Public Health Assessment for

PICATINNY ARSENAL
[a/k/a PICATINNY ARSENAL (USARMY)]
ROCKAWAY TOWNSHIP, MORRIS COUNTY, NEW JERSEY
EPA FACILITY ID: NJ3210020704
JULY 20, 2001

[redacted] DEPARTMENT OF HEALTH AND HUMAN SERVICES
[redacted] SERVICE
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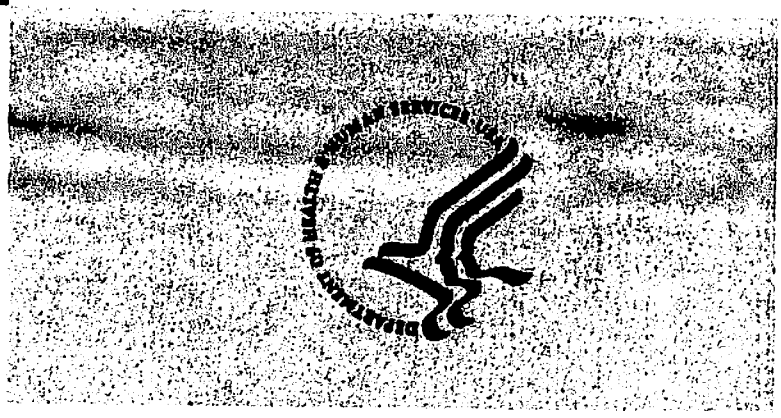

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ROCKAWAY TOWNSHIP, MORRIS COUNTY, NEW JERSEY

EPA FACILITY ID: NJ321002704

Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Additional copies of this report are available from:
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FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations the structure may vary from site to site. Nevertheless, the public health assessment process is not considered complete until the public health issues at the site are addressed.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan.

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, fullscale epidemiology studies, disease registries, surveillance studjes or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E56), Atlanta, GA 30333.

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LIST OF ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
CPF	cancer potency factor
CREG	Cancer Risk Evaluation Guide
CV	comparison value
cy	cubic yard
DOD	Department of Defense
DRMO	Defense Reutilization and Marketing Office
EMEG	Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
FS	feasibility study
LTHA	Lifetime Health Advisory for Drinking Water
MCL	EPA's maximum contaminant level
MNA	monitored natural attenuation
MRL	ATSDR's minimal risk level
mg	milligram
mg/kg/day	milligrams of contaminant per kilogram per day
NAAQS	National Ambient Air Quality Standard
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priorities List
oz	ounce
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PHA	Public Health Assessment
PHAP	Public Health Action Plan
Picatinny	Picatinny Arsenal
ppb	parts per billion
ppm	parts per million
RAB	Restoration Advisory Board
RBC	Risk-based Concentration
RfD	EPA's reference dose
RI	remedial investigation
RMEG	Reference Dose Media Evaluation Guide
SSL	Soil Screening Level
SVOCs	semi-volatile organic compounds

LIST OF ABBREVIATIONS (continued)

TCE	trichloroethylene
ug/dL	microgram per deciliter
ug/m^3	micrograms per cubic meter
UXO	unexploded ordnance
VOCs	volatile organic compounds
WHPP	wellhead protection plan

SUMMARY

The Agency for Toxic Substances and Disease Registry (ATSDR) has prepared this public health assessment (PHA) to examine whether people could be exposed (in the past, currently, or in the future) to harmful levels of contaminants in groundwater, surface soil, surface water, and sediment from the Picatinny Arsenal (Picatinny) site. Based on a review of the available information, ATSDR finds that under current site conditions exposures to contaminants at Picatinny are unlikely to result in adverse health effects. As such, ATSDR has categorized Picatinny as **"no apparent public health hazard"** (see definition in the Glossary in Appendix B).

Picatinny is an active installation located 4 miles northwest of the city of Dover and within Rockaway Township in Morris County, New Jersey. Occupying approximately 6,500 acres, the arsenal is situated in a valley with Green Pond Mountain to the west, Green Pond and Copperas Mountains to the northwest, and an unnamed ridge to the southeast. Community developments are located to the north, east, and south. Picatinny was established as a storage and powder depot in 1880, but produced ammunition during wartime. Picatinny's current mission is research and development of non-nuclear weapons and life-cycle engineering. Supporting activities have included landfilling, excavating sand and gravel borrow pits, operating motor pools and gasoline stations, administration, and providing residential housing and recreational activities for military personnel.

As a result of past arsenal operations, hazardous materials have been released to the environment. Potential contamination was identified at 175 sites located throughout Picatinny. Principal site contaminants are volatile organic compounds (VOCs), explosives, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and metals. The U.S. Environmental Protection Agency (EPA) placed Picatinny on the National Priorities List in March 1990 because of concerns about migration of VOC-contaminated groundwater.

In preparing this PHA, ATSDR obtained data from Picatinny, EPA, the New Jersey Department of Environmental Protection, and local water suppliers. ATSDR also spoke with community members about their health concerns. Based on a review of available data, ATSDR evaluated contaminants in groundwater, surface soil, surface water, sediment, and fish for potential health concerns.

Past activities have released contaminants to groundwater underlying Picatinny. Elevated levels of VOCs, explosives, and metals have been detected in on-site water supply wells and/or off-site private wells. Off-site public water supplies have not been impacted by Picatinny contamination. ATSDR evaluated past exposures based on conservative assumptions designed to overestimate the amount of contaminants to which people were exposed from use of on-site water supplies and off-site private wells. ATSDR determined that no public health hazards are associated with any past exposures to on- and off-site drinking water. To prevent current and future exposures, the Army installed a treatment system to remove VOCs from the arsenal water supply prior to

distribution. Regular monitoring is also conducted to ensure the safety of the water supply. When the potential for off-site contamination was identified, homes with potentially contaminated wells were immediately supplied with bottled water and were later connected to the municipal water supply in 1996. *Based on potential past exposures, conservatively estimated exposure doses, and actions conducted to prevent exposures, ATSDR concludes that past, current, and future use of groundwater as a drinking water supply is unlikely to result in public health hazards.*

Past arsenal activities resulted in surface soil contamination, primarily PAHs, explosives, and metals, throughout the arsenal. In addition, PCBs were found in Area B soil. On-site workers, recreational users, and residents may contact contaminants in surface soil. Contact by on-site workers and recreational users is expected to be brief and intermittent. In addition, arsenal employees working in areas of contamination are expected to wear proper protective equipment to prevent exposures. On-site housing is located away from areas of contamination and potential exposures are unlikely. In 1999, ATSDR completed a health consultation addressing PCB exposure at Area B and concluded that contact with PCBs in soil may result in adverse health effects for construction workers who are at the site for long-term (months) projects and who do not wear or use protective clothing and equipment. The Army is continuing to conduct site investigations and complete remedial actions to minimize current and future exposures and prevent possible adverse health effects. *Based on potential exposures and ongoing investigations and remediation at the arsenal, ATSDR concludes that past, current, and future exposure to surface soil is unlikely to result in public health hazards.*

Picatinny Lake, Lake Denmark, portions of Green Pond Brook, and several ponds at Picatinny are used by military and civilian personnel and their families for boating and fishing. Semi-volatile organic compounds (SVOCs), PCBs, explosives, and metals have been detected in surface water and/or sediment. Samples of fish tissue fillets, the edible portion of fish, contained metals above conservative screening values, whereas whole body samples, which include edible and inedible portions of fish, contained SVOCs, pesticides, PCBs, and metals above screening values. Exposure to surface water and sediment during boating and fishing is expected to be brief and infrequent. Elevated contaminant levels in fish tissue were found in only a portion of the samples. In addition, recreational fishers are only expected to consume fish infrequently. Nonetheless, the Army has implemented a fish consumption advisory consistent with state of New Jersey fish advisories. This advisory suggests that the general population follow state guidelines to eat no more than one meal per week of largemouth bass and chain pickerel. High risk individuals (e.g., pregnant women, nursing mothers, and children under 5 years old) should not eat any chain pickerel and only one meal per month of largemouth bass. The Army is also continuing to conduct site investigations and complete remedial actions to minimize current and future exposures and prevent possible adverse health effects. *Based on potential exposures and ongoing investigations and remediation at the arsenal, ATSDR concludes that past, current, and future recreational use of surface water bodies designated for fishing and boating and recreational fishing are unlikely to result in public health hazards.*

Exposure Hazard Summary Table - Picatinny Arsenal, NJ				
Exposure Scenario	**Time Frame**	**Exposure?**	**Public Health Hazard?**	**Actions Taken/Recommended**
Use of contaminated groundwater from on-base supply wells	past current future	yes no no	no no no	• Levels were not high enough to pose a hazard. • The Army closed contaminated wells, monitors active wells, and operates water treatment systems. • Investigations and remediation at the arsenal are ongoing.
Use of contaminated groundwater from off-base private wells south of Picatinny	past current future	yes no no	no no no	• Levels were not high enough to pose a hazard. • Homes were connected to the public water supply. • Investigations and remediation at the arsenal are ongoing.
Contact with contaminated surface soils in various areas throughout Picatinny	past current future	possible unlikely unlikely	no no no	• Levels are not high enough to pose a hazard. • The Army is conducting investigations and removal actions, as necessary, to prevent current and future exposures.
Contact with contaminants in surface water, sediment, and fish in recreational water bodies throughout Picatinny	past current future	possible possible possible	no no no	• Levels are not high enough to pose a hazard under recreational use. • The Army has restricted recreational use and fishing to designated water bodies. • The Army instituted a fish advisory consistent with the state of New Jersey advisory.

BACKGROUND

Site Description and History

Picatinny Arsenal (Picatinny) is an active military installation located 4 miles northwest of the city of Dover and within Rockaway Township in Morris County, New Jersey (Figure 1). The approximately 8 mile long and 1.5 mile wide installation covers 6,491 acres and contains 1,500 buildings serviced by approximately 85 miles of road. Most of the industrial areas of the arsenal are located between Picatinny Lake and the southern boundary of the site. These areas include a gas station, maintenance areas, storage yards, and manufacturing areas, where research and development and explosives manufacturing are or have been conducted. The arsenal is located in a valley with Green Pond Mountain to the west, Green Pond and Copperas Mountains to the northwest, and an unnamed ridge to the southeast. Community developments are located to the north, east, and south.

The U.S. War Department established Picatinny as a storage and powder depot in 1880. During wartime, the arsenal served as a major source of ammunition, producing powder charges for cannons and projectiles of all sizes. Picatinny has shifted its mission to research and development (of non-nuclear weapons) and life-cycle engineering. Today, arsenal operations are overseen by the U.S. Army Tank, Automotive, and Armaments Command.

Specific mission-related activities at the installation have included missile warhead programs, air craft weaponization, rocket-assisted projectiles, tank weaponry, and flare development. Secondary, or supporting, activities have included landfilling, excavation of sand and gravel borrow pits, operation of motor pools and gasoline stations, administration, and providing residential housing and recreational activities (e.g., golf) for military personnel.

As a result of past arsenal operations, hazardous materials have been released to the environment. Principal site contaminants are volatile organic compounds (VOCs)—primarily trichloroethylene (TCE) and tetrachloroethylene (PCE)—explosives, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and metals.

In 1982, the Army and the U.S. Geological Survey initiated a water resources investigation following the detection of VOCs in groundwater at the arsenal, primarily at buildings where plating and circuit-board etchings were conducted and at building 95 (IT 1998). The U.S. Environmental Protection Agency (EPA) placed Picatinny Arsenal on the National Priorities List in March 1990 because of concerns about migration of VOC-contaminated groundwater from building 24, located in Area D. Picatinny participates in the Installation Restoration Program, a Department of Defense (DOD) program to identify, investigate, and control the migration of hazardous contaminants at military and DOD facilities. An Interagency Agreement was signed by the Army and EPA in July 1991. The Army originally grouped 175 Defense Site Environmental Tracking System sites (referred to by PICA site number) into 16 broader areas based on similar

types of activities and locations. In 1990, the Army, with regulatory approval, prioritized the 16 areas from A through P for further investigation (Figure 2). Area A, containing only the burning grounds where explosive-contaminated sludge and sediment from manufacturing processes are incinerated, has been assigned the highest priority study. Areas A through P were further divided into three phases to be studied in succession. The Phase I remedial investigation/feasibility study addresses the highest priority areas (Areas A through G), which are generally located in the southern portion of the arsenal; Phase II examines Areas H through K; and Phase III will address the lowest priority areas, Areas L through P. Table 1 describes Areas A through P, discusses potential or detected contamination identified during investigations and monitoring, summarizes corrective actions and the current site status, and presents an evaluation of potential public health hazards.

The original three phased approach has been slightly modified by the implementation of DOD's Relative Funding Policy. The U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) has assigned each of the 175 sites a relative risk rating of 1A (the highest risk) to 3A (the lowest risk). Sites meeting a relative risk of 1A will be funded for investigation/cleanup before other sites. A record of decision that would outline the clean-up measures at Picatinny has not been signed. However, during the remedial investigations (RIs) and feasibility studies (FSs) the Army has implemented several interim clean-up actions, removing contaminated media that could be harmful to the public (IT 1998).

ATSDR Involvement

In May 1991, the Agency for Toxic Substances and Disease Registry (ATSDR) visited the arsenal and met with local officials and Picatinny representatives, toured waste areas, and reviewed arsenal files. At the time, ATSDR was concerned about low levels of explosives that had been detected in private wells just south of the arsenal, but additional data were needed to more fully evaluate this pathway (ATSDR 1991). Since ATSDR's first visit, considerable sampling has been completed at the arsenal. ATSDR revisited Picatinny between April 22 and 23, 1998, again collecting information and meeting with Picatinny representatives and local officials. ATSDR also attended a restoration advisory board (RAB) meeting, where ATSDR staff presented an overview of the public health assessment (PHA) process (Picatinny Arsenal 1998b). From these meetings and a review of the available data, ATSDR determined that no immediate threats to public health existed, but that several potential exposure pathways and community health concerns required further evaluation. ATSDR addresses the public's health concerns in the "Evaluation of Potential Exposure Pathways" and "Community Health Concerns" sections of this public health assessment.

At the request of the RAB, ATSDR evaluated potential public health hazards associated with PCB-contaminated soil, with respect to future uses of PICA sites 63 and 66 in Area B (also known as remedial investigation concept sites 20/24). In the January 1999 Health Consultation, ATSDR recommended that the Army remediate or restrict access to a PCB-hot spot (north and southwest of a gravel pad) prior to any future construction activities because of possible

noncancer health effects to construction workers. A detailed discussion of ATSDR's conclusions and recommendations is presented in the "Evaluation of Potential Exposure Pathways" section of this PHA.

Demographics and Land Use

ATSDR examines demographic information, or population information, to identify potential receptors, including sensitive populations such as young children and the elderly, in the vicinity of a site. Demographic information also provides details about residential history in a particular area, which helps ATSDR assess time frames of potential human exposure to contaminants. ATSDR also reviews land uses at and near Picatinny to identify information on the types and frequency of activities conducted by the surrounding population and possible exposures that may result from these activities.

The area of Morris County around Picatinny was at one time predominantly suburban and summer-vacation property. As a result of the westward urban expansion along the Intestate 80 corridor from New York City, however, nearby communities are rapidly growing. Currently, Morris County has a population of more than 421,000 residents. Morris County residents have access to 27 county parks, 19 golf courses, several recreational areas (e.g., ski areas), and numerous natural lakes that provide fishing and water sports. Education needs are provided by 38 public school districts with 146 public schools, 7 parochial schools, and 21 private schools. More than 158 private nursery schools, 140 day care centers, and 210 family child care providers are located within the county (IT 1998).

Picatinny employs 2,800 civilian and military personnel who research and develop explosives and military weaponry. Arsenal access is restricted to military personnel, their families, and civilian employees. Gate guards are on-duty part-time during the day and full-time at night. A perimeter fence surrounds most of Picatinny; some areas, such as Lake Denmark, are beyond the perimeter fence. Picatinny police regularly patrol all areas of Picatinny, both inside and outside of the perimeter fence, every day of the year. Additional measures are also in place to minimize trespassing, however, the Army has not released the details of the measures for security reasons. Several areas within Picatinny have greater security requirements and access is further limited by fences and security checks. Arsenal visitors must obtain a badge and permit to enter the arsenal. In 1994, approximately 120 military personnel and their families resided at the arsenal. On-site housing primarily consists of detached housing located along Parker Road and other connected smaller roads that cross the southern portion of the arsenal (within and near Area C) (D&M 1998e; Rosen 1999a; Gabel 2001). Other housing areas are located along Farley Avenue and in the Naval Hill Area (within and near Area L) (Gabel 1999). At this time, the Army does not have plans to convert any of the industrial areas into residential use as defined by the current Master Plan (D&M 1998e).

Recreational areas at Picatinny include baseball fields, parks and recreation areas, a golf course, a skeet and trap range, hunting grounds, and lakes and streams. Four baseball fields are located throughout the arsenal. Parks and recreational areas are located throughout the arsenal proximate to the baseball fields and Lake Denmark. The golf course and skeet and trap ranges are located in the southern portion of the arsenal. The Army also issues about 200 hunting permits each year, resulting in an estimated harvest of about 50 deer annually. Hunting activity occurs in less developed, low-lying land such as Areas B and C in the southern portion of the arsenal (Gabel 1999; D&M 1998e). Consumption of deer harvested at Picatinny is unlikely to expose people to site contamination. Most hunting occurs in the southern portion of the arsenal. Much of the habitat in this part of the arsenal is undeveloped land and is not contaminated. In addition, the Army has studied bioaccumulation of contaminants in deer at the Joliet Army Ammunition Plant in Illinois and the Aberdeen Proving Ground in Maryland. Similar to Picatinny, these facilities are used for munitions production, storage, and/or research. At these facilities, the Army studied bioaccumulation of PCBs, pesticides, metals, and explosives, which were found in similar concentrations at Picatinny (CHPPM 1995; USAEHA 1994). ATSDR concluded that consumption of deer taken from Picatinny during recreational hunting would no result in illness or adverse health effects because 1) studies of similar Army facilities with similar contaminants and concentrations found contaminants in deer tissue below levels of health concern, and 2) much of the deer habitat at Picatinny is undeveloped and uncontaminated, so that deer would only have limited exposure to contaminants.

Recreational lakes include the 200-acre Lake Denmark in the northern portion of the arsenal and the 108-acre Picatinny Lake in the central portion of the arsenal. Both lakes are at most 20 feet deep. Green Pond Brook is a recreational stream that originates at Green Pond located just beyond the northern arsenal boundary and flows southerly through the arsenal. Ponds located in the eastern portion of the arsenal—Fishers Pond, EOD Pond, South Basin, North Basin, 1500 Pond, G2 Pond, and Gravel Dam Cove—are also used for recreation. Although swimming is prohibited, boating is allowed in Picatinny Lake and Lake Denmark. Approximately 400 fishing permits are issued annually to military and civilian personnel for fishing at Picatinny Lake, Lake Denmark, Green Pond Brook between Lake Denmark and Area F, and the ponds. The Army annually stocks Picatinny Lake with northern pike and 7 to 9 inch largemouth bass. Lake Denmark is stocked with walleye. These fish require several years of growth before reaching their legal catch size. The Army also stocks Green Pond Brook with rainbow and brown trout once or twice a year. The trout are stocked at their legal catch size. Fishing may also occur beyond arsenal boundaries in both Green Pond Brook and Rockaway River, located downstream of Green Pond Brook (D&M 1998e; Gabel 1999; Van der Ventor 2000).

Quality Assurance and Quality Control

In preparing this PHA, ATSDR relied on the information provided in the referenced documents. Documents prepared for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) programs must

meet specific standards for adequate quality assurance and control measures for chain-of-custody procedures, laboratory procedures, and data reporting. The validity of the analyses and conclusions drawn in this document are dependent on the availability and reliability of the referenced information. The environmental data presented in this PHA are from preliminary assessments, site investigations, and RIs completed by the Army; a geohydrologic study and biological study of recreational waters conducted by CHPPM (formerly the U. S. Army Environmental Hygiene Agency); and groundwater and surface water assessments done by the U.S. Geological Survey.

EVALUATION OF POTENTIAL EXPOSURE PATHWAYS

In this section, ATSDR evaluates whether community members have been (past), are (current), or could be (future) exposed to harmful levels of chemicals. Figure 3 describes the conservative exposure evaluation process used by ATSDR. As the figure indicates, ATSDR considers how people might come into contact with, or be exposed to, contaminated media (e.g., groundwater and surface soil). Specifically, ATSDR determines whether an exposure could occur through ingestion, dermal (skin) contact with contaminated media, or inhalation of vapors, and also considers the likely length (duration) and frequency of the exposure.

