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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service
Agency for Toxic
Substances and
Disease Registry Region
III
1650 Arch Street, 3HS00
Philadelphia, PA 19103

SDMS DocID 2163558

MEMORANDUM

Date: June 24, 2008

From: Senior Regional Representative
ATSDR Region III

Subject: Public Health Assessment – Final Version
U.S. Army Aberdeen Proving Ground, Michaelsville Landfill

To: Mr. Frank Vavra, EPA RPM
Ms. Cindy Powels (USA Garrison Army Proving Ground)
Ms. Mary Moses (Harford County)
Mr. Clark Row (Community Member)
Mr. Ken Shannon (Community Member)
Mr. Kenneth P. Stachiw (Ken), Restoration Advisory Board Army Co-Chair)
Mr. Dennis Warwick (Community/Business Member)
Ms. Ruth Ann Young (Community Member)
Dr. Cal Baier-Anderson (University of Maryland)
Mr. Dion F. Guthrie (Harford County Council)
Mr. Robert Wagner (Harford County Council)
Honorable Nancy Jacobs (Harford County Representative to the Maryland State Senate)
Dr. Katherine Squibb (University of Maryland)
Delegate Mary Roe Walkup

Attached is a copy of the Public Health Assessment for the U.S. Army Aberdeen Proving Ground, Michaelsville Landfill, Aberdeen, Harford County, Maryland dated June 17, 2008. This public health assessment (PHA) addresses only the APG-AA portion of APG, an area of approximately 17,000 land acres bordered by the Chesapeake Bay to the east and south, the Bush River to the west, and the city of Aberdeen to the north.

The primary intent of this public health assessment is to inform you of any actions we have recommended in order to prevent or mitigate exposures to the contaminants of concern at the site. Please inform us if you discover significant errors or omissions in the document that could change its conclusions and recommendations.

I can be reached at telephone number (215) 814-3141, email address lkw9@cdc.gov, or for written responses at the address listed below.

Lora S. Werner
ATSDR
c/o US EPA Region III
Hazardous Site Cleanup
Division (3HS00)
1650 Arch Street
Philadelphia PA 19103

Attachment

cc: Freda Dumas, ATSDR Records Center (memo only)
Rolanda Morrison, ATSDR (memo only)

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ATSDR

AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

ANNOUNCES
the

PUBLIC HEALTH ASSESSMENT

for

U.S. ARMY ABERDEEN PROVING GROUND
ABERDEEN AREA
U.S. ARMY APG, MICHAELSVILLE LANDFILL
ABERDEEN, HARFORD COUNTY, MARYLAND

EPA FACILITY ID: MD3210021355

Enclosed for your review is the Public Health Assessment for the Aberdeen Proving Ground. This document, dated June 17, 2008, was prepared by the Agency for Toxic Substances and Disease Registry (ATSDR).

Please address correspondence to:

Agency for Toxic Substances and Disease Registry
ATTN: Records Center
1600 Clifton Road, NE, MS F-09
Atlanta, GA 30333

If there are questions, please direct them to Angel Sanchez, Health Assessor, at (770) 488-0751.

Enclosure

You Can Contact ATSDR Toll Free at
1-800-CDC-INFO or
Visit our Home Page at: http://www.atsdr.cdc.gov

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ATSDR Public Health Assessments

APG Michaelsville June 17, 2008

Page 2 of PHA - Says sed + SW at Swan Creek a risk - sediment in swale on at base of landfill - Ask ATSDR

Page 17 - Says APG hasn't sampled for metals or nutrients - has Harford County?

Page 27 - Swan Creek sediment - again swale on base

Page 62 - Did APG agree to sample turtles?
* DU - still test, is?

APG Edgewood May 20, 2008

Page 17 - off-site residential well near Carroll Isle / GQ had lead at 40 ppb - resolution

Page 12 - On past wells near border of Wetwood - Table 5 - high in metals - Call Cindy + ATSDR

Page 45 - Where is BR Bom designed area

PP-72 - I Wetwood GW - metals high

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ORIGINAL

Public Health Assessment for

U.S. ARMY ABERDEEN PROVING GROUND,
ABERDEEN AREA
U.S. ARMY APG, MICHAELSVILLE LANDFILL
ABERDEEN, HARFORD COUNTY, MARYLAND

EPA FACILITY ID: MD3210021355

JUNE 17, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
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.

Agency for Toxic Substances & Disease Registry ..... Julie L. Gerberding, M.D., M.P.H., Administrator
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Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

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PUBLIC HEALTH ASSESSMENT

U.S. ARMY ABERDEEN PROVING GROUND,
ABERDEEN AREA
U.S. ARMY APG, MICHAELSVILLE LANDFILL
ABERDEEN, HARFORD COUNTY, MARYLAND

EPA FACILITY ID: MD3210021355

Prepared by:

Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

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List of Abbreviations

aEMEG	ATSDR's Environmental Media Evaluation Guide for acute exposures
APG	Aberdeen Proving Ground
APG-AA	Aberdeen Proving Ground, Aberdeen Area
APG-EA	Aberdeen Proving Ground, Edgewood Area
Army	U.S. Army
ATC	Army Test Center
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
BSAF	EPA's Biota to Sediment Accumulation Factor
BTC	Beef transfer coefficient
CAP	City of Aberdeen Public water supply
CREG	ATSDR's Cancer Risk Evaluation Guide
CV	Comparison Value
DOD	Department of Defense
DU	Depleted Uranium
EMEG	ATSDR's Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Agency
HCP	Harford County – Perryman
iEMEG	ATSDR's Environmental Media Evaluation Guide for intermediate exposures
IEUBK	EPA's Integrated Exposure Uptake Biokinetic
IUR	inhalation unit risk
kg	Kilogram
MCL	EPA's Maximum Contaminant Level for drinking water
MDE	Maryland Department of the Environment
MEC	Munitions and Explosives of Concern
mg	Milligram
MRL	ATSDR's minimal risk level
NIOSH	National Institute of Occupational Safety and Health
NPDES	National Pollution Discharge Elimination System
NPL	EPA's National Priorities List
NRC	U.S. National Research Council
OC&S	Ordnance Center and School
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene
PEL	OSHA's Permissible Exposure Limit
PHA	Public Health Assessment
PHAP	Public Health Action Plan
ppb	parts per billion, which is the same as µg/kg in soil, or µg/L in water

List of Abbreviations

ppm	parts per million, which is the same as mg/kg in soil, or mg/L in water
RAB	Restoration Advisory Board
REL	NIOSH's Recommended Exposure Limit
RDX	Cyclotrimethylene trinitramine, an explosive
RfC	EPA's reference concentration
RfD	EPA's reference dose
RMEG	ATSDR's Reference Dose Media Evaluation Guide
ROD	Record of Decision
SSL	EPA's Soil Screening Level
TCE	Trichloroethylene
UST	Underground storage tank
UXO	Unexploded Ordnance
WBSA	Western Boundary Study Area
$\mu g/m^3$	Microgram per cubic meter

Summary

Aberdeen Proving Ground (APG) is an active U.S. Army (Army) post that encompasses approximately 72,000 acres of land and water in Harford and southeastern Baltimore Counties. APG is divided into two areas: the Aberdeen Area (APG-AA)[1] and the Edgewood Area (APG-EA). This public health assessment (PHA) addresses only the APG-AA portion of APG, an area of approximately 17,000 land acres bordered by the Chesapeake Bay to the east and south, the Bush River to the west, and the city of Aberdeen to the north.

APG-AA has been the site of ordnance testing and training since 1918. Munitions tested included small arms ammunition, grenades, mines, rockets, bombs, artillery shells and tank ammunition, including depleted uranium projectiles. Vehicles, weapons systems, aircraft and other equipment were also tested. The operation of APG-AA, the disposal of post wastes, and the use and testing of munitions has resulted in contamination of groundwater, surface water and sediment, and surface soil at various locations throughout APG-AA. These contaminants may be released to air during range fires and bioaccumulate in the food chain. In addition, past ordnance testing has resulted in the presence of munitions or explosives of concern (MEC)[2] at several sites at APG-AA.

In preparing this PHA, the Agency for Toxic Substances and Disease Registry (ATSDR) obtained data from the Army and local water suppliers and spoke with community members about their health concerns. Based on available data and community concerns, ATSDR evaluated contaminants in groundwater, surface water, sediment, surface soil, air, and the food chain for their potential to reach people (exposure) and cause health effects. ATSDR also assessed possible harm from contact with MEC.

ATSDR has concluded that, although APG-AA is highly contaminated in some areas, the potential for people to be exposed to this contamination is decreased because of access restrictions to the most contaminated portion of the post, and because of restrictions on contact with affected shorelines. However, there are a few ways in which people are or could be exposed to contamination or MEC.

> **Ingestion of contaminated groundwater.** Contamination from the base is impacting public supply wells for both Harford County and the city of Aberdeen. Contaminants in the supply wells include perchlorate, trichloroethylene (TCE), tetrachlorethylene (PCE), and other munition-related substances. However, the county and city governments, the Army, and other agencies have taken actions to ensure that the water is treated properly before entering the distribution

1 APG-AA is listed on the US Environmental Protection Agency's National Priorities List (Superfund) as Aberdeen Proving Ground (Michaelsville LF).

2 Munitions or Explosives of Concern (MEC) include unexploded ordnance and other military munitions that have been abandoned or discarded.

system. For this reason, no adverse health effects are expected to occur from drinking the treated water.

Contact with surface water and sediment contamination. A few areas of localized contamination of sediment by copper (site 12—Old Chemical Dump on Spesutie Island) and lead (Old Dump on Swan Creek, site 30b—the Known Distance Range) might cause minor effects to workers, hunters, and trespassers who remain in the contaminated areas for an extended period of time. Lead in sediment at the Old Dump on Swan Creek, which is near a playground and an on-post residential area, could be hazardous to older children who trespass in the area by circumventing the partial fence around the area. The likelihood of health effects happening is small because people access these areas infrequently, contamination is localized. Furthermore, these hazards are expected to be eliminated soon because Records of Decision (RODs), which have been issued since 2003 or are pending, outline remediation activities at these sites that minimize or eliminate these potential exposures.

Contact with surface soil contamination. Localized contamination of surface soils by lead (site 30b—the Known Distance Range) could cause minor effects to workers and trespassers who remain in the area for an extended period of time. A ROD outlining soil removal activities and land use controls was issued in summer 2007. These hazards are expected to be eliminated soon

Ingestion of contaminated deer. Deer were found to have levels of lead which are of concern. However, it is not clear whether this contamination is from post activities or other sources. An elevated level of lead was observed in an off-post deer sample from Gunpowder Falls State Park. The source of elevated lead is unclear and additional sampling to assess lead levels in deer is recommended. Regardless of the source, the level of lead in the meat and liver of some deer could contribute to any existing lead exposure to children.

Contact with Munitions and Explosives of Concern (MEC). Munitions and explosives have been fired or disposed of on the post for many years. Workers and trespassers might contact unexploded munitions in restricted areas of the post and recreational users may contact unexploded munitions if they do not follow post restrictions regarding shoreline contact.

Because the post is contaminated with hazardous substances, wastes, and unexploded munitions, it is imperative that access restrictions continue to be enforced, and that community members comply.

Background

Site Description and History

Aberdeen Proving Ground (APG) is in southern Harford County and southeastern Baltimore County, Maryland, on the western shore of the Chesapeake Bay, and is bordered by the bay to the east and south (Figure 1). Gunpowder Falls State Park and residential areas are west of APG; the towns of Edgewood, Magnolia, Aberdeen, and Perryman are to the north.

APG is an active U.S. Army (Army) post that encompasses approximately 72,000 acres of land and water. APG is divided into two areas: the Aberdeen Area (APG-AA) and the Edgewood Area (APG-EA). APG-AA consists of approximately 17,000 land acres and is separated by the Bush River from APG-EA's approximately 13,000 land acres. Because of the complexity of environmental issues at APG, the different missions of APG-AA and APG-EA, and the physical separation of the two areas, they will be addressed in separate documents. This Public Health Assessment (PHA) addresses only the APG-AA portion, which is listed on the US Environmental Protection Agency's National Priorities List as "Aberdeen Proving Ground (Michaelsville LF). A separate PHA has been prepared for APG-EA.

Military use of APG began in 1917 when the government acquired APG-AA, and established the Ordnance Proving Ground. APG-EA was also acquired in 1917 and was established as the Edgewood Arsenal. These two facilities operated independently until 1971 when the Edgewood Arsenal became a part of APG. APG-AA has been the site of ordnance testing and training since 1918. Munitions tested included small arms ammunition, grenades, mines, rockets, bombs, artillery shells and tank ammunition, including depleted uranium projectiles. Vehicles, weapons systems, aircraft and other equipment were also tested. The current mission of APG-AA continues to be the design and testing of munitions and vehicles, as well as training military and civilian personnel in their use.

APG-AA currently supports a variety of tenants, including:

- the U.S. Army Research Laboratory, which conducts ballistics research, human factors engineering, and robotics research and development;
- the Aberdeen Test Center, which tests military equipment, and operates the Superpond, a 150-foot deep pond on the shore of the Bush River where underwater explosions are conducted; and
- the Ordnance Center and School (OC&S), which is the largest training center in the United States for military and civilian personnel in the fields of maintenance and management of combat firepower and ground mobility.

Environmental Contamination and Safety Hazards

Environmental contamination has occurred from the use and testing of munitions, as well as from other normal operations at APG-AA, such as waste disposal. Groundwater,

surface water, sediment, and soil have been affected at various locations throughout APG-AA. A few of the contaminants found on APG-AA (or their by-products) have also been found in nearby fish and animals.

Throughout its operation, APG-AA has generated and disposed of a variety of wastes; much of this waste was disposed of in landfills on the post. These wastes were comprised of municipal garbage, maintenance wastes, laboratory wastes, batteries, and pesticides. A major recipient of this waste was the Michaelsville Landfill, which was active from 1969 to 1980. It has since been capped, and continues to be monitored.

Other operations have also contributed to the environmental contamination. For example, fire training and maintenance areas have caused soil and groundwater contamination by chlorinated solvents. Another example is areas which were used for testing munitions. These areas are littered with unexploded ordnance and debris, and are contaminated with explosives and propellants. There has been concern that these components may contaminate the air during unintended brush fires.

In addition, past ordnance testing and laboratory waste disposal has left unexploded ordnance and chemical materials and wastes on the shoreline and in sediments in waters surrounding APG-AA, posing a safety hazard to boaters who trespass within these waters.

In 1976, the Army began to identify locations at APG-AA where hazardous materials and munitions and explosives of concern (MEC) might have been released to the environment. Initial investigations included a review of historical documents to identify areas where releases may have occurred. Based on results from this initial investigation, the U.S. Environmental Protection Agency (EPA) proposed in 1985 that the Michaelsville Landfill in APG-AA be placed on the National Priorities List (NPL), otherwise known as Superfund. Although the remainder of APG-AA was not listed on the NPL, it is being investigated and remediated with EPA oversight.

The Army has identified several areas of known or potential contamination at APG-AA. These areas are grouped into three study areas:

- Michaelsville Landfill;
- Western Boundary Study Area (WBSA); and
- Other Aberdeen Areas (41 sites).

The location of each of these areas is shown in Figures 2 and 3.

ATSDR Involvement

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted site visits at APG in March 1991 and April 1992 with the intent to gain an understanding of current site conditions, learn about proposed and completed remedial actions, and identify community concerns. ATSDR reviewed site documents and toured the environmental study areas at APG. ATSDR staff spoke with the APG Environmental Management Division staff, the Directorate of Safety Health and Environment, and the EPA Remedial

Project Manager for APG. Discussions also were held with members of the Army Health Clinic about preventive medicine and industrial hygiene activities at APG. ATSDR also attended meetings of the Restoration Advisory Board (RAB) to discuss concerns among community members regarding public health effects related to environmental contamination at APG. ATSDR spoke with members of the RAB as well as with members of the general public.

In 1993, ATSDR issued a PHA on APG-AA for public comment. At that time, environmental contamination had not been well characterized due to the size and complexity of APG. As a result, ATSDR could not determine whether environmental contamination at APG was a public health hazard [ATSDR 1993]. ATSDR recommended the following actions:

- conduct additional sampling to further characterize contamination, including:
    - at the playground near the Old Dump on Swan Creek,
    - at the Phillips Army Airfield, and
    - air sampling downwind of range fires;
- restrict access to the Old Dump on Swan Creek;
- conduct a private well survey;
- install additional access controls to minimize contact with MEC; and
- obtain information about fish and game.

Since the PHA was issued for public comment in 1993, the Army has conducted additional sampling as requested, constructed a three-sided fence around the Old Dump on Swan Creek, conducted a well survey, continued and strengthened access restriction and signage, and sampled additional fish tissues for site-related contamination.

