/L unless noted)	Field equipment: Detection ranges (mg/L unless noted)		
	Army WQAS-PM		M272
	HACH® WQL	Test Strips	
Physical properties			
Turbidity (NTU)	0.1 – 400	--	--
pH (pH units)	-2.0 – 13.9	6.2 – 8.4	--
TDS	0 – 50000	--	--
Temperature (C°)	-5.0 – 105	--	--
Color (CU)	5 – 500	--	--
Chemical properties			
Arsenic	--	0 – 0.5	--
Cyanide	--	0 – 1.0	--
Magnesium	10 – 4000	--	--
Chloride	10 – 10000	--	--
Sulfate	2 – 70	200 – 1600	--
Microbiological properties			
Coliforms (per 100 mL)	P/A	--	--
Escherichia Coli	P/A		
Radioactivity[2] (µCi/L)			
	--	--	--
Chemical warfare agents			
Hydrogen cyanide[1]	--	--	20
Lewisite[1] (as arsenic)	--	--	2
Sulfur mustard[1]	--	--	2
Nerve agents[1]	--	--	0.02
BZ[2]	--	--	--
T-2 mycotoxins[2]	--	--	--

Legend:
WQL = Water Quality Laboratory; mg/L = milligrams per liter; µg/L = micrograms per liter; mL = milliliters; µCi/L = microcuries per liter; NTU = nephelometric turbidity unit; WQAS = water quality analysis set; PM = preventive medicine; WQAS-P = water quality analysis set-purification; TDS = total dissolved solids; CU = color units; BZ = 3-quinuclidinyl benzilate; P/A = presence/absence

Notes:
®HACH is a registered trademark of The HACH Company, Loveland, Colorado.
[1] M272 kit is not able to measure this agent at the concentrations required by the MFWS, but it is used as an acceptable gross level clearance.
[2]Currently, field equipment that is capable of detecting this constituent at the indicated concentration is not available. Water may still be certified potable without testing for this constituent. When the testing capability becomes available, the water must meet the indicated standards to be certified potable.

contamination as low as the emergency standards require, according to the LLNL study (Daniels, 1990), acute health effects resulting from drinking water contaminated with these contaminants at concentrations below the detection limits of the M272 test kit are not likely. The operator's manual for the M272 Test Kit is TM 3–6665–319–10.

(4) *DREL/2400(2800) CWQL (HACH #2922600)*.

(a) The CWQL instrumentation includes the DR/2800 potable spectrophotometer, a digital titrator, a pH and conductivity meter, and a portable turbidimeter. It also provides the apparatus and reagents specifically for testing to determine water quality in the field. Every portable laboratory also includes a power supply (110-volt adapter), a comprehensive illustrated procedure manual, and two durable carrying cases, one for equipment and one for reagents. A rechargeable lithium ion battery (HACH #LZV551) is available as an option.

(b) The CWQL provides PM personnel with the capability to measure 6 physical characteristics of water and to determine the concentrations of 22 chemical constituents. A replacement reagent set (HACH # 2923200) is available and reduces the burden on the logistics system by having one NSN for resupply rather than 22 separate items.

(c) The CWQL is expandable and with the addition of specific reagent sets and apparatus it can be used to perform approximately 130 additional water analyses (see the HACH Web site @ www.hach.com).

(5) *Microbiological Test Kit (Colilert).* Colilert is an EPA-approved presence/absence test for coliforms in water. The Colilert method detects both TC and *E. coli* simultaneously using ortho-nitrophenyl-ß-D-galactopyranoside and 4-methylumbelliferyl-ß-D-glucuronide (ONPG–MUG) indicators. All coliforms produce a yellow color in ONPG after 24 hours incubation and *E. coli* fluoresce in UV light in the presence of the MUG indicator. A color comparator standard to help confirm positive results is available as an optional accessory (IDEXX catalog #WP104). The comparator displays the lowest level of yellow and fluorescence which can be considered positive. A typical positive test is much more intense than the comparator (for additional information, see the IDEXX Web site @ www.idexx.com). The kit consists of the following equipment:

(a) Colilert Media, 20 or 200-Pack (NSN 6630–01–357–5910 and NSN 6630–01–362–8299, respectively)

(b) Colilert Sample Bottles, 120 mL (NSN 6640–01–389–7029)

(c) Vessel Labels (NSN 7690–01–506–5566)

(d) Field Incubator (NSN 6640–01–466–9987)

(e) Pocket Fluorescent UV Lamp (NSN 6530–01–451–5144)

b. New water testing equipment and emerging technologies are continuously evaluated and considered for fielding to deployed units through rapid fielding initiatives and as long-term upgrades or replacements to currently fielded equipment. This includes commercially available portable water quality laboratories and individual analyte water test kits that are not currently part of the military supply system. If equivalent or better test equipment or kits than are in the system are available to personnel or units in the field, they may be used as substitutes for the issued items described above. However, such items should be vetted with higher level PM support prior to purchasing, and items purchased by units and individuals should not be expected to be supported from resupply and maintenance perspectives in the same way that issued equipment is. Questions should be directed to the USACHPPM Water Supply Management Program (WSMP) (see Appendix B).

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Chapter 16
Army Preventive Medicine Inspections and Reporting

16–1. Inspections of field water systems while in garrison

Field water systems are best inspected in the operational environment or when they are setup, operating, and producing water, as they should be in field training exercises. If that is not possible, they should be inspected at least semiannually in the operating mode in garrison to ensure their deployment readiness. For all PM inspections of field water systems, the QM/engineering water unit, water treatment supervisor, or other knowledgeable individual(s) must accompany the PM inspector to answer questions and note deficiencies. Personnel from PM sections and detachments should maintain liaison with military and contractor water purification teams and conduct joint training sessions on the water quality test equipment used by the operators.

16–2. Field inspections

a. Inspection requirements. Ideally, PM personnel perform periodic inspections according to the inspection criteria outlined below. Adjustments are encouraged to optimize both the efficient employment of PM personnel available and PM oversight of field water operations consistent with operational mission requirements.

(1) Army policy requires potable water production operations to be inspected and product water to be tested and approved by PM prior to issuing water for drinking. However, for situations where PM cannot perform the inspections and testing in a timely manner, water purification operations supervisors may issue water once they are confident, based on their own inspection and product water testing, that the treatment and disinfection equipment is operating properly, and that the water produced is indeed potable. They should document the observations and test results they used as a basis for issuing the water, and be prepared to defend their decision to the local area medical authority and to PM personnel when they arrive to inspect the system. Recommended post-approval inspection and testing frequencies for water production sites are shown in table 16–1. The PM leaders, local area medical authority, and commanders may direct changes to the suggested frequencies, as necessary. The inspections are documented using DA Form 5456 (Water Point Inspection).

(2) Potable water containers such as water trailers, tank racks, and fabric tanks or drums must be inspected prior to deployment. During deployments, supporting PM assets should inspect fielded containers according to table 16–1. For deployments lasting less than 30 days, FSTs will conduct routine inspections. All inspections should be recorded on DA Form 5457 (Potable Water Container Inspection).

(3) Owners/operators of shower points, including contractors, should inspect the points on startup and daily thereafter. They should test and record the chlorine residual of water in associated storage containers each time water is added or at least daily. PM personnel should perform monthly inspections to ensure the sanitary condition of the operations and waste disposal as well as acceptable water quality, to review the chlorine residual test logs, and to perform a chlorine quality assurance test. Inspection results are recorded on DA Form 5458 (Shower/Decontamination Point Inspection).

b. Reporting requirements.

(1) Inspection findings and water sample analytical results are recorded on the applicable DA forms indicated in appendix A.

Table 16–1
Recommended inspections and frequencies during deployments

WHAT	WHO			WHEN		
	PM	Owners	Operators	Initial	At and after 30 days	Additional Notes
Raw water sources	X			X		Annual Sanitary Survey Annual AWT
Water purification points	X			X	Monthly	Semiannual AWT
			X	X	Hourly	FAC, Turbidity, TDS, pH
Storage and distribution facilities	X			X	Monthly	Inspect and FAC
		X	X	X	Daily	Inspect and FAC
Bottled water storage	X			X	Monthly	10 bottles/lot sampling until lot is exhausted
Unit potable water containers	X			X	Monthly	Inspect and direct cleaning and disinfection as needed
		X			2 x Daily	FAC
Bulk storage	X			X	Monthly	Disinfection
		X	X	X	Daily	FAC
Mobile water storage and delivery	X			X	Monthly	Semiannual Disinfection
		X	X	X	Daily	Logs
Fabric tanks and drums	X			X	Monthly	
		X		X	Hourly, Daily	FAC
Showers and personal sanitation points	X			X	Monthly	Cleanliness, FAC
		X	X	X	Daily	Cleanliness, FAC
Supplies		X		X	Weekly	Order early

(2) PM inspectors/testers retain the original report, leave one copy with the inspected unit, and send copies to the command surgeon, the headquarters of the unit that was inspected. They also upload the information to the DOEHS Data Portal or follow other command-directed reporting procedures.

(3) PM and other trained unit-level personnel record the results of their potable water FAC residual tests and actions on locally generated forms, and submit them at least monthly to the nearest PM unit personnel who archive and report the results according to current command policies.

16–3. Site conditions for water operations

a. Water site development. Water purification and FST personnel ensure that:

(1) Drainage is provided to prevent pooling of water at fill points,

(2) Dust control measures are practiced to prevent dust-borne bacteria from contaminating water and equipment, and

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

b. Bivouac areas.

(1) Bivouac areas should be located at least 100 yd downhill from water supply wells and a similar distance downstream from surface-water intakes (ground-water flow typically follows surface terrain).

(2) Latrines should be located at least 100 yd downstream or downhill from water sources and/or purification operations and properly constructed and maintained.

(3) Hand-cleaning stations should be stocked with hand-cleaning supplies.

(4) Garbage and trash should be properly stored, handled, and disposed of at least 100 ft from any water point operations.

c. Sources of pollution. Sources of pollution should not exist in the immediate surrounding area and as far as 2 miles upstream or uphill from water points.

16–4. Field water production point inspections

This paragraph is fairly specific to military ROWPU operations. However, the principles apply to COO systems as well, so the inspector should evaluate whatever section or piece of equipment that correlates with the one described herein, and check it for proper care and operation. PM personnel inspect water systems and record their findings on DA Form 5457 to ensure the following conditions are met at water production points and operations.

a. Intake line.

(1) The intake line is located in such a way as to optimize the quality of the water drawn from the source.

(2) An intake strainer is attached to the intake hose.

(3) A float and anchor hold the intake between 8 inches below the surface and 8 inches above the bottom of the source.

b. Effluent line.

(1) Backwash water disposal is adequate.

(2) Sludge sump is present (if necessary).

(3) Wastewater effluent discharges are contained or at least 25 yd away (downstream, if the source is flowing) from the intake.

c. RO unit.

(1) The unit is level.

(2) The multimedia filter backwash tank is filled with brine.

(3) Separate storage tanks used for raw water and brine water are labeled if raw water storage is necessary.

d. Generator.

(1) The generator is adequately grounded.

(2) Fire extinguishers are present and charged.

(3) Ventilation is adequate to prevent carbon monoxide intoxication (generally, outdoor operation of generators will provide sufficient ventilation).

e. Operator protective equipment.

(1) Operators wear rubber hip boots, long rubber gloves, rubber aprons, and industrial safety eye protection meeting ANSI Z87.1 when working in water, especially where diseases such as schistosomiasis and leptospirosis are endemic or prevalent.

(2) Personnel use hearing protection within 50 ft of the generator.

(3) Operators wear MOPP gear beneath the water protective equipment specified in the preceding subparagraph when chemical agents are likely to be present or deployed.

f. Operator operations and monitoring logs. These should include at least the following:

(1) TDS (source water and product water)
(2) FAC residual
(3) pH
(4) Operator observations and actions
(5) Water distribution and tracking log

g. Water system vulnerability assessment.

(1) The most recent assessment should be available, applicable, and adequate.

(2) Inspectors should note unresolved or new vulnerabilities in the inspection sheet comments area.

16–5. Operational monitoring/storage and distribution equipment inspections

PM personnel verify the adequacy of the following conditions and procedures periodically, and provide assistance to rectify any problems identified.

a. Operational monitoring.

(1) The operators' WQAS–P (NSN 6630–01–477–2395) should not contain expired, damaged, or corroded chemicals.

(2) Water purification personnel conduct tests for pH, temperature, TDS, turbidity, and chlorine residual as often as necessary to ensure proper equipment performance, water potability prior to issue, and detection of significant changes in source water quality that could affect equipment operation. Tests for chemical agents in water should be performed as noted in table 4–7.

(3) Operators complete DA Form 1713–R (Daily Water Production Log – ROWPU), or its equivalent, with all appropriate operational information including the time, the knob settings, and the charges of citric acid, sodium hexametaphosphate, calcium hypochlorite, and polymer.