If exposure was or is possible, ATSDR then considers whether chemicals were or are present at levels that might be harmful to people. ATSDR does this by screening the concentrations of contaminants in an environmental medium against health-based comparison values (CVs). CVs are chemical concentrations that health scientists have determined are not likely to cause adverse effects, even when assuming very conservative exposure scenarios. Because CVs are not thresholds of toxicity, environmental levels that exceed comparison values would not necessarily produce adverse health effects. If a chemical is found in the environment at levels exceeding its corresponding CVs, ATSDR examines potential exposure variables and the toxicology of the contaminant. ATSDR emphasizes that regardless of the level of contamination, *a public health hazard exists only if people come in contact with, or are otherwise exposed to, harmful levels of contaminated media.*

After an initial review of potential health hazards at the Picatinny Arsenal, ATSDR identified the groundwater, surface soil, and surface water and sediment exposure pathways as requiring further evaluation. Following the strategy outlined above, ATSDR examined whether human exposure to harmful levels of contaminants via these pathways existed in the past, exists now, or could potentially exist in the future. ATSDR summarizes its evaluation of potential exposure pathways in Table 2 and describes it in more detail in the discussion that follows. To acquaint readers with terminology used in this PHA, a list of CVs and a glossary are included in Appendices A and B, respectively. In addition, Appendix C presents the methods and assumptions used to estimate exposures and support some of the PHA's conclusions.

Groundwater Exposure Pathway

After reviewing groundwater monitoring data, drinking water well sampling data, and potential exposures, ATSDR concluded that exposure to contaminants in groundwater at Picatinny is unlikely to cause adverse health effects. The information presented below supports ATSDR's conclusion.

Hydrogeology

Groundwater in the vicinity of Picatinny is a source of drinking water for the arsenal and surrounding communities. Three separate underground layers of water, or aquifers, were identified beneath the arsenal: an unconfined glacial aquifer (water table), a semi-confined aquifer consisting of an upper and lower unit, and a bedrock aquifer. An unconfined aquifer has no barriers that might prevent water from entering or leaving the aquifer—water movement is unrestricted. A semi-confined aquifer has barriers that slow or influence how the water enters or leaves the aquifer, such as clay layers—water movement is partially restricted. Groundwater in the aquifers largely flows toward the southwest and Green Pond Brook, although groundwater flow direction in the lower semi-confined aquifer is influenced by pumping wells. Most area drinking water is drawn from the more productive glacial deposits in the lower semi-confined aquifer, but domestic bedrock wells that require low yield are also common in the area (D&M 1998e; ICF Kaiser Engineers 1998a).

Groundwater Use

On-site Drinking Water Wells: Picatinny obtains its drinking water from potable groundwater-supplied wells that primarily draw water from the lower semi-confined aquifer. Well water is pumped to a treatment plant, where water is aerated and chlorinated and then distributed to drinking water taps. To date, the following 13 potable wells have been drilled at the installation:

TABLE 3: On-Site Drinking Water Supply Wells

Well Number	Period of Operation	Use
410 and 430A (Area F)	1940s to present	These wells serve as emergency use supply wells and provide drinking water and process water, used for non-drinking purposes, to the arsenal. Drinking water is chlorinated and treated to remove VOCs prior to use and process water remains untreated. Well 430A was closed for a period in 1996 due to mechanical problems and is not currently used.
302D (Area G)	1921 to present	Well 302D is an active water supply well. Drinking water is chlorinated and treated to remove VOCs prior to use.
Cove Well (3820) (Area J)	unknown to present	Cove Well, also referred to as Well 3820, is a drinking water supply well for the Lake Denmark picnic area and, as such, is only used during the summer months.

TABLE 3: On-Site Drinking Water Supply Wells

Well Number	Period of Operation	Use
129 (Area D)	1947 to 1998	Well 129 operated as a drinking water supply well until 1998 when it was closed because of VOC contamination. Between 1983 and 1998, however, Well 129 only served as an emergency supply well. The Army received approval from the New Jersey Department of Environmental Protection (NJDEP) to use Well 129 as an emergency supply during 1989 when Well 430A was closed due to mechanical problems. NJDEP required that, based on sampling results, well water meet all state drinking water standards for use. These standards for chemical concentrations apply to water samples collected at the point of use, or tap. This well was permanently closed under local, state, and federal regulations in summer 2000 because of contamination.
130 (Area D)	1947 to 1983	VOC contamination lead to the closure of Well 130. Later site investigations found that pumping this well may have drawn contamination from the unconfined (water table) aquifer to the lower aquifers.
131 (Area D)	1999 to present	The Army installed Well 131 to replace Well 129 and is awaiting NJDEP approval before using this well as a drinking water supply. As-of February 2000, this well has been used on a temporary basis.
101 (Area I), 507B (Area I), 509 (Area I), 530 (Area I)	unknown to 1979	These wells were closed because of high manganese concentrations and/or mechanical problems. Each of these wells ceased supplying water during or before 1979.
305A (Area G)	1938 to 1983	In 1983, the Army closed Well 305A. The reason for closure is unknown.
1227 (1227A) (Area O)	unknown	This well is no longer used. It is unknown when the well was closed and why.

Source: D&M 1997 1998b, 1998c; Gabel 1999, 2001; USAEHA 1979

Of these 13 wells, 8 have been closed for a number of reasons. One well, Well 129, was permanently closed in accordance with all local, state, and federal regulations in summer 2000. The process for closing the other seven wells is unknown. Most of these wells were closed over 20 years ago and the process and regulations for closing wells at that time are unknown. The Army is currently gathering additional information about the seven closed wells and planning investigations of the wells (Gabel 2001). Because improperly closed wells can pose a physical hazard to people at the surface and can serve as a preferred migration pathway for transporting contamination from one aquifer to another, ATSDR will review new information about the well closures to assess the impact of the closed wells on public health.

The active on-site supply wells draw water from the lower semi-confined aquifer strata. The Army pumps the wells on a rotating basis, depending on the quantity of water in each of the wells. The available water supply in any one well tends to fluctuate in response to the pumping duration. Currently, the water is treated with an air stripper unit to remove VOCs before it is distributed to drinking water taps. The Army investigated treatment methods to remove explosives from the water, if needed. There are no current plans to install drinking water wells that would draw water from the unconfined (water table) aquifer, which typically contains the highest levels of contamination and is often non-potable because of other factors such as high mineral content (D&M 1998e).

Off-site Public Wells: Towns surrounding Picatinny operate groundwater wells to provide the municipal drinking water supply for local residents. The Dover Water Department and Wharton Water Department operate municipal water supply wells located within 2 miles of Picatinny. The nearest public supply wells are operated by the Wharton Water Department and are located along West Central Avenue, approximately 1 mile south of Picatinny. None of the wells operated by the Dover or Wharton Water Departments have been impacted by contamination at Picatinny. Both suppliers regularly test their water supplies under state regulations to ensure that safe drinking water is provided to the community. Other drinking water suppliers located proximate to Picatinny include the Boonton Water Department, Denville Township Water Department, Rockaway Borough Water Department, and Rockaway Township Water Department. Wells operated by these suppliers are located 2 miles or more beyond the Picatinny boundaries and are also not impacted by any site-related contamination (NJDEP 1999; Ruig 1999).

Off-site Private Wells: Some residents near Picatinny operate private wells for their drinking water supply. During site investigations, the Army identified 21 private wells south of Picatinny that may be impacted by arsenal contamination. Five of these wells are located proximate to the southeastern property boundary along Richard Mine Road, Teabo Road, and Bobinic Lane. It is unknown if these wells draw water from the unconfined glacial aquifer (water table), semi-confined aquifer, or bedrock aquifer (Picatinny Arsenal 1998a; Roy F. Weston 1992).

Nature and Extent of Groundwater Contamination

On-Site: Since the 1970s, several hundred groundwater monitoring wells have been installed at Picatinny to monitor the groundwater quality in potential areas of contamination and in areas where this contamination may migrate off site along the southern arsenal boundary. Picatinny has analyzed groundwater samples for VOCs, semi-volatile organic compounds (SVOCs), explosives, pesticides, metals, radiological parameters, and dioxins to determine the presence, nature, and extent of contamination in the unconfined (water table) aquifer, the semi-confined glacial aquifer consisting of an upper and lower unit, and the bedrock aquifer.

VOCs, primarily PCE and TCE, SVOCs, pesticides, explosives, and metals have been detected in groundwater underlying the arsenal. The highest concentrations were generally detected in the

unconfined (water table) aquifer. Much lower concentrations, if any, were measured in the lower semi-confined aquifer, from which on-site drinking water is drawn. A summary of site investigations conducted in Areas A through G is provided below. During preliminary investigations, the Army identified these areas as having the greatest potential for exposure for arsenal contaminants to migrate beyond Picatinny boundaries. The maximum detected contaminant concentrations for each area are provided in Table 4.

- Area A: This 7-acre area consists of an active burning area, an inactive waste pile, and an inactive landfill. The burning area is used to treat wastes derived from explosive manufacturing. The waste pile and landfill were used for storage disposal of arsenal wastes, primarily cement, bricks, and wood. The waste pile has been removed. The burning grounds are located along the southern boundary of the arsenal and groundwater contaminants in this area may migrate to off-site private wells to the south. Groundwater sampling of shallow, intermediate, and deep monitoring wells between 1989 and 1993 detected TCE, bis(2-ethylhexyl)phthalate, RDX, 2,4,6-trinitrotoluene, and metals above CVs. The explosive nitrocellulose was also detected, but no CV is available (D&M 1994).

- Area B: Located along the southern boundary of the arsenal, PICA sites 63 and 66 were used for pyrotechnic training and landfilling, respectively. There is a concern about contaminants migrating from this area toward private wells to the south of the arsenal. Carbon tetrachloride, vinyl chloride, naphthalene, 1,3,5-trinitrobenzene, and metals were detected above CVs in groundwater samples from the unconfined (water table) aquifer. Only manganese (to a maximum concentration of 116 parts per billion [ppb]) was detected above CVs in the lower semi-confined aquifer. The explosive compound nitrocellulose was also found in groundwater, but no CVs currently exist for this compound. Additional groundwater sampling conducted in 1997 and 1998 found benzene, 1,1-dichloroethene, 1,2-dichloroethene, TCE, vinyl chloride, bis(2-ethylhexyl)phthalate, n-nitrosodiphenylamine, arsenic, and manganese above CVs in the unconfined (water table) aquifer. 1,1-Dichloroethene, 1,2-dichloroethene, TCE, and vinyl chloride were found above CVs in the upper semi-confined aquifer. No contaminants were found above CVs in the lower semi-confined aquifer (Picatinny Arsenal 1998a; D&M 1997; ICF Kaiser Engineers 1999b).

- Area C: Area C includes six PICA sites. Area-wide investigations in the early 1990s found carbon tetrachloride, TCE, vinyl chloride, bis(2-ethylhexyl)phthalate, naphthalene, pesticides, 1,3,5-trinitrobenzene, and metals above CVs in the unconfined (water table) aquifer. Nitrocellulose was also detected, however, there is no CV for this explosive. Only arsenic (to 9.2 ppb), lead (to 34.2 ppb), and manganese (to 907 ppb) were detected above CVs in the lower semi-confined aquifer (D&M 1998a).

  PICA site 65 is located in Area C along the southeastern arsenal boundary and poses the greatest concern for off-site migration toward nearby private wells. PICA site 65 is a 2-

acre landfill known as the Post Farm Landfill. Between the 1940s and the late 1970s, the southern most section of the landfill, known as the Drum Burial Area, was used for disposal of fly ash from coal burning operations and for disposal of industrial wastes, including soil, tar, batteries, and small containers of chemicals. Only bedrock groundwater sampling has been completed at this site and only metals have been detected above CVs. In 1993, the Army conducted a non-time critical removal action to eliminate contaminant sources. Approximately 30 cubic yards (cy) of soil, 30 cy of scrap metal and solid waste, 41 drums of various wastes, and 349 empty drums were disposed of off site. The excavated areas were backfilled with clean soil and the area was seeded to promote vegetative growth (Roy F. Weston 1992, 1993).

- Area D: Area D consists of 14 PICA sites, including PICA sites 76 and 120 which are associated with buildings 24 and 31. A TCE groundwater plume extends 1,600 feet from these sites and is the main reason for the listing of Picatinny on the National Priorities List. Two sand-lined lagoons and a dry well at building 24 were the likely sources of VOC groundwater contamination. From the 1960s through 1981, wastewater from a wastewater treatment system for a metal plating operation was discharged into the two lagoons. The sandlined bottoms of the lagoons allowed some of the wastewater to seep into the ground. Residual wastewater was also discharged to Bear Swamp Brook, a tributary to Green Pond Brook. Groundwater sampling between 1981 and 1984 found 1,2-dichloroethene, PCE, TCE, and metals above CVs. The maximum detected concentrations of these contaminants were found in the unconfined (water table) aquifer.

  Additional groundwater sampling conducted in 1993 and 1994 under the Phase I RI found VOCs, bis(2-ethylhexyl)phthalate, heptachlor, PCBs, metals, and explosives above CVs in the unconfined (water table) aquifer. Only TCE (to 15 ppb), heptachlor (to 0.05 ppb), and metals were found above CVs in the upper semi-confined aquifer. The lower semi-confined aquifer contained TCE and metals, whereas the bedrock aquifer contained TCE, bis(2-ethylhexyl)phthalate, and metals above CVs. Nitrocellulose was detected in each of these aquifers, however, no CVs exist for this explosive. The maximum detected concentrations of most contaminants were found in the unconfined (water table) aquifer. To mitigate this groundwater plume, the seepage lagoon was replaced with a concrete lined settling basin in 1981, contaminated soil contributing to the plume was removed in 1985, and a relief line that led to an overflow pit was capped (USGS 1990). Since 1992, a pump and treat facility has operated to provide a hydraulic barrier to protect Bear Swamp Brook (Picatinny Arsenal 1998a; D&M 1999).

- Area E: Four PICA sites located in the south-central portion of the arsenal comprise Area E. Groundwater sampling in Area E found VOCs, bis(2-ethylhexyl)phthalate, alpha-HCH (alpha-hexachlorocyclohexane), total PCBs, and metals above CVs in the unconfined (water table) aquifer. The explosive nitrocellulose, which has no CV, was also detected. Only iron (to 31,700 ppb) and manganese (to 601 ppb) were detected in the lower semi-

confined aquifer. Building 95 and associated impoundments were found to be the greatest contributors to area groundwater contamination. The impoundments consisted of two unlined sand filter lagoons and one unlined sludge drying bed. From the early 1960s through October 1981, the lagoons received wastewater from the metal plating and etching process at building 95, and the drying beds received sludge. Contaminants in the treated wastewater and sludge included VOCs and metals. These impoundments were closed in 1981 and early 1990 (D&M 1998c).

- Area F: The 17 PICA sites associated with Area F are located south of Picatinny Lake and proximate to Green Pond Brook. Groundwater investigations of Area F detected VOCs, bis(ethylhexyl)phthalate, RDX, and metals above CVs in the unconfined (water table) aquifer. Nitrocellulose was also detected in groundwater, but there is no CV for this explosive. PCE (to 1 ppb), RDX (to 14 ppb), arsenic (to 5.2 ppb), iron (to 22,100), lead (to 48 ppb), and manganese (to 1,000 ppb) were detected above CVs in the lower semi-confined aquifer (D&M 1998c).

- Area G: Area G is comprised of eight PICA sites located along Green Pond Brook in the south central portion of Picatinny. PCE, TCE, RDX, and metals were found in groundwater above CVs during area-wide investigations. In addition, the explosive nitrocellulose, which has no CV, was detected. Sampling of the lower semi-confined aquifer found TCE (to 5.6 ppb), RDX (to 6.1 ppb), arsenic (to 3 ppb), iron (to 19,500 ppb), manganese (to 597 ppb), and thallium (to 144 ppb) above CVs (D&M 1998d).

During arsenal investigations and as part of normal operation, the Army sampled the water supply wells at the arsenal. The following paragraphs provide a description of both active and inactive wells at Picatinny, including a general summary of contaminants found in these wells. The maximum detected concentrations of contaminants detected above CVs in supply wells are provided in Table 5.

- Active Wells: Well 410, 302D, Cove Well, and 131 serve as the active water supply wells at Picatinny. During sampling conducted between 1987 and 1991, VOCs, RDX, and metals were detected above CVs in water from Well 410. Sampling of Well 302D found only manganese above its CVs. No contaminants were found above CVs in Cove Well (D&M 1998c, 1998d; USGS 1986). Well 131 was installed to replace the closed Wells 129 and 130. The Army is currently awaiting NJDEP approval before beginning operation of this well; this well has operated on a temporary basis as of February 2000. The Army currently operates a groundwater treatment system to remove VOCs from the water supply. The Army also conducts regular water supply sampling to ensure successful VOC treatment and ensure that concentrations of explosives are below drinking water standards. Moreover, the Army investigated possible means to remove explosives from the water supply, if needed (Picatinny Arsenal 1998a; Gabel 1999)

- Inactive Wells: There are nine inactive water supply wells at Picatinny (Wells 430A, 129, 130, 101, 507B, 509, 530, 305A, and 1227). Well 430A was closed due to mechanical problems in 1996. Only arsenic and manganese had been detected in this well above CVs. Wells 129 and 130 were closed because of VOC contamination. Well 129 was later abandoned permanently because of mechanical problems. Benzene, PCE, TCE, iron, lead, and manganese were detected in these wells above CVs. Wells 101, 507B, 509, and 530 were closed due to high concentrations of manganese, which is naturally occurring in regional groundwater, and/or mechanical problems. Well 305A was closed in 1983; the reason for closure is unknown. Arsenic, iron, lead, and manganese were detected above CVs during past sampling of this well. Well 1227 was also closed, but the reason for its closure and the date of closure are unknown. No contaminants have been found above CVs in this well (D&M 1998c, 1998d; USGS 1986; USAEHA 1979).

Off-Site: There is potential for contaminants in the southern portion of the arsenal to migrate beyond arsenal boundaries in groundwater or groundwater discharge to surface water (Green Pond Brook). Several municipalities operate groundwater wells which provide the public drinking water supply. Public water supply wells are tested regularly under state regulations. No contaminants associated with Picatinny have been found in the public drinking water supplies. During site investigations, the Army identified 21 homes located along the southern arsenal boundary that operate private wells for their drinking water supply. Because on-site contamination may migrate to these wells, the Army conducted the following private well sampling:

- Starting in 1988, the Army conducted annual well water monitoring of residential wells along the southern boundary of the arsenal. Each of these wells has been sampled over 20 times as part of the annual monitoring program. In the fall of 1990, the sampling revealed low levels of explosive compounds in three residential wells. RDX was found at a maximum concentration of 8.6 ppb (Table 6). In 1991, the Army began a monthly sampling program at 16 off-site private wells to the south. During the first year, the explosive RDX was detected one time at very low levels. As soon as the explosives were detected, the Army began providing bottled water to residents. The Army continued to supply residents with bottled water until 1996, when the homes were connected to the municipal water supply (Picatinny Arsenal 1994, 1998a; Rosen 1999b, 1999c).

- In July 1991, the Army sampled five off-site private wells located along Richard Mine Road, Teabo Road, and Bobinic Lane, which are proximate to PICA site 65 (Post Farm Landfill). These wells were sampled for explosives to determine if contamination from PICA site 65 may have impacted the wells. No explosives were detected. The residential wells were sampled again in December 1991 for VOCs, SVOCs, and metals. No VOCs or SVOCs were found and metal concentrations met state and federal safe drinking water standards (D&M 1998a)

Evaluation of Potential Public Health Hazards

On-site Drinking Water Supply Wells: In the past, on-site workers and residents were exposed to VOCs, RDX, and metals detected above CVs in on-site water supply wells. To determine whether the detected concentrations may have posed a health hazard to on-site workers or residents, ATSDR calculated exposure doses using the maximum detected concentrations of contaminants in on-site wells and conservative ingestion rates (2 liters per day). Because it is unknown when contamination first entered on-site wells, ATSDR also assumed that workers or residents would have consumed drinking water every day over 30 years for an adult or 6 years for a child. These are extremely conservative assumptions because workers receive only a portion of their daily water intake from Picatinny water supplies and military personnel and their families are stationed at Picatinny for much shorter periods than assumed. ATSDR also assumed that 100 percent of the water used for drinking contained the maximum detected contaminant concentrations over the entire exposure period, a conservative assumption about exposure since most consumers probably drank water from other sources and were probably exposed to much lower concentrations, if any, over time. A more detailed discussion about the methods and assumptions used in ATSDR's evaluation is presented in Appendix C of this PHA.

ATSDR compared the estimated doses with available health guidelines (such as ATSDR's minimal risk levels and EPA's reference doses), cancer guidelines, and with data from available toxicologic studies. The health guidelines provide a conservative estimate of daily exposures to a chemical that are not likely to result in adverse effects, even for the most sensitive members of a community (e.g., pregnant women, children). In its analysis, ATSDR found that, even when assuming an individual drank all his or her water from the affected well containing the highest chemical concentrations, the estimated doses are less than the corresponding health guidelines and/or are lower than adverse effect levels reported in toxicologic literature for daily lifetime ingestion of these chemicals. For this reason, ATSDR finds that past consumption of drinking water is not expected to harm the health of workers or residents at the arsenal, or increase their likelihood of developing of cancer.