Because of the indeterminate findings of the 1993 draft PHA, as well as the unique nature of APG, ATSDR decided not to release a final version of the document. Instead, ATSDR later revisited the site as additional environmental sampling was being pursued. In October 1999 and April 2000, ATSDR visited APG and spoke with the APG Environmental Management Division staff, conducted a site tour, and attended a RAB meeting. Since then, additional sampling data has become available, which was used to prepare this PHA. In addition, comments submitted to ATSDR on the 1993 draft PHA have been addressed in this PHA.

Demographics

ATSDR examines demographic data (i.e., population information) to determine the number of people potentially exposed to environmental chemicals and to determine the presence of sensitive populations, such as children (age 6 and younger), women of childbearing age (age 15-44), and the elderly (age 65 and older). Estimates of the numbers of people in these groups are listed in Table 1, for people who live on the APG-AA post, and the people who live within one mile of the APG-AA boundary.

Table 1: Estimated numbers of people living on or near the Aberdeen Proving Ground – Aberdeen Area [Census 1991 and 2001].

Population Group	On-Post Residents		Off-Post Residents (within one mile)		Total	
	1990 Census	2000 Census	1990 Census	2000 Census	1990 Census	2000 Census
Everyone	6,250	3,880	10,340	10,120	16,590	14,000
Ages 6 and Younger	750	590	1,290	1,110	2,040	1,700
Women Aged 15 to 44	1,340	1,010	2,500	2,280	3,840	3,290
Ages 65 and Older	70	110	990	1,170	1,060	1,280

In addition to people who live on or near the post, there are many people who are employed on the post. The Aberdeen Proving Ground (both the Aberdeen and the Edgewood Areas) has more than 5000 military personnel, more than 7500 civilian employees, and nearly 3000 contractors or employees of private businesses.

Land and Natural Resources Uses

Off-Post

Land surrounding APG-AA is occupied by residential communities, which include local parks and schools. Three county parks, which provide picnic areas and a boat launch to the Bush River, are located near the northern boundary of APG-AA. The Gunpowder State Park is located along the western boundary of APG-EA. This park encompasses more than 11,000 acres along the Gunpowder River and supports picnicking areas, hiking trails, and horse trails. A swimming beach is on the shore of the Gunpowder River.

The majority of APG-AA lands are surrounded by the Chesapeake Bay and its tributaries. These waterways are used for boating, water skiing, and commercial and recreational fishing. The Army owns and restricts use of portions of the Chesapeake Bay, Bush River, and their tributaries near APG-AA. These restrictions are discussed as part of the on-post land uses in the following section of this PHA.

Drinking water for residences and businesses in Harford County is primarily drawn from surface water bodies upstream of APG, such as the Loch Raven Reservoir and the Susquehanna River located north of APG. Groundwater provides roughly one-fourth of the Harford County water supply, from seven wells in Perryman, which is immediately off site to the northwest. This area is near the WBSA-Operable Unit 1 (OU1) (Figure 2). Groundwater flow in the vicinity of the Harford County Perryman (HCP) wells is generally to the southeast, towards the Chesapeake Bay, but pumping activities at these wells have influenced the flow so that some groundwater also flows toward these wells from APG-AA.

The city of Aberdeen operates eleven water supply wells; four are on the post, and seven are immediately off the post at the northernmost point of APG-AA (Figure 2). This area is near the WBSA-OU2. Pumping activities at these wells have influenced the flow so that some groundwater also flows toward these wells from APG-AA.

The drinking water supplies for both Harford County and the city of Aberdeen are treated and regularly monitored to ensure that federal drinking water standards are met. Some of these supply wells have been impacted by environmental contamination originating at APG-AA. The Evaluation of Environmental Contamination and Potential Exposure Pathways section of this PHA discusses in detail concerns associated with impacted wells.

On-Post

APG-AA is an active military facility that supports three types of land use: current and former weapons testing areas, research/administrative areas, and on-site housing areas. Weapons have been, and continue to be, tested in the southern portion of APG-AA. Weapons testing areas are located in both the WBSA and the Other Aberdeen Areas. Access to former and current weapons testing areas from land is restricted by fences, gates, and guard check points. Access to these areas from the water is restricted by warning signs, buoys, and regular patrols by the military police and other security forces. Disposal areas, including Michaelsville Landfill, the airfield landfills, and the Old Dump on Woodrest Creek are located within these restricted areas of the post. Fences also separate APG-AA from the surrounding neighborhoods.

Facilities in the research/administrative areas include research laboratories, office buildings, and the OC&S. These facilities are located in the far northeastern portion of the post in unrestricted areas of WBSA and Other Aberdeen Areas. The Old Dump on Swan Creek is located in the unrestricted portion of Other Aberdeen Areas, but is enclosed on three sides by a 5-foot wire fence.

On-site housing areas are located in the northeastern portion of APG-AA. Family housing is located along Aberdeen Boulevard and the Plum Point loop near Swan Creek. Officer housing along the Plum Point loop has been used since the opening of the post. During peacetime, officers typically spend 3 to 5 years stationed at APG-AA before transfer; during wartime, transfer occurs sooner. Several areas have contained troop barracks since the post's opening. Barracks currently in use are located between Boothby Hill Road and Maryland Boulevard and house students of the OC&S. Currently, approximately 3,880 people, including military personnel and their families, live in on-post housing.

APG-AA was most active during World Wars I and II. During World War I, Army soldiers worked at the research and development facilities and test ranges. During World War II, civilian employees worked at the research and development facilities and Army soldiers conducted testing and training programs at the test ranges. There is currently a mixture of civilian and military workers in the office and laboratory facilities. At peak operations during World War II, approximately 50,000 people worked at APG (both APG-AA and

APG-EA). Currently, approximately 15,000 people work at APG. At APG-AA, most of these people work in an administrative capacity, and a smaller portion are engineers and scientists.

APG-AA allows recreational use of its resources by active personnel and approximately 20,000 military retirees and their families. Picnic areas are located at Woodpecker Point near Spesutie Island, Shore Pool, Swan Creek, and the Maryland Boulevard gate. A golf course is located near the Maryland Boulevard gate. Fishing areas are found along Bush River, Romney Creek, Swan Creek, and Spesutie Narrows [USAG 2000a].

Much of APG-AA is covered with extensive woodlands and wetlands that provide habitat for many animals, including white tail deer, foxes, and wild turkeys. Under strict Army control, hunting and trapping is permitted in designated areas of APG-AA. Table 2 lists the game and areas where hunting is permitted. The Army issues hunting permits to people that have obtained state hunting licenses and are either associated with APG or are sponsored by an APG employee. Hunters must remain in designated areas only and follow Army regulations. Punishment for violating the regulations is severe and may include revoking a person's hunting permit.

Table 2: APG-AA Hunting Information [USAG 1998]

Game	Designated Areas
Upland Game (hunting)	Areas designated for upland game are located in Western Boundary, Spesutie Island, and the northernmost and southernmost parts of Other Aberdeen Area.
Woodchuck and Deer (bow hunting)	Bow hunting is allowed in the same locations as upland game.
Deer (from gun stands)	Deer stands are located throughout the Other Aberdeen Areas and Western Boundary.
Migratory Game Birds (from duck blinds)	Duck blinds are located along the Chesapeake Bay coast, up Romney Creek, along Bush River, in the Spesutie Narrows on the Spesutie Island side, and one location at the Swan Creek inlet.
Snapping Turtle (trapping)	Trapping areas are located in a few areas in Western Boundary, and in the northernmost part of the Other Aberdeen Areas, including Spesutie Island.

Deer are the most common game sought at APG. During the fall deer hunting season, trained volunteers escort permitted hunters to assigned hunting locations. Hunters must remain within 50 yards of their assigned location. These locations are selected by the Army based on safety concerns for the hunter; areas may be closed if hazards are found in the area or testing activities are being conducted nearby. In 1999, approximately 450 deer permits were issued for hunting at APG-AA. Historically, between 700 and 900 deer permits were issued to hunters annually. Hunters are permitted to take as many as seven deer in each of three seasons, but the average hunter only takes two deer. Trespassers without permits take approximately 100 deer annually [DSHE 1992].

APG-AA also includes water bodies as part of its property, including on-post streams and portions of the Bush River, Romney Creek, Swan Creek, and Chesapeake Bay. Because of concerns about recreational users contacting MEC, the Army has

implemented use restrictions to prevent harm from MEC to the public. Several streams are always closed to public use. At APG-AA, these are Cod Creek, Abbey Creek, Romney Creek, Delph Creek, Mosquito Creek, and Spesutie Narrows (Figure 4). Fishing, boating, water skiing, and crabbing is permitted in navigable waters (Bush River, Chesapeake Bay, and Swan Creek) in the evenings and on weekends, unless temporary restrictions are in effect because of testing. Commercial and recreational fishers can catch a variety of fish and shellfish, such as striped bass, white perch, American shad, and blue crab. Boating and water skiing are also permitted in navigable waters provided that people do not touch any land, either along the shorelines or underwater. Swimming is prohibited in all water bodies at all times. The Army enforces these restrictions using signs, buoy markers, and patrol boats. In addition to boating activities, shoreline fishing and crabbing is allowed from designated areas along Swan Creek and Spesutie Narrows. Personnel with access to restricted areas in APG-AA may also fish in the restricted area along Romney Creek and Bush River. In the past, as much as 4,000 pounds of snapping turtles were annually harvested by trapping at APG. Data from 1996 indicate that only about 800 pounds of snapping turtle were trapped for consumption that year [USAG 1996a, 1998a, AEHA 1994].

Drinking water at APG-AA is currently provided by surface water body intakes at Deer Creek, located upstream of APG. These intakes have been the main source of drinking water at APG-AA since their construction in 1942. Surface water is treated and regularly monitored to ensure that federal drinking water standards are met. According to recent information from the EPA, no contaminants have been found in the APG water supply above the federal drinking water limits [EPA 2005a].

Groundwater wells have been present on post and were the likely source of drinking water before construction of the Deer Creek intakes. Groundwater no longer serves as a drinking water supply and these wells have been designated as standby wells. The treatment plant well field consists of five groundwater wells located southwest of One Mile Loop and Swan Creek. These wells have not been used since before 1968, and were most likely used before construction of the Deer Creek intakes. A water treatment plant is associated with these wells.

Evaluation of Environmental Contamination and Potential Exposure Pathways

Introduction

What is Exposure?

ATSDR's PHAs are driven by exposure, or contact with contamination in the environment. If exposure occurs, chemical contaminants which have been disposed or released into the environment have the potential to cause adverse health effects. However, *a release does not always result in exposure.* People can only be exposed to a contaminant if they come in contact with that contaminant. Exposure may occur by

breathing, eating, or drinking a substance containing the contaminant or by touching a substance containing the contaminant.

How does ATSDR determine which exposure situations to evaluate?

ATSDR scientists evaluate site conditions to determine if people are exposed, were previously exposed, or might be exposed in the future to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (water, soil, air, or biota) has occurred, is occurring, or will occur through ingestion (eating), dermal (skin) contact (touching), or inhalation (breathing).

If exposure was, is, or could be possible, ATSDR scientists then consider whether contamination is present at levels that might affect public health. ATSDR scientists select contaminants for further evaluation by comparing them against health-based comparison values (CVs). CVs are developed by ATSDR from scientific literature available on exposure and health effects. These CVs are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., amount of water or soil consumed) and body weight.

CVs are not thresholds for adverse health effects. ATSDR's CVs establish contaminant concentrations many times lower than levels at which no effects were observed in experimental animals or human epidemiologic studies. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency), the toxicology of the contaminant, and other epidemiology or medical studies.

Some of the CVs used by ATSDR scientists include:

- ATSDR's Environmental Media Evaluation Guide (EMEG, iEMEG, and aEMEG)
  - is based on ATSDR's Minimal Risk Level, an exposure dose below which no adverse health effects are expected to occur.
  - uses estimates on how much and how long a person may be exposed.
  - can be different exposure timeframes:
    - chronic, or long-term exposure lasting over a year (EMEG);
    - intermediate exposure lasting from two weeks to a year (iEMEG); and
    - acute exposure lasting up to two weeks (aEMEG).
- ATSDR's Reference Dose Media Evaluation Guide (RMEG):
  - is based on EPA's Reference Dose, an exposure dose below which no adverse health effects are expected to occur;
  - uses estimates on how much and how long a person may be exposed; and
  - Is developed for chronic, or long-term exposure.
- ATSDR's Cancer Risk Evaluation Guide (CREG):
  - Is a concentration at which the hypothetical or theoretical risk of excess cancer from exposure is less than one in a million;
  - Is based on EPA's oral cancer slope factor or inhalation unit risk;

  - uses estimates on how much and how long a person may be exposed;
  - is developed for lifetime exposures lasting as long as 70 years; and
  - in most cases, is *extremely* protective of public health.
- EPA's Maximum Contaminant Level (MCL) is an enforceable drinking water regulation.
- EPA's Soil Screening Level (SSL) is a health-based screening level.

If no CV is available, a substance will be evaluated individually based upon a review of the toxicological literature.

CVs are further described in the Appendix. More information about the ATSDR evaluation process can be found in ATSDR's Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html.

If someone is exposed, will they get sick?

Exposure does not always result in harmful health effects. The type and severity of health effects that occur in an individual from contact with a contaminant depend on many factors: the exposure concentration (how much); the frequency and/or duration of exposure (how often and for how long); the way in which the individual was exposed (breathing, eating, drinking, or touching); and the multiplicity of exposure (combination of contaminants). Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status of the exposed individual influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant. Together, these factors and characteristics determine the health effects that may occur as a result of exposure to a contaminant in the environment.

There is considerable uncertainty about the true level of exposure to environmental contamination. To account for the uncertainty and to be protective of public health, ATSDR scientists typically use high-end, worst-case exposure level estimates as the basis for determining whether adverse health effects are possible. These estimated exposure levels usually are much higher than the levels to which people are really exposed. If the exposure levels indicate that adverse health effects are possible, then a more detailed review of exposure combined with scientific information from the toxicological and epidemiologic literature about the health effects from exposure to hazardous substances is performed.

Identification of Potential and Completed Exposure Pathways at APG-AA

Summary of Known Contamination on the Post

Many investigations have been made about potential contamination of various environmental media on APG-AA. Results of most of those investigations since the early 1990s have been included in a single database provided to ATSDR by APG [USAG 2004]. This database was reviewed to evaluate known contamination of the post, as well as to consider the extent of the sampling and analysis. Information in this database is the result of investigations into areas of suspected or known contamination. As such, the sampling is not random. Instead, it is biased, so that it is representative of

contaminated areas; it is not representative of the entire post, which is comprised of both contaminated and uncontaminated areas.

A summary of the contamination in various environmental media across the post is given in Table 3. The presence of moderate or high levels of contamination in an environmental medium does not indicate that people are experiencing adverse health effects; this depends upon whether people are exposed to the contamination. Also, most of the moderate and high levels of contamination are due to only a few samples which had elevated concentrations, usually localized to a few areas. Details of any contamination to which people are exposed will be discussed in more detail later in this document. Contamination which people are not exposed to will not be discussed further.

Table 3: Summary of known contamination observed on APG-AA [USAG 2004]. Note: Information in this table does not consider whether people are actually being exposed to contaminated environmental media at APG-AA. Possible exposures will be evaluated later in this document.

Substance Type	Ground water	Surface Water & Seeps	Sediment	Surface Soil (to one foot deep)	Subsurface Soil	Air	Fish	Deer
Explosives	**High**	Low	Moderate	Low	Low	Moderate		ND
PAHs	ND	ND	Moderate	Moderate	Low			
PCBs	Low	Low	Moderate	Moderate	Low	Low	Low	ND
Pesticides	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	ND
Metals	**High**	**High**	**High**	**High**	**High**	Moderate	Low	Moderate
Solvents	**High**	Moderate	Low	Low	Low	Moderate		
Radionuclides	Low	Low	Low	Low	Low	Low		

ND – Substances were analyzed for, but not detected.
Blank entries – Media was not analyzed for substance.
Low – Substances were detected, but not at concentrations that might cause health effects.
Moderate – At least one substance in one sample was detected at a concentration that could cause health effects if children were exposed every day for as long as 1 year.
High – At least one substance in one sample was detected at a concentration that could cause health effects if adults or children were exposed every day for as long as 1 year.

Who might be exposed?