(4) The pH and FAC residual of treated water should be checked at least hourly and recorded on DA Form 1713–R or its equivalent.

(5) Water testing kit, chemical agents (M272) (NSN 6665–01–134–0885) contains sufficient materials for 1 day of testing at MOPP 4.

b. Water storage.

(1) Water storage tanks should be level.
(2) Safety bottom aprons should be placed under tanks where appropriate.
(3) Open-top tanks should be covered.
(4) Tanks must be maintained in a sanitary condition.
(5) Water storage capacity needs to be sufficient to support issue requirements.

c. Water distribution.

(1) Standpipe hoses should be at least 4 ft above the ground to prevent contamination.

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

(3) Operators should check water container interiors for cleanliness prior to filling them (see chap10 for equipment cleaning and sanitizing guidance).

(4) Tankers, trailers, drums, cans, pumps, or other containers, hose lines or other equipment intended or previously used for storage or distribution of petroleum products or other materials not intended for drinking should NOT be used to store or distribute potable water under any circumstances. If a situation seems to necessitate the use of any of these items for potable water, PM, the local medical authority, and the commander should perform a risk assessment on the proposed operation and make a decision.

(5) All containers used to store or transport nonpotable water must be clearly and legibly labeled so they are not mistaken with containers holding potable water.

16–6. Potable water containers
PM inspectors ensure the following:

a. The interiors and exteriors of containers are clean and in good repair.

b. The words "POTABLE WATER ONLY" are stenciled on both long sides of the exterior of the containers.

c. Nonstandard containers used for storage and transportation of water comply with requirements in paragraphs 16–6*a* and *b* above. Additionally, their water contact materials are nontoxic and preferably made of FDA food grade or NSF International Standard 61-listed material.

16–7. Water trailer inspections
The following list contains important points that must be checked each time a water trailer is inspected. For other storage containers, follow the guidance that is applicable.

a. Manhole covers.

(1) Manhole covers are sealed effectively to prevent contamination of contents. Rubber gaskets are intact and do not have cracks, missing pieces, or excessive dry rot, and fit properly.

(2) Locking mechanisms function.

(3) Covers and interiors are not rusted.

(4) Insulation is not damaged.

b. Dispensing spigots.

(1) All spigots function properly.

(2) "T" handles open and close freely.

(3) Spigot protective boxes are intact and free of excessive rust.

(4) Locking devices for spigot protective boxes function properly.

c. Drain plugs.

(1) Drain plugs are installed hand-tight only.

(2) Drain plugs can be easily removed.

(3) Threads in plug and drain holes are not stripped or damaged. Thread corrosion is removed at least semiannually.

d. Interior surfaces.

(1) Interior seams are intact, do not leak, and will not allow contaminants to enter the container. Excessive interior surface rust (~25 percent of the surface area, or rust that imparts objectionable color, taste, or odor to the water) should be brought to the attention of the owner/operator of the container.

(2) Stainless steel interiors of DOD water trailers are not generally painted or coated. Non-DOD container interiors and coatings must be approved for potable water contact by NSF International or an equivalent organization. If no information on the contact surface is obtainable, contact a higher level PM organization for instructions on how to sample the water for testing and approval as a potable water container.

(3) Damaged tanks and tanks in which large cracks are found are repaired. Spot repairs to the stainless steel surface may be made with NSF-approved materials.

16–8. Tank truck inspections

a. Manhole covers. Inspection criteria are the same as in paragraph 16–7*a*, above.

b. Dispensing valves.

(1) Valves operate freely and close tightly.

(2) Threads for hose couplings are intact and undamaged.

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

c. Filling ports.

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

(2) Mesh screens inside the port are intact and free of rust or corrosion.

d. Interior surfaces. Metal interiors will not be painted and will be free of rust and corrosion. (This does not apply to non-DOD trucks and trailers. Coating must be approved for potable water contact by NSF or equivalent authority.)

16–9. Fabric water tank and drum inspections

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

b. Valve assembly.

(1) Check-valve adapters are undamaged.

(2) Check valves open easily.

(3) Dust caps are attached to couplers whenever couplers are not in use.

16–10. Water trailer location and dry water point inspections

a. Site conditions.

(1) Manholes, ports, and other openings are closed.

(2) Soakage pits are constructed as needed.

b. Water quality.

(1) Water is tested for FAC residual prior to initial issue and periodically thereafter.

(2) At locations where purification operations do not occur, but water tanks or other bulk containers have been prepositioned for potable water resupply (dry distribution points), potable water FAC residuals are normally maintained at 1 mg/L. Higher levels may be prescribed by the command/theater or unit surgeon. If an acceptable chlorine residual cannot be maintained in the bulk storage containers, the water should be rechlorinated so it contains 1 mg/L FAC as it is distributed to using units.

(3) When unit water supplies have been replenished from a potable water distribution point, the recommended minimum chlorine residual at the time of distribution to individuals (such as in unit water trailers) is 0.2 mg/L. The unit or theater/command surgeon may prescribe a different level.

(4) When units do not have access to an approved potable water source and must disinfect untreated raw water from a surface- or ground-water source for drinking water, an FAC residual of 2 mg/L after a 30-min chlorine contact time will provide adequate disinfection. If *Giardia* or *Cryptosporidium* is endemic in the area, the residual should be boosted to FAC 5 mg/L. Alternatively, if an extended contact time can be guaranteed prior to consumption, the FAC residual level may be lowered proportionately to provide the same concentration-contact-time product or “CT” of 150 mg-min/L. For instance, maintaining either a 2-mg/L FAC residual for 75 min or a 3-mg/L FAC residual for 50 min before distributing it to individuals for drinking would produce a CT of 150 mg-min/L.

c. Documenting inspection results. All inspection results must be documented and reported according to the guidance in paragraph 16–2*b*.

16–11. Shower and decontamination point inspections

PM personnel will assess the following items when performing inspections of shower and decontamination points.

a. Site conditions.

(1) The site is located on firm, well-drained ground.

(2) Rodent and insect breeding areas are controlled to prevent the spread of disease.

(3) The numbers of latrines are adequate based on the population served and the duration of use as prescribed in FM 8–250.

(4) Hand-washing devices are supplied with soap and water.

(5) Garbage and trash are properly stored and disposed of.

b. Water sources.

(1) Nonpotable water that must be used for showers and personal sanitation is chlorinated and at least 1 mg/L FAC residual is maintained (owners/operators check the residual daily).

(2) Water purification personnel conduct tests for chemical agents and radioactivity based on MOPP conditions as shown in table 4-7.

(3) Records are kept of where the water was procured or supplied from.

c. Wastewater control.

(1) Drainage ditches convey shower wastewater away from the area.

(2) Wastewater and runoff are discharged at least 25 yd downstream from the raw water intake.

(3) For decontamination stations, contaminated wastewater is drained to soakage pits or sumps away from the water source.

(4) Soakage pits and decontamination waste sumps are closed out and marked properly when the unit vacates the area.

d. Intake lines.

(1) Intake strainer is attached to intake hose.

(2) Float and anchor hold the intake at least 8 in from the surface and bottom of the source.

e. Shower units.

(1) Shower surfaces, nozzles, and floors are kept clean of dirt, soap scum, and mold.

(2) Air circulation is provided to reduce humidity and odors.

(3) If the shower water is not potable, a sign is posted at the shower entrance such as "NONPOTABLE WATER. DO NOT DRINK – USE BOTTLED WATER TO BRUSH TEETH."

f. Generator.

(1) The generator is located at least 50 ft from the shower area and will be sandbagged to reduce noise hazards.

(2) Ventilation is adequate to prevent carbon monoxide intoxication (generally, outdoor operation of generators will provide sufficient ventilation).

g. Owner/operator water monitoring.

(1) Owners/operators monitor and record pH and chlorine residuals daily. The FAC residual is maintained at least 1 mg/L or higher as directed by the command/theater or unit surgeon.

(2) Owners/operators test raw and treated water using the water testing kit, chemical agents (M272) at the frequency specified in table 4–7. A new kit contains sufficient test materials for 1 day of testing at MOPP 4.

(3) Owners/operators monitor shower water temperatures and maintain them between 95 and 100 °F.

h. Water storage.

(1) Storage tanks are level.

(2) Safety bottom aprons are placed under tanks.

(3) Open-top tanks are covered.

(4) Tanks are maintained in a sanitary condition.

(5) Water storage capacity is sufficient to support issue requirements.

16–12. Water recycle and reuse

a. General. Sanitary inspections of recycling operations safeguard the health of the troops by ensuring the treatment and handling of recycled wastewater is conducted properly.

b. Inspection requirement. Field-water recycling equipment will not normally be evaluated in garrison unless it cannot be evaluated in the field training environment. In the field or combat environment, PM inspections of recycling equipment will be performed periodically.

c. Inspection criteria.

(1) Field shower points with recycling equipment should be inspected using the same criteria as those found in paragraph 16–11.

(2) PM personnel collect water samples from shower heads and analyze them for the following constituents:

(a) pH

(b) FAC residual

(c) turbidity

(d) TDS

(e) hardness

(f) temperature

(g) chemical agents (only when there is a threat justifying testing)

(h) radioactivity (only when there is a threat justifying testing)

(3) Shower water sample test results are compared to:

(a) The pH, chlorine residual, hardness, TDS, and turbidity limits specified in either paragraph 9–4*b* or 9–4*c*, depending on the application.

(b) The chemical agents and radioactivity standards listed in table 4–2.

(4) Water temperature should ideally be between 95 and 105 °F (35 and 41 °C).

d. Reporting requirements. Inspection findings are recorded on DA Form 5458.

16–13. Recordkeeping and supply storage

a. Records. Water production personnel maintain records of equipment gauges and meters, chlorine residual, and pH of treated water, chemical usage, amount of water issued, and the units that have been issued water. For shower points, a bath and clothing exchange log is used to report daily, weekly, and monthly activities. A report format is suggested in FM 10–280.

b. Supply storage criteria.

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

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

(3) Activated carbon and calcium hypochlorite are stored separately to prevent mixing. Combining these chemicals will result in a violent reaction.

(4) Fuels, chemicals, and other supplies are stored at a location and in a manner to avoid contamination of the raw water supply in the event of an accidental or intentional spill, or release from hostile fire.

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Chapter 17
Army Field Water System Vulnerability Assessments

17–1. Introduction

Drinking water is a critical asset on the battlefield. Water for cooking and sanitation are also important and necessary to preserve force readiness, health, and morale. Any disruption of the normal flow of potable, palatable water from the raw water source to the cups, canteens, and personal hydration devices of field personnel is undesirable. Depending on the current tactical situation, such disruptions can cause unacceptable reductions in force protection and readiness ranging from individual disgruntlement to dehydration, sickness, and death. FWSVA is a risk assessment tool which is based on the procedures described in USACHPPM TG 230 and used to evaluate a drinking water system and its operation from the standpoint of vulnerabilities or weaknesses that could be exploited by aggressors. The vulnerabilities identified, if exploited, could result in physical damage to or destruction of water system assets, or chemical, biological, or radiological contamination of the field water supplies. After the vulnerabilities have been identified and prioritized by level of risk, focus should be placed on the actions and resources necessary to reduce the higher risk vulnerabilities to more acceptable levels.

17–2. Methodology

Fixed facility water system vulnerability assessments (WSVAs) are described in USACHPPM TG 188. This chapter is a distillation of the information and procedures described therein with a focus on field drinking water systems. As with the WSVAs described in USACHPPM TG 188, the risk assessment method employed for FWSVAs is based on the six-step composite risk management (CRM) processes described in FM 5−19. The FWSVA is concerned with steps 1 and 2, and the first actions of step 3. At that point, the documented FWSVA is briefed and given to the commander, and the commander incorporates it into the overall C/ORM process for the entire operation and decides whether or not to implement the recommended actions. The CRM process described in FM 5−19 consists of six major steps with subtasks similar to the following:

a. Step 1 – identify hazards (vulnerabilities) of the field water system:
- (1) Identify the potential aggressors.
- (2) Identify the system assets.
- (3) Determine potential threat events for each asset.
- (4) Evaluate current security and mitigating factors to prevent threat events.

b. Step 2 – assess hazards (vulnerabilities):
- (1) Estimate the probability of occurrence of each threat event.
- (2) Estimate the severity of each threat event if it were to occur.
- (3) Determine the risk levels for all threat events and prioritize them.

c. Step 3 – develop risk reduction actions and estimate residual risks:
- (1) Generate actions that will reduce unacceptable risks (reduce either the probability or severity or both).
- (2) Estimate potential residual risks.
- (3) Decide whether to implement risk reduction actions.

d. Step 4 – implement selected actions.

e. Step 5 – monitor and evaluate effectiveness of implemented actions.

f. Step 6 – return to Step 3 if the evaluation indicates the need for additional actions.