Exposure is not occurring now, nor is it expected to occur in the future. A treatment facility is operating to remediate VOC-contaminated groundwater and the Army monitors the water supply for explosives. The Army also investigated potential treatment option for removing explosives from the water supply, if needed. Although a groundwater treatment program is in place, ATSDR recommends that the Army inform the agency if the treatment program is altered. ATSDR will evaluate the effectiveness of new remedial options in protecting public health.

Off-site Public Wells: No exposure to arsenal-related contaminants in off-site public wells is likely to have occurred (past), is occurring (current), or will occur (future). Public water suppliers are required to routinely test drinking water to ensure that the water meets safe drinking water standards. No contaminants associated with Picatinny have been found in public water supply wells. Furthermore, the nearest public drinking water wells are located approximately 2 miles

from the southern boundary of Picatinny. ATSDR does not expect on-site groundwater contamination to move beyond arsenal boundaries and result in future impacts to off-site drinking water wells. ATSDR, however, recommends that the Army notify developers of land located downgradient of site groundwater contamination in order to provide further assurance to the public that new water supplies are safe to drink.

Off-site Private Wells: In the past, explosive compounds were detected in off-site private wells located along the arsenal's southern boundary. Using the same conservative process described for exposure to contaminants in on-site well water, ATSDR evaluated whether off-site private well users could have been exposed to harmful levels of contaminants when they drank water from their taps. A more detailed discussion about the methods and assumptions used in ATSDR's evaluation is presented in Appendix C of this PHA.

In comparing estimated doses with available health guidelines, ATSDR found that, even when assuming an individual drank all of his or her water from the private well, the estimated doses are less than the corresponding health guidelines and often many times lower than adverse effect levels reported in toxicologic literature for daily lifetime ingestion of these chemicals. For this reason, ATSDR finds that past consumption of drinking water is not expected to harm the health of the private well users, or increase their risk of cancer.

Exposure is not occurring now, nor is it expected to occur in the future. The Army has supplied bottled water and funded the extension of the Wharton waterline to the homes with wells potentially affected by explosives. The Rockaway Board of Health regulates private well drilling in the neighborhood where explosives were found in off-site groundwater. To drill a new well, a home owner must receive a permit from the NJDEP. After receiving a NJDEP permit, the homeowner applies for a town permit. The Rockaway Board of Health will only allow a homeowner to drill a drinking water well if no municipal water supply is available. A private drinking water well must be inspected by the Rockland Board of Health and tested before use. If a municipal supply is available, a homeowner can use a private well for non-drinking purposes (e.g., irrigation), but must use the municipal supply for drinking water. In the neighborhood where explosives were found in off-site groundwater, a municipal water supply is available and must be used as a drinking water source (Correale 2001).

Soil Exposure Pathway

After review of surface soil data and potential exposures, ATSDR concluded that exposure to contaminants in surface soil at Picatinny is unlikely to result in adverse health effects. The information presented below supports ATSDR's conclusion.

Nature and Extent of Soil Contamination

The majority of the 175 areas of contamination are located within the southern portion of Picatinny proximate to the arsenal facilities. Surface soil samples have been collected from these areas of contamination during site investigations. The primary soil contaminants are PAHs, explosives, and metals. High levels of PCBs were detected in Area B. ATSDR evaluated exposure to the PCB-contaminated soil in a separate health consultation, as discussed in the "ATSDR Involvement" section of this PHA and below.

Several areas of contamination are located within recreational areas of the arsenal. A summary of contaminants detected above CVs at recreational areas is provided in Table 7. Two baseball fields are located within PICA site 92, in Area C, in the southern portion of Picatinny. Surface soil sampling found arsenic (to a maximum concentration of 6.57 parts per million [ppm]) and iron (to 34,400 ppm) above CVs (D&M 1998a). A third baseball field is partially located within PICA site 176 in Area L. A site investigation has been completed and no further action with institutional controls is proposed because contaminants were found below levels that might adversely affect a person's health. PICA site 97 consists of a building located within the golf course in the southern portion of the arsenal. Past investigations found chlordane and metals above CVs in surface soil. The Army is conducting ongoing investigations at this site (Picatinny Arsenal 1998a; Rosen 1999a). The Army issues approximately 200 hunting permits each year. Hunting occurs primarily in the low-lying, undeveloped portions of the arsenal near Areas B and C. Surface soil sampling in these areas detected PAHs, pesticides, PCBs, and metals above CVs (D&M 1998e). Remaining recreational areas, including a fourth baseball field near Lake Denmark and a trap and skeet shooting range in the southern portion of the arsenal, are located beyond areas of contamination identified at Picatinny.

Evaluation of Potential Public Health Hazards

People that may come into contact with contaminants in surface soil include on-site workers, recreational users, and hunters. On-site housing is located away from areas of contamination, therefore, residents are not expected to contact contamination at their homes. Access restrictions to the arsenal also prevent exposures. On-site workers, including military and civilian personnel, may contact contaminated soil, primarily PAHs, explosive compounds, and metals. Any exposure, however, is expected to be brief and intermittent. Recreational users may contact contaminants in surface soil, including PAHs, pesticides, PCBs, and metals, at the baseball fields and golf course, and hunters may contact contaminants in low-lying, undeveloped portions of the arsenal used for hunting, primarily Areas B and C. Potential health hazards from contact with PCBs are discussed below. PAHs and pesticides were detected in less than half the surface soil samples collected, and not all detected concentrations were above CVs. Metals were detected in most soil samples, however, metals are a natural component of soil and not all detected concentrations were above CVs. In addition, CVs are derived assuming daily contact with contaminants in soil. Recreational use and hunting is expected to occur less frequently than assumed by the CV, based on the

regional climate and hunting season constraints. Past exposures by on-site workers, recreation users, and hunters, therefore, are unlikely to pose potential health hazards. Soil remediation has been completed at some areas and is ongoing at others to prevent current and future exposures.

Potential health hazards from exposure to PCB-contaminated soil in Area B were evaluated separately by ATSDR under a health consultation completed in 1999. The RAB for Picatinny requested that ATSDR evaluate potential health hazards from contact with PCBs in surface soil at PICA sites 63 and 66 (also known as sites 20/24) at Area B because of a decision by the Army to conduct no further remediation at these sites. ATSDR evaluated the potential for an increased risk of developing cancer or experiencing noncancer effects from PCB exposure at these sites. ATSDR concluded that there was no increased risk of cancer, however, construction workers at the site for long-term (months) projects may suffer noncancer effects from exposure to a PCB hot spot (to 296 ppm). Evaluation of chronic exposures (exposures that occur over many years) found no increase in possible health effects to trespassers or hunters that may infrequently access the site. To protect future construction workers, ATSDR recommended that the Army remediate or restrict access to areas with high PCB concentrations, including the areas north and southwest of the gravel pad and the western portion of the sampling area, prior to any future construction activities (ATSDR 1998b, 1999a). Past and current exposures are not expected to result in adverse health effects because exposures to trespassers or hunters were and are likely brief and infrequent due to site access restrictions and workers were and are expected to have worn personal protective equipment.

Surface Water and Sediment Exposure Pathway

After review of surface water, sediment, and fish tissue data and potential exposures, ATSDR concluded that exposure contaminants in on-site water bodies is unlikely to result in adverse health effects. The information presented below supports ATSDR's conclusion.

Surface Water Hydrology

Most surface water runoff and water bodies at Picatinny discharge to Green Pond Brook, which runs southerly through the arsenal. Tributaries to Green Pond Brook include Burnt Meadow Brook, which flows through Lake Denmark in the northern portion of the arsenal, and Bear Swamp Brook, which flows along the western property boundary in the southern portion of the arsenal. Green Pond Brook flows southerly from Green Pond north of the arsenal, through Picatinny Lake, and eventually into Rockaway River, about 1 mile southeast of the site. Rockaway River continues about 12 miles before emptying into the Jersey City Reservoir (or Boonton Reservoir), a source of water for Jersey City. Near the eastern portion of Picatinny, surface water drains into Ames Brook rather than to Green Pond Brook. In addition to the streams and lakes at the arsenal, there are numerous wetlands located in poorly drained areas throughout the arsenal (ICF Kaiser Engineers 1998b).

Recreational use of water bodies at Picatinny is limited to fishing activities. Swimming is prohibited throughout the arsenal. Boating, usually by fishermen, is permitted in Picatinny Lake and Lake Denmark. Fishing from the shoreline or from boats, where possible, is permitted in Picatinny Lake, Lake Denmark, Green Pond Brook north of the Area F, Fishers Pond, EOD Pond, South Basin, North Basin, 1500 Pond, G2 Pond, and Gravel Dam Cove. G2 Pond and Gravel Dam Cove are only rarely used for fishing because these ponds are shallow and filled with aquatic vegetation. In addition to natural fish populations caught (perch, crappie, walleye, and sunfish), the Army also stocks game fish. The Army annually stocks Picatinny Lake with largemouth bass and northern pike and Lake Denmark with walleye. These fish require several years of growth before reaching their legal catch size. The Army also stocks Green Pond Brook with rainbow and brown trout once or twice a year. The trout are stocked at their legal catch size. Fishing may also occur south of the arsenal in both the Green Pond Brook and the Rockaway River (D&M 1998e; Gabel 1999; Van de Ventor 2000).

Nature and Extent of Surface Water/Sediment Contamination

Wastewater discharge from arsenal activities, past spills and releases, munitions storage, and short falls from munitions testing may have released contaminants to Picatinny Lake and Lake Denmark. Between 1989 and 1998, the Army conducted surface water and sediment sampling at Picatinny Lake, Lake Denmark, and Green Pond Brook upstream of the Area F, which are where recreational activities are permitted. Samples were analyzed for VOCs, SVOCs, PCBs, pesticides, metals, and explosives. No CVs are available for surface water and sediment, therefore, drinking water and surface soil CVs are used to evaluate detected contaminant concentrations. Drinking water CVs are derived assuming ingestion of 2 liters of water every day and soil CVs assume contact and ingestion of soil every day. These CVs, therefore, are extremely conservative values for assessing surface water and sediment, which are only contacted during recreational use. Sampling from Picatinny Lake detected methylene chloride, bis(2-ethylhexyl)phthalate, arsenic, chromium, lead, and manganese in surface water and PAHs and arsenic in sediment above CVs. At Lake Denmark, bis(2-ethylhexyl)phthalate, antimony, cadmium, lead, and selenium in surface water and benzo(a)pyrene, arsenic, and lead in sediment were detected above CVs. Samples collected from Green Pond Brook upstream of the lakes contained Aroclor-1260 (a PCB), RDX, arsenic, lead, and manganese in surface water and PCBs, arsenic, iron, and thallium in sediment above CVs (D&M 1998d, 1999; USGS 1996; USAEHA 1990; ICF Kaiser Engineers 1996, 1999a; IT Corporation 1999). Sampling results for surface water and sediment are presented in Tables 8 and 9, respectively.

In May 1989 and April 1990 and again during the Phase I and II RIs, the Army collected fish tissue samples throughout the arsenal. During these sampling events, the Army caught a variety of fish species for analysis, including minnows/shiners, mudminnow, suckers, catfish/bullhead, sunfish, perch, pickerel, bass, and trout. Some of these are stocked fish, but the majority are native to the lakes and streams at Picatinny and spend their entire lifecycle in Picatinny waters. Fish were also caught in a range of sizes (weight and length) to represent ranges of ages and

length of exposure to contaminants in the water. The 1989 and 1990 fish tissue samples included only the fillet, or edible portion of the fish. Fish samples from Picatinny Lake, Lake Denmark, Green Pond Brook, Fishers Pond, EOD Pond, South Basin, 1500 Pond, and G2 Pond contained chromium, mercury, nickel, and silver above CVs (USAEHA 1990). Table 10 summarizes the 1989 and 1990 sampling results. The Phase I and II RI fish tissue samples collected from throughout the arsenal included the whole fish, both edible and inedible portions. The whole body samples contained SVOCs, pesticides, PCBs, and metals, including mercury, above CVs (D&M 1998e; IT Group 2000). Table 11 summarizes the Phase I and II RI investigation results for whole body fish.

Evaluation of Potential Public Health Hazards

On-site recreational users may contact contaminants in surface water and sediment during boating and/or fishing at Picatinny Lake, Lake Denmark, Green Pond Brook, and ponds. If contaminants are transported off site during a flooding event, off-site recreational users may be exposed to contaminants in surface water or sediment. Although contaminants tend to disperse, or lessen in concentrations, when transported off site during flooding events, ATSDR assumed that off-site recreational users would be exposed to the same levels of surface water and sediment contamination as on-site recreational users. People that catch and consume fish from these water bodies may also be exposed to contaminants in fish tissue. No CVs are available for surface water and sediment, therefore, contaminant concentrations detected in surface water and sediment were compared to drinking water and surface soil CVs, respectively. Drinking water and surface soil CVs are derived using conservative assumptions, such as daily ingestion of 2 liters of drinking water or daily contact with and incidental ingestion of soil. Exposures to surface water and sediment are likely to be much less frequent based on recreational activities and constraints of the northeastern climate. In addition, surface water at Picatinny and immediately downstream of the arsenal is not used as a drinking water supply. Infrequent contact with contaminants in surface water and sediment during recreational use, either on or off site, is unlikely to result in adverse health effects.

Several metals, including mercury, were detected in the fish fillets, the edible portions of fish tissue, above their CVs. The whole body samples contained SVOCs, pesticides, PCBs, and metals above CVs. In evaluating potential health effects, ATSDR considers contaminant concentrations found in the fish fillets as representative of possible exposures because this is the portion of the fish actually consumed. Contaminant concentrations in the whole fish samples are considered an over estimate of actual exposures because many contaminants bioaccumulate in portions of the fish that are not consumed. Of the 15 contaminants found in whole body fish samples, 10 were detected in more than 25% of the samples. Bis(2-ethylhexyl)phthalate, alpha-BHC, DDD, DDE, DDT, Aroclor-1254, and Aroclor-1260 are lipid (or fat) soluble (ATSDR 1998c, 1999b, 2000a, 2000b). As such, these contaminants tend to accumulate in the fatty tissues of the fish, which are typically not consumed. Arsenic selectively accumulates in the liver in fish, which also is usually not consumed (ATSDR 1998a). Information about where and if iron selectively bioaccumulates in

fish is limited. Iron, however, is an essential nutrient and no known cases of iron poisonings or illnesses have been reported from exposure to iron in foods. Iron poisonings are a concern for children under 6 years who accidentally consume a number of iron-containing multivitamins (FDA 2000). Information about chromium bioaccumulation is also limited, however, chromium was found in the fillet samples at higher levels than in the whole body fish samples. ATSDR, therefore, considered the chromium concentrations reported in the fillet samples as representative of possible exposures.

The CVs for fish tissue are derived using the conservative assumption that a person eats, on average, one serving of fish every 2 days. Studies of recreational fishermen found that they eat one serving of fish every 6 to 20 days. In addition, contaminants were detected above CVs in only a portion of the samples with detected concentrations. Recreational fishers at Picatinny are unlikely to continuously consume fish with the maximum detected metals concentrations (chromium, mercury, nickel, and silver) in fillet samples at the frequency assumed by the CVs. Past exposure to contaminants in fish tissue, therefore, is unlikely to have resulted in adverse health effects.

The Army is conducting remediation activities at various locations throughout Picatinny to prevent additional contamination from entering surface water bodies. The Army is continuing to investigate the impacts of contamination to fish populations. ATSDR will review data generated from these investigations to evaluate public health impacts from consuming fish from arsenal water bodies. In 1999, the Army drafted fishing restrictions based on a state of New Jersey fish consumption advisory prompted by the detection of elevated mercury levels in freshwater lakes throughout New Jersey. This advisory suggests that the general population follow state guidelines to eat no more than one meal per week of largemouth bass and chain pickerel. High risk individuals (e.g., pregnant women, nursing mothers, and children under 5 years old) should not eat any chain pickerel and only one meal per month of largemouth bass. Current and future exposures to contaminants in surface water, sediment, and fish tissue, therefore, are unlikely to result in adverse health effects. Picatinny personnel and fishermen were notified about the draft restrictions in 1999. In March 2000, the Army further notified Picatinny fishermen, residents, and employees about the fishing restrictions. This notification was also printed in the Rod and Gun Club Newsletter. Since the initial notification in 1999, people obtaining fishing permits for the arsenal receive a copy of the fishing restrictions. The fishing restrictions are also available for any person requesting a copy (Gabel 2001).

COMMUNITY HEALTH CONCERNS

As part of its community relations activities, Picatinny personnel meet periodically with community members to monitor community concerns. These meetings occur during regular RAB sessions and also during public meetings held as required during the remediation process under CERCLA (IT 1998). ATSDR identified several community concerns, as discussed below and in the "Evaluation of Potential Exposure Pathways" section of this PHA, through discussions with community members and RAB members during the April 22, 1998, RAB meeting; reviewing the 1998 Community Relations Plan, which contains results of an Army interview of community members; and speaking with Army personnel throughout the PHA process. Individuals who would like more information on the activities and proposed remedial actions for specific areas at Picatinny may review copies of arsenal documents in the following repositories: the Morris County Library, Rockaway Township Public Library, and Building 319 at Picatinny. As required under CERCLA, the information repositories are kept up-to-date by the Administrative Record Clerk at Picatinny. On a quarterly basis, new documents are added to the record and supplied to the libraries and EPA. The information repositories consist of (1) a list of administrative documents, (2) a point of contact, which is the Administrative Record Clerk, (3) fact sheets, (4) the Community Involvement Response Plan, (5) environmental assessments, and (6) the RAB Meeting Minutes and handouts (IT 1998; Gabel 2001).

- Off-site migration of contaminated groundwater and possible future effects on municipal wells.

  As discussed in the "Evaluation of Potential Exposure Pathways" section of this PHA, groundwater contaminants pose no public health hazards to people using off-site public water supplies. The nearest public water supply well is located approximately 2 miles south of Picatinny and is operated by the Dover Water Department. This well has not been impacted by arsenal contamination. In addition, the Dover Water Department, as well as other municipal water suppliers, are required to test their water supply wells regularly to ensure the safety of the water supply.

- Potential exposure of recreational users to site-related contaminants.

  Potential exposures to site-related contaminants during recreational use of Picatinny were assessed in the "Evaluation of Potential Exposure Pathways" section of this PHA. Recreational users at several baseball fields, the golf course, and hunting areas may contact contaminants above CVs in surface soil. Recreational users at designated fishing areas may contact contaminants above CVs in surface water, sediment, and fish tissue. In reviewing potential exposures, ATSDR concluded that potential exposures from recreational use of these areas are unlikely to cause adverse health effects. The drinking water and soil CVs used to screen contaminant concentrations detected in surface water, surface soil, and sediment were derived assuming that exposure occurs daily. Recreational

exposures are expected to be less frequent than assumed by the CVs. In addition, not all contaminant concentrations detected in each media were above CVs. The CVs for fish tissue were derived assuming that a person eats one serving of fish every 2 days. Studies of recreational fishermen found consumption rates are less frequent, one serving every 6 to 20 days. Contaminants were also detected above CVs in only a portion of the samples with detected concentrations. For example, mercury was detected in 61 of the 67 fish fillet tissue samples collected from Picatinny, but only in two samples did the mercury concentration exceed its CV.

- Exposure to air pollutants released from the ongoing on-site open burning of ammunition and the schedule for constructing an incinerator to replace the open burning pits.

The burning grounds (Area A) occupy approximately 7 acres in the southern portion of the arsenal. Various wastes have been burned at this site in the past and currently, including off-specification ammunition, sludge and sediment settled from explosive manufacturing waste water, and dust from filtration systems. Contaminants that may be found in these materials include nitrobodies, explosives, acids, and organics. Before 1985, materials were placed on the ground surface and burned. Since 1985, materials have been placed in metal pans for burning. Since 1994, burning operations have occurred approximately three times a week.

ATSDR considered possible exposures to people living off site through inhalation of fugitive dust generated by wind erosion of contaminated soil and inhalation of particulate matter from smoke from burning activities. Conclusions were based on a review of site-specific data, health-based air quality standards, and chemical characteristics of explosives—the primary material burned at the burning grounds.

As part of the investigations conducted at the burning grounds, the Army conducted an air pollution assessment in 1989. This assessment focused on estimating ambient air concentrations of soil due to wind erosion (fugitive dust). The study predicted that the highest concentrations of site contaminants transported as dust would be expected to be deposited in areas 2,500 to 3,000 feet northeast of the site (D&M 1994). Homes nearest to the burning grounds are located approximately 2,700 feet to the south and southeast along Richard Mine Road and it's side-streets (IT 1998). This study also included particulate matter monitoring around the perimeter of the site and found a maximum particulate matter level of 71 micrograms per cubic meter (ug/m^3) (D&M 1994).