ATSDR reviewed information about people who may be present on or near the post and information about what controls are in place to prevent contact with contamination. At APG-AA, ATSDR considered several potentially exposed populations. This PHA focuses on the most relevant:

- *On-post workers.* Both military and civilian personnel work at APG-AA. Most Army personnel are stationed at APG-AA for 2 to 3 years before transferring to other locations. Soldiers may work in APG's offices, laboratories, or firing ranges while stationed at APG. Civilian personnel, however, may be employed in APG's offices or laboratories for many years. In evaluating

potential exposures to workers, ATSDR considers only those exposures that occur inadvertently as a result of environmental contamination. Exposures that occur as part of normal work practices are controlled under the Occupational Health and Safety Administration (OSHA) regulations and are not evaluated by ATSDR in this PHA.

- *On-post residents.* Military personnel and their families reside in housing located in the northern portion of APG-AA, including family housing for officers along Aberdeen Boulevard and Plum Point Loop and barracks along Maryland Boulevard and Boothby Hill Road. Military personnel may live in on-post housing while stationed at APG, usually 2 to 3 years.

- *Off-post residents.* Residential neighborhoods are located along the northern boundary of APG-AA, near Western Boundary. The City of Aberdeen and Harford County are adjacent to the post.

- *Recreational users.* Picnic areas and a golf course are available for use by active post personnel, as well as military retirees and their families. Designated water bodies (Chesapeake Bay, Bush River, and Swan Creek) are also open to members of the public for boating and water skiing. Recreational users may include on-post workers, on-post residents, and off-post residents.

- *Hunters and trappers.* The Army permits hunting and trapping in portions of APG-AA. Hunters must receive a permit from the state and from the Army. Only personnel associated with APG or sponsored by an APG employee may obtain a permit. Hunters and trappers are assumed to be adults and older children. Hunters, trappers, and their families likely consume animals taken from APG-AA.

- *Fishers and crabbers.* Fishers may fish from boats in navigable waters (Chesapeake Bay, Bush River, and Swan Creek). Crabbers may harvest crab from shores near APG-AA. Fishers and crabbers may include on-post workers, on-post residents, and off-post residents that return to the area year after year for many years. Fishers, crabbers, and their families likely consume fish and crab taken from near APG-AA.

- *Trespassers.* To limit trespassing, the Army maintains fences and signs stating access restrictions, and notifies boat owners and fishers through local boat launches and sports clubs. Regular patrols also reduce the potential frequency of trespassing. Signs clearly marking areas of unexploded ordnance (UXO) are posted throughout restricted access areas. A small number of people, however, may disregard access restrictions and trespass on APG-AA lands. Trespassers' exposures to site contaminants would be limited because the areas of greatest concern are secured so that trespassing is difficult.

How Might People be Exposed?

After identifying potentially exposed populations, ATSDR reviewed how these populations use the land and resources at the post to identify possible exposure pathways (i.e., how people may contact site contaminants). ATSDR then evaluated whether or not these exposures are actually occurring, and if so, could these exposures lead to adverse health effects. At APG-AA, ATSDR considered the following possible exposure pathways:

- Ingestion of contaminated groundwater
  - Off-post residents in Harford County and the City of Aberdeen may potentially be exposed through private wells and public water supplies.
- Incidental ingestion of contaminated surface water and sediment
  - On-post workers may potentially be exposed throughout the post.
  - On-post residents may potentially be exposed on or near the residential areas of the post.
  - Recreational users may potentially be exposed while on the post.
  - Hunters and trappers may potentially be exposed while on the post.
  - Fishers and crabbers may potentially be exposed to contamination in surface water and sediment while off the post. Although fishing is allowed in some areas on the post, fishers are not allowed to contact the shoreline, and so would not become exposed while on the post.
  - Trespassers may potentially be exposed in accessible areas of the post.
- Incidental ingestion of contaminated surface soil
  - On-post workers may potentially be exposed throughout the post.
  - On-post residents may potentially be exposed on or near the residential areas of the post.
  - Recreational users may potentially be exposed while on the post.
  - Hunters and trappers may potentially be exposed while on the post.
  - Trespassers may potentially be exposed in accessible areas of the post.
- Inhalation of air emissions from range fires
  - On-post workers and residents may potentially be exposed while on the post.
  - Off-post residents may potentially be exposed in areas near the post.
  - Recreational users may potentially be exposed while on the post.
  - Hunters and Trappers may potentially be exposed while on the post.
  - Fishers and crabbers may potentially be exposed while near the post.
  - Trespassers may potentially be exposed while on the post.
- Ingestion of contaminants which have accumulated in the food chain
  - Hunters, trappers, and their families may potentially be exposed when eating game harvested from the post.
  - Fishers, crabbers, and their families may potentially be exposed when eating fish and crab harvested near the post.
- Contact with Munitions and Explosives of Concern

- On-post workers are potentially exposed infrequently during work in contaminated areas.
- Recreational users who ignore restrictions may come into contact with MEC along shorelines.
- Trespassers may potentially come into contact with MEC while in accessible areas of the post.

A summary of these potential exposure pathways which are considered in this PHA is given in Table 4.

Table 4: Exposure pathways considered in this PHA.
Note: Some people might be included in more than one population, such as off-post residents who also fish.

Exposed Population	Groundwater Ingestion	Surface Water and/or Sediment Ingestion	Surface Soil Ingestion	Air Inhalation	Food Chain	Munitions and Explosives of Concern (MEC)
On-Post Workers		✓	✓	✓		✓
On-Post Residents		✓	✓	✓		
Off-Post Residents	✓			✓		
Recreational Users		✓	✓	✓		✓
Hunters & Trappers		✓	✓	✓	✓	
Fishers & Crabbers		✓		✓	✓	
Trespassers		✓	✓	✓		✓

For each of these exposure pathways, ATSDR conducted a detailed evaluation of how populations might contact contaminants through a given exposure pathway, and whether this exposure could potentially result in harm.

Ingestion of Contaminated Groundwater

Hydrogeology

> **Summary**
> *Public supply wells for both Harford County and the City of Aberdeen have been affected by contamination from the post. Treated water entering the distribution system contains low levels of perchlorate and 2-nitrotoluene (Harford County Perryman [HCP] wells only). No adverse health effects are expected to occur due to these low levels of exposure.*

Groundwater in the region of APG-AA is found in a complex structure of aquifers. In general, groundwater is found in three aquifers (surficial, upper, and lower) that are separated by two confining layers (upper and lower). The thickness and depth of the aquifers and confining layers increase from west to east. Groundwater flow is generally to the southeast, however, groundwater in the surficial aquifer generally flows from topographical highs to the nearest surface water body, such as the Bush River or Chesapeake Bay. Supply wells primarily obtain water from the lower aquifer. Each aquifer and confining layer is described below, in order from shallowest to deepest (ICF 1995).

- The **surficial aquifer** is unconfined or semi-confined and may be nearly non-existent in some areas (e.g., Graces Quarters in APG-EA) and over 100 feet thick in other areas (e.g., Michaelsville Landfill). This aquifer is composed of clay and sand found in recent alluvium (river deposits) or Talbot Formation soil. Near the Chesapeake Bay and its tributaries, groundwater in the surficial aquifer is influenced by the changing tides.

- The **upper confining layer** is present only in some areas. It is made of clay and silt that limits groundwater migration from the surficial aquifer to the upper aquifer.

- The **upper aquifer** is confined in most areas of APG-AA, and ranges from 10 to 100 feet thick. The aquifer is composed of silt, sand, and gravel found in Talbot Formation or Potomac Group soils.

- The **lower confining layer** is present throughout the region. This layer is composed of 15 to 65 feet of clay in the Potomac Group soils that limits or prevents groundwater migration from the upper aquifer to the lower aquifer.

- The **lower aquifer** is confined and has an undetermined thickness. It is composed of sand found in Potomac Group soils. This aquifer is the primary source of water for both private and municipal water supply wells.

Groundwater Use

Drinking water for off-post residences and businesses in the area is primarily drawn from surface water bodies upstream of APG, such as the Susquehanna River. Groundwater also provides a portion of the water supply for the region. Harford County operates seven water supply wells (HCP wells) along the northwestern post boundary in Perryman. The city of Aberdeen operates eleven water supply wells (CAP wells) near the border of APG-AA to the north and within APG-AA borders.

Some homes near the APG-AA boundary also use private wells as a source of potable water. In 1994, a private well survey was conducted to identify homes and businesses located along APG's boundaries that rely on private wells for drinking water. Private well information was collected by reviewing state records and mailing surveys to nearby homes and businesses. Along APG-AA's boundary, private wells were identified in the Forest Green neighborhood, where railroad tracks along the eastern APG-AA boundary cross the Bush River [HCHD 2001].

Nature and Extent of Known Contamination – On Site

As a result of environmental releases, areas of groundwater contamination are found at various locations throughout APG-AA. Chemicals found in groundwater include chlorinated and non-chlorinated solvents, petroleum and fuel components, pesticides, metals, and explosives. Radionuclides found in the groundwater include radium-226, strontium-90, tritium, and uraniums 234, 235, and 238 [USAG 2004]. In most areas of

the post, however, groundwater is not used as a source of drinking water. This section of the PHA focuses on groundwater contamination that has or may impact drinking water supplies.

Nature and Extent of Contamination - Harford County Public Water Supply

Seven community water supply wells operated by Harford County (HCP wells) are located near the APG-AA boundary. In 1991, low levels of trichloroethylene (TCE), 6 parts per billion (ppb) or less, were detected in two of the HCP wells. Based on investigations at APG-AA, a groundwater contamination plume originating at the Fire Training Area in the WBSA was identified as the source of contamination in the HCP wells. As a result, in 1993, the Army installed a treatment plant to remove TCE from the water supply before distribution and removed the source of the plume. The Army has since expanded the treatment facilities, and has committed to their continuing operation. TCE contamination of the untreated water continues. Additional contaminants (perchlorate and explosive compounds) have also been found in the untreated water. APG has not sampled and analyzed water from HCP wells for metals or radionuclides. Table 5 indicates the concentrations of contaminants recently found in the untreated water.

Table 5: Noteworthy contaminants, which exceed or lack comparison values (CVs), in recent sampling by APG of **untreated** water from Harford County public supply wells located near APG-AA [USAG 2004]

Contaminant	Median and [Range] of Detected Concentrations and (Number of Detects / Number of Samples)			Comparison Value[a]
	2001	2002	2003	
Explosives and Explosive-Related Substances				
2-Amino-4,6-Dinitrotoluene	0.06 ppb[c] [0.03 to 0.43 ppb] (3/19)	ND (0/12)	ND (0/17)	None[b]
4-Amino-2,6-Dinitrotoluene	0.03 ppb[c] [0.01 to 0.09 ppb] (3/19)	ND (0/12)	ND (0/17)	None[b]
2-Nitrotoluene	0.5 ppb[c] [0.5 to 0.06 ppb] (3/19)	ND (0/13)	ND (0/17)	None[b]
Perchorate	ND (0/5)	0.78 ppb (1/5)	0.17 ppb [0.17 to 0.57 ppb] (32/34)	7 ppb (RMEG)[d]
Solvents				
TCE	7.2 ppb [4.9 to 9.2 ppb] (8/19)	6.4 ppb [4.7 to 7.4 ppb] (4/13)	6.8 ppb [6.2 to 7.5 ppb] (8/17)	5 ppb (MCL)

a: CVs are for long-term exposure (> 1 year) to children and adults
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.
c: The three detected concentrations for explosive-related substances in 2001 were detected on September 11, 2001 in the three wells that were sampled that day (wells 4, 5, and 6). These substances were not found in any of these wells before or since.
d: The concentration of perchlorate never exceeded its CV. It is included in this table for later discussion due to public concerns about this contaminant.

Groundwater is treated before it entered the Harford County public water distribution system. The treated water contained much less TCE and other substances. Details of the analysis by APG of the treated water are given in Table 6. Trihalomethanes have not been included, since they result from the disinfection treatment of the water, and are not likely a result of contamination by APG-AA. No metals or radionuclides were analyzed by the APG. However, the Harford County government has continuously monitored its treated water for regulated substances, including metals and radionuclides; none have been found to exceed EPA's drinking water standards [EPA 2005].

Table 6: Noteworthy contaminants, which exceed or lack comparison values (CVs), in recent sampling by APG of **treated** water from the Harford County Public Supply wells located near APG-AA [USAG 2004].
Note: Gray entries indicate a substance is not of concern, and will not be considered further in the evaluation of this exposure pathway.

Contaminant	Median and [Range] of Detected Concentrations and (Number of Detects / Number of Samples)			Comparison Value[a]
	2001	2002	2003	
Explosives and Explosive-Related				
2-Amino-4,6-Dinitrotoluene	ND (0/4)	ND (0/4)	ND (0/3)	None[b]
4-Amino-2,6-Dinitrotoluene	ND (0/4)	ND (0/4)	ND (0/3)	None[b]
2-Nitrotoluene	0.53 ppb (1/4)	1.1 ppb [0.18 to 2.1 ppb] (2/5)	ND (0/4)	None[b]
Perchorate	ND (0/1)	ND (0/3)	0.41 ppb [0.28 to 0.56 ppb] (6/7)	7 ppb (RMEG)[c]
Chlorinated Solvents				
TCE	ND (0/5)	ND (0/4)	ND (0/3)	5 ppb (MCL)

a: CVs are for long-term exposure (> 1 year) to children and adults
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.
c: The concentration of perchlorate never exceeded its CV. It is included in this table for later discussion due to public concerns about this contaminant.

Nature and Extent of Contamination - City of Aberdeen Public Water Supply

Sampling of the CAP wells in 1998 and 1999 identified benzene and tetrachloroethylene (PCE) above CVs. However, neither were found above CVs in the treated water which entered the City of Aberdeen public water distribution system [CHPPM 1999; RAB 1999]. PCE continues to be found in the untreated water, although infrequently.

In April 2001, CAP wells and the finished water were sampled for perchlorate; none was detected above the reporting limit of 5 ppb. Later sampling, conducted in June 2002 with lower reporting limits, indicated perchlorate in water from one well at a maximum of 5 ppb. Details of the perchlorate and other contaminants which were recently found in CAP wells in untreated water are given in Table 7.

Table 7: Noteworthy contaminants, which exceed or lack comparison values (CVs), in recent sampling by APG of **untreated** water from the City of Aberdeen wells on and near the APG-AA [USAG 2004]

Contaminant	Median and [Range] of Detected Concentrations and (Number of Detects / Number of Samples)				Comparison Value[a]
	2001	2002	2003	2004	
Explosives and Explosive-Related					
2-Nitrotoluene	0.78 ppb [0.74 to 1.13 ppb] (5/8)	ND (0/1)	ND (0/2)		None[b]
Perchlorate	ND (0/10)	1.2 ppb [0.28 to 5 ppb] (106/259)	0.5 ppb [0.13 to 3.1 ppb] (207/274)	0.78 ppb [0.15 to 3.9 ppb] (46/55)[c]	7 ppb (RMEG)[d]
Chlorinated Solvents					
PCE	5.4 ppb [1.09 to 8.31 ppb] (4/15)		ND (0/1)		5 ppb (MCL)

a: CVs are for long-term exposure (> 1 year) to children and adults
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.
c: through 8/17/2004
d: The concentration of perchlorate never exceeded its CV. It is included in this table for later discussion due to public concerns about this contaminant.

Water was treated and blended before it entered the City of Aberdeen public water distribution system. Finished water contained much less PCE and 2-nitrotoluene. Details of the analysis of finished water are given in Table 8. Trihalomethanes have not been included, since they result from the disinfection treatment of the water, and are not a result of contamination by APG-AA. Metals were not analyzed for by APG. Radionuclides were analyzed for in one sample in 2001, in which nothing was detected. The City of Aberdeen has monitored its treated water for regulated metals and radionuclides; none have been found to exceed EPA's drinking water standards [EPA 2005]. The Army also conducts semi-annual sampling of monitoring wells and quarterly inspections under the Source Water Protection Plan, which serves to protect on-post recharge areas for drinking water wells [USAG 2008].

Table 8: Noteworthy contaminants, which exceed or lack comparison values (CVs), in recent sampling by APG of **treated** water from the City of Aberdeen Public Supply wells located on or near APG-AA [USAG 2004].
Note: Gray entries indicate a substance does not exceed screening levels, and will not be considered further in the evaluation of this exposure pathway.

Contaminant	Median and [Range] of Detected Concentrations and (Number of Detects / Number of Samples)				Comparison Value[a]
	2001	2002	2003	2004	
Explosives and Explosive-Related					
2-Nitrotoluene		ND (0/1)	ND (0/2)		None[b]
Perchlorate	ND (0/1)	0.67 ppb [0.6 to 1 ppb] (10/27)	0.48 ppb [0.2 to 1 ppb] (23/29)	0.43 ppb [0.16 to 0.78 ppb] (13/15)[c]	7 ppb (RMEG)[d]
Chlorinated Solvents					
PCE	1.1 ppb (1/2)		0.44 ppb (1/1)		5 ppb (MCL)

a: CVs are for long-term exposure (> 1 year) to children and adults
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.
c: through 8/24/2004
d: The concentration of perchlorate never exceeded its CV. It is included in this table for later discussion due to public concerns about this contaminant.