17–3. Classification guidance
Generally, all information collected during the FWSVA will be considered FOUO and maintained with positive control. In the field, the FWSVA team leader will discuss the security classification of the collected information with the appropriate security personnel responsible for the area the water system supports. The final written report will be given to the commander, and he will determine its proper disposition in consultation with his security advisors.

17–4. Predeployment preparation
If time is available prior to the deployment, the individual responsible for conducting the FWSVA will gather as much information about the planned water system as possible. He should participate in the PM IPB, the predeployment water source reconnaissance, and water treatment unit site selection, or at least discuss the information with the person who does, and provide appropriate guidance and recommendations concerning procedures to minimize water system vulnerability from the outset. Sources of intelligence concerning proposed deployment areas are discussed in chapter 14. Any information that can be garnered from engineer, QM, security, or other personnel who are involved in field water system planning, establishment, operation, or security will be helpful to have for the onsite FWSVA.

17–5. Performing a field water system vulnerability assessment
FWSVAs should be performed by a team led by a PM Officer (Environmental Scientist, Sanitary Engineer, Entomologist, or Health Physicist) or NCO (68S). At least two individuals should conduct the assessment, but additional team members can reduce the burden of collecting information and making subjective judgments. One or more personnel who have interaction with and responsibility for the operation and protection of the personnel, location, equipment, and supplies related to drinking water production, distribution, and quality can make up the rest of the team. Paragraph 17–6 contains a list of units and personnel and their responsibilities associated with field water systems to help identify potential team members and sources of information.

a. Step 1 – identify the hazards. In terms of field water system vulnerabilities, a hazard exists when an aggressor is potentially capable of adversely affecting any part of the water system. To define the hazards, the team must identify the potential aggressors and targets and evaluate their accessibility to the potential targets.

(1) *Potential aggressors.* In the field combat setting the most obvious external aggressor is the enemy. However, the team must also consider the possibilities that members of the local population, terrorists, vandals, and angry or disgruntled Soldiers and civilian personnel might want to poison, destroy, or disrupt the water system. The ability of these different aggressors to be successful depends on the complexity of the intended threat event, the aggressors' technical prowess, their knowledge and understanding of the water system components and operation, and the equipment, vehicles, and weapons, including chemical and microbiological contaminants, they have at their disposal. Team members should get as much threat information as possible from intelligence and security personnel concerning the presence and abilities of these different groups in the AO. Commanders as well as chaplains and other support personnel can provide insight as to the morale of units and deployed personnel to help assess the potential internal threat of sabotage. In lieu of definitive or adequate information, the assessment team can presume that there are both external and internal adversaries that are technically savvy, well acquainted with the water system and its operation, well equipped, and highly motivated. Such an approach will produce a worst-case scenario and result in a conservative FWSVA.

(2) *Potential targets.* Identifying the water system components that would be considered targets of opportunity by potential aggressors in field water systems is not difficult since there is not a lot of variability among field water systems and operations. Table 17–1 identifies seven major components and typical sub-elements of field water systems that could be targeted by aggressors. The assessment team should contact engineer, QM, and transportation units as necessary, review available system maps, and visit the location of each potential target to gain a good understanding of the overall AO water system and the function and importance of each component.

Table 17−1
Typical target field water system components

Target component	Elements of concern
Water sources	Existing water systems, surface water (lakes, rivers, springs), ground water (community wells, rural wells, drilled wells), bottled/packaged field water, potential contamination from an accidental or intentional release of a toxic industrial chemical from a facility upstream from the water source
Intakes and pumping stations	Water treatment system intakes, hoses, valves, pumping and distribution stations, chemical storage, chemical injectors (hypochlorination tanks)
Treatment units	LWP, TWPS, and 600- and 3,000-gph ROWPUs and associated equipment, bottled and packaged field water production facilities, host nation treatment plants
Distribution systems	Water supply points, potential cross connections in laundry and shower services, valves, hose lines, tactical distribution systems, access points within distribution system, host nation distribution systems
Water storage	20,000- and 50,000-gal collapsible fabric tanks, 3,000-gal onion tanks, water tank trucks, water trailers, 5-gal containers, canteens, personal hydration devices, and bottled/packaged field water facilities
Power supply	Generators, transmission lines, transformers
Communications	Telephones, radios, telemetry

(3) *Onsite system assessment.*

(a) Commander's briefing. It is important to brief the commander of the AO that the water system serves to let him know the importance and usefulness of the FWSVA. Use the list in paragraph 17–6 to develop an invitation list for the briefing. Have the commander's staff setup the briefing and contact those who should attend. Some units and individuals who might not otherwise be supportive will attend a briefing at the invitation of the commander, and he can task them to support you. The purpose of the briefing is to meet the stakeholders and to explain the purpose and scope of the project. It will be important to record the attendees' names and

contact information to facilitate possible later discussions. The team leader should present the following information at the briefing:

(i) The purpose of the FWSVA.

(ii) The survey procedures to be followed.

(iii) The time frame for performing the survey.

(iv) The implications of the FOUO classification of information to be gathered.

(v) The disposition and availability of the final report.

(vi) All other pertinent information relating to meeting with different units/individuals during the assessment.

(b) Review of available military intelligence resources. One of the most important components of an FWSVA is the acquisition of accurate intelligence. Accurate intelligence gathered near the water system and surrounding military assets is used to help the assessment team determine the probability of attack scenarios. Without accurate intelligence, teams bias the assessment by relying solely on personal judgment and experience. If possible, before deploying to the TO, classified threat assessments specific to the local and any surrounding installations should be obtained. These assessments should be reviewed to determine specific types of threats and previous incidents, specifically those concerning water supply. During the assessment, the unified command intelligence and security representative (J2) should be contacted. Information acquired from the unified command will better describe the overall threat. If possible, the assessment team should visit unified command intelligence representatives enroute to the subject water system/installation. After arriving at the subject water system/installation, local military intelligence representatives should be contacted. Information regarding documented security incidents and threats in the surrounding area should be obtained. Local threat assessments should also be reviewed.

(c) Physical inspection of assets (targets). A critical part of the FWSVA deployment phase is the physical inspection and evaluation of the field water treatment, distribution, and storage assets. The team inspects the assets for four reasons:

(i) To become more familiar with the location, capabilities, assets, and operations of the field water system components.

(ii) To consider potential threat events that could cause physical harm to or contaminate the system.

(iii) To assess the ability of the current security measures to prevent the aggressors from causing those events.

(iv) To identify deficiencies in any areas that represent weaknesses in the safety and security of the water system.

(d) Teams. During the FWSVA, QM personnel should escort the team, explain the system operating procedures, and answer questions from the team members. Team members should record their observations in field notebooks for reference later in the assessment. After visiting each potential target, team members should review their notes and lists of elements with the system operators to ensure completeness. If possible, digital photographs should be taken of all components and elements for easy reference and as reminders when analyzing vulnerabilities at a later date. Pictures of specific vulnerabilities or weaknesses in security can convey definitive information to the commander and other personnel during the post-assessment briefing. The team leader must get permission to take pictures prior to conducting the FWSVA.

(e) Security evaluation. During the onsite visits, team members should consider how easily an aggressor might be able to contaminate, ruin, or destroy each potential target.

They should identify existing physical and operational barriers to an attack. Army FM 3−19.30 is an excellent source of information on physical security. For the purposes of the FWSVA, table 17–2 shows different kinds of security items and measures that team members should look for and evaluate for effectiveness. Some of the listed items will obviously not apply in all situations. Physical barriers' presence and function are generally easily discerned. Operational barriers include operator presence and routine checks on equipment and supplies, and security rounds performed by QM operators, unit personnel, and military or contract security personnel. These barriers must be discovered through conversations with appropriate personnel who have knowledge of the specific operations.

Table 17−2
Examples of physical and operational security measures that may be employed at various locations in field and semifixed facility water systems

Types of measures	Security items/measures
Physical security	Fences, locks, signs, bars on windows, lighting, vehicle barriers, anti-climb devices on ladders, screens on vents/drains/overflow outlets, security cameras, intrusion detection systems
Operational security	Security patrols/inspections, operational and maintenance rounds, required ID badges for non-uniformed personnel, parking policy, set-back distance
Other system protection	Chlorine residual test frequency, other routine water quality sampling, shut-off valves, availability of replacement parts, CBRNE filter sets, fire suppression equipment
Practices that monitor protection	Equipment calibration, routine quality control checks, active maintenance/cleaning programs, daily inspections, ID checks, testing of alarms, incident response rehearsals, functional checks of emergency/back-up equipment, monitoring sick call, an aid station, and medical facility illness trends

(f) FWSVA documentation. Team members can use DA Form 7575 (FWSVA Worksheet) to evaluate and document each area of concern for possible threats against each potential target identified either during or after the onsite survey (figure 17–1). It may be easier to take notes in a field notebook and fill in the worksheet electronically afterwards. Instructions for completing the worksheet are also in figure 17–1.

FWSVA WORKSHEET

For use of this form, see TB MED 577; the proponent agency is OTSG.

1. COMPONENT	2. ID#	3. LOCATION
Source/Treatment	23 QMC-0105	Near Baghdad 34-34-055N 115-52-030E

4. ELEMENT	5. PICTURE
Source A Infiltration well near river 15' diameter	[X] YES [ ] NO

6. THREAT	7. PHYSICAL DAMAGE/DESTRUCTION	8. CONTAMINATION
SECURITY (ACCESSIBILITY)	Short fence chain link, barbed wire - camouflage	Outside of main fenced compound - underground line
REDUNDANCY (BACKUPS)	No backup for pump or generator	Bottled water available at warehouse 50km-Logistics
OTHER PROTECTION MEASURES	Operators within 50m, 24hr surveillance - but playing cards	Treated by ROWPU
PROTECTION MONITORING	MPs not aware of threat to water system	Quarterly sample to CHPPM daily inspection by ROWPU OPS
KNOWN DEFICIENCIES	No lights at night - near well travelled road - vandals	Industrial area nearby - easy access to chemicals
PROBABILITY	[ ] A [X] B [ ] C [ ] D [ ] E	[ ] A [ ] B [ ] C [X] D [ ] E
SEVERITY	[ ] I [X] II [ ] III [ ] IV	[ ] I [ ] II [X] III [ ] IV
INITIAL RISK	[ ] Extremely High [X] High [ ] Moderate [ ] Low	[ ] Extremely High [ ] High [ ] Moderate [X] Low

9. ELEMENT	10. PICTURE
2 ea. 600gph ROWPU 18hr/day operation	[X] YES [ ] NO

11. THREAT	12. PHYSICAL DAMAGE/DESTRUCTION	13. CONTAMINATION
SECURITY (ACCESSIBILITY)	Inside fenced compound Double fence - concertina top	MP frequent roving patrols
REDUNDANCY (BACKUPS)	3 units available; only use 2 3rd unit in same location	Bottled water - don't know who much possible truck from other nearby units
OTHER PROTECTION MEASURES	No camouflage	No general access - even to GIs Good PA program on water security
PROTECTION MONITORING	Hourly Chlorine - TDS PM does bact wkly	See discussion on back page
KNOWN DEFICIENCIES	Within grenade toss of fence line	Host Nation passersby show great interest in operation
PROBABILITY	[ ] A [ ] B [X] C [ ] D [ ] E	[ ] A [ ] B [ ] C [X] D [ ] E
SEVERITY	[ ] I [ ] II [X] III [ ] IV	[ ] I [ ] II [X] III [ ] IV
INITIAL RISK	[ ] Extremely High [ ] High [X] Moderate [ ] Low	[ ] Extremely High [ ] High [ ] Moderate [X] Low

DA FORM 7575, NOV 2005 APD V1.00

Figure 17−1. DA Form 7575, FWSVA Worksheet

Legend for Figure 17−1, DA FORM 7575

DA Form 7575 may be used to record and organize information gathered during an FWSVA. Assessment team leaders and members can use it in the following suggested manner. It would probably be filled out by hand during the onsite assessment of each asset.

Component: Use this block to identify the major component or asset of the water system such as: Raw Water Source, Treatment System, Storage Facility, Distribution Point.

ID #: Give the component an ID number. It can be any alphanumeric number you like, as long as it is unique and identifies this component uniquely compared to other components visited during the FWSVA.

Location: Identify the location using GPS if possible. If not, use a map and list grid locations.

Element: If the water system component has multiple parts that are differentiable with respect to the threat, enter the specific element here. See table 17-1 for examples of elements of water system components.

Picture Y___ N___: Check here whether or not the team took a picture of this particular element.