In a subsequent 1994 investigation of the burning grounds, the Army evaluated possible health impacts to on-site workers and off-site residents from inhalation of fugitive dust and contact with contaminants in surface soil. Community members have expressed concern about dioxins produced during burning. Dioxins, which are generally produced during burning of chlorinated compounds, are not typically produced during burning of

explosives. However, some of the wastes burned at the site may have contained low-levels of chlorinated solvents. As such, investigations included an assessment of dioxin exposures. In conducting this assessment, the Army found that on-site workers would be exposed to the highest levels of contaminants in air and soil even though levels of off-site fugitive dust deposition were expected to be highest 2,500 to 3,000 feet northeast of the site. On-site soil contamination levels were anticipated to be higher than off-site soil contamination from fugitive dust deposition because a vegetative cover minimized soil movement and contamination would disperse during migration, which effectively reduces the contaminant concentrations. The Army evaluation, which was reviewed by ATSDR, found that contaminant levels on site were too low to result in adverse health effects to on-site workers, therefore, off-site contaminant levels would be too low to result in adverse health effects to off-site residents (D&M 1994).

No data are available to assess exposure to particulate matter in smoke during burning activities. The materials most commonly disposed of at the burning grounds consist of manufacturing wastes contaminated with explosives. Explosives are chemicals manufactured to be highly reactive in order to cause explosive destruction. As such, when an explosive is burned, it is quickly destroyed. Because burning causes complete destruction of explosives, the Federal Remediation Technologies Roundtable, a work group composed of federal agencies involved in site remediation, has identified open burning as an acceptable method for treating explosive-contaminated material. In open burning, explosives are destroyed by their own ability to react and burn (FRTR 2001).

Explosives are destroyed during open burning, therefore, ATSDR evaluated exposures to particulate matter generated in the smoke during open burning. EPA has set a National Ambient Air Quality Standard (NAAQS) for particulate matter, specifically PM_{10}, at 150 ug/m^3 averaged over 24 hours. NAAQS are health-based standards that are derived to protect public health, including sensitive populations such as asthmatics, children, and the elderly (EPA 2001a). Available monitoring data from the perimeter of the burning grounds found a maximum concentration of 71 ug/m^3. Particulate matter concentrations at the nearest homes, approximately 0.5 miles from the site, would be much lower due to dilution and dispersion in the air. In addition, EPA tracts air quality standards throughout the United States and designates areas where NAAQS are exceeded as Nonattainment Areas. A search of EPA data found that no area in New Jersey has been designated a Nonattainment Area based on exceedences of PM_{10} (EPA 2001b). Because measured PM_{10} levels are below the health-based NAAQS, ATSDR concluded that open burning is not expected to cause adverse health effects. The Army, however, is constructing an incinerator, scheduled for completion in 2001, to address concerns about exposures from open burning.

- Potential exposures to unexploded ordnance (UXO).

  Two locations at Picatinny are know to contain UXO. These sites are fenced to prevent access. The Safety Office at Picatinny has procedures and regulations in place to address UXO concerns and address inadvertent discovery of UXO throughout the arsenal (Gabel 2001).

ATSDR CHILD HEALTH INITIATIVE

ATSDR recognizes that infants and children may be more sensitive than adults to environmental exposure in communities faced with contamination of their water, soil, air, or food. This sensitivity is a result of the following factors: (1) children are more likely to be exposed to certain media like soil when they play outdoors; (2) children are shorter and therefore may be more likely to breathe dust, soil, and vapors close to the ground; and (3) children are smaller than adults and therefore may receive a higher dose of chemical exposure relative to their body weight. Children also can sustain permanent damage if exposed to toxic substances during critical growth stages. ATSDR is committed to evaluating children's special interests at sites such as Picatinny as part of its Child Health Initiative. *ATSDR identified no situations in which children are likely to be exposed to chemical contaminants associated with Picatinny.*

ATSDR has attempted to identify populations of children at and in the vicinity of Picatinny and any public health hazards threatening these children. Approximately 175 children live in on-site housing. There are no schools at Picatinny. A day care center and after school program are located at buildings 175 and 3228 (Area F and I, respectively) and serve approximately 115 children. During the summer, a camp is operated at Building 3228 (Area I) and is attended by approximately 100 children. ATSDR determined that harmful exposures are unlikely to occur because children who live at the arsenal are not typically present in areas of concern or locations of contamination at Picatinny. Furthermore, ATSDR did not identify any harmful exposures associated with the arsenal that are specific to children at nearby schools, residential neighborhoods, or recreational areas. Similar to adults at Picatinny, children may have been or may be exposed to site contamination through ingestion of groundwater as drinking water and contact with surface soil, surface water, sediment, and fish tissue during recreational use of the baseball fields and surface water bodies. These potential exposure pathway are discussed extensively in the "Evaluation of Potential Exposure Pathways" section of this PHA.

CONCLUSIONS

Conclusions regarding potential past, current, and future exposures to various environmental media on and in the vicinity at the Picatinny Arsenal are based on a thorough evaluation of remedial site investigation data, groundwater and surface water monitoring data, municipal drinking water supply data, and observations made during site visits. Based on available information, ATSDR concluded that exposures are at levels below those likely to cause adverse health effects. Because exposures are possible, however, ATSDR has categorized Picatinny as a *no apparent public health hazard.* (A description of this public health hazard conclusion category is included in the glossary in Appendix B.) Conclusions regarding exposures are as follows:

- No adverse health effects are likely from use of on-site drinking water wells, off-site public wells, or off-site private wells. VOCs, explosives, and metals were detected above CVs in on-site drinking water wells. ATSDR evaluated whether potential health hazards were associated with drinking water from these wells and determined that exposure to even the highest levels detected were unlikely to result in adverse health effects. The water supply is remediated to remove VOCs prior to distribution and monitored regularly to ensure safety and prevent current and future exposures. Off-site public water supplies are sampled regularly under state regulations and no site contaminants have been detected in municipal water supply wells. Explosive compounds were found in off-site private wells at levels above CVs. ATSDR evaluated whether potential health hazards were associated with drinking water from these wells and determined that exposure to even the highest levels detected were unlikely to result in adverse health effects. No exposure is occurring now or is expected to occur in the future through these private wells because owners of the affected wells now use municipal water.

- No adverse health effects are likely to result from exposure to surface soil contamination, primarily PAHs, explosives, and metals, identified throughout the site. PCBs were found in Area B. On-site workers, recreational users, and residents may contact contaminants in surface soil. Contact by arsenal workers and recreational users is expected to be brief and intermittent. In addition, arsenal employees working in areas of contamination are expected to wear proper protective equipment to prevent exposures. On-site housing is located away from areas of contamination. In 1999, ATSDR completed a health consultation addressing PCB exposure at Area B and concluded that contact with PCBs in soil may result in adverse health effects for future construction workers who are at the site for long-term (months) projects. This health consultation recommended that the Army remediate or restrict access to the PCB-hot spot (north and southwest of a gravel pad) prior to any future construction activities. The Army is continuing to conduct site investigations and complete remedial actions to minimize current and future exposures and prevent possible adverse health effects from contaminants in surface soil.

- No adverse health effects were identified as likely resulting from recreational use of designated fishing areas. SVOCs, PCBs, explosives, and metals have been detected in surface water and/or sediment above the drinking water and surface soil CVs, respectively. Exposure during boating and fishing is expected to be brief and infrequent. Metals have been detected above CVs in fish fillet tissue, whereas SVOCs, pesticides, PCBs, and metals were found above CVs in whole body fish samples. Contaminants in fish tissue were found above CVs in only a portion of the samples. In addition, fish tissue CVs are derived assuming subsistence fishing; recreational fishers are expected to consume fish much less frequently. The Army is continuing to conduct site investigations and complete remedial actions to minimize current and future exposures and prevent possible adverse health effects from contaminants in surface water, sediment, and fish tissue.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the Picatinny Arsenal contains a description of actions taken and those to be taken by ATSDR, the Army, EPA, and state regulators at and in the vicinity of the site after the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, being implemented, or planned are as follows.

Completed Actions:

- The Army has investigated more than 175 sites under Superfund requirements. Of these, the Army has completed response actions at some sites and many areas are now considered to pose no threat to human health or the environment. At 19 sites where no further action is proposed, the Army is awaiting regulatory concurrence.

- ATSDR conducted a site visit to Picatinny in 1998 and determined that the site posed no immediate human health threat, but that the groundwater, surface soil, and surface water and sediment exposure pathways needed further evaluation.

- At the request of the RAB, ATSDR investigated potential health hazards associated with PCBs in soil at Area B in a 1999 health consultation. As a result of the health consultation, ATSDR recommended that the Army remediate or restrict access to a PCB-hot spot (north and southwest of a gravel pad) prior to any future construction activities

- To prevent exposures to explosives in off-site private wells, the Army connected affected homes to the municipal water supply in 1996.

- In 1999, the Army drafted fishing restrictions based on a state of New Jersey fish consumption advisory prompted by the detection of elevated mercury levels in freshwater lakes throughout New Jersey. Picatinny personnel and fishermen were notified about the draft restrictions at that time. In March 2000, the Army further notified Picatinny fishermen, residents, and employees about the fishing restrictions. This notification was also printed in the Rod and Gun Club Newsletter.

Ongoing/Planned Actions:

- Investigations are in various stages at several locations as the Army continues to define the extent of contamination and recommend appropriate remedial actions.

- To prevent exposures to VOCs in on-site water supply wells, the Army installed a water treatment system to remove VOCs prior to distribution. Since 1992, a groundwater treatment system has also been in operation at PICA sites 76 and 120 (buildings 24 and 31) to address the VOC plume originating at these sites and prevent further impact to on-site water supply wells. In addition, the Army conducts regular monitoring of the water supply to ensure it's safety. The Army is also investigating treatment options to address explosives in groundwater, if needed.

- Construction and operation of an incinerator replacing the open burn pits in Area A is scheduled for 2001.

- Recreational users of Picatinny obtaining fishing permits for the arsenal or any person submitting a request to the arsenal are provided with copies of the arsenal's fishing restrictions.

- If warranted or if requested to do so, ATSDR will review new information that may be generated from remedial investigation activities, such as contamination found in fish tissue, and investigations of past well closure practices to evaluate impacts on public health.

Recommended Actions

- ATSDR recommends that the Army notify developers of land located in the downgradient groundwater flow path about on-site groundwater contamination to provide assurance to the public that new water supplies are safe to drink.

- Although a groundwater treatment program is in place, ATSDR recommends that the Army inform the agency if the treatment program is altered. ATSDR will evaluate the effectiveness of new remedial options in protecting public health.

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TABLES

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Phase I Areas				
Area A The Lower Burning Ground (PICA site 2)	Area A occupies 7 acres in the southern part of the arsenal. The area, which is entirely enclosed by a chain link fence, consists of an active open burning ground, inactive waste piles, and landfilling areas. The area has been used for the disposal of contaminated wastes. Sludge and sediment from the manufacturing of explosives and dust from wet vacuum filtration systems constituted much of the disposed material. Until 1985, material was burned directly on the ground; since then, it has been burned in metal pans.	**Groundwater:** Trichloroethylene (TCE), bis(2-ethylhexyl)phthalate, RDX, and metals were detected at levels above ATSDR comparison values (CVs). Radiological parameters are within background concentrations. **Surface Soil:** Polycyclic aromatic hydrocarbons (PAHs) and metals were detected at levels above CVs. Explosive compounds were detected at levels below CVs.	Between 1983 and 1991, a series of nine environmental investigations were conducted to determine the nature and extent of contamination in the area. The Army has given a high priority to the remedial investigation/feasibility study (RI/FS) of Area A. The expedited RI/FS for this area included sampling in 1991 and 1993, a risk assessment, and a wetlands assessment. The results were submitted to the U.S. Environmental Protection Agency (EPA) for approval in 1994.	No public health hazard exists because the groundwater beneath the site is not used for drinking water and contaminated soils at Area A are inaccessible to the public.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area B Southern Boundary, West of Green Pond Brook (PICA sites 63, 66, and 205)	Area B comprises 32 acres containing an active pyrotechnical range (63) and an inactive sanitary landfill (66). Sanitary waste, fly ash, ordnance, industrial waste, and sludge from the water treatment plant was reportedly placed in PICA site 66. The area also contains a shallow 1-acre pond, Landfill Pond, that receives drainage from PICA site 63. Groundwater is being investigated under PICA site 205.	**Groundwater:** Carbon tetrachloride, vinyl chloride, naphthalene, 1,3,5-trinitrobenzene, and metals were found at concentrations above CVs in groundwater. Only manganese was found in the lower semi-confined aquifer at levels above CVs. **Surface Soil:** Polychlorinated biphenyls (PCBs), pesticides, and metals were detected at levels above CVs. Radiological parameters were similar or less than background levels. **Surface Water**: VOCs, pesticides, and metals were detected at levels above CVs.	Soil sampling found levels of PCBs above state guidance. The Army is considering whether removal is necessary. There is an ongoing area-wide groundwater investigation. In January 1999, ATSDR completed a health consultation examining potential health effects from exposure to PCBs in surface soil. On the basis of health hazards for immune and development effects, PCBs in soil (at a maximum concentration of 296 parts per million [ppm]) pose a human health hazard for construction workers who may be at the site for many months. ATSDR has recommended that the Army remediate or restrict access to the PCB-hot spot (north and southwest of a gravel pad) prior to any future construction activities.	No public health hazards were found from exposure to contaminants in groundwater in Area B because groundwater does not serve as a drinking water supply. PCBs in surface soil may pose a public health hazard to future construction workers, therefore, ATSDR recommended remediation or access restrictions prior to future construction. Contaminants in surface water pose no health hazards because recreational use of Green Pond Brook in this portion of the site is restricted and surface water does not serve as a drinking water supply.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area C Southern Boundary, East of Green Pond Brook (PICA sites 20, 65, 67, 68, 92, 93, and 206)	Area C encompasses 126 acres east of Green Pond Brook, near the southern boundary. Area C includes a pyrotechnic demonstration area (20), two landfills (65 and 67), a dredge pond (68), baseball fields (92), and a waste burial area (93). Except for the baseball fields, all sites are inactive. Groundwater is being addressed under PICA site 206.	**Groundwater:** An area-wide sampling event found volatile organic compounds (VOCs), 1,3,5-trinitrobenzene, and metals above CVs in groundwater. Only arsenic, manganese, and lead were found in the lower semi-confined aquifer above CVs. **Surface Soil:** PAHs, metals, and PAHs were detected at levels above CVs. Radiological parameters were similar or less than background levels. **Surface Water:** Pesticides and metals were detected at levels above CVs.	Remediation at PICA sites 20, 68, and 92 includes institutional controls and land use control plans. At PICA site 65, the Army removed all buried drums, other containers, and contaminated fly ash; conducted thermal recovery and water treatment; covered the landfill with a temporary cap; and fenced the area. At the request of the restoration advisory board, the Army also sampled a spring near PICA site 65, but found no contaminants. A feasibility study is proposed or ongoing at PICA site 67. The Army sampled soil at PICA site 93. Additional investigations and appropriate removal actions are planned. A feasibility study for area-wide groundwater at Area C (PICA site 206) is now being developed.	Groundwater poses no public health hazard because no drinking water wells are located in this area. Contaminants in surface soil and surface water pose no public health hazards. Any contact with surface soil by on-site workers would be brief and infrequent. On-site housing is not located in areas of contamination. Surface water within Area C is not used for recreational activities or as a drinking water supply.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area D Central Manufacturing Valley (PICA sites 11, 71, 76, 78, 84, 88, 94-100, 120, 190, 192, and 207)	Area D is the central manufacturing valley located in the south central part of the arsenal. The area includes an apple orchard (192) and many buildings (all other PICA sites for this area).	**Groundwater:** 1,2-Dichloroethene, tetrachloroethylene (PCE), and metals were found at levels above CVs. **Drinking Water Supply Wells:** Wells 129 and 130 contained benzene, PCE, TCE, and metals above CVs. Well 131 has been installed in Area D to replace Wells 129 and 130. The Army is waiting for New Jersey Department of Environmental Protection (NJDEP) approval before beginning operation of this well. **Surface Soil:** PAHs, PCBs, and metals were detected at levels above CVs.	A TCE groundwater plume extends 1,600 feet from PICA sites 78 and 120, or buildings 31 and 24, and PICA site 76, the surface impoundment associated with building 24, toward Green Pond Brook. The plume is the main reason for the listing of Picatinny Arsenal on the National Priorities List. Contaminated soil contributing to the plume was removed in 1985. Since 1992, a pump and treat facility has remediated the contamination. A survey of nearby residential basements also indicated that no public health hazard is associated with exposure to TCE in soil gas. Contingent upon sampling, results, the Army may propose an institutional control plan for PICA sites 88, 95, 99, and 100. On the basis of the Army Center for Health Promotion and Preventive Medicine's (CHPPM) low relative risk ranking, RIs have been deferred at PICA sites 94, 96, 190, and 207. The Army plans to remove a building from PICA site 97 before proceeding with the engineering evaluation/cost analysis. The Army has plans to investigate the apple orchard (PICA site 192). An investigative workplan was developed for PICA sites 71, 78, and 84. A removal action may be warranted for PCB and PAH contamination at PICA site 11.	Exposure doses from contaminants detected in drinking water supply wells are below levels found to cause adverse health effects. Wells 129 and 130 no longer provide drinking water and have been replaced by Well 131. Groundwater use, therefore, poses no public health hazards. Exposure to contaminants in surface soil pose no public health hazards because no on-site housing is located in Area D and any contact by on-site workers would be brief and infrequent.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area E Building 95 Area (PICA sites 10, 70, 77, and 83)	Area E is situated on 38 acres in the south central portion of the arsenal. The site is bounded by Green Pond Brook to the southwest and Bear Swamp Brook to the north. This area encompasses a former impoundment (10), a sewage treatment plant (70), a plating and etching building (77), and a golf course maintenance shop (83). With the exception of the golf course maintenance shop, all sites are inactive.	**Groundwater:** VOCs, RDX, and metals were found at concentrations above CVs in groundwater underlying Area E. Only iron and manganese were detected above CVs in the lower semi-confined aquifer. **Surface Soil:** PAHs and metals were found at concentrations above CVs.	Institutional controls are required at PICA site 70. Additional sampling plans have been developed for PICA sites 10, 77, and 83. Based on the sampling results, PICA sites 77 and 83 may be designated as no further action site.	Contaminants in groundwater pose no public health hazards because groundwater underlying Area E does not serve as a drinking water supply. No on-site housing is located in Area E. On-base worker exposure to contaminants in surface soil is brief and intermittent. Contaminants in surface soil, therefore, are unlikely to cause adverse health effects.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area F Propellant Area (PICA sites 36, 101- 115, 122, 208, and 209)	Area F comprises 77 acres east of Green Pond Brook and is about 400 feet southwest of Picatinny Lake. Most of the buildings at these PICA sites were used for propellant manufacturing, mixing, and testing activities. The area also includes a waste dump (102) and a depleted uranium storage area (208). Area F is currently enclosed and secured because an unexploded ordnance (UXO) survey has not been conducted throughout the area.	**Groundwater:** VOCs, bis(2-ethylhexyl)phthalate, RDX, and metals were found at concentrations above CVs during area-wide groundwater sampling. PCE, RDX, arsenic, iron, lead, and manganese were detected above CVs in the lower semi-confined aquifer. **Drinking Water Supply Wells:** Sampling of Wells 410 and 430A found VOCs, RDX, and metals above CVs. **Surface Soil:** PAHs, pesticides, total PCBs, and metals were detected at levels above CVs. **Surface Water:** Metals were detected at levels above CVs.	An additional investigative plan for area-wide groundwater has been submitted. No further action is required at PICA sites 105 and 112, and possibly at 36, 102, 106, 110, 113, and 114. On the basis of CHPPM's relative risk ranking, additional sampling, RI, or FS activities have been deferred at PICA sites 101, 103, 104, 108, 109, 111, 115, 122, and 208. The FS at PICA site 107 was put on hold in March 1998. The Army Corp of Engineers is scoping a workplan for PICA site 209.	No exposure doses that may result in adverse health effects were found from use of on-site drinking water wells in Area F. The Army conducts sampling to ensure the safety of the water supply. No public health hazards are associated with soils. No on-site housing is in this area and worker exposure is expected to be brief and infrequent. Surface water in Area F is not used for recreational activities and, therefore, presents no public health hazards.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area G Defense Reutilization and Marketing Office (DRMO) Yard and Surroundings (PICA sites 29, 72, 89, 116-119, 121, 188, 193, 194, and 210)	Area G comprises 40 acres of sites and buildings in the northwest corner of the arsenal. Included in the area is a waste oil storage area (29), the DRMO Yard (72), a petroleum leak (89), gas station and storage buildings (116), service shops (117), a metallurgical laboratory (118, 119), and a laundry facility (121).With the exception of the laundry facility, all sites are active. Two PICA sites, Bear Swamp Brook (193) and Green Pond Brook (194), are water bodies included in Area G.	**Groundwater:** VOCs, RDX, and metals were found at concentrations above CVs in groundwater during area-wide sampling. TCE, RDX, arsenic, iron, manganese, and thallium were present above CVs in the lower semi-confined aquifer. **Drinking Water Supply Wells:** Well 302D contained only manganese above CVs. **Surface Soil:** PAHs, explosives, and metals were detected at levels above CVs. **Surface Water**: VOCs, pesticides, and metals were detected at levels above comparison criteria. PCBs were detected one time above CVs. **Sediment:** PAHs, pesticides, PCBs, and metals were detected at levels above CVs.	The Army will develop an Area G-wide groundwater investigation. They are also scoping an RI work plan for PICA site 72 (the DRMO). (PICA site 116 may be combined with PICA site 72.) No further action is planned at 117, contingent upon sampling results. On the basis of CHPPM's relative risk ranking, the Army has deferred additional investigations at PICA sites 119, 188, and 210. In 1997, additional soil sampling was conducted under buildings in PICA site 118. A FS is being developed for Green Pond Brook and Bear Swamp Brook (193 and 194). PICA sites 29, 89, and 121 were combined, but the FS is on hold until cleanup issues are resolved.	No exposure doses that may result in adverse health effects were found from use of the on-site drinking water wells in Area G. The Army conducts regular sampling to ensure the safety of the water supply. No public health hazards are associated with surface soil. No on-site housing is in this area and worker exposure is expected to be brief and infrequent. Surface water bodies in Area G are not used for recreational activities and, therefore, surface water and sediment contaminants present no public health hazards.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Phase II Areas				
Area H Munitions Assembly Area (PICA sites 91, 123-133, and 204)	Area H, a former munitions assembly area, is located behind a security fence in the west central part of the arsenal. Bear Swamp Brook flows through the area.	On the basis of preliminary data, possible contaminants of concern include VOCs, PAHs, PCBs, explosives, and metals.	The Army will develop an area-wide groundwater investigation (PICA site 204). RI reports are to be submitted for PICA sites 91, 124-128, and 130-132. No further actions are being proposed for 123, 129, and 133.	No public health hazard exists because no one is exposed to contaminated media. Contaminated soils at Area H are inaccessible to the public and the groundwater beneath the site is not used for drinking water.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area I (PICA sites 6, 12, 18, 22, 47, 57, 64, 73, 74, 79, 85, 86, 134-156, 203)	Area I includes all sites close to and including Picatinny Lake, a recreational water body. The area has been used for the storage and manufacture of explosives, shell washout, and other activities related to munitions. Other sites in the area include the guncotton line, formerly demolished and buried buildings, and a poison gas lab.	On the basis of preliminary investigations, possible contaminants of concern include VOCs, PAHs, PCBs, explosives, and metals. **Surface Water/Sediment:** Bis(2-ethylhexyl)phthalate, PAHs, and metals were detected above CVs in surface water and/or sediment from Picatinny Lake. **Fish Tissue:** Chromium and nickel were detected above CVs in fish tissue samples from Picatinny Lake.	RI reports are to be submitted for all PICA sites except for PICA site 203 because it was assigned a low relative risk by CHPPM. No further action is being proposed for PICA sites 12, 134, and 135.	Groundwater underlying Area I is not used as a drinking water supply. Recreational areas are not located in areas of contamination, therefore, exposure to contaminants in surface soil is not expected. Use of Picatinny Lake for recreation is restricted to military personnel, retired personnel, and civilian workers. No public health hazards are likely because contact with surface water and sediment during fishing and boating is expected to be brief and infrequent and fish caught in Picatinny Lake are not expected to serve as a subsistence food.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area J (PICA sites 7, 8, 157, 158, and 202)	Area J is located on the northeastern part of Picatinny. One of the sites is a helicopter maintenance building (158) and the other sites are associated with past rocket testing activities. The Ames Creek headwaters are located in this area.	On the basis of preliminary investigations, potential contaminants include rocket fuel components, petroleum products, VOCs, explosives, and metals. **Drinking Water Supply Wells:** No contaminants above CVs have been detected in Cove Well.	The Army will submit an RI with a proposal for no further action at PICA site 158. An assessment by the CHPPM indicates that the response is complete at PICA 202. Investigations are ongoing under the Phase II RI at PICA sites 7, 8, and 157.	No public health hazards are posed by area contamination. No contaminants have been found in Cove Well and contact with surface soil is expected to be brief and infrequent. No on-base housing is located in areas of contamination, although a trailer area is located nearby. The G2 Pond is a permitted fishing area, however, the water is shallow and the pond filled with aquatic vegetation, which inhibits fishing.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area K (PICA sites 50, 87, 159, 160, 161, 189, and 199)	Area K, also known as Navy Hill, is on the east central side of Picatinny. Sites within the area include a reaction motor/rocket fuel test site and an old sewage treatment plant (161), a firehouse (189), and a pistol range dump (199).	Some possible contaminants include rocket fuel components, oil, VOCs, PCBs, explosives, and metals.	RI reports are to be submitted for PICA sites 50, 159, 160, 161, and 199. On the basis of CHPPM's relative risk ranking, the Army has delayed an RI for PICA site 189. No further action is proposed for PICA sites 159, 160, and 161. In 1997, CHPPM completed an investigation of PICA site 87, resulting in the removal of an underground storage tank.	No public health hazards are posed by area contamination. Groundwater does not serve as a drinking water supply. Only arsenal workers have access to Area K, therefore, contact with surface soil is expected to be brief and infrequent. The 1500 Pond, which is permitted for fishing, is in Area K, but beyond areas of contamination