September 2002 sampling identified perchlorate in the treated water at 1 ppb. In response, the City of Aberdeen closed the well that contained the highest levels of perchlorate and reduced operation of the other wells containing perchlorate to 50% of their capacity. Water from these wells and others are blended such that the perchlorate concentration in the finished water remains below 1 ppb. In addition, the city has begun treating water from the most contaminated well with an ion-exchange resin, which removes much of the perchlorate contamination. The city plans to place additional ion-exchange treatment units on the other affected wells. The Army is conducting additional investigations of WBSA-OU2 to understand the nature and extent of on-post contamination and to minimize potential impacts to the water supply. Perchlorate has been found in soil (but not surface water or sediment) collected from drainage areas adjacent to locations with perchlorate in groundwater [USAG 2008]. Groundwater and water supply monitoring is ongoing. The Army currently conducts semi-annual sampling of monitoring wells and quarterly inspections under the Source Water Protection Plan, which serves to protect on-post recharge areas for drinking water wells [USAG 2008].

Nature and Extent of Contamination - Private Wells

In 1993 and 1994, the Harford County Board of Health conducted a private well survey along the APG-AA boundary. Private wells were located in the Forest Green neighborhood, where railroad tracks along the APG-AA boundary cross the Bush River. Private wells were sampled for volatile organic compounds (VOCs). Only carbon tetrachloride (to 8.6 ppb) was detected above its CV (0.3 ppb). The source of this carbon tetrachloride is believed to be a spill along the railroad tracks and not related to releases at APG-AA [HCHD 2001a; USAG 2001].

Evaluation of Potential Public Health Hazards

Off-post residents (adults and children) may have been exposed to contaminants in the HCP wells, CAP wells, or private wells. To assess exposures to contaminants found above CVs in drinking water, ATSDR calculated exposure doses based on conservative assumptions about how much water a person may drink each day. ATSDR assumed that adults would drink 2 liters (about a half-gallon) of water from a single source every day for 30 years and children would drink 1 liter of water from a single source every day for 6 years. Drinking water was assumed to contain contaminants at concentrations equal to the maximum detected concentration found during sampling; this assumption overestimates actual exposures[3]. The potential for perchlorate, 2-nitrotoluene, and carbon tetrachloride to cause a health problem are discussed separately below.

Perchlorate in Drinking Water

Perchlorates are colorless salts that have no odor. Five perchlorates are manufactured in large amounts; magnesium perchlorate, potassium perchlorate, ammonium perchlorate, sodium perchlorate, and lithium perchlorate.

Although perchlorate was detected at concentrations below CVs, ATSDR included the following detailed evaluation of perchlorate due to public concerns about this contaminant.

Naturally-occuring perchlorates have been found in Chile, South America, and to a lesser extent in Texas and New Mexico [Jackson 2004]. Naturally-occurring perchlorates may be widespread. However, the high levels of perchlorates which are found at APG-AA are likely not naturally-occurring, but instead are the result of the previous use of flares and explosives during weapons testing and training.

Perchlorates are found in the environment in two forms. If no water is present, as in a drum or on top of dry ground, then they will exist as solids. If water is present, then they will dissolve and dissociate. The perchlorate portion is the part which is of concern.

Once perchlorates are released to the environment, they slowly wash away with rainwater. As the rainwater soaks into the ground, the perchlorates soak into the soil, and eventually enter the groundwater. Perchlorates can last in water and soil for a very long time.

Perchlorates in the soil and water are also taken up and concentrated in foods. They have been observed in almost every sample of the two types of foods which were tested by the US Food and Drug Administration, lettuce and cow's milk. Mean concentrations for perchlorate in lettuce was about 11 ppb, and in cow's milk was about 6 ppb [FDA 2004]. The widespread and relatively uniform levels in these foods suggest

3 The average adult drinks 1.4 liters of water a day and the average child, age 3 or younger, drinks 0.61 liters of liquid each day. On average, homeowners move every 14 years. An exposure duration of 30 years for adults represents an upper estimate of how often people live in a single residence. An exposure duration of 6 years is considered to represent childhood exposures from birth to 6 years, when exposures are highest (EPA 1997).

that the perchlorate in these foods may come from naturally-occurring sources. Currently, levels of perchlorate in other foods are unknown, so it is impossible to determine what a normal dietary intake of perchlorate might be.

People can ingest perchlorates by eating food or drinking water containing them. Because they easily dissolve in water, they quickly pass through the stomach and intestines and enter the bloodstream. In the blood, perchlorate passes into the kidneys, which then excrete it into the urine. The body begins to clear itself of perchlorate in this way within 10 minutes of exposure. Within a week, most of the perchlorate has been eliminated, unless the exposure is continuing.

The main target organ for perchlorate toxicity in humans is the thyroid gland. Perchlorate affects the ability of the thyroid gland to make hormones that regulate certain body functions. It does this by inhibiting the uptake of iodine by the thyroid. Iodine is needed by the thyroid to produce thyroid hormones. Less iodine means less thyroid hormone can be produced. However, the body can compensate to an extent by stimulating the thyroid to produce more hormone. This effect is not recognized as being harmful to a person's health. Excessive amounts of perchlorate may overwhelm this compensation, and decrease the level of thyroid hormone. The medical name for low levels of thyroid hormone is hypothyroidism. Hypothyroidism can also be caused by conditions totally unrelated to perchlorates.

Several studies have looked at populations that have been exposed to perchlorate through drinking water. The most pertinent studies of children and infants are discussed here. The focus is on children and infants because they are the most sensitive to changes in thyroid function. A summary of these studies is presented in Table 9.

Table 9: Summary of significant epidemiological studies of children and infants exposed to perchlorate through drinking water

Highest Perchlorate Concentration	Increased Thyroid Stimulation	Decreased Thyroid Hormone Level	Other Observations	Adverse Effect?	Reference
120 ppb	No[a]	No[b]	Decreased incidence of goiter (thyroid enlargement) among exposed group	No	Crump et al 2000
15 ppb		No		No	Z. Li et al 2000
15 ppb	No			No	F.X. Li et al 2000
> 12 ppb	**Yes**	**Yes**	Incidence of hypothyroidism independent of exposure	**unknown**	Schwartz 2001
9 ppb	No		Incidence of hypothyroidism independent of exposure	No	Kelsh et al 2003

a: The level of thyroid stimulation was independent of exposure for children, but lower for exposed infants, which is opposite of expected effects.
b: The level of thyroid hormones was higher among the exposed children and infants, which is opposite of expected effects.

Newborn babies and school-age children were studied in an area in Chile where levels of perchlorate in the drinking water are naturally high (up to 120 ppb). Some of the measures of thyroid function were different in the children from the region of highest perchlorate levels. Paradoxically, they were different in an opposite manner than was expected; their thyroid function appeared to be higher than in the unexposed group, and the incidence of goiter (thyroid enlargement) was lower in the exposed group [Crump et al 2000].

Three studies were performed of newborn babies in areas from California and Nevada, where perchlorate has been found in the drinking water at levels from a mean of 1 ppb to a high of 15 ppb. These studies also found no thyroid abnormalities associated with perchlorate exposure [Z. Li et al 2000, F.X. Li et al 2000, and Kelsh et al 2003].

An additional study of babies in California found that babies born to women who were exposed to perchlorate in the drinking water had increased thyroid stimulation and lower levels of thyroid hormone. It is not known whether the observed differences in hormone levels will have any effects on the children later in life. The levels of perchlorate in drinking water were over 12 ppb [Schwartz 2001].

After considering these and other studies, the U.S. National Research Council (NRC) has determined that a dose of 0.0007 mg perchlorate per kg body weight per day is a conservative limit on how much perchlorate a person of any age can safely consume

[NRC 2005]. Recently, EPA has developed a Reference Dose of the same value. It is important to note that these doses were determined from a study of healthy adult volunteers who drank water containing a known amount of perchlorate every day [Greer et al, 2002]. This amount of perchlorate did not inhibit the uptake of iodine into the thyroid, and so did not interfere with thyroid function. This amount of perchlorate exposure was in addition to their normal dietary exposure, so that this dose can be considered a safe level for consuming perchlorate in addition to a normal dietary exposure.

As discussed earlier, the levels of perchlorate in drinking water at both Harford County and the City of Aberdeen have remained at or below 1 ppb since monitoring began in 2001. This is lower than the lowest value in Table 9 (9 ppb) at which no effects were observed in infants. In addition, the estimated exposure doses for adults, children, and formula-fed infants are well below the safe level set by NRC and EPA. Therefore, no adverse effects are expected to occur to people in Harford County or the City of Aberdeen from perchlorates in drinking water at the previously detected levels.

2-Nitrotoluene in Drinking Water

2-Nitrotoluene is an intermediate in the production of TNT and DNT. Traces of 2-nitrotoluene remain in the explosives after manufacture. It is also a biodegradation product of DNT. 2-Nitrotoluene was found at a maximum concentration of 2.1 ppb in the Harford County treated water.

2-Nitrotoluene exhibits a low level of toxicity, and is not a regulated contaminant in drinking water. Animal studies have found some toxic effects at exposures much higher than would occur to people drinking water from the Harford County water supply [HSDB 2005]. For this reason, no adverse health effects are expected to occur as a result of exposure to this amount of 2-nitrotoluene.

Carbon Tetrachloride in Drinking Water

Carbon tetrachloride was found in private wells at a maximum concentration of 8.6 ppb. Although this concentration is slightly above the US EPA's drinking water standard of 5 ppb, the resulting amounts that people are exposed to are much lower than levels that have been found to cause adverse health effects in animals [ATSDR 2003]. For this reason, no adverse health effects are expected to occur as a result of exposure to this amount of carbon tetrachloride.

Contact with Surface Water and/or Sediment Contamination

Nature and Extent of Known Contamination – Post-Wide

On-post workers could be exposed to contamination at specific areas in sediment and surface water throughout the post. However, because of the localized nature of the contamination, and because these areas are not in usual workplaces, on-post workers are infrequently exposed to contamination.

Trespassers who ignore and circumvent access restrictions placed upon several water bodies within the APG-AA boundaries might be exposed to contamination in surface water and sediment across the post. Trespassers are assumed to access the base only infrequently, and so would not often be exposed to contamination in sediments and surface water.

Post-wide contamination was evaluated for exposure to adults (including teenagers) who might be on-post workers or trespassers, and who access the contaminated areas on an infrequent basis. CVs were used for adult exposure, and for a short timeframe: acute (every day for up to two weeks); or intermediate (every day for up to one year). Table 10 summarizes the sediment and surface water contaminants which exceed these CVs or do not have CVs. Contaminant concentrations presented in Tables 10 through 12 only represent conditions at APG-AA for a single point in time. ATSDR reviewed data collected through 2003, which was the data set available to ATSDR during the PHA process. However, the Army has conducted remediation activities since that time and continues to investigate and remediate soil contamination found at the post. Most notably, Records of Decision (RODs) have been issued or are pending to address contamination found at the Old Dump on SWAN Creek, the Old Chemical Dump on Spesutie Island, and the Known Distance Range [EPA-Region III 2008a; USAG 2008].

Summary

People might contact contaminated surface water and sediment while on the post.

Based on an evaluation of data collected prior to 2003, children who circumvent fences and trespass on the Old Dump on Swan Creek could be exposed to elevated lead levels in the sediment. Children who come in to contact with the highest detected concentrations of lead could experience acute changes in blood chemistry. Exposures would also contribute to a child's cumulative blood lead level.

Health effects could potentially occur to workers, hunters, and trespassers who contact sediments at concentrations reported in the 2003 data sets from the Old Dump on Swan Creek, the Old Chemical Dump on Spesutie Island, or the Known Distance Range. While these health effects should be avoided, they are minor and will end soon after the exposure ends.

RODs, which have been issued or are pending, outline remediation activities at these sites that minimize and eliminate these potential exposures. In addition, the likelihood of health effects happening is small because people access these areas infrequently and contamination is localized.

Table 10: Noteworthy contaminants, which exceed or lack comparison values (CVs), in sediment and surface water across APG-AA [USAG 2004]

Medium	Contaminant	Median and [Range] of Detected Concentrations and (Detects / Samples)	Comparison Value[a]
Sediment	Metals		
	Copper	36.6 ppm [0.8 to 16,200 ppm] (505/508)	7000 ppm (iEMEG)
	Lead	41.3 ppm [1.9 to 11,900 ppm] (504/504)	None[b]
	Mercury	0.2 ppm [0.02 to 225 ppm] (300/400)	None[b]
Surface Water, Seeps and Springs	Metals		
	Lead	5 ppm [1.1 to 6,820 ppb] (108/142)	None[b]

a: CVs are for short-term exposure to adults
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.

The sediment lead contamination is mainly associated with site 30b—the Known Distance Range and site 2—the Old Dump on Swan Creek. The sediment copper contamination is associated with site 12—the Old Chemical Dump on Spesutie Island. The surface water lead contamination is associated with site 1—the Old Dump on Woodrest Creek, and site 30b—the Known Distance Range.

Nature and Extent of Known Contamination – On-Post Residential Areas

Military families living at APG-AA might contact contamination in sediment and surface water if contamination is present near their homes. The only known contaminated area near housing is site 2—the Old Dump on Swan Creek. It is adjacent to military housing and a playground in Plum Point. Sediments associated with the Swan Creek Dump are contaminated with metals, specifically lead (to 11,900 parts per million [ppm]; no CV available) and arsenic (to 77.1 ppm; CREG=0.5 ppm).

APG has addressed the contamination at the Old Dump on Swan Creek in several ways. The Army has removed surface debris and covered the dump with crushed rock and geotextile fabric. This minimizes migration of contamination from the dump into surrounding areas [Foster Wheeler 1996]. However, elevated levels of lead and arsenic are still found in the sediment. The area has also been fenced on three sides by a five-foot high fence to prevent access. This fence extends north into Swan Creek and south to connect with a fence associated with the Building 120 facility [USAG 2008]. For this reason, on-post residents, including children, are likely not exposed to contamination in sediment and surface water at the Old Dump on Swan Creek. In addition, the Army is currently preparing a ROD that outlines remedial actions, which are scheduled for late 2008 and 2009 [EPA-Region III 2008a; USAG 2008]. This remediation is expected to

eliminate exposures. However, until remediation is complete, the potential remains for older children to access the area through the unfenced side.

Nature and Extent of Known Contamination – On-Post Recreational Areas

People might come into contact with contaminated surface water and sediment while using recreational areas on the post. Picnic areas are located at the Maryland Boulevard gate, Shore Pool on Swan Creek, and Woodpecker Point near Spesutie Island. A golf course is near the Maryland Boulevard gate. A marina is near Spesutie Island, and boat docks are on Plum Point.

Surface water and sediment at the Maryland Boulevard golf course and picnic area flow onto the post from off-site. No areas of contamination have been suspected or identified in the area. Since no contamination is expected to affect the surface water or sediment, no sampling of these media has been conducted in this area. People using these facilities are not expected to be exposed to contamination in surface water and sediment.

The Shore Pool picnic area includes a portion of the shoreline of Swan Creek. Although no contaminated sites are in the immediate vicinity of the picnic area, Swan Creek receives drainage from contaminated areas, such as the Old Dump on Swan Creek (one of the Other Aberdeen Areas). No sampling of the surface water or sediment has been made in the vicinity of the Shore Pool picnic area. Swimming is not allowed at the picnic area, although people may wade out with small boats launched from the shore. Since there is little contact with surface water and sediment in this area, little to no exposure to contamination in these media is expected to occur.

The picnic area on Woodpecker Point is in the vicinity of site 22 (Buildings 309 and 390 sewer outfalls) in the Other Aberdeen Areas. Contaminants in sediment near Woodpecker Point include low levels of polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Surface water at site 22 was analyzed only for metals. Contaminants which exceed CVs in surface water near Woodpecker Point include low levels of arsenic, manganese, and thallium. Contaminants from those portions of the site 22 investigation which were nearest the Woodpecker point picnic area are listed in Table 11.

Table 11: Noteworthy contaminants, which exceed comparison values (CVs), in surface water and sediment at those portions of the site 22 investigation that were nearest the Woodpecker Point picnic area [USAG 2004].