Threat: The two primary threats of concern for field water systems are listed as column headings for the following five rows. As the assessment is made, some of the measures observed and evaluated will apply to physical damage and destruction, and some to contamination. Most will apply to both. The separate columns are provided to help team members maintain the dual threat focus. Also remember to think in terms of the probability and severity of threats against the specific element as the assessment proceeds. Remember to consider, under the contamination heading, the potential for contamination from an accidental upstream release of a toxic chemical.

Security: Enter existing physical security measures that control accessibility to each element.

Redundancy: List any back-up equipment/systems that could be used to replace the specific element if it were disabled or destroyed. Ask, "What options are available if this element becomes inoperable, is destroyed or is contaminated, and how rapidly could they be implemented?" Quartermaster and engineer personnel should be able to answer those questions.

Other protection measures: Identify other measures that provide protection against an attack. Include here, for instance, operational monitoring and PM surveillance information such as the frequency of chlorine residual and bacteriological evaluation of the system by operator, PM, and other personnel.

Current practices that monitor protection measures: List any actions employed to ensure that that the existing protection measures are functioning. These might include status checks by supervisors, unscheduled inspections by higher commands, and any other practices that add assurance to security measures.

Known deficiencies: Record any existing deficiencies observed or reported in the operation or structure of any of the components and assets. Some may be obvious, and others may become evident through questioning of operators during the assessment visit.

Probability: Check the probability category determined for the element as described in paragraph 17-5*b*(1), where the letters A, B, C, D, and E represent the probability categories Highly Likely, Likely, Probable, Questionable, and Unlikely, respectively.

Severity: Check the severity category determined for the element as described in paragraph 17-5*b*(2), where roman numerals I, II, III, and IV represent the severity categories Catastrophic, Critical, Marginal, and Negligible, respectively.

Initial Risk: Check the overall initial risk determined for the element by combining the probability and severity ratings using figure 17-2 as described in paragraph 17-5*b*(3).

(g) *Document review.* After the physical inspection, finish reviewing any QM operation and maintenance logs and PM inspection checklists concerning field water, water quality testing results, SOPs, water quality monitoring plans, and emergency/contingency plans. This review is to ensure that testing, operational monitoring, and PM surveillance are being conducted, and to ensure that if contamination of field water were to occur, early detection and early containment is possible.

(4) *Interviews*. Personnel who are involved in any portion of the field water operations should be interviewed. The greatest insights about vulnerabilities are frequently gained by speaking with personnel who have the daily responsibilities for the field water treatment and distribution system and those who guard and secure the field water. Paragraph 17–7 contains an example of a water system-related interview questionnaire.

b. Step 2 – assess the hazards (vulnerabilities). The CRM process described in FM 5−19 is used to determine the overall risk posed by aggressors to each target component. The team leader, with other team members if possible, determines the overall baseline risk of each threat event based on the probability that the event will occur and severity of the event if it does occur according to the definitions presented below.

(1) *Probability of event occurrence*. Having gathered all the intelligence and information necessary, the team can at this point estimate the probability, or likelihood, that an aggressor could successfully exploit any weaknesses identified in step 1. The determination is subjective and takes into account all those items addressed above. Five categories of probability are used in the ORM process. Table 17–3 lists these categories from highest (category A, highly likely) to lowest (category E, unlikely) probability. The five categories provide a fairly continuous spectrum of probabilities that may be difficult to choose from. If the team is more comfortable using only three levels of probability as they make their determinations, any three consecutive categories may be used with the selection based on the overall perceived threat in the area. Based on information gathered from security and intelligence units, if the threat is generally high, the choice would be A, B, and C. If it is minimal, C, D, and E could be used, and if the overall threat level is in between high and low, B, C, and D could be used. If less than all five categories are used to make the determination, it is important to document in the FWSVA report the reasons for the categories selected. The probability of occurrence determined for each threat event should be checked or circled in the appropriate row of the worksheet.

(2) *Severity of threat events*. Next, the team determines the extent of the damage that would be done if specific threat events were to occur. To properly evaluate the severity to the system and to personnel, certain criteria must be established from the beginning of the assessment. Severity determination factors include what immediate damage is done and whether the damage is recoverable or not. Can the damage be bypassed? Can the system be repaired or decontaminated? If so, how long will it take? Are there backup equipment and supplies on hand or will they need to be ordered? How many personnel will get a little sick, very sick, or die? Can the mission still be accomplished? Table 17–4 contains suggestions on how to weight different kinds of threat events to come up with an estimate of their severity. Consider each threat event, as before, and enter the selected severity in the appropriate row in the worksheet.

Table 17–3
Hazard probability estimates

Probability estimate	Criteria
A **Highly likely**	High value target. Easy to execute. No or minimal deterrent safeguards. No specialized training required and very little equipment required. *(80 to 100 percent success rate)*
B **Likely**	High value target. Low level of training needed, and supplies are easily obtained. Minimal protective measures in place. *(60-80 percent success rate)*
C **Probable**	Any target. Capability exists and current security measures are inadequate to deter. Collusion with an insider could provide the necessary access, training, and equipment. *(40-60 percent success rate)*
D **Questionable**	Remotely possible. Specialized knowledge, training, and equipment required. Information may be obtained by an outsider from generic sources. *(20-40 percent success rate)*
E **Unlikely**	Can assume aggressor would not attempt this or would not be successful due to lack of capability and existing control measures. Relies on facts not easily obtained by an installation outsider. *(0-20 percent success rate)*

Table 17–4
Severity levels table

Severity level	Physical destruction	Contamination
I **Catastrophic**	• Complete loss of ability to provide safe drinking water to large part of or entire AO • Will take more than 2 days to restore service	• Medical threat – causes death or widespread severe illness in all or large part of AO • Will result in mission failure
II **Critical**	• Severely damages ability to provide an adequate volume of safe drinking water to specific areas in the AO • Service restoration will take more than 1 day	• Health threat – causes severe illness in some individual Soldiers, or minor illness in many, but debilitating none or few • Reduces multiple units' effectiveness, makes mission accomplishment questionable
III **Marginal**	• Can replace damaged section/unit or bypass damage and still produce water with delay of 1 day or less • Can still meet 75 percent of required daily production	• Health threat – causes minor illness in a few susceptible individuals and/or units • Affects taste and odor only • Mission accomplishment not jeopardized
IV **Negligible**	• Little or no adverse impact on ability to provide an adequate volume of safe drinking water • Little property damage • Does not affect normal equipment operation	• No apparent adverse effects on individual or unit health • Disinfectant residual can destroy contaminant type and concentration added

(3) *Baseline or initial risk.* Using the probability and severity categories chosen for each element, determine the overall risk posed to that element using the risk assessment matrix below (figure 17–2), and enter the result into the last row of the worksheet. Risk is expressed in terms of Extremely High, High, Moderate, and Low. These values represent the baseline or initial risk assessment of the field water system components or assets. The assessment team now lists the components and related elements in priority from highest to lowest risk. The list can be recorded in a table similar to the one shown in figure 17–3 (DA Form 7576, FWSVA Summary Data Sheet). The rank-ordered list of target components provides the basis for a presentation to the commander and for recommending improvements to the identified system components to reduce or mitigate unacceptably high risk situations.

Severity	**Hazard Probability**				
	Highly likely	**Likely**	**Probable**	**Questionable**	**Unlikely**
Catastrophic	Extremely high	Extremely high	High	High	Moderate
Critical	Extremely high	High	High	Moderate	Low
Marginal	High	Moderate	Moderate	Low	Low
Negligible	Moderate	Low	Low	Low	Low
	Risk Estimate				

Figure 17–2. Relating hazard probability and severity to overall risk

c. Step 3 – develop risk reduction recommendations. Upon completion of the risk assessment, the next step in the FWSVA process is to identify means of reducing the risk to the most vulnerable areas so recommendations can be made to the commander. The recommendations should always be practical and result in a reduction in the initial or baseline risk. Risk is reduced by taking actions that reduce the hazard probability, the hazard severity, or both. As the team considers security improvements for each element with an unacceptable risk, the changes in probability and severity that would result from implementing the recommendations should be considered to determine if they will reduce the risk to that particular component, element, or system. If so, the information should be recorded and presented to the commander for him to make a decision on what priority to give the recommendations in combination with his overall risk management of the operation. DA Form 7576 can be used to present a summary of the FWSVA results to commanders and other concerned parties. After transferring the ID#, target component or element name, and the baseline risk from the FWSVA worksheet onto the report sheet, the recommendations and new risk level should be added. This completed summary sheet should provide a concise view of the FWSVA results that will be useful to decision makers concerned with the protection of field water systems. It should be completed and included with the report that is briefed and presented to the commander. Some

FWSVA SUMMARY DATA SHEET

For use of this form, see TB MED 577; the proponent agency is OTSG.

FWSVA SUMMARY DATA SHEET PURPOSE	TEAM LEADER	DATE (YYYYMMDD)
		20050123

ID #	ELEMENT	INITIAL RISK	RECOMMENDED IMPROVEMENTS	RESIDUAL RISK
23QMC 0105	Source A	Physical High	Have MPs patrol the area 2xdaily Tell operators to be vigilant. Increase fence height PROB C	Still High
23QMC 0105	Source A	Cont. Low	Continue to provide ROWPU treatment. Reevaluate if that changes	Still Low
23QMC 0105	ROWPU	Physical Moderate	Camouflage unit - move backup ROWPU to other side of compound PROB D	Low
23QMC 0105	ROWPU	Cont. Low	Find out how much B.wat is available and contact other units to set up help if needed	Still Low
23QMC 0105	Distribution Waterpoint A	Phys./Cont. Ext High	Stop letting Host Nation personnel use water unmonitored - lock spigots when unattended PROB B	High
23QMC 0105	Distribution Waterpoint B	Cont. Ext High	Close and lock all water buffalo hatches. Get FST to check residual 2xdaily. Provided added training to FST PROB D	Low
	Reminder Comment		Set up exit briefing time with XO, Security, Log, Eng, QM	0800 Fri.
	Comment		Need to check with AAFES on bottled water availability in case of emergency	
	Comment		MPs were very willing to include water assets to their patrol list	

DA FORM 7576, NOV 2005 APD V1.00

Figure 17–3. DA Form 7576, FWSVA Summary Data Sheet

Notes:

[1] ID#, element, and initial risk are transferred from FWSVA worksheet.
[2] Residual risk is that risk that remains after implementing the recommended upgrade to reduce either hazard probability, hazard severity, or both.

Legend

DA Form 7576 may be used to consolidate and prioritize the risk determinations made for the components and elements of the field water system during an FWSVA. The worksheet and the information in it can be used to provide a summary of pertinent FWSVA results to commanders and other individuals responsible for the safe and secure operation of the field water system.
Starting with the component with the highest initial or baseline risk, and moving downward both on the figure and in risk levels, enter the information in each column as follows:
ID #: Transfer the ID # for the specific component from the FWSVA worksheet that was filled out for that component during the onsite survey.
Element: Enter a short description indicating the specific element of the identified component.
Initial Risk: Enter the initial risk category from the FWSVA worksheet.
Recommended Improvements: Enter the improvements that the team or team leader has identified that, if implemented, will reduce the probability and/or severity related to the element and produce a reduced risk.
Residual Risk: Enter the (reduced) residual risk category from figure 17-1 that is expected to describe the element after the recommendations are implemented to reduce the probability and/or the severity.

suggested methods of increasing protection in the field which may or may not be applicable to a particular operation include:

(1) *Improving physical security.* Emphasis should be placed on restricting access to the water system components at highest risk. Upgrading or installing physical barriers, such as fences, concertina wire, and locks, reduces the likelihood of a terrorist attack. Improving lighting can serve as a deterrent in situations where it does not compromise battlefield cover andconcealment requirements. Increasing the frequency of security inspections increases the chance of early detection of an intrusion.

(2) *Increasing operational water quality monitoring.* Increasing the frequency and locations of water quality monitoring improves the chance that a contamination event will be detected soon after it occurs.

(3) *Developing or improving a field water emergency response plan.* While not required by regulation, written and rehearsed emergency response plans can provide a degree of order amidst the chaos of water system attacks. Each unit and individual knowing what their responsibilities are and how to execute them in an emergency situation will, at a minimum, reduce reaction and recovery times appreciably. Plans should be rehearsed and revised, and should address potential repairs, spare equipment and parts procurement and installation, potential alternate water and power sources, and notifying higher headquarters.

(4) *Repairing observed deficiencies.* One of the easiest methods of reducing vulnerabilities is to fix any observed deficiencies in existing protection measures. These deficiencies were identified in step 1 of the vulnerability assessment. Corrective action can be as simple as repairing a hole in a fence or informing the military police of the locations of distribution lines and asking them to patrol them.

(5) *Increasing health surveillance.* Interaction with local medical authorities is important in identifying potential water quality problems, especially biological agent contamination. Since there is a delayed onset of symptoms for many diseases, increased hospitalizations may be the first sign of trouble. PM personnel need to actively monitor admissions and sick-call visits for illness trends or spikes.