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Phase III Areas				
Area L (PICA sites 1, 21, 37, 52, 75, 80, 81, 82, 162-174, 176, 177, 191, 195, and 200)	Area L activities include explosive manufacturing areas. Sites include two shell burial areas (52 and 162), a coal storage area (191), tetryl pits (1), sanitary sewer lines (176), and a Little League baseball field (176).	On the basis of preliminary investigations, potential contaminants include explosives, pesticides, VOCs, and metals.	RI workplans were submitted to EPA for PICA sites 1, 21, 37, 52, 82, 162, 163, 164, 167, 168, 172, 195, and 200. On the basis of the supplemental investigation, no further action is proposed for PICA sites 75, 80, 81, 166, 176, and 177. On the basis of CHPPM's relative risk ranking, the Army has deferred RIs at PICA sites 165, 169, 170, 171, 173, 174, 191.	No public health hazards are posed by area contamination. Groundwater does not serve as a drinking water supply, contact with surface soil is expected to be brief and infrequent, and on-site housing areas are located beyond areas of contamination. Several ponds permitted for fishing are located in Area L, but are beyond areas of contamination
Area M (PICA sites 61, 175, and 178-181)	Area M, a munitions test area, is located on the west side of Picatinny. The area includes numerous buildings and an explosive testing area (180), and contains the headwaters of the Bear Swamp Brook.	On the basis of preliminary investigations, some potential contaminants include solvents, VOCS, explosives, and metals.	On the basis of CHPPM's relative risk ranking, the Army has deferred RIs at PICA sites 61, 175, 178, and 179. No further action is proposed for PICA site 180. Funding for study and remediation of PICA site 181 is still being determined.	No public health hazards are posed by area contamination. Groundwater does not serve as a drinking water supply. Contact with surface soil by arsenal workers is expected to be brief and infrequent.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area N (PICA sites 53-56, 58-60, 182, 198)	Area N is located in the western portion of Picatinny. Several sites are used to test fire munitions.	On the basis of preliminary investigations, possible contaminants include explosives, propellants, UXO, metals, cyanide, phenols, and pickling liquor residues.	RI workplans have been submitted to EPA for PICA sites 56 and 58. On the basis of CHPPM's relative risk ranking, the Army has deferred RIs at PICA sites 54, 55, and 60. A supplemental investigation has been completed but no further action is proposed for PICA site 53. Funding for study and remediation of PICA sites 59 and 182 is still being determined. CHPPM indicates that response is complete at PICA site 198.	No public health hazards are posed by area contamination. Groundwater does not serve as a drinking water supply. Arsenal workers' contact with surface soil is expected to be brief and infrequent.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area O (PICA sites 15, 183, and 197)	Area O is located in the northern section of Picatinny. The area includes Lake Denmark, which was used as an impact area and a dump for UXO and explosive debris after a 1926 Navy Hill explosion.	Potential contaminants include explosives and propellants. **Drinking Water Supply Wells:** No contamination has been found in Well 1227. This well no longer provides drinking water to the arsenal. **Surface Water/Sediment:** Bis(2-ethylhexyl)phthalate and metals were detected above CVs in surface water and/or sediment samples collected in Lake Denmark. **Fish Tissue:** Chromium, mercury, and silver were detected above CVs in some fish samples collected from Lake Denmark.	A RI workplan has been submitted to EPA for PICA site 15. On the basis of the supplemental investigation, no further action is proposed for PICA site 183. CHPPM indicates that response is complete at PICA site 197.	No public health hazards are associated with Area O. No contaminants were found in Well 1227 and this well no longer provides drinking water to the arsenal. Recreational areas are not located in areas of contamination, therefore, exposure to contaminants in surface soil is not expected. Use of Lake Denmark for recreation is restricted to military personnel, retired personnel, and civilian workers. Contact with surface water and sediment during fishing and boating is expected to be brief and infrequent and fish caught in Lake Denmark are not expected to serve as a subsistence food.

TABLE 1. Evaluation of Public Health Hazards Associated with Areas A through P at the Picatinny Arsenal

Study Area	Area Description/Waste Disposal History	Investigation Results/Environmental Monitoring Results	Corrective Activities and/or Current Status	Evaluation of Public Health Hazard
Area P (PICA sites 13, 69, 184-187, and 201)	Area P, located on the southwestern area of the arsenal, was used primarily as a storage area.	On the basis of preliminary investigations, potential contaminants include solvents, explosives, propellants, metals, photochemicals, and radionuclides.	RI workplans have been submitted to EPA for PICA sites 13, 69, and 184. On the basis of CHPPM's relative risk ranking, RIs were deferred at PICA sites 185, 186, and 187. CHPPM also indicates that response is complete at PICA site 201.	No public health hazards are posed by area contamination. Groundwater does not serve as a drinking water supply and contact by arsenal workers with surface soil is expected to be brief and infrequent. No housing or recreational areas are located in Area P.

Sources: ATSDR 1998b, 1999; D&M 1994, 1997, 1998a-d; IT 1998; Gabel 1999; Picatinny Arsenal 1998a; Roy F. Weston 1992, 1993; USAEHA 1979, 1990; USGS 1986, 1990, 1996

CHPPM = U.S. Army Center for Health Promotion and Preventive Medicine
DRMO = Defense Reutilization and Marketing Office
NJDEP = New Jersey Department of Environmental Protection
PCBs = polychlorinated biphenyls
ppm = parts per million
TCE = tetrachloroethylene
VOCs = volatile organic compounds
CVs = comparison values
EPA = U.S. Environmental Protection Agency
PAHs = polycyclic aromatic hydrocarbons
PCE = tetrachloroethylene
RI/FS = remedial investigation/feasibility study
UXO = unexploded ordnance

TABLE 2. Exposure Pathways at Picatinny Arsenal

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
On-site Drinking Water Supply Wells	Contaminant releases throughout Picatinny Volatile organic compound (VOC)-plume at PICA sites 76 and 120 (buildings 24 and 31)	Groundwater	On-site drinking water wells	Ingestion, dermal contact, and inhalation	Arsenal workers and residents	**Past :** VOCs, RDX (an explosive), and metals were detected in on-site wells. Arsenal workers and residents may have been exposed to contaminants when they drank water from on-site wells. Based on an evaluation of estimated exposure doses, the Agency for Toxic Substances and Disease Registry (ATSDR) has concluded that exposures to contaminant concentrations are unlikely to cause harmful effects. **Current and Future :** No exposure to harmful levels of contaminants is occurring or is expected to occur because the Army is remediating the water supply for VOC contamination and regularly monitors the water supply to ensure its safety.
Private Drinking Water Wells	Contaminant releases in the southern portion of Picatinny	Groundwater	Private wells along the southern arsenal boundary	Ingestion, dermal contact, and inhalation	Private well users along the southern arsenal boundary	**Past :** Explosive compounds were detected in three off-site private wells located along the southern arsenal boundary. ATSDR has concluded that exposures, if any, to contaminants at the concentrations present in these private wells is unlikely to cause harmful effects. No exposure has occurred since 1990, when the Army provided residents with affected wells with bottled water. **Current and Future :** No exposure to harmful levels of contaminants is occurring or is expected to occur. The Army funded the extension to the Wharton Water Department water line, therefore, residents living south of the site no longer use water from affected private wells.

TABLE 2. Exposure Pathways at Picatinny Arsenal

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
Surface Soil	Contaminant releases throughout Picatinny	Surface soil	Surface soil throughout Picatinny	Incidental ingestion and/or dermal contact	Arsenal workers, recreational users, and residents	**Past:** Elevated levels of polycyclic aromatic hydrocarbons, explosives, and metals were detected in soil throughout Picatinny. No harmful exposures to contaminated soil are likely to have occurred because the areas of contamination were inaccessible to the general public and any contact with contaminants is expected to have been brief and infrequent. Surface soil contamination was not located in residential areas of the arsenal. **Current and Future:** The Army is conducting site investigations and has completed removal actions to prevent current and future exposures. In a 1999 Health Consultation, ATSDR recommended that the Army remediate or restrict access to a polychlorinated biphenyl hot spot in Area B prior to any future construction based on the potential for adverse health effects to construction workers at the site for long-term (months) projects.

TABLE 2. Exposure Pathways at Picatinny Arsenal

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
Surface Water, Sediment, and Fish	Contaminant releases adjacent to Picatinny Lake, Lake Denmark, Green Pond Brook, and on-site ponds	Surface water and sediment	Surface water, sediment, and fish tissue from Picatinny Lake, Lake Denmark, Green Pond Brook, and on-site ponds	Incidental ingestion and/or dermal contact with surface water and sediment and ingestion of fish tissue	Arsenal recreational users	**Past:** Elevated levels of contaminants were detected in surface water, sediment, and fish tissue. No harmful exposures to contaminated soil are likely to have occurred because any exposures during recreational use are likely to have been brief and infrequent. In addition, recreational fishers are not expected to use fish from the arsenal as a subsistence food supply. **Current and Future:** The Army is conducting site investigations and has completed removal actions to prevent current and future exposures. The Army also instituted a fish advisory consistent with the state of New Jersey advisories.

TABLE 4: Maximum Detected Concentrations of Contaminants Found Above Comparison Values in On-Site Monitoring Wells

Contaminant	On-Site Monitoring Wells Detected Contaminant Concentrations (ppb)								Comparison Value (ppb)	
	Area A	Area B	Area C	Post Farm Landfill	Area D	Area E	Area F	Area G	Value	Source
Benzene		2.5					7.6		1	CREG
Carbon tetrachloride		10	10						0.3	CREG
1,1-Dichloroethene		21			12	38			0.06	CREG
1,2-Dichloroethene		640			542				200	RMEG-c
Methylene chloride					6				5	CREG
1.12,2-Tetrachloroethane						1.6			0.2	CREG
PCE					197	150	150	3	0.7	CREG
TCE	3.4	34	3.5		44,000	52	16.8	5.6	3	CREG
Vinyl chloride		1,050	160		16				0.2	EMEG-c
bis(2-Ethylhexyl)phthalate	50	75	19		260	17	26		3	CREG
Naphthalene		23	23						20	LTHA
n-Nitrosodiphenylamine		101							0.002	CREG
Aldrin			0.036						0.002	CREG
Dieldrin			0.014						0.002	CREG
alpha-HCH						0.014			0.006	CREG

TABLE 4: Maximum Detected Concentrations of Contaminants Found Above Comparison Values in On-Site Monitoring Wells

Contaminant	On-Site Monitoring Wells Detected Contaminant Concentrations (ppb)								Comparison Value (ppb)	
	Area A	Area B	Area C	Post Farm Landfill	Area D	Area E	Area F	Area G	Value	Source
Heptachlor					0.05				0.008	CREG
Heptachlor epoxide			0.0078						0.004	CREG
Total PCBs					17.7	0.32			0.02	CREG
Nitrocellulose	8,900	1,310	42,000		1,090	2,820	5,000	1,720	n/a	
RDX	200				3.5		14	6.1	0.3	CREG
1,3,5-Trinitrobenzene		8.6	8.6		1.7				0.5	RMEG-c
2,4,6-Trinitrotoluene	340				3				1	CREG
Aluminum		40,800	150,000	150,000	118,000	370,000			37,000	RBC
Antimony		70.1	70.1	68.5	237	84.2			4	RMEG-c
Arsenic	130	35.2	130	46.3	45.7	121	5.2	12	0.002	CREG
Barium			1,210		1,550	4,820			700	RMEG-c
Beryllium					31.4	24.7			20	RMEG-c
Cadmium			108	108	92.8	19.5			2	EMEG-c
Chromium	140		216	216	1,200	415			100	LTHA
Copper	3,950		3,950			2,610			1,500	RBC

TABLE 4: Maximum Detected Concentrations of Contaminants Found Above Comparison Values in On-Site Monitoring Wells

Contaminant	On-Site Monitoring Wells Detected Contaminant Concentrations (ppb)								Comparison Value (ppb)	
	Area A	Area B	Area C	Post Farm Landfill	Area D	Area E	Area F	Area G	Value	Source
Cyanide					430				200	RMEG-c
Iron	118,000	178,000	269,000	269,000	1,200,000	893,000	159,000	73,600	11,000	RBC
Lead	60.2	123	900	300	7,300	551	67.7	35.9	15	MCL
Manganese	3,860	3,840	7,340	7,340	24,000	31,000	1070	7,450	50	RMEG-c
Nickel			239		376	656			200	RMEG-c
Thallium					179	701			0.4	LTHA
Vanadium	71.2	146	220		565	532	61.4	144	30	iEMEG-c
Zinc	4,640		110,000			110,000			3,000	EMEG-c

Sources: D&M 1997, 1998a-d, 1999; USGS 1990; Roy F. Weston 1992, 1993

CREG = ATSDR's Cancer Risk Evaluation Guide
EMEG-c = ATSDR's Environmental Media Evaluation Guide for a children
i = intermediate
LTHA = EPA's Lifetime Health Advisory for drinking water
MCL = EPA's Maximum Contaminant Level
n/a = not available
ppb = parts per billion
PCBs = polychlorinated biphenyls
PCE = tetrachloroethylene
RBC = EPA Region III's Risk Based Concentrations for tap water
RMEG-c = ATSDR's Reference Dose Media Evaluation Guide for children

TCE = trichloroethylene
Blank cells indicate that the contaminant was not detected or was detected below CVs.

TABLE 5. Maximum Detected Concentrations of Contaminants Found Above Comparison Values in On-Site Drinking Water Supply Wells

Contaminant	On-Site Drinking Water Wells[1] Detected Contaminant Concentrations (ppb)							Comparison Value (ppb)	
	Well 129	Well 130	Well 302D	Well 305A	Well 410	Well 430A	Well 507B	Value	Source
Benzene	2.0				46.9			1	CREG
Bromodichloromethane					4.6			0.6	CREG
Bromoform					7.4			4	CREG
Carbon tetrachloride					1.0			0.3	CREG
Chlorobenzene					124			100	MCL
Chloroform					30			6	CREG
Chloromethane					30			3	LTHA
Dibromochloromethane					2.9			0.4	CREG
Methylene chloride					15.7			5	CREG
PCE	5.7	70			1.0			5 0.7[2]	MCL CREG
TCE	27.2	260			13.6			5 3[2]	MCL CREG
RDX					6.3			0.3	CREG

TABLE 5. Maximum Detected Concentrations of Contaminants Found Above Comparison Values in On-Site Drinking Water Supply Wells

Contaminant	On-Site Drinking Water Wells[1] Detected Contaminant Concentrations (ppb)							Comparison Value (ppb)	
	Well 129	Well 130	Well 302D	Well 305A	Well 410	Well 430A	Well 507B	Value	Source
Arsenic		22		7	24	31		0.002	CREG
Cadmium					2			2	EMEG-c
Iron		14,000		460,000				11,000	RBC
Lead	31			16	26	53		15	MCL
Manganese	820	800	300	400	60	3,000	66	50	RMEG-c

Sources: D&M 1998c, 1998d; Sargent 1988; USAEHA 1979; USGS 1986

CREG = ATSDR's cancer risk evaluation guide
EMEG-c = ATSDR's Environmental Media Evaluation Guide-child
LTHA = EPA's Lifetime Health Advisory for drinking water
MCL = EPA's maximum contaminant level
PCE = Tetrachloroethylene
ppb = parts per billion
RBC = EPA Region III's Risk Based Concentrations for tap water
RMEG-c = ATSDR's Reference Dose Media Evaluation Guide-child
TCE = trichloroethylene

[1] Well 1227 and Cove Well were tested for metals in May 1979. No metals were found above CVs.
[2] ATSDR is currently re-evaluating the CREGs for PCE and TCE.

Blank cells indicate that the contaminant was not detected or detected below CVs.