Medium	Contaminant	Median and [Range] or Detected Concentrations and (detects / samples)	Comparison Value[a]
Sediment	PAHs		
	Benzo(a)pyrene	0.2 ppm (1/6)	0.1 ppm (CREG)
	Benzo(b)fluoranthene	0.96 ppm [0.42 to 1.5 ppm] (2/6)	0.9 ppm (SSL)
	Indeno(1,2,3-c,d)pyrene	0.25 ppm [0.14 to 0.36 ppm] (2/6)	0.9 ppm (SSL)
	PCBs		
	Aroclor 1254	1.14 ppm [0.54 to 1.75 ppm] (2/5)	1 ppm (EMEG)
	Aroclor 1260	0.71 mg/kg (2/5)	0.4 ppm (CREG for PCBs)
Surface Water	Metals		
	Arsenic	3.5 ppb (1/3)	0.02 ppb (CREG)
	Manganese	565 ppb [501 to 889 ppb] (3/3)	500 ppb (RMEG)
	Thallium	2.5 ppb (1/3)	0.5 ppb (LTHA)

a: CVs are for long-term exposure (> 1 year) to children and adults
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.

Boaters using the boat dock or marina may contact surface water in Swan Creek. No sampling is available for surface water in Swan Creek. However, the tidal nature of the creek and the high volume of flow likely maintain low levels of contamination. This, coupled with the small amounts of surface water which boaters likely accidentally ingest, indicate that boaters are not expected to be exposed to significant levels of contamination.

Nature and Extent of Known Contamination - Hunting & Trapping Areas

Hunters and trappers can access several water bodies, streams, and creeks on the APG-AA. Sampling of the sediment from water bodies and streams near hunting and trapping areas indicates contamination with copper, lead, and mercury. The lead contamination is mainly associated with site 30b—the Known Distance Range and site 1—the Old Dump on Woodrest Creek. The Army, however, is scheduled to conduct a removal action at the Known Distance Range in 2008 [EPA-Region III 2008a; USAG 2008].The copper and mercury contamination is associated with site 12—the Old

Chemical Dump on Spesutie Island. Contaminants that exceed or lack CVs are detailed in Table 12.

Samples of the surface water from the accessible water bodies and streams were analyzed only for metals. The results indicate contamination with lead, manganese, and thallium. The lead contamination is associated with site 1—the Old Dump on Woodrest Creek, and site 30b—the Known Distance Range.

Table 12: Noteworthy contaminants, which exceed or lack comparison values (CVs), in surface water and sediment in hunting and trapping areas [USAG 2004].

Medium	Contaminant	Median and [Range] or Detected Concentrations and (detects / samples)	Comparison Value[a]
Sediment	Metals		
	Copper	34.1 ppm [0.77 to 16,200 ppm] (265/267)	500 ppm (iEMEG)
	Lead	40.4 ppm [1.9 to 7,900 ppm] (267/267)	None[b]
	Mercury	0.2 ppm [0.02 to 225 ppm] (146/202)	None[b]
Surface Water, Seeps, and Springs	Metals		
	Lead	4.5 ppb [1.1 to 6,820 ppb] (61/84)	None[b]
	Manganese	353 ppb [10.3 to 5,730 ppb] (87/87)	None[b]
	Thallium	3 ppb [1.4 to 7.2 ppb] (6/77)	None[b]

a: CVs are for short-term exposure to children and adults
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.

Nature and Extent of Known Contamination - Fishing & Crabbing Areas

Fishing from boats is permitted in Bush River, Chesapeake Bay, and Swan Creek. Recreational use of these water bodies is allowed in the evenings, on weekends, and on most national holidays, unless temporary restrictions are in effect because of testing. Fishing along the shoreline is permitted along areas of Bush River, Romney Creek, Swan Creek, and Spesutie Narrows. Swimming and any activities that result in people touching land—along the shorelines or underwater—are prohibited. The Army also prohibits boating in several streams at all times, including Cod Creek, Abbey Creek, Delph Creek, Mosquito Creek, Spesutie Narrows, and Romney Creek.

Because of the restrictions on contact with the shoreline, fishers and crabbers are not exposed to contamination in either surface water or sediment on the post.

Evaluation of Potential Public Health Hazards

To assess exposures to contaminants found above CVs in sediment and surface water, ATSDR calculated exposure doses based on conservative assumptions about how a person may contact these environmental media. ATSDR assumed that a person, either adult or child, would use the recreational areas 5 days a week for 26 weeks a year (130 days) over a period of 30 years for an adult and 6 years for a child.[4] Adult or child hunters and trappers were assumed to hunt or trap two days a week for a month each year (8 days). Adult workers and trespassers were assumed to access contaminated areas every day for up to two weeks (14 days). Based on studies of how much soil a person may accidentally ingest when outside, ATSDR assumed that an adult may accidentally ingest 100 milligrams (mg) of sediment and a child may accidentally ingest 200 mg of sediment every day.[5] In addition, both adults and children were assumed to accidentally swallow 10 milliliters of surface water every day. An additional, conservative assumption was made that people were exposed to the maximum level of contamination observed during sampling; this assumption overestimates actual exposures. Further, the Army has completed or is conducting remediation activities throughout the post, and specifically at the Old Dump on SWAN Creek, the Old Chemical Dump on Spesutie Island, and the Known Distance Range. As such, contaminated sediment has been removed from some areas and will be removed from others, which eliminates possible exposures in these areas. Exposures of children to lead in sediment and surface water were estimated by using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) for Lead in Children [EPA 2005c].

Exposure doses were estimated for each contaminant in the sediment and surface water for adult hunters and trappers, and for adults and children using the recreational area at Woodpecker Point. These doses were then compared to those found in ATSDR Toxicological Profiles [ATSDR 1999], and in the toxicological literature [Stuik 1974, Perry at al. 1988] to determine whether they could cause adverse health effects. None of these doses were high enough to cause any adverse effects.

Exposure doses were estimated for each contaminant in the sediment and surface water across the post for adult on-site workers and trespassers. These doses were then compared to those found in ATSDR Toxicological Profiles, and in the toxicological literature to determine whether they could cause adverse health effects. No adverse health effects are expected to occur due to exposure to mercury. However, exposure doses for copper and lead were elevated; these metals will be discussed in more detail.

4 An exposure duration of 30 years for adults represents an upper estimate of how often people live in a single residence. An exposure duration of 6 years is considered to represent childhood exposures from birth to 6 years, when exposures are highest [EPA 1997].

5 Studies have found that adults will accidentally ingest between 30 and 100 mg of soil per day. Children under the age of 6, on average, will accidentally ingest 200 mg of soil each day. The amount of soil ingested daily drops during the winter when the ground is frozen or covered in snow.

Copper in Sediment

Copper was elevated above its CV in only one sample, taken near site 12—the Old Chemical Dump on Spesutie Island, prior to remediation activities. If someone were in the vicinity of site 12 all day, they might have ingested sufficient amounts of copper to experience nausea, vomiting, and other symptoms of gastro-intestinal discomfort. However, these symptoms are temporary and reversible [ATSDR 2004]. Further, infrequent access to this area and the localized nature of the elevated copper concentration minimized the likelihood of these effects occurring. Completed remediation activities at this site eliminate exposures to elevated copper in sediment.

Lead in Sediment

Lead was highly elevated in sediment in two areas of the post. The highest level, 11,900 ppm, was observed near the Old Dump on Swan Creek. The Old Dump on Swam Creek area is near on-post housing and a playground, but is fenced on three sides to minimize access, particularly to young children. The next highest concentration of lead, 7,900 ppm, was observed in site 30b—the Known Distance Range.

Based on dose estimates, should a child trespass on the Old Dump on Swan Creek through the unfenced side, and happen to contact the most contaminated sediments, he or she could experience acute effects (reversible changes in blood chemistry) [ATSDR 1999]. However, this exposure is unlikely to occur often because the unfenced side is along Swan Creek and only accessible by boat or wading through the creek. Only older, less vulnerable children would likely access the area. In addition, exposures could elevate blood lead levels, which alone would not be harmful, but would contribute to a child's cumulative blood lead level and increase the potential for adverse health effects. In addition, the Army is currently preparing a ROD that outlines remedial actions, which are scheduled for late 2008 and 2009. This remediation is expected to eliminate exposures. Regardless, the Army should continue efforts to prevent trespassing and possible exposures.

Lead was highly elevated in sediments at the Known Distance Range. The amount of lead that workers, trespassers, and hunters might be exposed to in these areas is similar to levels which caused small, reversible changes in blood chemistry in people who voluntarily took lead acetate in laboratory experiments. However, lead acetate is much more soluble in water than the forms of lead found in sediment. The less soluble forms of lead are absorbed into the bloodstream at a slower rate, and some may pass completely through the digestive tract without being absorbed. This diminishes the potential for people to experience these health effects [ATSDR 1999, EPA 2005c]. In addition, the Army is scheduled to conduct a removal action at the Known Distance Range in 2008.

Contact with Surface Soil Contamination

ATSDR defines surface soil as the top 3 inches of soil. It is the top 3 inches that people are most likely to be exposed to, through activities such as digging and playing, or because it may become wind-borne, and then inhaled and subsequently ingested by nearby people.

Most of the surface soils analyzed before 2003 at APG-AA have been sampled to a depth of 6 inches. Some have been sampled to a depth of 1 foot. All of these samples will be used to approximate the composition of the top 3 inches of soil. The Army has conducted remediation activities since that time and continues to investigate and remediate soil contamination found at the post. Most notably, the Army is scheduled to conduct a removal action at the Known Distance Range in 2008 [EPA-Region III 2008a; USAG 2008].

Summary

People might contact contaminated surface soil while on the post.

Health effects could potentially occur to workers and trespassers who contact surface soils at the Known Distance Range. While these health effects should be avoided, they are minor and will end soon after the exposure ends. In addition, the Army has scheduled a removal action, which is expected to eliminate exposures, for completion in 2008.

Nature and Extent of Known Contamination - On-Post

On-post workers may come into contact with contaminated surface soil at specific areas throughout the post. However, because of completed and ongoing remediation activities, the localized nature of the contamination, and because these areas are not in usual workplaces, on-post workers are infrequently exposed to contamination.

Trespassers who ignore and circumvent access restrictions within the APG-AA boundaries might be exposed to contamination in surface soil across the post. Trespassers are assumed to access the base only infrequently, and so would not often be exposed to contamination in surface soil.

Post-wide contamination was evaluated for exposure to adults (including teenagers) who might be on-post workers or trespassers, and who access the contaminated areas on an infrequent basis. CVs were used for adult exposure, and for a short timeframe: acute (up to two weeks); or intermediate (up to one year). The only contaminant of concern in surface soils across the post is lead, at a maximum concentration of 20,500 ppm. High levels of lead were found in surface soils at: site 30b—the Known Distance Range; site 2—the Old Dump on Swan Creek; and site 30a—the Pistol Range [USAG 2004]. However, completed and ongoing remediation activities at these sites are expected to minimize and eliminate these potential exposures [EPA-Region III 2008a; USAG 2008].

Nature and Extent of Known Contamination - On-Post Residential Areas

Military families living at APG-AA might contact contamination in surface soil if contamination is present near their homes. Site 2—the Old Dump on Swan Creek is adjacent to military housing and a playground in Plum Point. Soils associated with the Swan Creek Dump are contaminated with metals, primarily lead (to 2,370 ppm) [USAG 2004]. The area has been fenced on three sides to prevent access to young children, and the dump has been covered to minimize migration of the contamination from the dump. Vegetation has been encouraged to further minimize the potential for exposure. In addition, the Army is currently preparing a ROD that outlines remedial actions, which

are scheduled for late 2008 and 2009 [EPA-Region III 2008a; USAG 2008]. For this reason, on-post residents are not likely to be exposed to contaminants in soils at the Old Dump on Swan Creek. Older children, however, could circumvent the fences and trespass in the area.

Nature and Extent of Known Contamination – Recreational Areas

People might come into contact with contaminated surface soil while using recreational areas on the post. Picnic areas are located at Shore Pool on Swan Creek, the Maryland Boulevard gate, and Woodpecker Point near Spesutie Island. A golf course is near the Maryland Boulevard gate.

No areas of contamination have been suspected or identified near recreational areas at the Shore Pool or the Maryland Boulevard gate. Since no contamination is expected to affect the surface soil, no sampling has been conducted in this area. People using picnic areas or golf course are not expected to be exposed to contamination in surface soil.

Although the picnic area on Woodpecker Point is in the vicinity of site 22 (Buildings 309 and 390 sewer outfalls), this site is not associated with contaminated surface soil. Since no contamination is expected to affect the surface soil, no sampling has been conducted in this area. People using these facilities are not expected to be exposed to contamination in surface soil.

Nature and Extent of Known Contamination – Hunting & Trapping Areas

Surface soils in the hunting and trapping areas have been analyzed for many different substances, but only lead was found at concentrations which could be of concern to adults or older children who are infrequently exposed. Lead was found in surface soils at site 30a—the Pistol Range, at a maximum concentration of 1,460 ppm.

Evaluation of Potential Public Health Hazards – Lead in Surface Soil

To assess exposures to contaminants found above CVs in surface soil, ATSDR calculated exposures doses based on conservative assumptions about how a person may contact this environmental medium. ATSDR assumed that a person, either adult or child, would use the recreational areas 5 days a week for 26 weeks a year (130 days) over a period of 30 years for an adult and 6 years for a child. Adult or child hunters and trappers were assumed to hunt or trap two days a week for a month each year (8 days). Adult workers and trespassers were assumed to access contaminated areas every day for up to two weeks (14 days). Based on studies of how much soil a person may accidentally ingest when outside, ATSDR assumed that an adult may accidentally ingest 100 mg of soil, and a child may accidentally ingest 200 mg of soil every day. An additional, conservative assumption was made that people were exposed to the maximum level of contamination observed during sampling; this assumption overestimates actual exposures. Further, the Army has completed or is conducting remediation activities throughout the post, specifically at the Old Dump on Swan Creek

and the Known Distance Range. As such, contaminated sediment has been removed from some areas and will be removed from others, which eliminates possible exposures in these areas. Exposures of children to lead in surface soil were estimated by using EPA's IEUBK for Lead in Children [EPA 2005c].

Lead was elevated in surface soil at the Old Dump on Swan Creek. Older children who trespass on the area (14 days a year) might experience a slight elevation in blood lead level. This exposure is unlikely to occur often because the unfenced side is along Swan Creek and only accessible by boat or wading through the creek. Under usual circumstances, this increase would not lead to any adverse health effects. However, should the child also be exposed to other sources of lead, the increase in blood lead levels would be cumulative, increasing the potential for adverse health effects to occur [ATSDR 1999a, EPA 2005c]. The Army is currently preparing a ROD that outlines remedial actions, which are scheduled for late 2008 and 2009. This remediation is expected to eliminate exposures.

Lead was highly elevated in surface soil at the Known Distance Range. The amount of lead that workers and trespassers might be exposed to in this area is similar to levels which caused small, reversible changes in blood chemistry in people who voluntarily took lead acetate in laboratory experiments. However, lead acetate is much more soluble in water than the forms of lead found in soil. The less soluble forms of lead are absorbed into the bloodstream at a slower rate, and some may pass completely through the digestive tract without being absorbed. This diminishes the potential for people to experience these health effects [ATSDR 1999, EPA 2005c]. In addition, the Army is scheduled to conduct a removal action at the Known Distance Range in 2008.

Inhalation of Air Emissions from Range Fires

Ordnance testing occasionally sparks fires within the testing ranges at APG-AA. When these fires occur, they are managed by the post fire department as controlled burns within an established perimeter. The perimeter provides distance between the firefighters and possible explosions from unexploded munitions within the burn area. Range fires are most common in the late summer and early fall months.

Summary

People might be exposed to contaminated air while on or near the post during a brush fire on a firing range. Sampling during brush fires found contamination with explosive-related substances, PCBs, a pesticide, metals, and solvents. However, the concentrations were low enough that adverse health effects are not expected to occur from short-term exposure to smoke from range fires.

Nature and Extent of Contamination

In 1998, a study using computer models and information about site contamination was completed to assess the potential off-post impacts of these range fires. The study modeled lead, arsenic, TCE, depleted uranium, DDT, vinyl acetate, 2-furaldehyde, mustard gas, and phosgene releases during range fires and predicted that none of these chemicals would be released in concentrations high enough to impact human health [ANL 1998].

Because of continued community concerns about range fires, in 1999, the Army proposed a program of testing air during controlled burns at APG. Three locations, representing possible worst-case releases, were selected for controlled burns: one in the Other Aberdeen Areas, where depleted uranium (DU) ordnance had been tested, and two areas in APG-AA. Controlled burns were conducted in April 1999 (Other Aberdeen Areas), and December 1999 and April 2000 in APG-AA. The Army collected downwind air samples during each of the controlled burns. Samples collected during the controlled burns were analyzed for VOCs, pesticides, explosives, metals, radionuclides, and chemical warfare material. Air sampling found explosive-related substances, PCBs, a pesticide, metals, and solvents at concentrations above CVs for long-term exposures, but below CVs for short-term exposures; the short-term CVs are more appropriate for this exposure [GP 2001; USAG 1999]. Since not all of the substances have short-term CVs, occupational standards were also used. Table 13 summarizes the sampling results for contaminants that exceed or lack CVs.