(6) *Optimizing water purifying systems.* A properly operated water purification system is a great countermeasure against contamination of the raw water source. Ensure that the operators are competent and that they perform the required operational testing at prescribed frequencies or more often.

d. Exit briefing. The assessment team leader should brief the unit commander and pertinent staff on assessment team actions to date, highest identified vulnerabilities, countermeasures that could reduce those vulnerabilities, and the reduced risks. Refer to the FWSVA worksheets and show and discuss the summary report sheet using any photographs that were taken to support the assessment findings and recommendations. Baseline and reduced risks can be changed as a result of the commander’s input, concerns, or additional information.

e. Final report. The team leader should prepare a final report in the form of a memorandum for the commander upon completion of the vulnerability assessment exit briefing. The memorandum should identify the team leader, assessment team members, and survey dates, and provide a short description of facilities visited, highest risks identified, and recommended actions to reduce the risks. A copy of the memorandum should also be sent via SIPRNET to oehs@usachppm.army.smil.mil for archiving purposes. The commander, in concert with his security personnel, will determine the distribution to other authorized recipients.

f. Additional assistance. Additional assistance for all aspects of performing and documenting FWSVAs can be obtained from the USACHPPM WSMP by calling DSN (312) 584-3919 or (410) 436–3919, or by e-mailing water.supply@apg.amedd.army.mil.

17–6. Field units and their relationships to field water system vulnerability

a. LOGCAP contractors. These contractors handle all of the logistics, treatment, storage, and sometimes delivery and supply of water in certain instances and locations. In locations where they provide drinking water support, they would have knowledge of the locations of wells, treatment systems, water storage and distribution systems, supply points, bottled/packaged field water facilities, and so forth.

b. Engineers. Engineer units are responsible for source development. This includes well drilling and development, construction to support and/or improve tactical water supply points (when necessary), and the construction of fixed and semifixed water treatment and distribution facilities. The Corps of Engineers and appropriate J/G/S-4 staff sections are good resources for determining all well locations and water supply points in the specified AO.

c. G–2 intelligence. The G–2 may have accurate intelligence concerning individuals and groups who may constitute a threat to the security of the water system(s) under consideration. They may be able to provide information on the capabilities and intentions of such individuals and groups, and can provide an estimate of the level of threat in the area.

d. G–3 operations. The G–3 develops and recommends the concept of operations. This includes assigning security responsibilities and missions to subordinate commanders who then plan, prepare, and execute security operations. Every unit has a continuous security role as described in FM 71−100−2, chapter 5. Coordinate with the G–3 to determine which units are securing the water production sites and any other area of the water distribution system.

e. Installation commander (semifixed facilities). The commander grants access to water system components (either escorted or unescorted) and permission to photograph waterworks structures and any field water operations.

f. Installation security/military intelligence (semifixed facilities). Similar to the G–2 *intelligence* described above, installation security and local military intelligence units may be able to provide local threat information as well as guidance on the appropriate classification of FWSVA findings.

g. PM personnel. PM personnel may lead FWSVAs. They perform periodic inspections of water sources, test treated water to ensure that water quality standards are met, and inspect water treatment and storage locations. PM personnel will also know the locations of the various sample collection points in the water distribution system.

h. QM. The QM has the mission to produce, treat, and distribute potable water on the battlefield in a tactical environment. These water purification units are great allies to the PM Specialist who must ensure the quality of the water. Additionally, these units are good sources of information. They have the most knowledge about field water treatment, distribution, and storage systems. They will also know about the locations of water supply points and water treatment operations.

i. Subordinate commanders. Coordination with the commanders to review SOPs for security, water testing, and speaking with unit FSTs.

j. Unit FSTs. At the company level, FSTs are responsible for checking drinking water quality. These Soldiers know all their storage assets and can give information on the testing and disinfection of their water supply. Coordinate with each unit's FST to retrieve information on their unit water supply.

k. Water treatment plant operators and maintenance personnel (semifixed facilities). Plant operators and maintenance personnel can provide information relating to the locations of access points to distribution system components, the availability of backup and replacement equipment and parts, and potential problem areas in the distribution system. They should also know what operational monitoring is performed (parameters, frequency, location) and have information on currently used on-line monitors, copies of security SOPs/policies of information release, and any ongoing problem areas in the plant.

17–7. Interview questionnaire

The following questions are examples of the kinds of questions to ask key field water personnel during the assessment.

a. What do you think are some of the vulnerabilities of the field water treatment, distribution, and storage system (in ranked order of risk)?

b. How do you think an aggressor would attack the field water system or how would you attack the system based on what you know?

c. What would some of your suggestions be to harden the field water system from these vulnerabilities?

d. Have you witnessed any problems with security? If so, please explain them.

e. Have there been any recent events anywhere in the field water system, such as threat, suspicious activity, or vandalism?

f. What areas of the field water system do you have access to? What is your role in the monitoring program for the field water system?

g. What water testing equipment and supplies do you have? Is equipment calibrated and maintained, and are supplies current?

h. Who has access to the water sampling locations?

i. What is security like at these locations? Is there any guard coverage? If so, where, and describe the coverage (for example, 2 Soldiers at 3,000-gph ROWPU, each 8-hour shift, covered 24 hours per day).

j. Have the military police ever visited this site? Did they recommend any security improvements?

k. Have the military police ever been called for an incident? If so, what was the incident, and what was their response like?

l. Are there any concerns with local protestors?

m. Do you receive any alerts from local law enforcement?

n. Do you have an emergency/contingency and response plan? If so, has the plan been tested and when was the last time it was updated?

o. How are sick calls tracked and assessed for incidents of waterborne illness?

p. Who has access to the bottled/packaged field water facility?

q. What security measures are in place to guard the bottled/packaged field water facility?

r. Do operational monitoring and PM surveillance programs exist for bottled/packaged field water?

s. How often is the bottled/packaged field water inspected/tested? By whom?

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PART V
NAVY AND MARINE CORPS-SPECIFIC GUIDANCE

Chapter 18
Navy and Marine Corps Guidance

18–1. Importance of drinking water
Safe water, in sufficient quantities, is essential. Insufficient quantity or quality of water is not only debilitating to the individual but will have a significant impact on unit operational readiness. Water that is not properly treated and disinfected can spread bacterial 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, and schistosomiasis. Furthermore, chemical and radiological contaminants pose health risks and must be controlled. All personnel must be familiar with and follow proper water discipline. This includes drinking only water that has been properly treated, protected, and distributed. Every individual is responsible for ensuring that potable water does not become contaminated from careless or improper handling and being vigilant for the protection of a water supply from intentional or unintentional attack.

18–2. Roles
a. Unit commanders are ultimately responsible to ensure that there are sufficient quantities of safe water for their personnel. Commanders must 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 chemical contaminants, harmful microbes (pathogens), and enforcing water discipline. Furthermore, commanders must ensure that their personnel are familiar with the dangers of drinking untreated water and know the proper methods for disinfecting their personal drinking water supplies when required.

b. Engineers are responsible for providing sufficient potable water for the population to be served. This includes selecting sources of raw water and construction, operation, and maintenance of all the structures, facilities, and equipment used for collection, treatment, and distribution of potable water.

c. The preventive medicine authority (PMA) advises a commander on water quality issues. This may entail assisting the engineers in selecting a raw water source, conducting WVAs, performing routine bacteriological testing and measurement for halogen residual, assessing specific physical characteristics and chemical quality parameters per the short-term standards, and providing ORM recommendations. Assessment of additional parameters of water quality beyond the short-term standards may be required base on duration of deployment and findings from the WVA. The Army WSVA guidance found in chapter 17 provides useful information and should be used as guidance for a naval PMA conducting a WVA.

18–3. Drinking water quality standards and preventive medicine authority surveillance
a. DOD short-term (≤30 days) and long-term (>30 days) drinking water quality standards are found in chapter 4. Operational units need to address planning and appropriate level of support including PMA capability to test water for compliance to the short-term water quality standards. Generally, Navy and Marine Corps battalion level PM water testing includes daily chlorine measurements and weekly bacteriological testing. PM testing for other parameters may

be accomplished by higher echelon operational PM assets or possibly a Navy Forward Deployable Preventive Medicine Unit (FDPMU). Advanced water testing against the long-term standards (EPA) requires collection and shipment of samples for analysis out of theater to a USACHPPM laboratory. If an FDPMU is in the AO it is able to provide enhanced water quality testing support for organic PM assets. An FDPMU provides much quicker response and force health feedback for a commander ORM consideration. Prior to collection and shipping any water quality samples, a unit needs to contact the applicable laboratory for collection/sampling procedures and coordination.

b. Refer to chapter 14 for guidance for pre-deployment considerations pertaining to field water source planning.

c. Refer to chapter 16 for guidance for PM inspection and reporting for field water systems. Specifically, table 16–1 provides PMA-recommended frequencies for periodic surveillance of potable water production, storage, and distribution systems. Further guidance for daily chlorine and weekly bacteria testing is presented below.

(1) *FAC measurement*.

(a) Determine the FAC residual of all water supplies at least daily. Tests should be performed on all engineering water points, tankers, trailers, bladders, lyster bags, and on representative samples from 5-gal cans and distribution system spigots. In the latter instance, the sampling points must be varied from day to day and be representative of the entire lot of cans or the distribution system.

(b) Record the results and investigate the cause of any low readings. Report all significant findings to the unit engineer. Prompt action must be taken by the unit engineer to eliminate all sources of contamination or other factors contributing to the FAC dissipation and to restore the FAC to the appropriate levels which are described in detail in table 2–6 of this document.

(2) *Bacteriological testing*.

(a) Field water supplies must be tested bacteriologically at least weekly. PMA should establish a representative sampling plan to include engineering water points, tankers, trailers, bladders, lyster bags, 5-gal cans, and distribution system spigots. Sample points must be varied and represent the entire the water distribution system.

(b) Record the results in the Medical Department Water Log.

(c) Notify the unit commander of all positive results which indicated possible contamination and recommend that the container(s) or sampling point(s) in question be secured until disinfection and retesting can be performed.

(d) Bottled/packaged field water should be tested as detailed in paragraph 4–14 of this document.

18–4. Water logistics and planning

Water quantity guidance and water support planning is found in Marine Corps Warfighting Publication (MCWP) 4-11.6. This reference also contains information on water equipment and water support operations.

Chapter 19
Navy Forward Deployable Preventive Medicine Units

19–1. Purpose
Navy FDPMUs provide specialized PM support to forward deployed U.S. Forces and Joint Task Force Commanders.

19–2. Composition
FDPMUs provide enhanced PM support for organic PM assets. Each one consists of a 13-member team including four primary components and a Logistical Support Module. The four primary components are:

a. Preventive Medicine
b. Chemical (including Radiological Subcomponent)
c. Microbiological
d. Disease Vector

19–3. Capabilities
The PM component includes robust water quality testing capabilities to test for microbiological, inorganic chemicals, and organic chemicals. An FDPMU is outfitted with an advanced spectrophotometer and a portable gas chromatograph/mass spectrometer, and can perform AWT in a deployed environment.

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APPENDIX A
REFERENCES

Section I
Required Publications

There are no entries for this section.

Section II
Related Publications

A related publication is a source of additional information. The user does not have to read it to understand this publication. Air Force publications are available at http://www.e-publishing.af.mil and https://kx.afms.mil. Except as noted below, Army regulations are available online from the U.S. Army Publishing Directorate (APD) Web site: http://www.apd.army.mil. Field manuals are available online from the General Dennis J. Reimer Training and Doctrine Digital Library Web site: http://atiam.train.army.mil/portal/application (Library Search). Technical bulletins, medical, are available online from the USACHPPM Web site: http://chppm-www.apgea.army.mil (also available by contacting USACHPPM, ATTN: MCHB-CS-IPD, 5158 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5403). Technical manuals are available at: http://www.usace.army.mil/inet/usace-docs/armytm/. Codes of Federal Regulations are available online from the National Archives and Records Administration Web site: http://www.gpoaccess.gov/cfr/index.html. Standardization Agreements (NATO) (STANAG) and the Quadripartite Standardization Agreement (QSTAG) are available online at: http://assist.daps.dla.mil/. USACHPPM technical guides listed below are available online at: http://chppm-www.apgea.army.mil/tg.htm). USACHPPM information papers listed below are available online at: http://chppm-www.apgea.army.mil/dehe/pgm31/FldWaterRef.aspx).