TABLE 6. Contaminants Detected in Off-Site Private Drinking Water Supply Wells

Contaminant	Off-Site Private Drinking Water Wells Contaminant Concentration (ppb)			Comparison Value (ppb)	
	HO-3	HO-13	HO-18	Value	Source
RDX	8.6	4.3	2.7	0.3	CREG

References: Rosen 1999b, 1999c

Table 7: Summary of Surface Soil Data that Exceed Comparison Values

Chemical	Maximum Detected Concentration (ppm)	Frequency of Detection[1]	Comparison Value (ppm)	Source
Site 92/163 Baseball Fields				
Arsenic	6.57	23/23	0.5	CREG
Iron	34,400	5/5	23,000	RBC
Site 97/118 Building 41 (adjacent to golf course)				
Chlordane	0.88	3/4	0.5	CREG
Arsenic	31	4/4	0.5	CREG
Iron	39,100	4/4	23,000	RBC
Lead	2,400	4/4	400	SSL
Manganese	13,000	4/4	7,000	RMEG-c
Thallium	587	1/4	5.5	RBC
Areas B and C				
Benzo(a)anthracene	30	15/55	0.87	RBC
Benzo(a)pyrene	40	4/55	0.1	CREG
Benzo(b)fluoranthene	33	9/55	0.87	RBC
Dibenz(a,h)anthracene	1.4	3/55	0.087	RBC
Indeno(c,d-1,2,3)pyrene	100	3/55	0.87	RBC
Aldrin	0.94	6/56	0.04	CREG
Heptachlor	0.42	2/56	0.2	CREG
Heptachlor epoxide	0.12	8/56	0.08	CREG
DDT	6.7	25/54	2	CREG
Aroclor-1253[2]	35	2/56	0.4	CREG
Aroclor-1260[2]	29	15/56	0.4	CREG

Table 7: Summary of Surface Soil Data that Exceed Comparison Values

Chemical	Maximum Detected Concentration (ppm)	Frequency of Detection[1]	Comparison Value (ppm)	Source
Total PCBs	296	100/192	0.4	CREG
Arsenic	24.4	46/58	0.5	CREG
Copper	8,000	58/58	3,100	RBC
Iron	52,300	58/58	23,000	RBC
Lead	621	52/58	400	SSL
Thallium	161	2/55	5.5	RBC

Source: D&M 1997, 1998a; ATSDR 1998b

CREG	ATSDR's Cancer Risk Evaluation Guide
PCB	polychlorinated biphenyl
ppm	parts per million
RBC	EPA Region III's Risk-Based Concentration for residential use
RMEG-c	ATSDR's Reference Dose Media Evaluation Guide for children
SSL	EPA's Soil Screening Level

[1] Frequency of Detection = Times Detected / Times Sought
[2] A comparison value is not available for this specific PCB, the comparison value for total PCBs is presented.

TABLE 8: Summary of Surface Water Data that Exceed Comparison Values

Chemical	Maximum Detected Concentration (ppb)	Frequency of Detection[1]	Comparison Value (ppb)	Source
Green Pond Brook				
Aroclor-1260	0.837	1/7	0.02	CREG
RDX	0.935	1/7	0.3	CREG
Arsenic	1	4/4	0.02	CREG
Lead	18	4/4	15	MCL
Manganese	230	13/13	50	RMEG-c
Picatinny Lake				
Methylene chloride	120	12/28	5	CREG
bis(2-Ethylhexyl)phthalate	79	3/24	3	CREG
Arsenic	1	7/25	0.02	CREG
Chromium	59.9	3/23	30	RMEG
Lead	79.3	6/9	15	MCL
Manganese	225	25/25	50	RMEG
Lake Denmark				
bis(2-Ethylhexyl)phthalate	3	1/1	3	CREG
Antimony	14	1/4	3	LTHA
Cadmium	2.2	2/4	2	EMEG
Lead	23	2/10	15	MCL
Selenium	74	1/4	50	EMEG

Source: D&M 1998d; USGS 1996; USAEHA 1990; ICF Kaiser Engineers 1996, 1999a

CREG ATSDR's Cancer Risk Evaluation Guide
EMEG Environmental Media Evaluation Guide
LTHA Lifetime Health Advisory for Drinking Water
MCL EPA's Maximum Contaminant Level
ppb parts per billion
RMEG-c ATSDR's Reference Dose Media Evaluation Guide for children

[1] Frequency of Detection = Times Detected / Times Sought

Table 9: Summary of Sediment Data that Exceed Comparison Values

Chemical	Maximum Detected Concentration (ppm)	Frequency of Detection[1]	Comparison Value (ppm)	Source
Green Pond Brook				
PCBs	0.44	3/4	0.4	CREG
Arsenic	11	8/14	0.5	CREG
Iron	81,000	7/7	23,000	RBC
Thallium	60.6	1/7	5.5	RBC
Picatinny Lake				
Benzo(a)anthracene	1.0	1/1	0.87	RBC
Benzo(a)pyrene	1.4	1/1	0.1	CREG
Benzo(b)fluoranthene	1.2	1/1	0.87	RBC
Dibenz(a,h,)anthracene	0.58	1/1	0.087	RBC
Arsenic	27.5	24/31	0.5	CREG
Lake Denmark				
Benzo(a)pyrene	0.33	1/40	0.1	CREG
Arsenic	37.8	18/43	0.5	CREG
Lead	2,800	13/43	400	SSL

Source: D&M 1998d; USGS 1996; USAEHA 1990; ICF Kaiser Engineers 1996, 1999a; IT Corporation 1999

CREG ATSDR's Cancer Risk Evaluation Guide
PCB polychlorinated biphenyl
ppm parts per million
RBC EPA Region III's Risk-Based Concentration for residential use of soil
SSL EPA's Soil Screening Level

[1] Frequency of Detection = Times Detected / Times Sought

Table 10: Summary of Fish Fillet Tissue Data (1989 and 1990) that Exceed Comparison Values

Chemical	Maximum Detected Concentration (ppm)	Frequency of Detection[1]	Comparison Value (ppm)	Source
Chromium	86	54/67	4.1	RBC
Mercury	2	61/67	1	FDA
Nickel	83	6/67	27	RBC
Silver	66	5/67	6.8	RBC

Source: USAEHA 1990

Table 11: Summary of Whole Body Fish Tissue Data (Phase I and II RIs) that Exceed Comparison Values

Chemical	Maximum Detected Concentration (ppm)	Frequency of Detection[1]	Comparison Value (ppm)	Source
Bis(2-ethylhexyl)phthalate	5.6	12/32	0.23	RBC
Pentachlorophenol	0.039	1/14	0.026	RBC
alpha-BHC	0.00061	10/18	0.0005	RBC
gamma-Chlordane	0.035	1/12	0.009	RBC
DDD	0.021	28/32	0.013	RBC
DDE	0.07	32/32	0.0093	RBC
DDT	0.035	14/32	0.0093	RBC
Dieldrin	0.0026	4/18	0.0002	RBC
Aroclor-1248	1.47	2/12	0.0016	RBC
Aroclor-1254	0.26	15/18	0.0016	RBC
Aroclor-1260	0.346	13/13	0.0016	RBC
Antimony	0.818	2/14	0.54	RBC
Arsenic	1.7	11/32	0.0021	RBC
Chromium	4.6	23/32	4.1	RBC
Iron	694	18/18	140	RBC

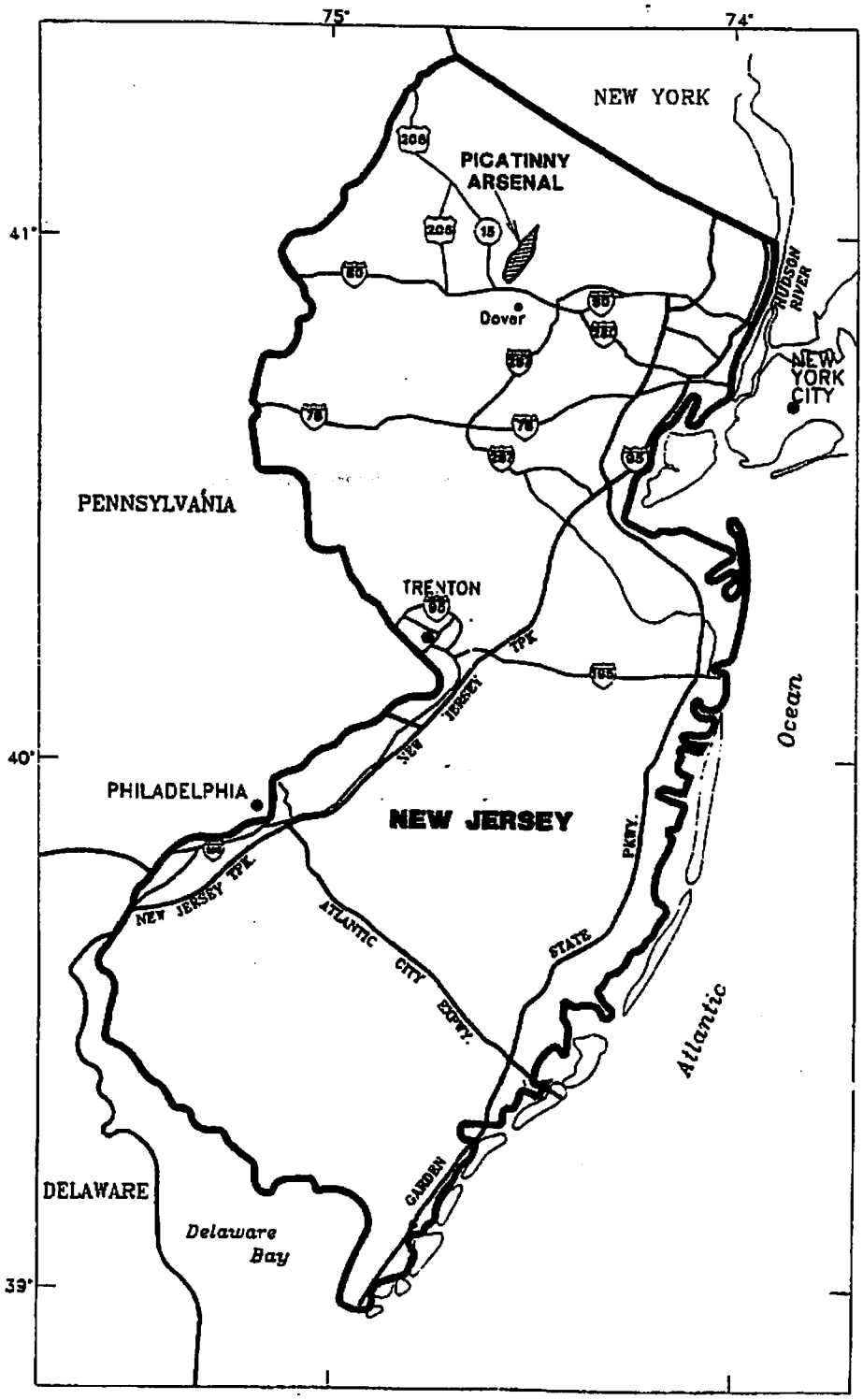
Source: D&M 1998e; IT Group 2000

FDA U.S. Food and Drug Administration's action level for methyl mercury in fish
ppm parts per million
RBC EPA Region III's Risk-Based Concentration for fish

[1] Frequency of Detection = Times Detected / Times Sought

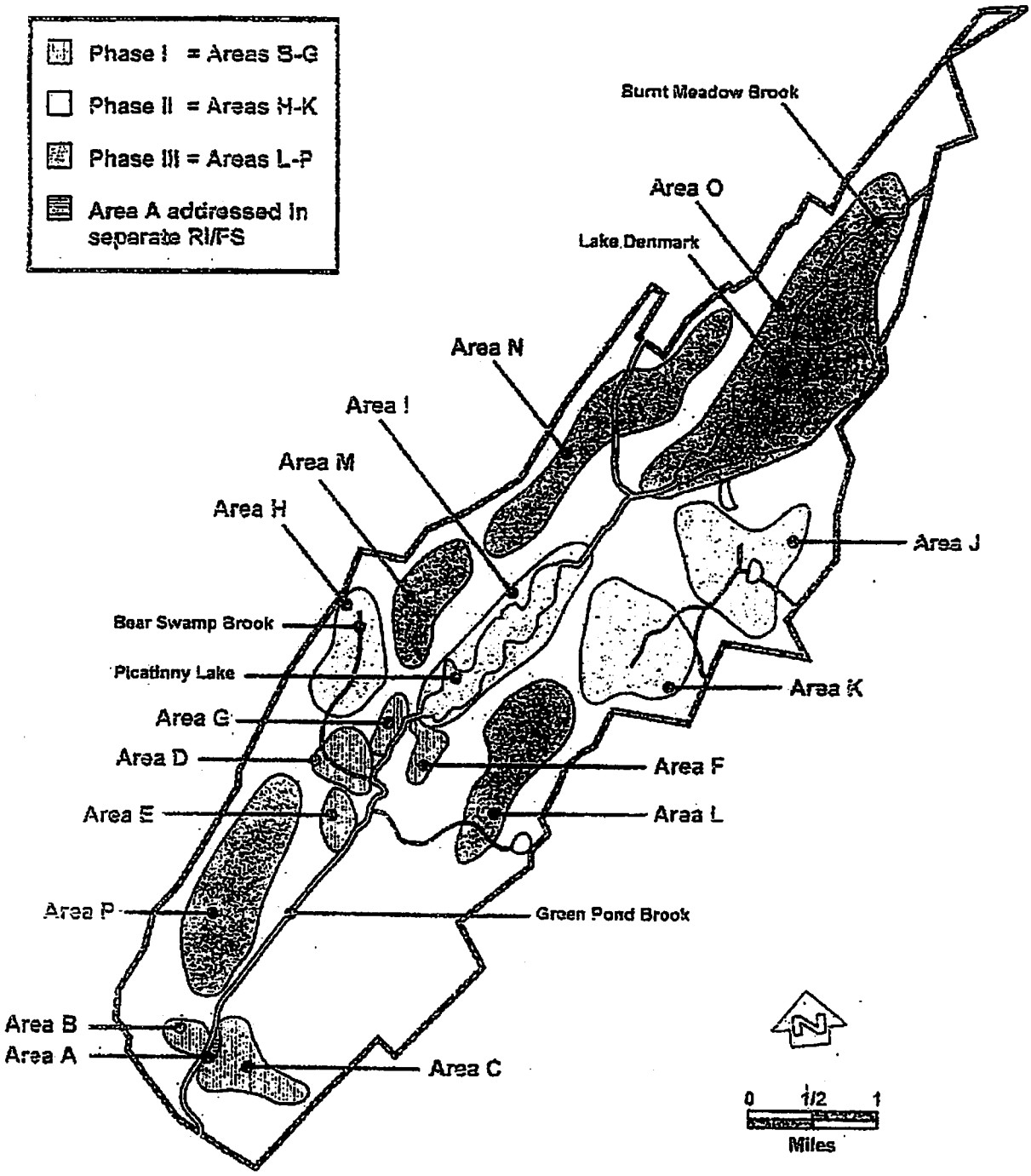
FIGURES

FIGURE 1: Area Map



Source: D&M 1997

FIGURE 2: Picatinny Arsenal



Source: IT 1998

Figure 3. ATSDR's Exposure Evaluation Process

REMEMBER: For a public health threat to exist, the following three conditions must all be met:

- People must come into contact with areas that have potential contamination
- Contaminants must exist in the environment
- The amount of contamination must be sufficient to affect people's health

Are People Exposed To Areas With Potentially Contaminated Media?

For exposure to occur, contaminants must be in locations where people can contact them.

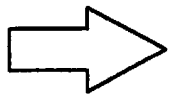
People may contact contaminants by any of the following three exposure routes:

Inhalation
Ingestion
Dermal absorption

Are the Environmental Media Contaminated?

ATSDR considers:

Soil
Ground water
Surface water and sediment
Air
Food sources



For Each Completed Exposure Pathway, Will the Contamination Affect Public Health?

ATSDR will evaluate existing data on contaminant concentration and exposure duration and frequency.

ATSDR will also consider individual characteristics (such as age, gender, and lifestyle) of the exposed population that may influence the public health effects of contamination.

APPENDIX A. List of Comparison Values

Comparison values represent media-specific contaminant concentrations that are used to select contaminants for further evaluation to determine the possibility of adverse public health effects. A contaminant that exceeds its comparison value does not mean that it will cause adverse health effects.

Cancer Risk Evaluation Guides (CREGs)

CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over their lifetime. ATSDR's CREGs are calculated from EPA's cancer potency factors (CPFs).

Environmental Media Evaluation Guides (EMEGs)

EMEGs are based on ATSDR minimal risk levels (MRLs) and factors in body weight and ingestion rates. A MRL is an estimate of daily human exposure to a chemical (in milligrams of contaminant per kilogram of body weight per day [mg/kg/day]) that is likely to be without noncarcinogenic health effects over a specified duration of exposure.

FDA Mercury Action Level (FDA)

The U.S. Food and Drug Administration (FDA) has established an action level of 1 ppm of methyl mercury in the edible portions of a fish. This action level was established to limit people's methyl mercury exposure to levels 10 times lower than the lowest levels associated with adverse effects (paresthesia) observed in mercury poisoning incidents. The action level is also based on the lowest level at which adverse effects were found to occur in fetuses and adults.

Lifetime Health Advisory (LTHA)

LTHAs are contaminant concentrations that EPA established to protect public health over a lifetime (70 years) at an ingestion rate of 2 liters of water per day. The LTHA is also developed considering the availability and economics of water treatment technologies.

Maximum Contaminant Level (MCL)

The MCL is the drinking water standard established by EPA. It is the maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet. MCLs are considered protective of public health over a lifetime (70 years) for individuals consuming 2 liters of water per day.

Reference Media Evaluation Guides (RMEGs)

ATSDR derives RMEGs from EPA's oral reference doses. The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

Risk-Based Concentration (RBC)
The RBCs were developed by EPA Region III. RBCs for tap water, air, and soil were derived using EPA RfDs and CPFs combined with standard exposure scenarios, such as ingestion of 2 liters of water per day, over a 70-year life span. RBCs are contaminant concentrations that are not expected to cause adverse health effects over long-term exposures.

Soil Screening Level (SSL)
Generic SSLs were derived by EPA for nation-wide application to sites used for residential areas. SSLs are estimates of contaminant concentrations that would be expected to be without noncancer health effects over a specified duration of exposure or to cause no more than one excess cancer in a million (10^{-6}) persons exposed over a 70-year life span.

APPENDIX B. ATSDR Plain Language Glossary of Environmental Health Terms (Revised December 15, 1999)

Absorption:	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure:	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
Adverse Health Effect:	A change in body function or the structures of cells that can lead to disease or health problems.
ATSDR:	The Agency for Toxic Substances and Disease Registry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level:	An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.
Biota:	Used in public health, things that humans would eat – including animals, fish and plants.
Cancer:	A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control.
Carcinogen:	Any substance shown to cause tumors or cancer in experimental studies.
CERCLA:	See Comprehensive Environmental Response, Compensation, and Liability Act.
Chronic Exposure:	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway:	See Exposure Pathway.

Comparison Value (CVs): Concentrations or the amount of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): **CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

Concern: A belief or worry that chemicals in the environment might cause harm to people.

Concentration: How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant: See **Environmental Contaminant**.

Delayed Health Effect: A disease or injury that happens as a result of exposures that may have occurred far in the past.

Dermal Contact: A chemical getting onto your skin. (see **Route of Exposure**).

Dose: The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".

Dose / Response: The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration: The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant: A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

Environmental Media: Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

U.S. Environmental Protection Agency (EPA): The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Exposure: Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Assessment: The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway: A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure, and
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste: Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: Lowest Observed Adverse Effect Level. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

MRL: Minimal Risk Level. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL: The National Priorities List. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL: No Observed Adverse Effect Level. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA: Public Health Assessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Plume: A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure: The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). For example: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population: A group of people living in a certain area; or the number of people in a certain area.

PRP: Potentially Responsible Party. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

Public Health Assessment(s): See **PHA**.

Public Health Hazard: The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:

1. Urgent Public Health Hazard
2. Public Health Hazard
3. Indeterminate Public Health Hazard
4. No Apparent Public Health Hazard
5. No Public Health Hazard

Receptor Population: People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:
- breathing (also called inhalation),
- eating or drinking (also called ingestion), and
- or getting something on the skin (also called dermal contact).

Safety Factor: Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.

SARA: The Superfund Amendments and Reauthorization Act in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from chemical exposures at hazardous waste sites.

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics: A branch of the math process of collecting, looking at, and summarizing data or information.