Table 13: Summary of controlled burn air sampling data for contaminants, which exceed or lack comparison values (CVs) [GP 2001].

Contaminant	Median and [Range] of Detected Concentrations ($\mu g/m^3$) And (No. of Detects / No. of Samples)		Comparison Value ($\mu g/m^3$)	
	Downwind	Upwind	Long-Term Exposure	Short-Term Exposure[a]
Explosives and Explosive-Related Substances				
2-Amino-4,6-Dinitrotoluene	0.457 (1/7)	ND (0/3)	None[b]	None[b]
4-Amino-2,6-Dinitrotoluene	0.1266 (1/7)	ND (0/3)	None[b]	None[b]
PCBs				
Total PCBs	0.001 [0.0005 to 0.012] (4/7)	0.0007 [0.0002 to 0.0012] (2/3)	0.01 (CREG)	500 (OSHA PEL)
Pesticides				
Dieldrin	0.0005 [0.0005 to 0.003] (3/7)	ND (0/7)	0.0002 (CREG)	250 (OSHA PEL)
Metals				
Arsenic	0.013 [0.0025 to 0.015] (4/7)	ND (0/3)	0.0002 (CREG)	10 (OSHA PEL)
Beryllium	0.00045 [0.0004 to 0.0005] (2/7)	ND (0/7)	0.0004 (CREG)	2 (OSHA PEL)
Cadmium	0.002 [0.0005 to 0.0036] (2/7)	0.05 (1/3)	0.0006 (CREG)	5 (OSHA PEL)
Chromium	0.008 [0.0035 to 0.04] (6/7)	0.005 (2/3)	0.00008 (CREG)	500 (NIOSH REL)
Lead	0.0325 [0.0061 to 0.07] (7/7)	0.0077 (3/3)	None[b]	50 (OSHA PEL)
Manganese	0.02 [0.006 to 0.55] (7/7)	0.015 (3/3)	0.04 (EMEG)	1,000 (NIOSH REL)
Uranium (total)[c]	0.0068 (2/3) – DU site ND (0/3) – non-DU site	ND (0/2)	0.3 (EMEG)	250 (OSHA PEL)
Solvents				
Acetaldehyde	4 (1/7)	ND (0/3)	0.5 (CREG)	360,000 (OSHA PEL)
Benzene	11.3 [2.3 to 20.5] (4/7)	3.65 [2.4 to 4.9] (2/3)	0.1 (CREG)	160 (aEMEG)
Methylene chloride	15.5 [5.9 to 25] (2/7)	6.4 (1/3)	3 (CREG)	2,000 (aEMEG)

a: Occupational standards are used when an acute EMEG is not available
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.
c: The concentration of total uranium never exceeded a CV. It is included in this table for later discussion.

Evaluation of Potential Public Health Hazards

Once emitted by fires, chemicals gradually disperse as smoke plumes blow downwind. ATSDR assumed that all of the populations identified at APG-AA (on-post workers and residents, off-post residents, recreational users, hunters, fishers, and trespassers) may be exposed to air emissions from range fires because contaminant migration within the smoke plume cannot be contained and may extend to on- and off-post locations. However, because none of the contaminants exceed CVs for short-term exposure, exposure to contaminants released during range fires is not expected to cause adverse health effects. In addition, the Army continues to implement procedures that minimize range fires.

Ingestion of Contaminated Biota – Fish and Aquatic Animals

Fishing, crabbing and trapping occur on or near APG-AA. Some contaminants on the post can be taken up by fish, crabs, and turtles. These contaminated animals can then pass this contamination on to people who eat them.

Potential for Contamination of Aquatic Species

Many of the contaminants found in the environment at APG-AA can accumulate in fish and other aquatic animals. Those contaminants which are known to accumulate well in fish and animals are PCBs, pesticides, and some metals. Other contaminants with less potential for accumulation are solvents and munitions-related substances. The potential for perchlorate to accumulate in fish and animals is currently unknown. However, as a general rule contaminants tend to accumulate in the hypetopenereus (nonflesh digestive system sections referred to as "mustard) than in fleshy meat.

Summary

Fish were found to be contaminated with PCBs, DDTs, and lead. Crabs have not been sampled. The potential for perchlorate to accumulate in fish, crabs, and turtles remains unanswered.

Adverse health effects aren't expected to occur as a result of the observed contamination, as long as people adhere to the fish consumption limits recommended by the Maryland Department of the Environment.

Many contaminants have been found at APG-AA within a quarter-mile of the shoreline, and so may potentially contaminate water bodies and the fish and aquatic animals living in them. Table 14 lists major contaminants which have bioaccumulation potential and were found in sediment, or surface or ground water near the APG-AA shoreline. The contaminants include munitions (RDX and two explosive degradation products), PCBs, a pesticide (chlordane), metals (arsenic, chromium, copper, lead and mercury), and solvents (benzene, trichloroethylene, and vinyl chloride). Except for the solvents, all of these substances were analyzed for in fish. The solvents were found in groundwater, but to a much lesser extent in surface water, indicating very little potential for them to accumulate in aquatic species. No samples were analyzed for perchlorate within a quarter-mile of the shoreline because no contamination was suspected in these areas.

Environmental contaminant concentrations in Table 14 are compared against available CVs which were developed regarding the bioaccumulation potential of each substance. For surface water and ground water, the CV based on fish consumption is divided by the Fish Bioaccumulation Factor, which is provided by the EPA [EPA 2000]. These values are also conveniently available through the Oak Ridge National Laboratory's Risk Assessment Information System [ORNL 2005]. For sediment, the fish CV is divided by the Biota to Sediment Accumulation Factor (BSAF), also provided by the EPA [EPA 2005b]. Contaminants with no CV or bioaccumulation factor to support developing a CV are also included in Table 14.

Table 14: Major contaminants, which exceed or lack comparison values (CVs), considering bioaccumulation within fish, within one quarter-mile of the APG-AA shoreline [USAG 2004]

Medium	Substance	Median and [Range] of Detected Concentrations	Number of Detects / Number of Samples	Comparison Value[a]
Sediment	**PCBs**			
	Aroclor 1254	0.754 ppm [0.537 to 1.75 ppm]	4/127	0.001 ppm (CREG)
	Pesticides			
	Chlordane	0.002 ppm [0.0003 to 0.0164 ppm]	14/132	0.004 ppm (CREG)
	Metals			
	Arsenic	8.8 ppm [0.31 to 77.1 ppm]	192/194	No BSAF
	Lead	44.5 ppm [1.9 to 11,900 ppm]	205/205	None[b]
	Mercury	0.26 ppm [0.02 to 225 ppm]	126/167	No BSAF
Surface Water	**Pesticides**			
	Chlordane	0.0305 ppb [0.028 to 0.033 ppb]	2/25	0.001 ppb (CREG)
	Metals			
	Lead	5 ppb [1.1 to 325 ppb]	28/38	None[b]
	Solvents			
	Trichloroethylene	2 ppb [0.9 to 5 ppb]	3/23	1 ppb (CREG)

a: CVs are for long-term exposure (> 1 year) to children and adults to contaminated fish
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.

Table 14 (continued): Major contaminants, which exceed or lack comparison values (CVs), considering bioaccumulation within fish, within one quarter-mile of the APG-AA shoreline [USAG 2004]

Medium	Substance	Median and [Range] of Detected Concentrations	Number of Detects / Number of Samples	Comparison Value[a]
Groundwater	**Munitions-Related**			
	2-Amino-4,6-DNT	1.4 ppb [0.66 to 23.4 ppb]	4/48	None
	4-Amino-2,6-DNT	2.9 ppb [0.82 to 17.7 ppb]	8/50	None
	RDX	12.9 ppb [3.8 to 21.9 ppb]	2/48	20 ppb (CREG)
	Metals			
	Arsenic	19.1 ppb [4.43 to 595 ppb]	29/54	1 ppb (EMEG)
	Chromium	46.2 ppb [0.98 to 9,680 ppb]	47/56	10 ppb (RMEG)
	Copper	17.4 ppb [0.96 to 7,730 ppb]	52/57	3,000 ppb (iEMEG)
	Lead	13.3 ppb [1.5 to 4,180 ppb]	42/55	None
	Solvents			
	Benzene	0.75 ppb [0.36 to 23.9 ppb]	24/50	10 ppb (CREG)
	Trichloroethylene	20.5 ppb [0.18 to 10,500 ppb]	173/265	1 ppb (CREG)
	Vinyl Chloride	2.7 ppb [0.38 to 20 ppb]	28/253	1 ppb (CREG)

a: CVs are for long-term exposure (> 1 year) to children and adults to contaminated fish
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.

In addition to the contamination detailed in Table 14, other wastes may cause contamination of aquatic species. Lab wastes and munitions and explosives have been disposed of in the past across APG-AA. Any of these wastes which remain may potentially contaminate surface water, sediment, and aquatic species.

Nature and Extent of Known Contamination – Fish

The Army, the Maryland Department of the Environment (MDE), and the University of Maryland have conducted food chain studies that investigate contaminant concentrations in fish. The purpose of these studies has been to determine whether local fish are contaminated, and how any observed contamination might impact human health.

Several studies of fish health have been conducted in the waters surrounding APG. Kidney and brain lesions were found in fish and eels. These problems were attributed to

diseases, parasites, and naturally poor water quality [U of MD 1991; Kane 2005; DSHE 1992; and MFHDP 1992].

The Army has sampled fish tissue for environmental contaminants. In 1995, the Army collected fish from Spesutie Narrows, Swan Creek, Romney Creek, Redmon Cove, and Bush River. These samples were analyzed for PCBs, pesticides, and metals. Contaminants which exceed CVs were PCBs, DDTs, and lead [USAG 1995]. Additional details about contaminants observed in this and the following studies are given in Table 15.

MDE has been sampling fish tissue from the Chesapeake Bay since the 1980s. Data prior to 2000, however, has significant quality assurance/quality control issues and is not appropriate for assessing impacts to public health. Currently, MDE collects and tests fish from the Chesapeake Bay each year and from the vicinity of APG about every 4 years.

In 2000, MDE analyzed channel catfish and white perch fillets from the Bush River for PCBs, pesticides (chlordane and DDT), and metals. Contaminants which exceed CVs were PCBs, total DDTs (including DDD, DDE, and DDT), and lead [MDE 2005b].

In 2002, MDE sampled yellow perch fillets from the Bush River for PCBs and methyl-mercury. Although both were found in every composite sample, only PCBs were elevated to a level of concern [MDE 2005b].

ATSDR and other agencies have studies on fish, crabs, and other seafood, and found that contaminants tend to be higher in the non-fleshy portions. People concerned about exposure to natural or manmade contamination should refrain from eating the non-fleshy portions.

Table 15: Contaminants, which exceed or lack comparison values (CVs) in fillets from fish caught on or near the Aberdeen Proving Ground – Aberdeen Area [MDE 2005b and USAG 1995].
Note: Gray entries are contaminants not detected or concentrations below the CV; bold entries are concentrations above both the CV and the background concentration.)

Substance	Species	Maximum Detected Concentration (ppb)							Comparison Value[a] (ppb)
		Bush River	Redmon Cove	Romney Creek	Spesutie Narrows	Swan Creek	Towner Cove	Back-ground	
PCBs	Channel Catfish	**347**		**158**			40		3 (CREG)
	White Crappie		**39**						
	White Perch	**312**	**74**	**23**	ND	ND	**4.63**	ND[c,d]	
	Yellow Perch	**136**							
DDTs	Channel Catfish	36		**106**			26	ND[c,d,e]	20 (CREG)
	Large Mouth Bass				ND	7			
	White Crappie		**36**						
	White Perch	ND	**52**	**80**	ND	ND	18	ND[c,d,e]	
Lead	Channel Catfish	**18**		ND			ND	ND[c,d,e]	None[b]
	Large Mouth Bass				ND	ND			
	White Crappie		ND						
	White Perch	**15**	**69**	ND	ND	ND	ND	ND[c,d,e]	

a: CVs are for long-term exposure (> 1 year) to children and adults to fish which have lived in contaminated sediments and surface water
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.
c: Magothy River
d: Patapsco River
e: Choptank River

In addition to environmental monitoring of fish tissue, MDE investigates fish for signs of poor health and encourages the public to report fishkills and unhealthy or malformed catch, which can be indicators of contamination. MDE scientists study the cause of abnormalities and poor health in the fish population. In most cases, the cause is unrelated to chemical contamination [MDE 2005b]. Between 2000 and 2004, MDE reported seven fishkills and four unhealthy or malformed fish near APG, including two large fishkills on the Bush River in May 2000 (700 fish) and in July 2003 (1,842 fish) caused by bacterial disease and toxic algal blooms. The other fishkills and sick or deformed fish reported to MDE were attributed to natural causes, low levels of dissolved oxygen, or fishing pressures [MDE 2005c].

Nature and Extent of Known Contamination – Crabs & Turtles

No sampling has been made of crabs or turtles harvested on or near the Aberdeen area of the Aberdeen Proving Ground. The PHA for APG-EA, however, includes an assessment of potential health hazards resulting from ingestion of crab and snapping turtle collected from areas within APG-EA.

Evaluation of Potential Public Health Hazards

Fishers, trappers, and their families (adults and children) may have been exposed to contaminants in fish caught on or near APG-AA. To assess exposures to contamination in fish, ATSDR assumed that adults might regularly eat a 4 ounce meal of fish once or twice a week for 30 years, and children might eat a 2 ounce meal of fish once or twice a week for six years[6]. These levels are within the recommended consumption limits for several species of fish, which are provided by MDE [MDE 2005a]. The MDE recommendations are intended to protect individuals from exposure to potentially harmful levels of contamination in affected species. The amount of contaminant that people ingest with these foods was estimated by using the maximum concentration observed for each animal. This assumption overestimates actual exposures. Based upon the amount ingested, none of the contaminants are expected to cause adverse health outcomes.

<u>Additional Consideration – Perchlorate in Aquatic Animals</u>

Perchlorate has been found in groundwater and subsurface soils in north-central APG-AA. No samples have been analyzed for perchlorate near the shoreline.

Preliminary studies at Lake Meade and Longhorn Army Ammunition Plant address the potential for perchlorate to accumulate in fish in freshwater environments and suggest that perchlorate can bioaccumulate in at least some species of fish. These studies reported perchlorate in tadpoles and small fish, such as minnows and shiners that live in creeks and ponds. However, no perchlorate was detected in larger game fish, such as large mouth bass and catfish, which typically live in larger bodies of water where perchlorate contamination may have been highly diluted [Parsons 2001 and Smith et al 2001]. Unlike the smaller, freshwater environments considered in these studies, a larger

6 Assumptions about fish consumption are based on studies of aquatic food consumption [EPA 1997].

saltwater environment exists in the vicinity of APG. The dynamics of a large water body such as the Chesapeake Bay will likely decrease the impacts that could stem from a perchlorate release. Perchlorate, which is water soluble, will be more dilute in large bodies of water than in smaller ones, and will likely be dispersed and diluted further by the tide. This dilute amount of perchlorate will decrease the amount of contaminate that large fish can accumulate

Based on these findings, the potential for perchlorate to bioaccumulate to harmful levels in aquatic animals in the vicinity of APG is unlikely.

Ingestion of Contaminated Biota – Deer

Deer hunting occurs on APG-AA. Some contaminants on the post can be taken up by deer. These contaminated animals can then pass this contamination on to people who eat them.

Potential for Contamination of Deer

Many of the contaminants found in the environment at APG-AA can accumulate in game animals. Those contaminants which are known to accumulate in animals are PCBs, pesticides, and some metals. Other contaminants with less potential for accumulation are solvents and munitions-related substances. The potential for perchlorate to accumulate in animals is currently unknown.

> **Summary**
>
> *Deer were found to have levels of lead which are of concern. However, it is not clear whether this contamination is from post activities or other sources.*
>
> *The level of lead in the meat and liver of some deer could contribute to any existing lead exposure to children.*

Many contaminants have been found in surface water and surface soil across APG-AA, and so may potentially accumulate in game animals. Table 16 lists major contaminants with bioaccumulation potential, which were found in surface water or surface soil across APG-AA. No samples of surface water or surface soil were analyzed for perchlorate because no contamination was suspected.