A−1. NATO Publication

STANAG 2136
Minimum Standards of Water Potability During Field Operations and in Emergency Situations

STANAG 2473
Commanders Guide to Low Level Radiation Exposures in Military Operations

STANAG 2885
Emergency Supply of Water in War

A−2. DOD Publication

DOD 4715.5–G
Overseas Environmental Baseline Guidance Document (OEBGD)

(Available at: http://www.dtic.mil/whs/directives/corres/html/471505g.htm)

DODD 4705.1
Management of Land-Based Water Resources in Support of Contingency Operations
(Available at: http://www.dtic.mil/whs/directives/corres/html/470501.htm)

DODI 6490.03
Deployment Health (Available at: http://www.dtic.mil/whs/directives/corres/html/649003.htm)

MIL STD 3006C
Department of Defense Standard Practice, Sanitation Requirements for Food Establishments

A−3. Joint/Multiservice Publications

Joint Publication (JP) 4-03
Joint Bulk Petroleum and Water Doctrine

Memorandum
Joint Staff Memorandum MCM-0028-07, 02 NOV 07, Subject: Updated Procedures for Deployment Health Surveillance and Readiness
(Available at: http://amsa.army.mil/Documents/Docs.htm)

Unified Facilities Criteria (UFC) 3-230-02
Operation and Maintenance: Water Supply Systems
(Available at: http://www.wbdg.org/ccb/DOD/UFC/ufc_3_230_02.pdf)

A−4. Air Force Publications

AFI 10-211
Civil Engineer Contingency Response Planning

AFI 10-245
Air Force Antiterrorism (AT) Standards

AFI 10-246
Food and Water Protection Program

AFI 10-2501
Air Force Emergency Management (EM) Program Planning and Operations

AFI 31-101
The Air Force Installation Security Program

AFI 32-1054
Corrosion Control

AFI 32-1066
Plumbing Systems

AFI 32-1067
Water Systems

AFI 32-2001
The Fire Protection Operations and Fire Prevention Program

AFI 32-7041
Water Quality Compliance

AFI 41-106
Medical Readiness Planning and Training

AFI 48-144
Safe Drinking Water Surveillance Program

AFI 90-901
Operational Risk Management

AFIOH Technical Information Paper IOH-RS-BR-LT-2005-0059
Water Contingency Monitoring

AFM 10−2602
Nuclear, Biological, Chemical, and Conventional (NBCC) Defense Operations and Standards

AFMAN 32−1071
Security Engineering

AFOSH STD 48−14
Swimming Pools, Spas, Hot Tubs, and Bathing Areas

AFP 90−902
Operational Risk Management (ORM) Guidelines and Tools

AFPD 10−8
Homeland Defense and Civil Support

AFPD 10−24
Air Force Critical Infrastructure Program (CIP)

AFTTP 3−42.2
Health Service Support Casualty Prevention for Expeditionary Operations

USAFSAM WVA Technical Guide
Water Vulnerability and Risk Assessments for Potable Water Assets

A−5. Army Publications

AR 200–1
Environmental Protection and Enhancement

AR 40–5
Preventive Medicine

AR 40–657/ NAVSUP 4355.4H/ MCO P10110.31H
Veterinary/Medical Food Safety, Quality Assurance, and Laboratory Service

AR 700–135
Soldier Support in the Field

AR 700–136
Tactical Land Based Water Resources Management in Contingency Operations

AR 700−137
Logistics Civil Augmentation Program (LOGCAP)

AR 715−9
Contractors Accompanying the Force

ASTM E 2318–03
American Society for Testing Materials Standard Guide for Environmental Health Site Assessment Process for Military Deployments (Available at: http://www.techstreet.com)

Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement in the Republic of Korea (Available at: http://vets.amedd.army.mil/86256F90007C2D1D/korea)

FM 3–0
Operations

FM 3–19.30
Physical Security

FM 3–34.471
Plumbing, Pipe Fitting, and Sewerage

FM 3–100.12/ MCRP 5–12.1C/ NTTP 5–03.5/ AFTTP(I) 3–2.34
Risk Management for Multiservices Tactics, Techniques, and Procedures

FM 3–100/MCWP 3–3.7.1
Chemical Operations Principles and Fundamentals

FM 3−100.21
Contractors on the Battlefield

FM 3–100.4/MCRP 4–11B
Environmental Considerations in Military Operations

FM 4–02
Force Health Protection in a Global Environment

FM 4–02.17
Preventive Medicine Services

FM 4–25.12
Unit Field Sanitation Team

FM 5−19 (FM 100−14)
Composite Risk Management

FM 71–100–2
Infantry Division Operations, Tactics, Techniques, and Procedures

FM 8–10–8
Medical Intelligence in a Theater of Operations

FM 8–250
Preventive Medicine Specialist

FM 10–52
Water Supply in Theaters of Operations

FM 10–52–1
Water Supply Point Equipment and Operations

FM 10–280
Mobile Field Laundry, Clothing Exchange, and Bath Operations

FM 21–10/MCRP 4-11.1D
Field Hygiene and Sanitation

FM 4−100.2
Contracting Support on the Battlefield

IP 31–027
Criteria for Recycle of Gray Water for Shower Use

IP 31–032
Hand Held Water Treatment Devices

IP 31–035
Preventive Medicine Concerns of the M149 Water Trailer

IP 31–037
Preventive Medicine Concerns of Personal Hydration Systems

IP 32–024
Disposal Options and Procedures for Wastes Generated by Reverse Osmosis Purification Units (ROWPUs)

Memorandum, Office of The Surgeon General, DASG-PPM-NC, 13 Aug 2004, Subject: Medical Standards on Water Quality Criteria and Treatment Practices for Recycle of Laundry and Shower Wastewater for Shower Use

Potable Water Planning Guide, Directorate of Combat Developments for Quartermaster, U.S. Army Combined Arms Support Command, Fort Lee, VA, June 15, 1999. (Available by contacting Commander, CASCOM, DCD QM, ATTN: ATCL-QM, 3901 A Avenue, Suite 210, Fort Lee, VA 23801-1809)

RD 230
A Companion Document to Chemical Exposure Guidelines for Deployed Military Personnel

Study Report - Water Consumption Planning Factors, Directorate of Combat Developments (Quartermaster), U.S. Army Combined Arms Support Command, Fort Lee, VA, June 15, 1999 (Available by contacting Commander, CASCOM, DCD QM, ATTN: ATCL-QM, 3901 A Avenue, Suite 210, Fort Lee, VA 23801-1809)

TB MED 507/AFPAM 48–152 (I)
Heat Stress Control and Heat Casualty Management

TB MED 575
Swimming Pools and Bathing Facilities

TB MED 576
Sanitary Control and Surveillance of Water Supplies at Fixed Installations

TG 188
U.S. Army Food and Water Vulnerability Assessment Guide

TG 230
Chemical Exposure Guidelines for Deployed Military Personnel

TG 248
Guide to Deployed Preventive Medicine Personnel on Health Risk Management

TM 3–6665–319–10
Operator's Manual for Water Testing Kit, Chemical Agents: M272

TM 5–5430–212–13&P
Operator, Organizational, and Direct Support Maintenance Manual for Tank, 5000 Gallon Fabric, Collapsible, Potable Water, Semi-Trailer Mounted

TM 5–5430–213–13&P
Operator, Unit and Direct Support Maintenance Manual for Tank, 3000 Gallon Fabric, Collapsible, Potable Water, Semi-Trailer Mounted

TM 5–6630–215–12
Operator's and Organizational Maintenance Manual for Water Quality Analysis/Sets: Preventive Medicine

TM 5–810–5
Plumbing

TM 5–813–1
Water Supply, Sources and General Considerations

TM 5–813–3
Water Supply: Water Treatment Systems

TM 5–813–4
Water Supply: Water Storage

TM 5–813–5
Water Supply: Water Distribution

TM 5–813–6
Water Supply for Fire Protection

TM 5–813–7
Water Supply for Special Projects

TM 5–813–8
Water Desalination

TM 5–813–9
Water Supply: Pumping Stations

TM 9–2330–267–14&P
Operator's, Organizational, Direct Support, and General Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Trailer, Tank, Water, 400 Gallon, 1-1/2 Ton 2 Wheel M149

TM 9–2330–397–14&P
Operator's, Unit, Direct Support, and General Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Water: 400 Gallon, 1 ½ Ton, 8-Wheel M1112

TM 10–4320–317–13
Operator's, Unit, and Direct Support Manual for Tactical Water Distribution Equipment System

TM 10–4320–346–12&P
Operator's and Unit Maintenance Manual (Including Repair Parts and Special Tools List) for Forward Area Water Point Supply System Model Lab 9095

TM 10–4610–232–24P
Unit, Direct Support and General Support Maintenance Repair Parts and Special Tools List for Water Purification Unit Reverse Osmosis, 3000 GPH, Trailer Mounted, Flatbed Cargo

TM 10–4610–237–12
Operator's and Unit Maintenance Manual for 20k Gallon Water Storage and Distribution System Model 20KWSDS

TM 10–4610–240–10
Operator's Manual for Water Purification Unit, Reverse Osmosis, 600-GPH Trailer-Mounted Flatbed Cargo

TM 10–4610–241–24P
Model Direct Support and General Support Maintenance Repair Parts and Special Tools List for Water Purification Unit, Reverse Osmosis, 600-GPH, Trailer- Mounted Flatbed Cargo

TM 10–4610–242–13
Operator's, Unit and Direct Support Maintenance Manual for 300K Water Storage and Distribution System Model WSDS310

TM 10–4610–243–13
Operator's, Unit and Direct Support Maintenance Manual for 800K Water Storage and Distribution System Model WSDS810

TM 10–6630–245–13&P
Operator, Unit, and Direct Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Water Quality Analysis Set Preventive Medicine

TM 10–6630–246–12&P
Operator's and Unit Maintenance Manual (Including Repair Parts and Special Tools Lists) for Water Quality Analysis Set: Purification

TM 10–8110–201–14&P
Operator, Organizational, Direct Support, and General Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Drums, Fabric, Collapsible Non-Vented, 500 Gallon, Liquid Fuel

USAREUR Circular 40–657
European Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement (Available at: http://vets.amedd.army.mil/86256F90007C2D1D/Europe)

VETCOM Circular 40–1
DOD Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement (Available at: http://vets.amedd.army.mil/VETSVCS/approved.nsf)

A−6. Navy Instruction/Publications

BUMEDINST 6240.10A
Standards for Potable Water

OPNAVINST 5090.1C
Navy Environmental and Natural Resources Program Manual

OPNAVINST 3500.39
Operational Risk Management

OPNAVINST 3501.347
Projected Operational Environment and Required Operational Capability for the Navy Forward Deployed Preventive Medicine Unit

NAVMED P-5010
Manual of Naval Preventive Medicine

NAVMED P-117
U.S. Navy Manual of the Medical Department

A−7. Marine Corps Publications

MCO P5090.2A
Environmental Compliance and Protection

MCWP 4-11.6
Petroleum and Water Logistics Operations

MCO 3500.27B
Operational Risk Management

A−8. Other Publications

21 CFR 129
Processing and Bottling of Bottled Drinking Water

21 CFR 165
Beverages

21 CFR 165.110
Bottled water

40 CFR 141
National Primary Drinking Water Regulations

40 CFR 142
National Primary Drinking Water Regulations Implementation

40 CFR 143
National Secondary Drinking Water Regulations

40 CFR 260-280
Resource Conservation and Recovery Act

40 CFR 261
Identification and Listing of Hazardous Waste

ANSI Publication Z117.1-2003
Safety Requirements for Confined Spaces (Available at: http://www.ansi.org)

ANSI Z87.1
American National Standard Practice for Occupational and Educational Eye and Face Protection

Daniels, J.I. and G.M. Gallegos, eds., Evaluation of Military Field-Water Quality, Lawrence Livermore National Laboratories, 1990 (Available from USACHPPM WSMP)

NIOSH Publication 87-113
A Guide to Safety in Confined Spaces

NIOSH Publication No. 80–106
Criteria for a Recommended Standard: Working in Confined Spaces
(Available at: http://www.cdc.gov/niosh/80-106.html)

NSF/ANSI Standard 55
Ultraviolet Microbiological Water Treatment Systems

NSF/ANSI Standard 60
Drinking Water Treatment Chemicals – Health Effects

NSF/ANSI Standard 61
Drinking Water System Components – Health Effects

NSF P231
Microbiological Water Purifiers, NSF International, Ann Arbor, Michigan (Available at: http://www.nsf.org/business/engineering_and_research/protocols.asp?program=EngineeringSer

NSF P248
Military Emergency Operations Microbiological Water Purifiers

Presidential Review Directive 5
A National Obligation – Planning for Health Preparedness for and Readjustment of the Military, Veterans, and Their Families After Future Deployments
(Available at: http://www.fas.org/irp/offdocs/prd-5-report.htm)

Section III
Prescribed Forms
The DA Forms listed below are available on the Army Electronic Library (AEL) CD-ROM (EM 0001) and the APD Web site, www.apd.army.mil.

DA FORM 5456
Water Point Inspection. (Prescribed in para 16−2*a*(1).)

DA FORM 5457
Potable Water Container Inspection. (Prescribed in para 16−2*a*(2).)