Superfund Site: See **NPL**.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Tumor: Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

Urgent Public Health Hazard: This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

APPENDIX C. Estimated Exposures and Health Effects

Estimates of Human Exposure Doses and Determination of Health Effects

Deriving Exposure Doses

The Agency for Toxic Substances and Disease Registry (ATSDR) estimated human exposure doses from ingestion of water from on-site water supplies and private wells to the south of Picatinny Arsenal (Picatinny). Deriving exposure doses requires evaluating the concentrations of contaminants to which people may have been exposed and how often and how long exposure to those contaminants occurred. Together, these factors help influence the individual's physiological response to chemical contaminant exposure and potential outcomes. In the absence of complete exposure-specific information, ATSDR applied several conservative exposure assumptions to define site-specific exposures as accurately as possible for on- and off-site residents and arsenal workers.

Evaluating Potential Health Hazards

The estimated exposure doses are used to evaluate potential noncancer and cancer effects associated with chemicals of concern. When evaluating *noncancer* effects, ATSDR uses standard toxicity values, including ATSDR's minimal risk levels (MRLs) and the U.S. Environmental Protection Agency's (EPA) reference doses (RfDs) to determine whether adverse health effects will occur. The chronic MRLs and RfDs are estimates of daily human exposure to a substance that are unlikely to result in adverse noncancer effects over a specified duration. To be over protective of human health, MRLs and RfDs have built in "uncertainty" or "safety" factors that make them much lower than levels at which health effects have been observed. Therefore, if an exposure dose is higher than the MRL or RfD, it does not necessarily follow that adverse health effects will occur.

When evaluating *cancer* effects, ATSDR sometimes uses EPA's cancer potency factors (CPFs) that define the relationship between oral exposure doses and the increased likelihood of developing cancer over a lifetime. The CPFs are developed using data from animal or human studies and often require extrapolation from high exposure doses administered in animal studies to the lower exposure levels typical of human exposure to environmental contaminants. CPFs represent the upper-bound estimate of the probability of developing cancer at a defined level of exposure; therefore, they tend to be very conservative (i.e., overestimate the actual risk) in order to account for a number of uncertainties in the data used in the extrapolation.

ATSDR estimated the potential for cancer to occur using the following equation. (The estimated exposure doses and CPF values for the contaminants of concern are incorporated into the equation):

Lifetime Cancer Risk = Estimated exposure dose (milligrams of contaminant per kilogram of body weight per day [mg/kg/day]) x CPF $(mg/kg/day)^{-1}$

Although no risk of cancer is considered acceptable, it is impossible to achieve a zero cancer risk. Consequently, ATSDR often uses a range of 10^{-4} to 10^{-6} estimated lifetime cancer risk (or 1 new case in 10,000 to 1,000,000 exposed persons), based on conservative assumptions about exposure, to determine the likelihood of excess cancer resulting from this exposure.

In addition to estimating the likelihood of noncancer and cancer effects, ATSDR reviewed the toxicologic literature to evaluate possible health effects associated with exposure at the doses/concentrations estimated for the pathways described below.

Estimated Exposure Doses from Ingesting Water from On-Site Drinking Water Supply Wells

ATSDR determined drinking water from on-site wells containing even the highest detected contaminant concentrations is unlikely to have harmed the health of Picatinny workers or residents.

Volatile organic compounds (VOC), RDX (an explosive), and metals in the drinking water supply wells located at Picatinny exceeded health-based comparison values (CVs) for drinking water. Although not found in drinking water supplies, the explosive nitrocellulose was found in groundwater in some areas of Picatinny. No CV has been developed for nitrocellulose. To determine whether exposure to these contaminants in the well water may result in adverse health effects, ATSDR estimated exposure doses for people consuming water containing the highest measured concentrations in the wells. In estimating to what extent people might be exposed to contaminants, ATSDR used "conservative" or safe assumptions about possible human exposure and any associated health effects. ATSDR assumed that a person drank the well water containing the maximum contaminant concentrations. ATSDR also used conservative assumptions about how often people drink water and how much they drink. These assumptions allow ATSDR to estimate the highest possible exposure dose and determine the corresponding health effects. Although ATSDR expects that few individuals, if any, were exposed to the highest levels of contamination, the "conservative" estimates are used to protect public health.

Tables C-1 and C-2 summarize the estimates of exposure to contaminants in on-site well water and the following describes the equation and assumptions used to estimate the exposure:

$$\textit{Estimated exposure dose} = \frac{\text{Conc. x CF x IR x EF x ED}}{\text{BW x AT}}$$

where:

Conc.:	Maximum concentration in the well water (ppb)
CF:	Conversion factor to convert ppb to ppm (1/1,000)
IR:	Ingestion rate: adult=2 liters per day; child=1 liter per day
EF:	Exposure frequency or number of exposure events per year of exposure: 7 days/week x 52 weeks/year
ED:	Exposure duration or the duration over which exposure occurs: adult=30 years; child=6 years
BW:	Body weight: adult=70 kg (154 pounds); child=10 kg (22 pounds)
AT:	Averaging time or the period over which cumulative exposures are averaged (6 or 30 years x 365 days/year for noncancer effects or 70 years for cancer)

Assumptions for Estimating Exposure Doses

— ATSDR estimates that an adult drank 2 liters and a child drank 1 liter of water a day and that all drinking water came from the wells at the arsenal. This assumption likely leads to an overestimate of the actual exposure dose because individuals most likely drank water from other sources.

— The exposure frequency (EF), or number of exposure events per year, was assumed to be 365 days per year, based on a 7-day-a-week exposure over 52 weeks per year. This is an overestimate of how often a person would actually consume water from a single well.

— The duration of exposure (ED) is assumed to have occurred over a 30-year period for adults. For a child, ATSDR used a 6-year exposure duration.

Noncancer

Using the equation to calculate exposure dose, ATSDR estimated exposure doses from ingestion of water from the on-site water supply wells (Table C-1). Chloromethane (to 30 ppb) and lead (to 53 ppb) are not included in Table C-1 because there are no noncancer health guidelines for these contaminants. Exposure to lead and possible exposures to nitrocellulose are discussed separately.

TABLE C-1: Estimated Exposure Doses—Noncancer Effects from Ingestion of Drinking Water at Picatinny Arsenal

Contaminant	Maximum Detected Concentration (ppb)	Estimated Exposure Dose (mg/kg/day)[1]		Health Guideline (mg/kg/day)	Basis for Health Guideline[2]
		Adult	Child		
Benzene	46.9	0.001	**0.005**	0.003	RfD
Bromodichloromethane	4.6	0.0001	0.0005	0.007	MRL
Bromoform	7.4	0.0002	0.0007	0.2	MRL
Carbon tetrachloride	1.0	0.00003	0.0001	0.007	RfD
Chlorobenzene	124	0.004	0.01	0.02	RfD
Chloroform	30	0.0009	0.003	0.01	MRL
Dibromochloromethane	2.9	0.00008	0.0003	0.03	MRL
Methylene chloride	15.7	0.0004	0.002	0.02	MRL
PCE	70	0.002	0.007	0.01	RfD
TCE	260	0.007	0.03	0.2	acute MRL
RDX	6.3	0.0002	0.0006	0.003	RfD
Arsenic	31	**0.0009**	**0.003**	0.0003	MRL
Cadmium	2	0.00006	0.0002	0.0002	MRL
Iron	460,000	**10**	**50**	0.3	RfD
Manganese	3,000	**0.09**	**0.3**	0.02	RfD

Source: D&M, 1998c and 1998d; Sargent, 1988; USAEHA, 1979; USGS, 1986

[1] Bold indicates doses above the health guideline.

[2] Health guidelines are for long-term (chronic) exposure unless otherwise noted.

For adults, the estimated exposure doses for arsenic, iron, and manganese exceed the health guideline values. For children, the estimated exposure doses for benzene, arsenic, iron, and manganese exceed the health guideline values. Benzene was detected above its CV in only one well, Well 410, in only 2 of 57 samples collected between 1989 and 1990. Benzene was not detected in samples collected from Well 410 from 1981 through 1985. Therefore, the estimated dose, assuming ingestion of the maximum benzene concentration, greatly overestimates the actual dose. The maximum detected arsenic concentration (31 ppb) is lower than EPA's Maximum Contaminant Level (MCL) (50 ppb). Epidemiologic investigations suggest that noncancer effects from chronic arsenic exposure may lead to skin problems, neurological effects, and gastrointestinal irritations. The lowest observed levels at which these adverse effects have been

reported range from 0.014 to 0.05 mg/kg/day (ATSDR 1998a). The estimated doses for adults and children are at least five times lower than the lowest dose reported to cause health effects. Iron and manganese are both nutrients considered essential for human health. Manganese at high doses, however, has been found to cause some adverse health effects, such as mental and emotional disturbances. Studies found no adverse health effects from manganese ingestion at a dose of 1 mg/kg/day, which is at least three times higher than the estimated exposure dose for children consuming water with the maximum detected manganese concentration (ATSDR 1997b). Adverse health effects from iron are not expected.

Cancer

ATSDR derived cancer risk estimates for exposure to known or possible carcinogens found in on-site drinking water supply wells. Carcinogens, estimated exposure doses, and lifetime cancer risks are listed in Table C-2. Chlorobenzene, cadmium, iron, and manganese are not considered carcinogens. Lead is under consideration for classification as a possible carcinogen, however, no CPF is available as data are currently insufficient to establish a causal relationship.

TABLE C-2: Estimated Exposure Doses—Cancer Effects from Ingestion of Drinking Water at Picatinny Arsenal

Contaminant	Maximum Contaminant Concentration (ppb)	Estimated Exposure Dose-Cancer (mg/kg/day)[a]	Cancer Potency Factor	Lifetime Cancer Risk[1]
Benzene	46.9	0.0006	0.029	2×10^{-5}
Bromodichloromethane	4.6	0.00006	0.062	3×10^{-6}
Bromoform	7.4	0.00009	0.0079	7×10^{-7}
Carbon tetrachloride	1.0	0.00001	0.13	2×10^{-5}
Chloroform	30	0.0004	0.0061	2×10^{-6}
Chloromethane	30	0.0004	0.013	5×10^{-6}
Dibromochloromethane	2.9	0.00004	0.084	3×10^{-6}
Methylene chloride	15.7	0.0002	0.0075	1×10^{-6}
PCE	70	0.0009	0.052	4×10^{-5}
TCE	260	0.003	0.011	4×10^{-5}
RDX	6.3	0.00008	0.11	8×10^{-6}
Arsenic	31	0.0004	1.5	6×10^{-4}

Source: D&M, 1998c and 1998d; Sargent, 1988; USAEHA, 1979; USGS, 1986

[1] Bold indicates doses above the acceptable range of 10^{-4} to 10^{-6}.

Only the derived lifetime cancer risk for arsenic (6×10^{-4} or an increased likelihood of 6 in 10,000 of developing cancer) was above the "acceptable" range of 10^{-4} to 10^{-6}. Lifetime cancer risks for exposure to all other contaminants was within or below this range. EPA classified arsenic as a carcinogen based on epidemiological studies. Unlike other carcinogens, arsenic does not cause cancer in laboratory animals when administered orally. The basis for classifying arsenic as a human carcinogen is the results of a Taiwanese study in which the lowest exposure levels associated with the onset of cancer (skin) were 170 to 800 ppb in drinking water. People drank water containing these concentrations for a 45-year exposure period (ATSDR 1998a). Residents and workers at Picatinny were exposed to a maximum detected concentration almost 6 times lower than those observed in the Taiwanese study. In addition, it is unlikely that residents and on-site workers were exposed to the maximum detected arsenic concentration, which is below its MCL, over the entire exposure period. Therefore, it is unlikely that the levels of arsenic in on-site supply wells would lead to an increased risk of cancer. In addition, the Army conducts regular sampling to ensure the safety of the drinking water supply.

Lead

Lead was detected above EPA's MCL (15 ppb) in four of the on-site drinking water wells. Lead concentrations, however, only exceeded the MCL in 5 of the 58 samples collected from these wells with a maximum detected concentration of 53 ppb.

Although lead is a concern for adults, children are particularly susceptible to adverse effects from lead exposures. Scientific evidence indicates that blood lead levels of 10 to 25 micrograms per deciliter (ug/dL) may be related to delayed mental development, reduced intelligence quotient (IQ) scores, poor attention span, speech and language delays, and impaired hearing. Although no site-specific data regarding child blood levels are available at Picatinny, studies have been conducted to correlate water concentrations with blood lead levels. In general, blood lead levels increase by approximately 0.03 to 0.06 ug/dL for every 1 ppb of lead in water. Children exposed to the maximum detected lead concentration, assuming an increase rate of 0.06 ug/dL, would have a blood lead level of 3 ug/dL ($53 \times 0.06 = 3$). This is well below the 10 to 25 ug/dL level that may be related to adverse health effects (ATSDR 1997a). Based on well sampling results, children are expected to consume water with much lower concentrations of lead and exposure to the maximum detected concentration would not be continuous. Therefore, no adverse health effects are expected from lead detected in drinking water at the reported concentrations.

Nitrocellulose

Nitrocellulose is an explosive and principle ingredient in propellants, smokeless powder, rocket fuel, ball powder, and mortar increments. It is made by treating cotton or wood fibers with nitric and sulfuric acids to create an extremely flammable, fibrous, solid material. There are no data to suggested that nitrocellulose can be absorbed into the body either by touching or even ingesting water or soil containing nitrocellulose. Animal studies have found health effects only when the animals ingested large quantities of nitrocellulose (approximately 10% of their total diet). In these

cases, the health effect was intestinal impaction from the high amount of cotton and wood fibers ingested, no health effects from the explosive were seen (Roberts and Hartely 1992). As such, ATSDR does not expect adverse health effects to result from possible exposures to low-levels of nitrocellulose found in groundwater.

Estimated Exposure Doses from Ingesting Water from Private Drinking Water Wells

ATSDR determined drinking water containing even the highest detected concentration of explosives is unlikely to have harmed the health of off-site residents.

The explosive RDX was found in four off-site private drinking water wells at levels above the health-based CV for drinking water. To determine whether exposure to RDX in well water may result in adverse health effects, ATSDR estimated exposure doses for people consuming water containing the highest measured concentrations in the wells. The equation and conservative assumptions described above for the evaluation of exposure doses from ingesting water from on-site drinking water supply wells were also used to estimate the potential exposure doses from consuming RDX in private well water.

Noncancer
Using the dose equation described previously, ATSDR found an exposure dose of 0.0002 mg/kg/day for adults and 0.0009 mg/kg/day for children consuming RDX in off-site private wells. Both of these estimated doses are well below RDX's MRL of 0.003 mg/kg/day. No adverse health effects are expected because ATSDR used conservative assumptions that overestimate the potential doses and the estimated doses were below the MRL for RDX.

Cancer
RDX is considered a possible human carcinogen by EPA. ATSDR derived a cancer risk estimate for RDX of 1×10^{-5} (an increased likelihood of 5 in 100,000 of developing cancer), which is withing the "acceptable" range of 10^{-4} to 10^{-6}. In addition, ATSDR used conservative assumptions that likely overestimate actual cancer risks. ATSDR, therefore, concluded that RDX is unlikely to result in a increased risk of cancer.

APPENDIX D. Responses to Public Comments

The Agency for Toxic Substances and Disease Registry (ATSDR) received the following comments/questions during the public comment period (October 4 to November 22, 2000) for the Picatinny Arsenal Public Health Assessment (PHA) (October 4, 2000). For comments that questioned the validity of statements made in the PHA, ATSDR verified or corrected the statements. The list of comments does not include editorial comments concerning changes such as word spelling or sentence syntax.

1. **Comment:** *PCB Hot Spot at Site 20/24.* In 1999, ATSDR performed a health consultation pertaining to polychlorinated biphenyls (PCBs) in Area B. Recommendations of ATSDR were to complete remediation or restrict access to the PCB hot spot area. No remediation (capping) has taken place and access to the area may not be properly restricted. The security of the area is questionable and may present a threat to public health. ATSDR has addressed the area assuming that recommendations to complete remediation or restrict access have taken place.

   Response: ATSDR's 1999 recommendation to complete remediation or restrict access to PCBs in soil in Area B was based on possible noncancer health effects to construction workers who may contact the highest concentrations of PCBs every day over a number of months. Members of the public that trespass at the site or hunters that may inadvertently enter the site are not expected to experience adverse noncancer or cancer health effects from infrequent exposure to PCBs in soil in Area B. Although no remediation has been completed, actions will be taken to protect the health of future construction workers if the site is developed in the future.

   To minimize trespassing, the Army has implemented several security measures. A perimeter fence surrounds most of the site; some areas, such as Lake Denmark, are beyond the perimeter fence. Picatinny police regularly patrol all areas of Picatinny, both inside and outside of the perimeter fence, every day of the year. The Army has not provided details about additional measures to prevent access to the arsenal because of security reasons (Gabel 2001).

2. **Comment:** *Controlled Access.* It is reported that a perimeter fence surrounds most of Picatinny Arsenal. Gate guards are on-duty full-time at night. However, guards are only on duty part-time during the day. Based on the health assessment, it is unclear whether all areas of concern are contained within the perimeter fence of the facility. The absence of security at times during the day presents an opportunity for anyone, including trespassers (e.g., hunters, fishermen) to enter the site. The possibility of unrestricted access to the site should be considered in the PHA.

Response: Most areas of concern are located within Picatinny's perimeter fence; some areas, such as Lake Denmark, are beyond the fence. Trespassers entering Picatinny could potentially be exposed to contaminants in surface soil, surface water, sediment, and fish. Trespasser exposures to contaminants in these media are expected to be infrequent because security measures are in place to minimize potential trespassing, as discussed in the response to comment 1. To be conservative, ATSDR evaluated recreational users who have been approved to use arsenal facilities because they would be expected to contact contaminated site media more often than a trespasser illegally entering the arsenal. ATSDR found that potential exposures of recreational users contacting contaminants in surface soil, surface water, sediment, and fish at Picatinny are not expected to cause adverse health effects.

3. **Comment:** *Deer Consumption.* The PHA refers to two Army studies of bioaccumulation of contaminants in deer. Both studies found that only very low levels of metals were found and that no pesticides, PCBs, or explosives were detected in deer tissue. It is unclear from the PHA whether all of the same contaminants of concern at Picatinny Arsenal were present at the sites under consideration in the studies. Furthermore, the PHA states that only very low levels of metals were detected. However, it is unclear whether the concentrations that the subject populations were exposed to are similar to those found at Picatinny Arsenal and whether the concentration of the contaminant in the environment would affect the concentration accumulated in the deer tissue.

Response: The Army studied contaminant bioaccumulation in deer at the Joliet Army Ammunition Plant in Joliet, Illinois, and the Aberdeen Proving Ground in Aberdeen, Maryland. Similar to Picatinny, these facilities are used for munitions production, storage, and/or research. At these facilities, the Army studied bioaccumulation of PCBs, pesticides, metals, and explosives, which were found in similar concentrations at Picatinny (CHPPM 1995; USAEHA 1994). ATSDR concluded that consumption of deer taken from Picatinny during recreational hunting would not result in illness or adverse health effects because 1) studies of similar facilities with similar contaminants and concentrations found contaminants in deer tissue below levels of health concern, and 2) much of the deer habitat is undeveloped and uncontaminated, so that deer would only have limited exposure to contaminants.

4. **Comment:** *Out-of-Service Wells.* Several former water supply wells are referred to as being closed. It is unclear whether closed means that the wells have been properly abandoned. Proper abandonment techniques involve sealing up a well from depth to ground surface with grout to prevent migration of surface contaminants. As some of these wells were closed in the past and the reason for their closure may or may not be known, it may be prudent to evaluate whether proper abandonment has taken place. The unused wells present a hazard to people at the surface. In addition, improperly abandoned wells represent a means for contamination of underlying aquifers by surface spills. It is reported

that some of these wells have long well screen intervals and, as such, may also be a means of cross contamination of aquifers.

Response: A total of 13 potable wells have been drilled at Picatinny. Of these wells, eight have been closed for a number of reasons. The Army stopped using one well, Well 129, in 1998 because of contamination. This well was permanently closed in accordance with all local, state, and federal regulations in summer 2000 (Gabel 2001). This well, therefore, poses no threat to the public, either as a physical hazard or as a means for transporting contamination across aquifers.

The process for closing the other seven wells is unknown. Most of these wells were closed over 20 years ago and the process and regulations for closing wells in place at that time are unknown. The Army is in the process of gathering additional information about the seven closed wells and planning investigations of the wells (Gabel 2001). ATSDR will review information about the well closures if this information indicates that public health may be impacted as a result of past practices.

5. **Comment:** *Stocking of Fish.* It is reported that both Picatinny Lake and Lake Denmark are stocked with fish that require several years of growth before reaching their legal catch size. Green Pond Brook is supposedly stocked with fish at their legal catch size. Fish species requiring several years to attain catch size have an increased exposure to contaminants. It is unclear whether the increased duration of exposure (from the time of stocking until the fish attains legal catch size) affects the bioaccumulation of contaminants. It is also unclear whether previous fish tissue sampling has included samples of the stocked fish that have attained or exceeded their legal catch size.