Environmental contaminant concentrations in Table 16 are compared against CVs, if available, which were developed regarding the bioaccumulation potential of each substance. These CVs are derived from the CVs for deer. For surface water, the deer CV is then divided by the Beef Transfer Coefficient, which is provided by the EPA [EPA 2005c]. These values are also conveniently available through the Oak Ridge National Laboratory's Risk Assessment Information System [ORNL 2005]. For surface soil, the deer CV is used, along with the Beef Transfer Coefficient and the Soil-to-Dry Plant Uptake, also provided by the EPA [EPA 2005b]. Contaminants with no CV or no factors to support developing a CV are also included in Table 16.

Table 16: Major contaminants across APG-AA, which exceed or lack comparison values (CVs), considering bioaccumulation potential in deer [USAG 2004].

Medium	Substance	Median and [Range] of Detected Concentrations	Number of Detects / Number of Samples	Comparison Value[a]
Surface Soil	**PCBs**			
	Aroclor 1254	0.189 ppm [0.189 ppm]	1/44	0.04 ppm (CREG)
	Pesticides			
	Dieldrin	0.003 ppm [0.018 to 0.169 ppm]	12/45	0.09 ppm (CREG)
	Metals			
	Arsenic	4.2 ppm [0.84 to 24.2 ppm]	105/105	0.55 ppm (CREG)
	Copper	22 ppm [3.2 to 560 ppm]	105/105	70 ppm (iEMEG)
	Lead	79.8 ppm [2.4 to 20,500 ppm]	105/105	None
	Mercury	0.08 ppm [0.02 to 4.7 ppm]	82/104	2 ppm (EMEG)
Surface Water or Seep	**Metals**			
	Lead	5 ppb [1.1 to 6,820 ppb]	108/142	None

a: CVS are for long-term exposure (> 1 year) to children and adults to contaminated venison

In addition to the contamination detailed in Table 16, other wastes may cause contamination of game species. Laboratory wastes and munitions and explosives have been disposed of in the past across APG-AA. Any of these wastes which remain may potentially contaminate surface water, sediment, and game species.

Nature and Extent of Known Contamination – Deer

In May 1995, the Army completed an assessment of contaminants found in deer at APG. The Army collected deer muscle and liver samples from hunters during the 1993 hunting season. These samples were analyzed for PCBs, pesticides, metals, explosives, and explosive breakdown products [CHPPM 1995]. All of the contaminants listed in Table 16 were included in the analyses. Details of the contaminants in deer samples that exceed CVs, if available, are listed in Table 17. Table 17 also lists contaminants in deer samples that lack CVs.

Table 17: Contaminants, which exceed or lack comparison values (CVs) in deer from APG-AA [CHPPM 1995].
Note: Arsenic and lead were detected in all 20 samples of both muscle and liver at each location.

Portion	Substance	Median and [Range] of Detected Concentrations (ppb)				Comparison Value[a] (ppb)
		Spesutie Island (20 deer)	Impact Area (20 deer)	Old and New Bombing Areas (20 deer)	Background - Gunpowder Falls St Pk (20 deer)	
Muscle	Metals					
	Arsenic	715 [366 to 845]	830 [570 to 980]	730 [75 to 875]	323 [125 to 815]	4 (CREG)
	Lead	110 [65 to 4,590]	120 [63 to 1,460]	112 [45 to 243]	230 [134 to 1,600]	None[b]
Liver	Metals					
	Arsenic	724 [323 to 961]	845 [268 to 1,010]	700 [370 to 1,010]	394 [232 to 909]	4 (CREG)
	Lead	128 [63 to 6,020]	68 [21 to 352]	90 [65 to 1,010]	170 [86 to 596]	None[b]

a: CVs are for long-term exposure (> 1 year) to contamination by eating venison or deer liver
b: Since no CV is available, this substance will be evaluated based upon a review of the toxicological literature.

With a few exceptions, all lead levels in deer muscle were below 518 ppb. The exceptions are three deer in Spesutie Island (1,010 ppb, 2,390 ppb, and 4,590 ppb), one deer in the impact area (1,460 ppb), and one deer in the Gunpowder Falls State Park (1,600 ppb). It is unclear why these high levels were observed, particularly in Gunpowder Falls State Park, which is relatively free from known contamination. These high levels may be the results of environmental contamination from post operations. Alternatively, these levels may result from the past or current use of lead ammunition that may have contaminated the environment where deer feed. The Maryland Department of Natural Resources allows hunting with all-lead or lead alloy bullets [MDNR 2006].

Evaluation of Potential Public Health Hazards

Hunters and their families (adults and children) may have been exposed to contaminants in game from APG. To assess exposures to contaminants which exceed CVs in deer, ATSDR calculated exposure doses based on assumptions about how much venison a person may eat on a regular basis. ATSDR assumed that adults would eat a 4 ounce venison meal once or twice a week for 30 years, and children would eat a 2 ounce venison meal once or twice a week for 6 years.[7] We recognize that some

7 These assumptions are based on studies of deer consumption and EPA values from the Exposure Factor Handbook [EPA 1997].

hunters ingest more deer than described in this section at some times of the year, this will be discussed separately. Exposures of children to lead in deer were estimated by using EPA's IEUBK for Lead in Children [EPA 2005b]. Arsenic and lead will be discussed separately.

Arsenic in Deer

The levels of arsenic found in deer liver and muscle were elevated to as high as 1,010 ppb. People who eat deer which has the maximum level of arsenic would receive a moderately high amount of arsenic. However, much of the arsenic in animal tissue is in the relatively non-toxic organic form, which is rapidly excreted from the body in urine. Because little of the arsenic in animal tissue is in the toxic inorganic form, no adverse health effects are expected to occur to because of arsenic in deer on or near APG-AA [ATSDR 2000].

Lead in Deer

Most of the levels of lead found in deer muscle were found to be at or below 518 ppb. This level should be safe for all people who eat venison in the amounts assumed for this analysis. However, a few deer were found to have elevated lead levels in meat as high as 4,590 ppb at Spesutie Island, 1,010 ppb at the impact area, and 1,600 ppb at Gunpowder Falls State Park. If a child often ate deer meat over a long period of time at the maximum level of lead, his or her blood lead level might become slightly elevated.[8] Under usual circumstances, this increase would not lead to any adverse health effects.

What Should You Know About Lead?

Lead exposure can cause serious health effects, such as mental and physical developmental delays, especially in young children. Before discovery of these effects, lead was used in paint, gasoline, pipes, and other common household products. Lead may still be a part of hunting ammunition. You, however, can protect your children from lead by taking the following steps:

- Test you child regularly for blood lead levels. Maryland currently has laws requiring lead testing for some children.
- Properly address deteriorated or peeling lead-based paint, which is the most common cause of lead exposure. Lead paint, which was commonly used in homes until the 1970s, can deteriorate and contaminate dust and soil.
- Do not allow your children to handle lead-based ammunition.
- Completely remove lead-based ammunition from game before consumption.
- Remove clothing that may contain lead dust from work or hobby tasks (e.g., packing lead shot).

ATSDR 1999b

8 The 1995 Risk Assessment, which the Army performed using these data, concluded that lead in deer was not a problem. This assessment was based on site-specific consumption values and assumed an annual deer intake within the consumption range assumed by ATSDR. The Army's conclusion was based on the U.S. Food and Drug Administration (FDA) guidelines for shellfish, which was an appropriate method for that time. The determination for this PHA is based on EPA's IEUBK for Lead in Children, which considers accumulation of lead in blood based on site-specific conditions. This model is freely available from EPA [EPA 2005b]. The difference in evaluation methods—a comparison with shellfish guidelines versus modeling blood lead levels using site-specific information—accounts for the difference in findings.

However, should the child also be exposed to other sources of lead, the increase in blood lead levels would be cumulative, increasing the potential for adverse health effects to occur [ATSDR 1999a]. This scenario applies to children who consume meat from one or two deer with the highest lead levels. If children were to consume meat from multiple deer (assuming exposure to an average concentration of lead in deer meat), their exposures would be lower.

Contact with Munitions and Explosives of Concern (MEC)

> **Summary**
> *Munitions and Explosives have been fired or disposed of on the post for many years. The Army maintains access restrictions to minimize possible exposures. Workers and trespassers, however, might contact unexploded munitions in restricted areas of the post. Recreational users may contact unexploded munitions if they do not follow post restrictions regarding shoreline contact.*

APG-AA has been used as a testing area for ammunition and materials since its creation in 1917. As a result of over 80 years of testing, ammunition debris, UXO, and other munitions are located at former and current firing ranges, disposal areas, and target areas in the Bush River and Chesapeake Bay. Most firing ranges and disposal areas are located in areas of the post with restricted access. The Army, however, cannot guarantee that all areas of the post frequented by members of the public are free of MEC (e.g., along the shoreline or unknown disposal locations). As such, the Army has implemented investigations to further understand the extent of UXO at APG and plans to address MEC upon discovery [USAG 1996b, 2000b].

Restrictions are in place to prevent accidental contact with possible UXO. To enforce restrictions, the Army has placed buoys marking restricted waters to inform boaters about limitations. Pamphlets detailing boating restrictions are handed out at marinas and boat launches. Signs reading "DANGER, No Trespassing, Unexploded Ordnance, U.S. Army Property - Keep Out" are posted along the shorelines. The Army also operates patrol boats that police the APG waters to ensure that people are abiding by the use restrictions [USAG 2005].

Nature and Extent of Contamination

As a result of weapons testing, the Army estimated 25 years ago that 4 million rounds of UXO and 16 million projectiles of all calibers may remain in the open water impact areas around all of APG [ATHAMA 1980]. In 2000, the Army completed a random statistical sampling of APG-AA firing records. The Army reviewed 7,500 records, which reported the firing of approximately 12 million rounds of ammunition from APG-AA. Of the 12 million, over 11 million were small arms and less than 1 million were large caliber ammunition. The firing records also include information about ammunition firing and impact locations [USAG 2000b].

Areas which have been affected by unexploded ordnance and munitions are shorelines, impact areas and ranges within the restricted area of the post. In addition, munitions were disposed of in landfills on the post. Examples of disposal areas include the Bush

River Bomb Disposal Area, the Abbey Point Shoreline Piles, and the White Phosphorus Munitions Burial Area, all of which are within the restricted area of the post.

The Army continues to study the nature and extent of MEC contamination at APG. It is conducting remedial actions along study area shorelines to prevent the erosion of MEC into water bodies. Procedures for MEC discovery and removal at APG are detailed in the document *Annex S (UXO Operations) to the APG Disaster Control Plan* [USAG 1996b]. The Department of Defense (DOD) also established the Military Munitions Response Program as a national program to manage environmental, health, and safety concerns presented by UXO. APG serves as a pilot site for this program [USAEC 2008, EPA-Region III 2008b].

Evaluation of Potential Public Health Hazards

On-post workers and trespassers may contact MEC located in restricted areas of the post that were formerly used as firing ranges or MEC disposal areas. The Army continues to maintain access restrictions to minimize possible exposures to MEC. If recreational users ignore post restrictions and access the shoreline, they may contact MEC which were fired into water bodies surrounding the APG.

A single, unconfirmed incident of past harm from UXO may have occurred at APG-AA. This incident involved an on-post worker who removed a piece of UXO from APG-AA and was harmed when the UXO was hit forcefully and detonated. No reports documenting this incident have been identified. No incidents of detonation have been reported in recent memory [USAG 2001].

To prevent potential harm to current and future on-post workers or recreational users who may discover MEC, the Army has implemented access restrictions. To enforce restrictions, the Army has placed buoys marking restricted waters to inform boaters about limitations. Pamphlets detailing boating restrictions are handed out at marinas and boat launches. Signs reading "DANGER, No Trespassing, Unexploded Ordnance, U.S. Army Property - Keep Out" are posted along the shorelines. The Army also operates land and boat patrols to police APG-AA and to ensure that people are abiding by the use restrictions. Moreover, the Army is conducting ongoing investigations to better understand the possible distribution of UXO at APG-AA.

Additional Consideration – Radionuclides and Depleted Uranium

Radionuclides may be present at APG-AA from past operations, including a pulse reactor in the WBSA, a hospital, weapons laboratories, and waste disposal areas across the post. To assess possible radiation releases on a large scale, the Army conducted a radiation survey in the late 1990s. The radiation survey consisted of flying over the post and assessing surface radiation levels using radiation detection equipment. No elevated levels of radiation were detected at the surface [USAG 1999]. To assess possible radiation releases on a smaller scale, environmental samples were

analyzed for radionuclides at most of the identified potentially-contaminated sites. Radionuclides were not observed in any of the samples at levels of concern.

The pulse reactor is in the WBSA. It consists of a silo which contained a single, solid source of radiation. The silo is encircled by a large area of restricted access. The Army decommissioned the reactor. Decommissioning involved the removal of radioactive material and extensive sampling of the surrounding environment, which was completed in 2007. Final release of the site is scheduled for spring 2008 [USAG 2008]. Since access to the area is restricted, the potential for people to become exposed to radionuclides is limited. Due to security reasons, no sampling information associated with the pulse reactor is currently available to ATSDR. However, ATSDR is working with the army to gain access to this information. At that time, the site will be evaluated to determine the potential for exposure to cause adverse health effects.

Summary

Most areas with a known potential for contamination by radionuclides have been sampled, with radionuclides found at levels that were not of concern. A pulse reactor is currently being decommissioned on the post.

Depleted uranium has contaminated soils and sediments on a few firing ranges. However, workers and hunters access these areas infrequently, and so are not expected to experience adverse health effects.

Low levels of uranium were found in air downwind of a range fire, but not at levels of concern.

A related consideration is the testing of DU ordnance at APG-AA. The Army began testing DU ordnance in the 1970s in firing ranges in the Other Aberdeen Areas. Fragments of DU ordnance remain in some firing ranges. Soils in contact with these fragments can have very high concentrations of uranium, up to 12% (or 120,000 ppm) [LANL 1990]. Uranium from these fragments can slowly dissolve and move through soils and sediment.

DU is the by-product of uranium enrichment, which produces fuel for nuclear reactors and weapons. Natural uranium is a mixture of uranium isotopes, containing around 99.27% by weight of ^{238}U, and around 0.72% of ^{235}U. ^{235}U is more radioactive than ^{238}U and more valuable as nuclear fuel. The enrichment process increases the percentage of ^{235}U in enriched uranium. It also decreases the percentage of ^{235}U in DU, making DU less radioactive than natural uranium. For this reason, the toxicity of DU is governed more by its chemical properties than by its radioactive properties.

People living near APG-AA may only be intermittently exposed to DU when range fires occur. At APG-AA, studies were conducted to assess the potential for airborne DU contamination from these range fires. A computational model predicted that DU would not be released in concentrations high enough to impact human health [ANL 1998]. In addition, air samples taken downwind from range fires were analyzed for uranium (Table 13). Uranium was found at low concentrations downwind of a fire at a range where DU ammunition had been used. No uranium was found in air samples taken downwind of fires at ranges where DU had not been used. The observed concentrations of uranium in the air samples were not elevated to a level of concern. As

such, no adverse health effects are expected to occur from exposure to DU through inhaling smoke from range fires.

On-post workers and hunters may be exposed to DU-contaminated sediments and surface soils on or immediately adjacent to firing range where DU was used. On-post workers occasionally access these ranges. Hunters have access to a few of these areas. However, the exposures to workers and hunters are expected to occur rarely, and only for short periods of time, so that adverse health effects are not likely.

Summary of Exposure Pathways and Public Health Implications

Although APG-AA is highly contaminated in some areas, the potential for people to be exposed to this contamination is decreased by access restrictions to the most contaminated portion of the post, and restrictions on contact with affected shorelines. However, there are a few ways in which people are or could be exposed to contamination or unexploded munitions. These are detailed below, and listed in Table 18.

Contamination from the post is found in public supply wells for both Harford County and the City of Aberdeen. Concentrations in water entering the distribution system were not high enough to cause adverse health effects. However, this is a result of the continuing monitoring, treatment, and blending instituted by the public water supplies and the Army.

Lead in sediment at the Old Dump on Swan Creek is present in concentrations that could potentially cause acute changes in blood chemistry in older children who might trespass in the area through the unfenced side. Exposures would also contribute to a child's cumulative blood lead level. Exposures are expected to be infrequent, however, because the unfenced area is only accessible by boat or wading through the creek. Further, the Army is currently preparing a ROD that outlines remedial actions for this site.

Localized contamination of sediment with copper and lead and surface soils with lead might cause gastro-intestinal discomfort as a result of copper exposure and reversible changes in blood chemistry as a result of lead exposure to workers, hunters, or trespassers who remain in a contaminated area for an extended period of time. Workers, hunters, and trespassers, however, would likely only access these areas infrequently and completed and ongoing remediation activities are expected to minimize or eliminate exposures.

Representative range fires were found to contaminate the air to some extent, but not to levels of concern.

Although some site contaminants were observed in fish, no adverse health effects are expected to occur to people who follow the MDE recommendations on consumption of fish caught in the area.