DA FORM 5458
Shower/Decontamination Point Inspection. (Prescribed in para 16−2*a*(3).)

DA FORM 7575
FWSVA Worksheet. (Prescribed in para 17−5*a*(3)(*f*).)

DA FORM 7576
FWSVA Summary Data Sheet. (Prescribed in paras 17−5*b*(3) and 17−5*c*.)

DA FORM 7577
Treated Water Sampling Field Data Sheet. (Prescribed in para 4−12*d*.)

Section IV
Referenced Forms

DD Form 2796
Post Deployment Health Assessment

DA FORM 1712–R
Water Reconnaissance Report

DA FORM 1713–R
Daily Water Production Log – ROWPU

APPENDIX B
POINTS OF CONTACT FOR TECHNICAL ASSISTANCE

DOD

National Center for Medical Intelligence (NCMI)

Defense Intelligence Agency
200 MacDill Blvd
Washington, DC 20340-5100
ATTN: NCMI, Director, MA

Tech support: DSN 343–2181, Comm (301) 619–2181
JWICS: diafmic@dia.ic.gov, http://www.afmic.dia.ic.gov
SIPRNET: afmicops@afmic.dia.smil.mil, http://www.afmic.dia.smil.mil
NIPRNET: afmicops@NCMI.detrick.army.mil, http://www.ncmi.detrick.army.mil

https://www.intelink.gov/ncmi/index.php

AIR FORCE

U.S. Air Force School of Aerospace Medicine
2402 E Drive
Brooks City-Base, TX 78235–5114
DSN (312) 240–5454 / Toll Free 1-888-232-ESOH (3764)

U.S. Air Force School of Aerospace Medicine Detachment 3
Unit 5213
Kadena Air Base
APO AP 96368–5213
DSN (315) 634–9389, Comm +81 (98) 961-7361 or -9389

ARMY

VETERINARY SERVICES

DODVSA in the Office of The Surgeon General
5109 Leesburg Pike, Suite 686
Falls Church, VA 22041

DODVSA-San Antonio
2050 Worth Road, Suite 5
Fort Sam Houston, TX 78234-6005
http://www.veterinaryservice.army.mil/

QUARTERMASTER CORPS

Quartermaster
Fort Lee, VA 23801
Operations, Petroleum and Water Dept.
DSN (312) 687–2788, Comm (804) 734–2788
pwdweb@lee.army.mil
http://www.quartermaster.army.mil/

MEDICAL COMMAND

USACHPPM-Headquarters, 5158 Blackhawk Road, Aberdeen Proving Ground (APG), MD 21010-5403

Water Supply Management Program (WSMP)
DSN (312) 584–3919, Comm (410) 436–3919
e-mail: water.supply@amedd.army.mil
http://chppm-www.apgea.army.mil/dehe/pgm31/

Deployment Environmental Surveillance Program (DESP)
DSN 584–6096, Comm (410) 436-6096
http://chppm-www.apgea.army.mil/desp/

Global Technical Analysis Program (GTAP)
http://chppm-www.apgea.army.mil/gtap/

Environmental Surveillance Integration Program (ESIP)
http://chppm-www.apgea.army.mil/ESIP/

Environmental Health Risk Assessment Program (EHRAP)
DSN (312) 584-6096, Comm (410) 436-2953
http://chppm-www.apgea.army.mil/hra/

Directorate of Laboratory Services (DLS)
DSN (312) 584–2208, Comm (410) 436–2208
http://chppm-www.apgea.army.mil/dls/

USACHPPM-North
Fort George Meade, MD 20755–5225
DSN (312) 923–6502, Comm (301) 677–6502

USACHPPM-South
Fort Sam Houston, TX 78234-6230
DSN (312) 471–3495, Comm (210) 221–3495

USACHPPM-West
Fort Lewis, WA 98433–9500
DSN (312) 347–8447, Comm (253) 966–8447

USACHPPM-Europe
CMR 402, APO AE 09180
DSN (314) 486–8084, Comm 011–49–6371–86–8084

USACHPPM-Pacific
Unit 45006
APO AP 96343–5006
DSN (315) 263–8597, Comm

NAVY

Navy and Marine Corps Public Health Center (NMCPHC)
620 John Paul Jones Cir, Ste 1100
Portsmouth, VA 23708–2103
DSN (312) 377–0700, Comm (757) 953–0700, after hours (757) 621–1967
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http://www-nehc.med.navy.mil/main.htm

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1887 Powhatan St, Norfolk, VA 23511–3394
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e-mail: Fleet/FMFSupport@nepmu2.med.navy.mil
http://navymedicine.med.navy.mil/nepmu2/

NEPMU–5
3235 Albacore Alley
San Diego, CA 92136–5199
DSN (312) 526-7070, Comm (619) 556–7070
e-mail: nepmu5@nepmu5.med.navy.mil
http://www.nepmu5.med.navy.mil/

NEPMU–6
Pearl Harbor, HI 96860
DSN (315) 473–0555, Comm (808) 473–0555
e-mail: PostOffice@nepmu6.med.navy.mil
http://nepmu6.med.navy.mil/

MARINE CORPS

Marine Corps Engineer School
Utilities Instruction Company
PSC Box 20069
Marine Corps Base
Camp Lejeune, N.C. 28452-0067
DSN 750-7238, Comm (910) 450-7238
http://www.lejeune.usmc.mil/mces/MCES-Website/index.htm

OTHER

U.S. Environmental Protection Agency (EPA)—Ground Water & Drinking Water
http://www.epa.gov/safewater/

World Health Organization (WHO)
http://www.who.int/water_sanitation_health/en/

GLOSSARY

Section I. Abbreviations

^oC
Celsius; degree(s) centigrade

^oF
degree(s) Fahrenheit

AAR
after-action report

AFI
Air Force Instruction

AFIOH
Air Force Institute for Operational Health

AFOSH
Air Force Occupational Safety and Health

AFPD
Air Force Policy Directive

AFTTP
Air Force Tactics, Techniques, and Procedures

AMEDD
Army Medical Department

AML
area medical laboratory

ANSI
American National Standards Institute

AO
area of operations

AR
Army regulation

ARCENT
Army Forces, Central Command

AWT
advanced water testing

BCE
Base Civil Engineer

BE
bioenvironmental engineering

BEE
Bioenvironmental Engineer

Bq
Becquerel(s) (1 μCi = 37 kBq)

Bq/L
Becquerel(s) per liter

BUMEDINST
Bureau of Medicine Instruction

BW
biological warfare

BZ
3-quinuclidinyl benzilate

CASCOM
U.S. Army Combined Arms Support Command

CBRN
chemical, biological, radiological, and nuclear

CBRNE
chemical, biological, radiological, nuclear, and high energy explosive

CENTAF
Air Forces, Central Command

CENTCOM
Central Command

CFR
Code of Federal Regulations

COCOM
U.S. Combatant Command

CONUS
continental United States

COO
contractor-owned and -operated

C/ORM
composite/operational risk management

COTS
commercial off-the-shelf

cp
cup(s)

CRM
composite risk management

CSS
combat service support

CT
concentration-time

CU
color unit(s)

CW
chemical warfare

CWQL
Complete Water Quality Laboratory

CWQS
continued water quality surveillance

DBCP
dibromo-3-chlropropane

DCMA
Defense Contracting Management Agency

DEPMEDS
Deployable Medical System

DESP
Deployment Environmental Surveillance Program

DOD
Department of Defense

DODI
Department of Defense Instruction

DOEHS
Deployment Occupational and Environmental Health Surveillance

DOEHRS-EH
Defense Occupational and Environmental Health Readiness System - Environmental Health

DOS
day(s) of supply

DOTMLPF
doctrine, organization, training, materiel, leadership and education, personnel, and facilities

dp
drop(s)

DSN
Defense Switched Network

EBS
environmental baseline survey

EPA
U.S. Environmental Protection Agency

ESIP
Environmental Surveillance Integration Program

ESOH
environment, safety, and occupational health

FAC
free available chlorine

FAWPSS
forward area water point supply system

FDA
U.S. Food and Drug Administration

FDPMU
Navy Forward Deployed Preventive Medicine Unit

FHP
force health protection

FGS
Final Governing Standards

FM
field manual

FOUO
For Official Use Only

FST
Field Sanitation Team

FWSVA
(Army) field water system vulnerability assessment

FWVA
(Air Force) field water vulnerability assessment

gal
gallon(s)

GI
gastrointestinal

gpd
gallon(s) per day

gph
gallon(s) per hour

GTAP
Global Threat Assessment Program

Hippo
load handling system compatible water tank rack system

HOCl
hypochlorous acid

HTH
high test calcium hypochlorite

IPB
intelligence preparation of the battlefield

ISO
International Organization for Standardization

IWP
individual water purifier

IWPS
Individual Water Purification System

JCS
Joint Chiefs of Staff

JP
Joint Publication

kBq
kilobecquerel(s)

L
Liter(s)

lb
pound(s)

L/d
liter(s) per day

LD
Legionnaires' disease, lethal dose

LHS
load handling system

LLNL
Lawrence Livermore National Laboratory

LMT
Lightweight Medium Tactical

LOGCAP
Logistics Civil Augmentation Program

LTP
long-term potability

LWP
lightweight water purifier

m
meter(s)

MARCENT
Marine Forces, Central Command

MCL
maximum contaminant level

MCO
Marine Corps Order

MCWP
Marine Corps Warfighting Publication

MEG
military exposure guideline

METT-TC
Mission, Enemy, Terrain and weather, Troops and support available, Time, and Civil considerations

MF
micro filter

MF2K
Medical Force 2000

MFWS
Military Field Water Standards

mg/d
milligram(s) per day

mg/L
milligram(s) per liter (equates to part per million, or ppm)

μCi
microcurie(s)

μg
microgram(s)

MIL STD
military standard

min
minute(s)

mL
milliliter(s)

MMB
Multifunctional Medical Battalion

MOPP
mission-oriented protective posture

MP
military population

MRI
Medical Reengineering Initiative

MTF
medical treatment facility

NATO
North Atlantic Treaty Organization

NAVCENT
Navy Forces, Central Command

NAVMED
Navy Medical Department

NBC
nuclear, biological, and chemical

NCMI
National Center for Medical Intelligence

NCO
noncommissioned officer

NEPMU
Navy Environmental and Preventive Medicine Unit

NIOSH
National Institute for Occupational Safety and Health

NIPRNET
Nonsecure Internet Protocol Router Network (DOD replaces “Nonsecure” with “Unclassified but Sensitive” in its definition of the acronym

NMCPHC
Navy and Marine Corps Public Health Center

NOEL
no observed effect level

NPDES
National Pollutant Discharge Elimination System

NPDWR
National Primary Drinking Water Regulations

NSDWR
National Secondary Drinking water Regulations

NSF
NSF International (formerly the National Sanitation Foundation)

NSN
national stock number

NTTP
Navy Tactics, Techniques, and Procedures

NTU
nephelometric turbidity unit(s)

OCl^-
hypochlorite ion

OCONUS
outside the continental United States

OEBGD
Overseas Environmental Baseline Guidance Document

OEH
occupational and environmental health

OEHS
occupational and environmental health surveillance

OEHSA
occupational and environmental health site assessment

OP
organophosphate

OPNAVINST
Chief of Naval Operations Instruction

oz
ounce(s)

P/A
presence/absence

PAH
polycyclic aromatic hydrocarbon(s)

pCi
picocurie(s)

pH
negative log of the hydrogen-ion concentration

ppb
parts(s) per billion

ppm
part(s) per million (equivalent to mg/L of water)

PM
preventive medicine

PMA
preventive medicine authority

Pt
pint(s)

PWS/DS
potable water storage and distribution system

QM
Quartermaster

QSTAG
Quadripartite Standardization Agreement

qt
quart(s)

rem
roentgen equivalent man

RO
reverse osmosis

ROM
reverse osmosis membrane

ROWPU
reverse osmosis water purification unit

RWC
raw water characterization

SIPRNET
Secure Internet Protocol Router Network

SMART-__
special medical augmentation response team (-PM, preventive medicine; -NBC, nuclear, biological, chemical; -V, Veterinary)

SMFT
semitrailer-mounted fabric tank

SOP
standing operating procedure

SRC
standard requirements code

STANAG
Standardization Agreement (NATO)

STP
short-term potability

Sv
Sievert(s)

TB
technical bulletin

TB MED
technical bulletin (medical)

tbls
tablespoon(s)

TC
total coliform

TCDD
2,3,7,8-Tetrachlorodibenzo-p-dioxin (dioxin)

TDS
total dissolved solids

TEC
Topographic Engineering Center

TG
technical guide

TIC
toxic industrial chemical

TM
technical manual

TO
theater of operations

TON
threshold odor number

tsp
teaspoon

TTHM
total trihalomethanes

TWDS
tactical water distribution system

TWPS
tactical water purification system

UF
ultra filter

USACHPPM
United States Army Center for Health Promotion and Preventive Medicine

USAFSAM
United States Air Force School of Aerospace Medicine

USAREUR
United States Army Europe

UTC
unit type code

UV
ultraviolet

VETCOM
U.S. Army Veterinary Command

VS
U.S. Army Veterinary Service

WDWMS
water distribution and waste management system

WHO
World Health Organization

WQAS
water quality analysis set(s)

WQAS-E
water quality analysis set, engineer

WQAS-P
water quality analysis set, purification

WQAS-PM
water quality analysis set, preventive medicine

WQL
Water Quality Laboratory (HACH)

WRDB
Water Resource Database

WSMP
Water Supply Management Program

WSVA
(Army) water system vulnerability assessment

WVA
(Air Force) water vulnerability assessment

WWTP
wastewater treatment plant

yd
yard(s)

Section II. Terms

The definitions provided herein are presented as they are used in this publication, and may not be all inclusive. For more complete definitions, please consult a dictionary.