Response: The Army collected fish tissue samples throughout Picatinny in 1989, 1990, and during the Phase I and II Remedial Investigations. During these sampling events, the Army caught a variety of fish species for analysis, including minnows/shiners, mudminnow, suckers, catfish/bullhead, sunfish, perch, pickerel, bass, and trout. Some of these are stocked fish, but the majority of these fish are native to the lakes and streams at Picatinny and spend their entire lifecycle in Picatinny waters. Fish were also caught in a range of sizes (weight and length) to represent ranges of ages and length of exposure to contaminants in the surface water and sediment (USAEHA 1990; D&M 1998e; IT Group 2000). In each fish species or size, contaminants were found at concentrations below levels expected to result in health effects. Regardless, the Army implemented a fishing advisory for Picatinny following the state of New Jersey fish consumption advisory.

6. **Comment:** *Input of Community and RAB Members.* The PHA refers to routine meetings of Picatinny Arsenal personnel with community members. It is unclear whether the meetings referred to are Restoration Advisory Board (RAB) meetings or other gatherings. It is not clear how community concerns are brought to the attention of ATSDR. None of

the references cite written or personnel communication or interviews. It would be helpful to the RAB to be able to review documents describing such concerns to be certain that the concerns of their constituencies are adequately being addressed.

Response: Picatinny personnel and community members meet during RAB meetings. Additional public meetings are also held as required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (IT 1998). ATSDR gathered community health concerns by:

- attending the April 22, 1998, RAB meeting and speaking with RAB members;
- reviewing the 1998 Community Relations Plan, which contains results from an Army interview of community members; and
- speaking with Army personnel throughout the PHA process to continually assess issues that the local community may have brought to the attention of the Army.

7. **Comment:** *Nature of Fish Tissue Samples.* Phase I and II fish tissue samples were whole body samples rather than samples of the edible portions. ATSDR considers that whole body tissue analysis is an overestimate of concentrations because many of the contaminants bioaccumulate in portions of the fish that are not consumed. It is unclear whether this holds true for the types of contaminants observed at Picatinny Arsenal. It would be useful to have references cited to support this statement for each of the different contaminants. Where such an observation is not supported for certain critical contaminants (those that are especially widespread in distribution or are very high in concentration), it may be beneficial to resample fish tissue for the edible portions only. The PHA should be re-evaluated and revised, if necessary, on the basis of results of additional fish tissue sampling that is being planned.

Response: Of the 15 contaminants found in the whole body fish samples, 10 were detected in more than 25% of the samples collected. Bis(2-ethylhexyl)phthalate, alpha-BHC, DDD, DDE, DDT, Aroclor-1254, and Aroclor-1260 are lipid (or fat) soluble (ATSDR 1998c, 1999b, 2000a, 2000b). As such, these contaminants tend to accumulate in the fatty tissues of the fish, which are typically not consumed, rather than the muscle tissues, which are the edible portions of a fish. Arsenic was found in 34% of the whole body fish samples. Arsenic, however, selectively accumulates in the liver in fish, which is typically not consumed (ATSDR 1998a). A person consuming fillets from fish caught at Picatinny, therefore, would be exposed to these contaminants at lower levels than reported for the whole body samples.

Chromium was detected in 72% of the whole body fish samples. Chromium can be present in the environment in two forms—trivalent chromium and hexavalent chromium. Of these two forms, hexavalent chromium is more toxic, meaning lower concentrations of hexavalent chromium have been found to cause harm to animals and people compared to trivalent chromium. The results of analysis of whole body fish tissue and fillet samples,

however, were only reported as total chromium. To be overly protective of public health, ATSDR assumed that all of the reported chromium concentration consisted of hexavalent chromium. The toxicology literature, however, indicates that when a person or animal ingests hexavalent chromium, it is quickly changed to trivalent chromium in the gastrointestinal tract. The chromium found in fish tissue, therefore, is expected to consist of a mixture of hexavalent and trivalent chromium (ATSDR 2000c, EPA 1998). The comparison value for trivalent chromium is 2,000 parts per million (ppm), which is well above the maximum detected total chromium concentration of 4.6 ppm found in whole body tissue samples and 86 ppm found in fillet samples. The comparison value for hexavalent chromium is 4.1 ppm. ATSDR does not expect adverse health effects to result from consuming fish containing total chromium because the maximum detected concentration was well below the comparison value for trivalent chromium and only slightly above the comparison value for hexavalent chromium. In addition, these comparison values are derived for a person eating fish containing contamination once every 2 days. Recreational fishers at Picatinny are not expected to subsist on fish caught at Picatinny and only a portion of the fish caught contained chromium above the comparison value for hexavalent chromium.

Iron was detected in all of the whole body fish tissue samples collected at Picatinny. Iron is considered an essential nutrient by the U.S. Food and Drug Administration (FDA). FDA has set a recommended daily intake of iron at 18 milligrams (mg) (FDA 2001). As such, eating about 1 ounce (oz) of fish containing the maximum detected iron concentration of 694 ppm would provide a person with their recommended daily intake of iron. Eating more than the recommended daily intake, however, would not result in adverse health effects. A review of the toxicology literature found the greatest concern associated with iron is accidental iron poisoning in children under 6 years who overdose on multivitamins. Poisonings were reported when children ingested five or more vitamins containing 30 mg or more of iron at one time (at total of 150 mg of iron or the equivalent of eating an 8 oz meal of fish containing the maximum detected iron levels) (FDA 2000). No instances of iron poisoning from consuming foods, such as fish, were identified.

8. **Comment:** *Fish Consumption Advisory.* The Army has adopted a state of New Jersey fish consumption advisory due to concerns about exposure to certain contaminants through ingestion of fish. Presumably, such an advisory is known to people fishing at the facility whether they are authorized to do so or are trespassers.

Response: In 1999, the Army drafted fishing restrictions based on a state of New Jersey fish consumption advisory prompted by the detection of elevated mercury levels in freshwater lakes throughout New Jersey. Picatinny personnel and fishermen were notified about the draft restrictions at that time. In March 2000, the Army further notified Picatinny fishermen, residents, and employees about the fishing restrictions. This notification was also printed in the Rod and Gun Club Newsletter. Since the initial

notification in 1999, people obtaining fishing permits for the arsenal receive a copy of the fishing restrictions. The fishing restrictions are also available for any person requesting a copy (Gabel 2001).

Regardless of the fishing restrictions, trespassers who may infrequently fish in arsenal surface waters and consume these fish are unlikely to suffer adverse health effects. Contaminant concentrations detected in fish tissue samples are below levels that would cause adverse health effects from infrequent exposures. The Army implements site access restrictions, as described in the response to comment 1, to minimize possible trespassing at Picatinny.

9. **Comment:** *Availability of Documents.* The availability of documents pertaining to the site should be verified at the location cited in the health assessment. It may not now be possible to access documents at the cited locations.

Response: CERCLA requires that the Army keep an Administrative Record of activities conducted during remediation of a National Priorities List (NPL) site. The Administrative Record is a compilation of all documents associated with remediation decisions made at a site. These records must be maintained for at least 50 years after remediation is completed. At Picatinny, the Administrative Record is maintained at the arsenal and additional information repositories are maintained at the Morris County Library and the Rockaway Township Library. The Administrative Record Clerk, a Picatinny employee, ensures that the Administrative Record and information repositories are up-to-date. On a quarterly basis, new documents are added to the record and supplied to the libraries and the U.S. Environmental Protection Agency (EPA). The information repositories consist of (1) a list of administrative documents, (2) a point of contact, which is the Administrative Record Clerk, (3) fact sheets, (4) the Community Involvement Response Plan, (5) environmental assessments, and (6) the RAB Meeting Minutes and handouts (Gabel 2001).

10. **Comment:** *Evaluation of Supply Well Capture Zone Modeling.* The PHA states that the nearest public supply well is not now affected by Picatinny Arsenal contamination. The potential of future effects should be evaluated by reviewing the wellhead protection plan (WHPP) for the nearby public water supply well(s). The WHPP should include capture zone modeling which would be a useful tool in predicting whether any effects could potentially be realized.

Response: In evaluating groundwater contamination data and assessing potential exposures, ATSDR determined that conducting extensive groundwater modeling was unnecessary to protect public health. Beginning in the 1970s, the Army has installed and sampled hundreds of groundwater monitoring wells to characterize and track groundwater contamination at Picatinny. As a result of this monitoring, and continuing groundwater investigations, the Army has identified only one area where contaminants have migrated

beyond the arsenal boundaries. Low concentrations of the explosive RDX (to 8.6 parts per billion [ppb]) were found in samples from three private wells located along the southern arsenal boundary. As a result, the Army connected homes in this area to the municipal water supply to prevent exposures from use of private wells. The Army continues to track groundwater migration of explosives in this area, as well as monitor groundwater throughout the arsenal.

The nearest public water supply well to Picatinny is approximately 2 miles south of Picatinny. Under federal and state laws, public water suppliers are required to test the water supply to ensure that drinking water provided to the public meets stringent safe drinking water standards. As such, even if contamination migrated beyond Picatinny's boundaries, people using the public water supply would be protected from exposure to contaminants.

11. **Comment:** *New Public Supply Well.* A new development, very close to Picatinny Arsenal, called Highlands of Morris has filed for a New Jersey Department of Environmental Protection (NJDEP) water allocation permit. The new development will consist of 1,000 residential units. The NJDEP has not yet issued a water allocation permit. The PHA should consider the potential impact of groundwater contamination at Picatinny Arsenal on the Highlands of Morris drinking water supply.

Response: When installing a new well, the well installer must submit a permit to NJDEP. Although the permit application process does not require consideration of nearby groundwater contamination, public water supplies must meet stringent safe drinking water standards in order to ensure protection of public health. To further protect public health and to ensure that water supply wells remain free of contamination, the Army is monitoring and treating groundwater contamination, which has remained within arsenal boundaries except along the southern edge of the arsenal. As such, ATSDR does not expect on-site groundwater contamination to pass arsenal boundaries and result in impacts to off-site drinking water wells. ATSDR, however, recommends that the Army notify developers located in the downgradient groundwater flow path about site groundwater contamination to provide further assurance to the public that new water supplies are safe to drink.

12. **Comment:** *Parameters Monitored at Community Public Supply Wells.* The PHA states that public supply wells are routinely sampled for a variety of parameters. However, the typical parameter contaminant list does not include some of the compounds detected at Picatinny Arsenal. For example, explosives and RDX are not routine parameters. The parameter list that is currently analyzed for at the public supply wells should be compared to contaminants of concern at Picatinny Arsenal. The analytical parameters for public supply wells should be expanded to include contaminants of concern at Picatinny Arsenal.

Response: As discussed in the response to comment 10, the Army tracks groundwater contamination by sampling hundreds of monitoring wells. Monitoring is also conducted to protect both on- and off-site drinking water supplies from impacts from site contamination. As a result of this monitoring, only low concentrations of RDX, an explosive, have been found beyond arsenal boundaries. RDX was found in three private wells located near the southern base boundary. Otherwise, groundwater contamination is confined within arsenal boundaries and has not impacted off-site municipal water supplies. In addition, the public water suppliers and local boards of health are aware of the contamination issues at Picatinny. Public water supplies must meet stringent safe drinking water standards, which include standards for contaminants commonly found at hazardous waste sites, including Picatinny. Regulators review ongoing sampling procedures and results. The need for sampling of public supply wells for non-routine compounds would be identified before a public health hazard could occur. Monitoring groundwater contamination on site and required sampling of public water supplies is sufficient to ensure protection of public health.

13. **Comment:** *Potential Effects of Flood Releases.* In August 2000, Jefferson, Sparta, and parts of other surrounding communities were subjected to precipitation of a magnitude equivalent to a 500-year or greater storm. Dams on some lakes in the area were breached and some failed completely, releasing catastrophic floods. Other streams and rivers topped their banks. The human health effects of such a storm event, if it were to hit Picatinny Arsenal, are unclear.

Response: During a flooding event at Picatinny, large amounts of water and sediment could be carried from Picatinny Lake, Lake Denmark, and Green Pond Brook downstream to areas beyond the arsenal boundaries. As such, downstream recreational users may be exposed to the contaminants found in on-site surface water and sediment from these water bodies. In evaluating contaminant concentrations and assessing potential exposures, ATSDR assumed that people at Picatinny could be exposed to contaminants in surface water and sediment during recreational use. Contaminants in these media were below levels that would be expected to cause adverse health effects in on-site recreational users, therefore, contaminant concentrations are also below levels that would be expected to cause adverse health effects in off-site recreational users. In addition, transport of surface water and sediment during flooding would be expected to widely disperse the contamination over a wide area, which would reduce the contaminant concentrations off site. Therefore, a storm event is not expected to impact the potential public health effects posed by contamination in Picatinny surface water bodies. However, in such an event, in general, as a precautionary measure, local health agencies would assess the situation from a public health perspective.

14. **Comment:** *Cumulative Effects of Particulates from Burning Grounds.* The PHA cites a 1989 study that found that the highest concentration of particulates traveled between

2,500 feet and 3,000 feet northeast of the burning grounds and that there were no homes within that distance. The PHA does not state how close the nearest homes are. The PHA also states that contaminants present in low levels of particulate matter that may blow beyond Picatinny Arsenal boundaries are unlikely to result in adverse health effects. No references are cited. Nor is the cumulative effect of such releases addressed. Burning takes place 3 times a week. In addition, dioxin may have been detected in past sampling in the burning grounds area.

Response: Homes nearest to the burning grounds are located approximately 2,700 feet to the south and southeast along Richard Mine Road and it's side-streets (IT 1998). In this health assessment, ATSDR considered possible exposures to people living off site through inhalation of fugitive dust generated by wind erosion of contaminated soil and inhalation of particulate matter from smoke from burning activities. Conclusions were based on a review of site-specific data, health-based air quality standards, and chemical characteristics of explosives, which are the primary materials burned at the burning grounds.

As part of the investigations conducted at the burning grounds, the Army conducted an air pollution assessment in 1989. This assessment focused on estimating ambient air concentrations of soil due to wind erosion (fugitive dust). The study predicted that the highest concentrations of site contaminants transported as fugitive dust would be expected to be deposited in areas 2,500 to 3,000 feet northeast of the site. This study also included particulate matter monitoring around the perimeter of the site and found a maximum particulate matter level of 71 micrograms per cubic meter (ug/m^3) (D&M 1994).

In a subsequent 1994 investigation of the burning grounds, the Army evaluated possible health impacts to on-site workers and off-site residents from inhalation of fugitive dust and contact with contaminants in surface soil. Community members have expressed concern about dioxins produced during burning. Dioxins, which are generally produced during burning of chlorinated compounds, are not typically produced during burning of explosives. However, some of the wastes burned at the site may have contained low-levels of chlorinated solvents. As such, investigations included an assessment of dioxin exposures. In conducting this assessment, the Army found that on-site workers would be exposed to the highest levels of contaminants in air and soil even though levels of off-site fugitive dust deposition were expected to be highest 2,500 to 3,000 feet northeast of the site. On-site soil contamination levels were anticipated to be higher than off-site soil contamination from fugitive dust deposition because a vegetative cover on site minimized soil movement and contamination would disperse during migration, which effectively reduces the contaminant concentrations. The Army evaluation, which was reviewed by ATSDR, found that contaminant levels on site were too low to result in adverse health effects to on-site workers, therefore, off-site contaminant levels would be too low to result in adverse health effects to off-site residents (D&M 1994).

No data are available to assess exposure to particulate matter in smoke during burning activities. The materials most commonly disposed of at the burning grounds consist of manufacturing wastes contaminated with explosives. Explosives are chemicals manufactured to be highly reactive in order to cause explosive destruction. As such, when an explosive is burned, it is quickly destroyed. Because burning causes complete destruction of explosives, the Federal Remediation Technologies Roundtable, a work group composed of federal agencies involved in site remediation, has identified open burning as an acceptable method for treating explosive-contaminated material. In open burning, explosives are destroyed by their own ability to react and burn (FRTR 2001).

Because the explosives themselves are destroyed during open burning, ATSDR evaluated exposures to particulate matter generated in the smoke during open burning. EPA has set a National Ambient Air Quality Standard (NAAQS) for particulate matter, specifically PM_{10}, at 150 ug/m^3 averaged over 24 hours. NAAQS are health-based standards that are derived to protect public health, including sensitive populations such as asthmatics, children, and the elderly (EPA 2001a). Available monitoring data from the perimeter of the burning grounds found a maximum concentration of 71 ug/m^3. Particulate matter concentrations at the nearest homes, approximately 0.5 miles from the site, would be much lower due to dilution and dispersion in the air. In addition, EPA tracts air quality standards throughout the United States and designates areas where NAAQS are exceeded as Nonattainment Areas. A search of EPA data found that no area in New Jersey has been designated a Nonattainment Area based on exceedences of PM_{10} (EPA 2001b). Because measured PM_{10} levels are below the health-based NAAQS, ATSDR concluded that open burning is not expected to cause adverse health effects. The Army, however, is constructing an incinerator, scheduled for completion in 2001, to address concerns about exposures from open burning.

15. **Comment:** *Depositional Effects of Low Concentration Particulate Matter from Burning Grounds.* Based on the occurrence of burning at a frequency of 3 times a week, particulates must have accumulated at the site of deposition over the numerous years of operation of the burning grounds. No mention of surface soil sampling in the area of high concentration fallout is mentioned. Nor is there any mention of indoor wipe sampling of homes that may be exposed to particulate fallout.

Response: Concerns expressed in this comment are addressed above in the response to comment 14.

16. **Comment:** *Potential Well Restriction Area.* Explosives have been detected in groundwater off site. Residents who had relied on domestic supply wells have been connected to the Wharton municipal supply. If a well restriction area has not been established, it may be possible for other residents to drill their own supply well and become exposed to contaminated groundwater.

Response: The Rockaway Board of Health regulates private well drilling in the neighborhood where explosives were found in off-site groundwater. To drill a new well, a home owner must receive a permit from NJDEP. After receiving a NJDEP permit, the homeowner applies for a town permit. The Rockaway Board of Health will only allow a homeowner to drill a drinking water well if no municipal water supply is available. A private drinking water well must be inspected by the Rockland Board of Health and tested before use. If a municipal supply is available, a homeowner can use a private well for non-drinking purposes (e.g., irrigation), but must use the municipal supply for drinking water. In the neighborhood where explosives were found in off-site groundwater, a municipal water supply is available and must be used as a drinking water source (Correale 2001). The levels of explosives found in groundwater are below levels expected to cause illness or adverse health effects from non-drinking water uses. The Army also monitors groundwater at Picatinny to ensure that contamination remains within arsenal boundaries in all other locations.

17. **Comment:** *Termination of Pump-and-Treat System for Groundwater in Area D.* The PHA is based on continued operation of a pump-and-treat system for groundwater in Area D. The trichloroethylene (TCE) plume being remediated is the main reason for listing of the site on the NPL. The Army has proposed to shut down the pump-and-treat system; the approach to replace the active system would be monitored natural attenuation (MNA). EPA prefers active remedial measures. EPA cautions that the higher costs of active remedial measures must be considered against "their substantial advantage in reducing contaminant mass" and reducing loading to Green Pond Brook in a much shorter time frame. The PHA should consider the potential health effects of the MNA scenario which is being contemplated.

Response: Environmental laws and regulations require that the Army receive approval from EPA and NJDEP when selecting or altering remedial actions at Picatinny. As such, the Army must submit plans to EPA and NJDEP for a MNA program and receive approval before MNA could be implemented and the active pump-and-treat system could be closed. EPA and NJDEP consider protection of human health and the environment when approving remediation programs, therefore, ATSDR is confident that oversight of the Picatinny remediation efforts by EPA and NJDEP will be protective of future public health. However, because of expressed community concern, ATSDR has added a recommendation to the PHA asking the Army to inform ATSDR if the selected remedial actions are altered so that ATSDR can reevaluate potential public health impacts.

18. **Comment:** *Unexploded Ordnance.* The presence of unexploded ordnance (UXO) at Picatinny Arsenal is not addressed in the PHA. There are several documented areas where unexploded ordnance is known to be present. The presence of UXO at other areas is suspected.

Response: Two locations at Picatinny are know to contain UXO. These sites are fenced to prevent access. The Safety Office at Picatinny has procedures and regulations in place to address UXO concerns and address inadvertent discovery of UXO throughout the arsenal (Gabel 2001).

19. **Comment:** *Nitrocellulose.* No comparison value is cited in the PHA for nitrocellulose. Nitrocellulose has been detected at several areas of concern. The potential human health effects of nitrocellulose should be addressed in the PHA.

Response: Nitrocellulose is an explosive and principle ingredient in propellants, smokeless powder, rocket fuel, ball powder, and mortar increments. It is made by treating cotton or wood fibers with nitric and sulfuric acids to created an extremely flammable, fibrous, solid material. There are no data to suggest that nitrocellulose can be absorbed into the body either by touching or even ingesting water or soil containing nitrocellulose. Animal studies have found health effects only when the animals ingested large quantities of nitrocellulose (approximately 10% of their total diet). In these cases, the health effect was intestinal impaction from the high amount of cotton and wood fibers ingested, no health effects from the explosive were seen (Roberts and Hartely 1992).