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

Advanced water testing (AWT)
Procedures that involve the collection, packaging, and shipping of water samples by field PM personnel to a fixed facility laboratory to undergo advanced analytical procedures beyond the capabilities of typical field equipment. Used for three purposes: (1) to test raw water as part of EBSs performed to document the impacts of U.S. deployments on the operational environment; (2) to test raw and treated field water to determine the concentrations of certain OEH chemical parameters; and (3) to identify suspected contaminants resulting from accidental or intentional contamination of water supplies in the field.

Basic potability testing (BPT)
Onsite field testing conducted by PM personnel to determine if treated water is potable when compared to the MFWS.

Bottled water
Water that is commercially treated and sealed in plastic or glass bottles sold as a substitute for bulk-produced and distributed drinking water.

Brackish water
Untreated water in or taken from a natural water source that has a TDS concentration between 1,500 mg/L and 30,0000 mg/L.

Brine
The reject flow from an RO cartridge that contains the impurities that did not pass through the membrane, usually at a higher concentration than the influent water.

Carbon adsorption
A water treatment process that removed contaminants from water by forcing it through cartridges or other containers filled with activated carbon on to which the contaminants absorb.

Cartridge filters
Filter enclosures that contain several replaceable glass fiber-wound filters, employed in military ROWPUs as pretreatment for the RO elements. Cartridge filters remove particles ≥ 5 microns in the 600 GPH ROWPU and ≥ 3 microns in the 3,000 GPH ROWPU.

Coagulation
Destabilization and aggregation of colloidal (too small to settle by gravity) particles using anionic, cationic, or polymeric chemicals, making them easier to filter out of the water.

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.

Consumption
Two definitions are recognized: (1) all forms of water use, and (2) water taken into the body through the mouth (i.e., drinking). Context determines which definition is applicable in a given passage of text.

Contaminants
Unwanted physical, chemical, radiological, or biological materials generally dissolved, suspended, or mixed in water.

CT
An indicator of disinfection efficacy, the product of the free available chlorine residual concentration in mg/L and the contact time in minutes.

Dehydrate
To lose water from body tissues in excess of replacement water.

Deployment Occupational and Environmental Health Surveillance
The program described in DODI 6490.03 whereby Soldiers' occupational and environmental health exposures during deployments are to be monitored, recorded, and archived for future evaluation should it become necessary.

Disinfection
Disinfection is a water treatment process in which pathogenic (disease producing) organisms are killed, destroyed or otherwise inactivated. Common methods of disinfecting drinking water include boiling, ultraviolet (UV) radiation, and various procedures using chlorine, chlorine dioxide, iodine, or ozone. The preferred field method of military water disinfection is chlorination which can be accomplished using chlorine gas or chlorine compounds such as calcium hypochlorite (granular) and sodium hypochlorite (liquid bleach).

Emergency water supplies
See "Individual/emergency water supplies."

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

Environmental baseline survey (EBS)
Required for all deployments, the EBS documents observed and potential toxic substance releases into structures or into the air, ground, ground water, or surface water. EBSs are performed upon initial arrival at a site, and require, at a minimum, a final survey prior to military withdrawal from a site. Evidence may be based on visual observation, documentation, and any tests/analytical results of such environmental media. The EBS serves two purposes: (1) to document the effects that deployed personnel and operations have on the environment; and (2) to identify and quantify OEH health and safety hazards that may pose potential risks to U.S. personnel at U.S. Forces locations.

Environmental health site assessment (EHSA)
An assessment that specifically addresses whether there are potential adverse health implications to troops from OEH hazards is sometimes referred to as the OEH hazard assessment or the OEHSA. The OEH/OEHSA is based on an assessment of the presence or absence of completed pathways of human exposure to a hazardous substance. For water, this primarily means evaluating drinking water contaminants.

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 supplies
Field water supplies are generally portable and temporary. They include individual emergency, and bulk unit and larger, water source, treatment, disinfection, storage, and distribution systems. Their purpose is to provide potable, palatable water to support the short- and long-term health of deployed military and civilian personnel.

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.

Filtration
A water treatment process for removing solid (particulate) matter from water by passing it through porous medical such as sand or man-made filter.

Fixed facility water supplies
Fixed facility water supplies consist of permanent water sources, treatment, disinfection, storage, and distribution systems that provide water to a fixed or “brick and mortar” installation. They are characterized by permanent structures, unit operations equipment, and distribution systems of buried water mains, laterals, and connections to building systems.

Flocculation
The gathering together of fine (coagulated) particles in water by gentle mixing after the addition of coagulant chemicals to form larger settleable particles.

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

Fresh water
Fresh water is untreated water in or taken from a natural water source such as a lake, stream, river, spring, or well that has a TDS concentration of less than 1,500 mg/L.

Human contact water
Water that may come into intimate contact with human skin such as shower water and water used for personal sanitation.

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

Impurities
Unwanted physical, chemical, or biological materials generally dissolved, suspended, or mixed in water.

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

Individual/emergency water supplies
In cases where unit-level or larger water supply systems are not accessible, personnel may be required to find their own sources of raw water and treat them using personal treatment devices and/or disinfectants. Personal water treatment devices have capabilities and limitations that personnel must be aware of to ensure that the devices operate correctly and to reduce the risk of illness from device failure.

Ion exchange
A process in which ions in solution are exchanged with ions of similar charge that are electrostatically held on the surface of a solid immersed in the same solution.

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

Microfiltration
A membrane separation process in which particles with molecular weights $\geq$ 500,000 daltons or $\geq$ 0.1 micrometers

in diameter are screened out of the water in which they are suspended. The TWPS employs hollow-fiber membrane microfilters as pretreatment prior to the RO elements.

Military exposure guideline (MEG)
MEGs are protective guidelines used to assess the degree of risk to troops when exposed to chemical contaminants in environmental media (air, soil, and drinking water). MEGs are published and updated annually in USACHPPM Technical Guide 230.

Military Field Water Standards (MFWS)
Health standards developed for selected water characteristics and contaminants. Drinking water that meets the short- (up to 30 days) or long- (greater than 30 days) term standards during deployments will not normally result in either acute illness or disease, or chronic adverse health outcomes.

Multimedia filtration
Removal of suspended particles from water by forcing it through graded layers of anthracite, silica sand, and garnet supported on a bed of gravel. Used prior to the cartridge filters in the 600 GPH and 3,000 GPH ROWPUs.

Nonpotable water
In general, water that is not safe to drink. In the operational environment, water from any source that has not been approved by PM or another local medical authority for use as drinking water.

Occupational and environmental health hazard assessment
Required by DODI 6490.03, includes identification and assessment of all chemical hazards for which there are direct exposures to troops (see OEHSA).

Occupational and environmental health surveillance
See "Deployment Occupational and Environmental Health Surveillance"

Occupational and Environmental Health Site Assessment (OEHSA)
Documents the OEH conditions found at a site (base camp, bivouac site or outpost, or other permanent or semi-permanent basing location) beginning at or near the time it is first occupied. The assessment, done by Military Service preventive medicine personnel, includes site history; environmental health survey results for air, water, soil, and noise; entomological surveys; occupational and industrial hygiene surveys; and ionizing and non-ionizing radiation hazard surveys, if indicated. Its purpose is to identify hazardous exposure agents with complete or potentially complete exposure pathways that may affect the health of deployed personnel.

Packaged field water
Military- or contractor-treated water that is sealed in small plastic pouches or bottles by military or contractor personnel for ultimate distribution to individuals for drinking.

Palatable water
Water that is cool, aerated, significantly free from color, turbidity, taste, and odor, and is generally pleasing to the senses. Palatable water is not necessarily potable and may contain disease- or illness-causing substances.

Pathogenic organism
Any disease-producing microorganism.

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

Potable water
For purposes of this publication - Water that has been tested and approved by PM personnel to meet the STP or LTP standards, and is therefore considered safe to drink for the period that the standards apply to. Potable water may or may not be palatable.

Preliminary Hazard Assessment
The process of reviewing relevant intelligence data, past hazard assessments, and/or other available pre-deployment data for the area of deployment to identify potential OEH threats to deploying personnel.

Product water
Water effluent from a water treatment or purification system

Raw water
Fresh or sea water that has not been previously used, treated, or purified.

Raw water characterization (RWC) testing
Onsite field testing of raw water to determine its basic characteristics, quality, and ability to be treated with Army water purification equipment to meet the MFWS. Conducted by quartermaster (water purification) personnel and level II PM personnel.

Reverse osmosis (RO)
A process by which dissolved materials ($\geq$ 100 daltons or 0.001 microns) are removed from water by forcing the water through a semipermeable membrane through which the water, but not the dissolved materials, can pass. The 600 GPH ROWPU, 3,000 GPH ROWPU, TWPS, and LWP all employ RO as the final step in the water treatment process (excluding chlorination).

Salt water
Untreated water, usually in a sea or ocean, with a TDS concentration of 35,000 mg/L or greater.

Seawater
Untreated water, usually in a sea or ocean, with a TDS concentration of 35,000 mg/L or greater.

Sedimentation
A process in which particles that are more dense than water move downward and separate from the water by the force of gravity.

Semifixed facility water supplies
There is no hard and fast definition. A semifixed facility is a base camp or other field installation that has been established for some time, consists of more than just tents, and has a pressurized water distribution system consisting of water mains, laterals, and building plumbing systems compared to a field facility where units must visit a water point to obtain water for their unit, building, or tent. Water treatment facilities may be mobile or fixed, but distribution system(s) are pressurized and operate nearly continuously to provide drinking water for personnel who reside at the facility personnel. Engineer or quartermaster personnel collect and test water samples of raw water, treated water, and water at various points in the distribution, similar to that which occurs at fixed installations.

Straining
A sieving size-exclusion process in which particles are physically removed from water by passing the water through a screen with holes smaller than the particles desired to be removed.

Treated water
Water that has passed through unit processes such as coagulation, flocculation, sedimentation, filtration, RO, and disinfection. Having been treated does not ensure potability, and it must be inspected by PM personnel and approved by the command surgeon before it is considered potable.

Tri-Service Field Water Standards
Field water standards developed for the Army by Lawrence Livermore National Laboratories and published in TB MED 577 in 1986 (Daniels, 1990). These standards have been replaced by the MFWS presented in this publication.

Ultrafiltration
A pressure-membrane separation process in which particles with a molecular weight $\geq$ 1,000 daltons or $\geq$ 0.01 micrometers in diameter are screened out of the water in which they are suspended. The LWP employs hollow-fiber membrane microfilters as pretreatment prior to the RO elements.

Untreated water
Water that has not been treated or purified to improve its quality.

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

Water point
The location where water is dispensed for use.

Water purification point
The location where the water treatment system is setup and operated.

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

Water source
Surface water (rivers, ponds, lakes, springs), ground-water wells, and even host nation municipal water systems that can be accessed and treated using Army water purification equipment to produce potable drinking water.

Water source reconnaissance survey
Ground survey of potential water sources to select the most appropriate source and determine its suitability for treatment and production of drinking water. Conducted by a team including, but not limited to, engineers, quartermaster/water purification, PM, and Intel/security personnel.

Water source sanitary survey
Survey of a proposed or existing water source conducted by PM personnel to identify existing and/or potential sources of pollution/contamination to a water source (supports the water source reconnaissance survey).

Water supply
Treated potable water that is stored and distributed or otherwise made available for use.

Water treatment/water purification
Water treatment/purification is the combination of one or more processes employed to improve the quality of water. Treatment involves removing suspended and dissolved impurities and killing or inactivating microorganisms, usually with the goal of making the water potable and palatable. Typical water treatment processes include but are not limited to screening, aeration, chemical addition, coagulation, flocculation, sedimentation, filtration, RO, ion exchange, sorption processes, and disinfection.

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