Lead was found in venison and deer liver harvested on the post, as well as from a background location. The source of the lead is unclear. Adverse health effects are not expected to occur.

Unexploded munitions continue to be a major concern regarding public health safety. Workers, trespassers, and recreational users who do not follow access restrictions could contact munitions and explosives of concern.

Table 18: Summary of known potential public health hazards at APG-AA

Exposed Population	Groundwater Ingestion	Surface Water and/or Sediment Ingestion	Surface Soil Ingestion	Air Inhalation	Food Chain	Munitions and Explosives of Concern (MEC)
On-Post Workers		◉	◉	○		■
On-Post Residents		◉	○	○		
Off-Post Residents	○			○		
Recreational Users		○	○	○		■
Hunters & Trappers		◉	○	○	◉	
Fishers & Crabbers		○		○	○	
Trespassers		◉	◉	○		■

○ No adverse health effects are expected to occur as a result of exposure
◉ Minor, reversible adverse health effects could occur as a result of exposure
● Adverse health effects could occur as a result of exposure
■ Physical Hazard

Health Outcome Data Evaluation

Health outcome data, which come from sources such as state tumor registry databases, birth defects databases, vital statistics records, or other records, may provide information about the general health of the community living near a site. Other more specific records, such as hospital and medical records and records from site-specific health studies, may be used to evaluate the prevalence of diseases in the community. Evaluation of health outcome data can confirm the presence of excess disease or illness in a community. However, evaluations are not meant to establish a cause and effect between a substance and a disease. Elevated rates of a particular disease are not necessarily associated with hazardous substances in the environment.

When exposures that may lead to harm are identified, ATSDR reviews appropriate health outcome data to assist in identifying appropriate measures to further evaluate potential public health impacts and to identify actions to ensure the protection of public health. After a review of potential exposure scenarios, environmental data, and toxicity

data, ATSDR determined that a review of health outcome data at APG-AA was not necessary at this time.

No health studies have been conducted for the populations living near APG-AA. The Harford Board of Health uses the Maryland Cancer Registry and the Directory of Vital Statistics as sources of health outcome data. No disease or cancer clusters have been noted near APG that would prompt a health study, although a targeted study of APG has not been conducted [HCHD 2001b]. Cancer registries and vital statistics databases usually report data for population units, such as counties. If exposures to hazardous substances in the environment occur, generally, all residents within the county are not affected. Instead, the people exposed would be a smaller, localized group. Any evidence of excess illness in that smaller group may be hidden within the rates of illness for the larger group. As such, the amount of information that can be obtained from these health outcome data pertinent to illness caused by environmental contaminants is limited.

Child Health Considerations

ATSDR recognizes that infants and children may be more sensitive to exposures than adults in communities with contamination in water, soil, air, or food. This sensitivity is a result of a number of factors. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. Children are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, resulting in higher doses of chemical exposure per unit of body weight (e.g., per pound). The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

ATSDR has attempted to identify populations of children in the vicinity of APG-AA. Four elementary schools, one middle school, and one high school are located in the communities north of APG-AA (HCG 2000). Approximately 1,700 children 6 years of age or younger are estimated to live within one mile of APG [Census 2001].

Like other people living or working at or in the vicinity of APG-AA, children may contact contaminated site media, as discussed in the Evaluation of Environmental Contamination and Potential Exposure Pathways section of this PHA. ATSDR considered that the populations identified and assessed at APG-AA, including on-post residents, off-post residents, recreational users, and hunters and fishers, would include children as well as adults. As such the evaluations of the following exposure pathways considered exposures to children:

- Ingestion of contaminated groundwater
- Contact with surface water and sediment contamination
- Contact with surface soil contamination

- Inhalation of air emissions from range fires
- Ingestion of contaminants in the food chain (aquatic animals and deer)
- Contact with MEC

Using available information about potentially exposed children, site and area use, access restrictions, sampling data, and remedial actions, ATSDR evaluated to what extent, if any, children were exposed to contaminants in groundwater, surface water and sediment, surface soil, air, and the food chain, as well as MEC.

Community Involvement and Health Concerns

As part of the PHA process, ATSDR staff met with community members to gather information about their concerns regarding APG-AA and its potential health impacts. Community health concerns at APG-AA, were identified through several activities. ATSDR staff attended meetings of the APG RAB, which is comprised of several representatives of community organizations. Discussions with RAB members were extremely helpful in identifying concerns. The minutes of RAB meetings continue to aid in identifying concerns. Other community members were given opportunities to voice their concerns at public availability sessions. An additional source is the comments to the PHA for APG-AA, which was released in 1993. As a result, ATSDR identified the following community concerns.

Community members were concerned that limited data were available for drawing conclusions about potential public health hazards.

In conducting a PHA, ATSDR identifies possible site-specific exposures to environmental contaminants to assess health implications for the surrounding community. Because public health assessments are exposure driven, ATSDR considers whether community members contacted or could come into contact with harmful substances in the environment. Although contaminants may exist in the environment, these contaminants may only cause harm if people are exposed to them (i.e., come in contact with contaminants).

Once ATSDR establishes that exposures could occur, environmental sampling data are reviewed to determine if these exposures are likely to result in harm to community members. ATSDR determines if available sampling data were collected from areas where exposures could occur and if available data are sufficient to draw public health conclusions as part of the data review. No one approach is available for assessing data because of the vast number of available data collection techniques and unique site conditions. As such, ATSDR considers site-specific conditions to determine if data are sufficient to draw public health conclusions.

In 1993, when the PHA for APG-AA was first released for public comment, the available information did not indicate that exposure to contamination at APG-AA would cause adverse health effects. However, much information was still lacking. The environmental

contamination had not been well characterized due to the size and complexity of APG. As a result, ATSDR could not determine whether environmental contamination at APG was a public health hazard.

Since 1993, the Army and others (e.g., EPA and MDE) have conducted extensive investigations at APG and volumes of additional environmental data have been generated. In updating the PHA for APG-AA, ATSDR identified potential exposures and reviewed available environmental data characterizing those exposures. For each potential exposure pathway, ATSDR determined that available data were sufficient to draw public health conclusions. The Evaluation of Potential Exposure Pathways section of this PHA summarizes the data reviewed and evaluated for each of the potential exposures identified at APG-AA.

In reviewing this PHA, you should be aware that site characterization and remediation at NPL sites may continue for years after releases have first been suspected. Likewise, remediation may occur before, during, or after ATSDR's involvement begins. Sometimes, additional data are generated after remediation and after the PHA has been released to the public. As such, the PHA should not be considered a single fixed document, but should be viewed as an evolving document that reflects the dynamic process of collection and evaluation of new information. Therefore, if new data are collected or additional information is compiled that suggests the public health may be adversely affected, ATSDR will modify or add to the PHA to reflect the public health implications of the additional data and recommend actions to stop or reduce exposures.

Community members are concerned about whether rates of illness, specifically cancer, are elevated in communities surrounding APG-AA. They questioned whether exposure to contaminants from APG-AA may be the cause. Community members requested that ATSDR conduct health studies in the neighborhoods surrounding APG-AA.

ATSDR is aware of the concerns about possible illnesses and cancers resulting from exposures to chemicals used and released at APG. Before recommending health studies, however, ATSDR first considers available information about potential exposures and data regarding chemical toxicity. If exposure and chemical toxicity data indicate potential harm, ATSDR then reviews existing health outcome data to further understand possible health effects. A health study may be recommended if the health outcome data provide evidence of elevated illness or cancer rates or otherwise indicate that public health effects may be occurring.

At APG-AA, ATSDR identified and evaluated potential exposures and chemical toxicity. ATSDR then evaluated whether these exposures were frequent enough or chemical concentrations were high enough to possibly affect public health. Potential health effects associated with contamination at APG-AA include:

- Potential acute changes in blood chemistry in older children who might trespass in the Old Dump at Swan Creek;

- Temporary changes in blood chemistry and gastrointestinal discomfort in workers, hunters, and trespassers who access certain areas with elevated lead and copper in surface soil or sediment; and
- Hazards from unexploded munitions to workers, trespassers, and recreational users who do not follow post access restrictions.

These health effects could only occur in a very small subset of the population. They may more efficiently be addressed through access restrictions and additional environmental studies, rather than through a health study. In addition, the conclusions regarding potential health effects associated with copper and lead are based on data collected prior to 2003, which was the data set available to ATSDR during the PHA process. The localized nature of the soil contamination and the infrequent access to contaminated areas minimize potential exposures to elevated copper and lead concentrations in sediment and surface soil. Ongoing as of 2003 and completed remediation activities minimize or eliminate these potential exposures.

What are the potential health impacts to workers from exposures to environmental contamination at APG-AA?

The health of workers in the workplace is protected under the Occupational Safety and Health Act, which Congress passed in 1970. This act requires that employers provide "employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees" (section 5(a)(1)). As required, the Army and tenants at APG-AA follow OSHA standards and guidelines to protect their worker population.

However, in addition to potential workplace exposures, workers may also contact contamination or UXO that has been released to the environment. Contact with copper in sediment and lead in sediment and surface soil in certain areas of the post may lead workers to experience gastric distress or temporary changes in blood chemistry. These effects end soon after the exposure ends. In addition, there is a hazard from UXO. The potential for experiencing these effects can be greatly diminished by avoiding the affected areas whenever possible, and using appropriate caution and protective equipment and/or procedures when it is necessary to access these areas.

Community members asked if the Superpond construction would impact human health.

The Superpond is a man-made pond located along the Bush River in the southern portion of the Aberdeen Peninsula. This pond is approximately 1000 feet long, 900 feet wide, and 150 feet deep. Construction of the pond was completed in June 1995. The Army Test Center (ATC) uses this pond primarily to conduct shock testing on naval vessels. Before construction of the Superpond, shock testing was conducted in the Chesapeake Bay or off the coast of Key West, Florida. Testing in open waters affected aquatic life and resulted in several fish kills in the Chesapeake Bay. The Army, therefore, constructed the Superpond to minimize impacts to aquatic and marine life.

During shock testing, explosives to a maximum strength of 3,500 pounds TNT equivalent are detonated to study the impact of these charges on naval vessels. (The strength or power of an explosive is expressed in terms of the strength or power of TNT to enable comparison of the different explosives and their effects.)

ATC has implemented measures to track possible releases to groundwater and surface water because explosives can be released in the Superpond during testing. At a depth of 150 feet, the Superpond intersects the top two groundwater aquifers (the surficial aquifer and the upper aquifer). At its maximum depth, the Superpond is still 10 feet above the lower confining aquifer, which is the aquifer used to supply drinking water. Maintaining the integrity of the lower confining aquifer is a priority for ATC. Before conducting testing, therefore, ATC conducts calculations and modeling to ensure that the proposed test will not result in a break through to the lower confining aquifer. In addition, a ring of monitoring wells encompasses the pond to ensure that explosives are not released to these aquifers. Samples are collected from the monitoring wells every 6 months and analyzed for EPA priority pollutants and explosives. Contaminants have been detected in these wells sporadically at levels below concern. The Superpond has no direct outlet to the Bush River or other surface water bodies to prevent possible releases to surface water. If the pond needs to be drained, water from the pond is pumped to four dewatering ponds, which then discharge to the Bush River under a National Pollutant Discharge Elimination System (NPDES) permit [ATC 2002].

Based on a review of this information, ATSDR determined that potential releases of explosives during use of the Superpond are not expected to adversely affect the public health, as long as the Army keeps measures in place to monitor and prevent impacts to groundwater and surface water.

Conclusions

1. In response to ATSDR's 1993 public-comment PHA, the Army fenced the Old Dump on Swan Creek to prevent contact by children. Although the fencing protects young children, the most vulnerable population, from accessing the area, it may not prevent access by older children. Older children who might trespass in the area through the unfenced side could experience acute changes in blood chemistry from exposure to lead in sediment at the Old Dump on Swan Creek. Exposures would also contribute to a child's cumulative blood lead level. This exposure rarely occurs because the unfenced side is along Swan Creek and only accessible by boat or wading through the creek. In addition, the Army is currently preparing a ROD that outlines remedial actions, which are scheduled for late 2008 and 2009. This remediation is expected to eliminate exposures.

2. High lead levels were found in a few of the many samples of deer meat and liver. The source of these levels is unknown, and may include many sources throughout the area. Regardless of the source, the level of lead in the meat and liver of some deer could contribute to any existing lead exposure to children.

3. Off-post residents are not expected to experience adverse health effects as a result of ingesting contaminated groundwater from drinking water wells. This is because of the timely interventions of the Harford County and City of Aberdeen governments, the Army, the EPA, and members of the community. Past exposure to contaminants was not at levels that would cause illness. The Army currently conducts semi-annual sampling of monitoring wells and quarterly inspections under the Source Water Protection Plan, which serves to protect on-post recharge areas for drinking water wells. Continued vigilance by these parties will ensure that no health effects occur because of groundwater contamination.

4. Unexploded munitions present a physical hazard in areas throughout the post. As such, on-post workers, hunters, and trespassers may contact unexploded munitions. However, only a single incident of past harm has been reported at APG-AA. To minimize or prevent potential current and future harm, the Army has implemented access and use restrictions, as well as posted buoys and signs and distributed educational materials to notify people about areas potentially containing unexploded munitions. The Army also operates land and boat patrols to police APG-AA to ensure that people are abiding by the use restrictions. Army guidelines for addressing unexploded munitions discovered at APG-AA are in place to further minimize the potential for harm. No apparent public health hazard exists due to unexploded munitions, as long as the Army continues its vigilance in maintaining access restrictions and public education.

5. Localized contamination of sediment with copper and lead, and surface soil with lead, might cause minor, temporary adverse health effects to workers, hunters, or trespassers who remain in the area for an extended period of time. However, the likelihood of this happening is small because people access these areas only infrequently. In addition, the Army has continued to investigate and remediate contamination found throughout the post. Most notably, RODs have been issued or are pending to address contamination found at the Old Dump on Swan Creek, the Old Chemical Dump on Spesutie Island, and the Known Distance Range. For these reasons, this potential pathway presents no apparent public health hazard.

6. People who follow MDE guidelines on fish consumption are not expected to experience adverse health effects from eating fish caught in permissible areas at APG-AA. Although no fish were sampled for perchlorate, and the bioaccumulation potential for perchlorate remains a question, the potential for contamination by perchlorate remains low. For these reasons, the consumption of fish from permissible areas of APG-AA presents no apparent public health hazard. However, crabs and turtles are harvested on or near the post, and have not been sampled for site-related contamination.

7. Observed levels of air contamination downwind of range fires were not at levels of concern. For this reason, air contamination by accidental range fires is not

expected to cause adverse health effects, and so presents no apparent public health hazard.

Recommendations

ATSDR recommends that the following actions be taken to ensure the protection of public health at APG-AA and in surrounding communities.

1. The Army is currently preparing a ROD for the Old Dump on Swan Creek. This ROD outlines remedial actions that are scheduled for late 2008 and 2009. This remediation is expected to eliminate exposures. In the meantime, the Army should continue efforts to prevent trespassing and possible exposures.

2. Additional studies of contaminants, specifically lead, in deer harvested from the post by hunters should be conducted. These studies should gather information about trends in lead levels in deer muscle and liver samples. To prevent elevation in blood lead levels, hunters should limit the amount of venison from deer harvested throughout the area served to children until additional information about deer contamination and lead levels is obtained.

3. The Army and ATSDR should continue to work together to evaluate appropriate environmental sampling information regarding the pulse reactor.

4. The Army should continue to maintain access restrictions and educational efforts to advise and protect members of the public and the on-post community from unexploded munitions.

5. Until completion of remediation activities outlined in existing or pending RODs, workers who access areas with contaminated sediment or surface soil should be made aware of the status of the area, and should use appropriate protective equipment or procedures when working in the area. These areas include the Known Distance Range, the Old Dump on Swan Creek, and the Old Chemical Dump on Spesutie Island. Signs or access restrictions in these areas could also deter hunters and trespassers from entering them.

6. The Army should sample crabs and turtles, which are harvested on or near the post, for site-related contamination.

7. The Army should continue efforts to decrease the potential for range fires, and to improve firefighting capabilities to extinguish range fires quickly and safely.

Public Health Actions

The Public Health Action Plan (PHAP) for APG-AA contains a description of actions taken and those to be taken by ATSDR and the Army subsequent to the completion of

this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment.

In the 1993 PHA, ATSDR recommended that the Army conduct additional sampling to further characterize contamination, conduct a private well survey, restrict access to the Old Dump on Swan Creek, install access controls to minimize contact with UXO, and obtain information about fish and game. The actions completed or underway to address these recommendations, as well as additional measures completed and ongoing or planned are listed below.

Completed Actions

1. The Army has conducted investigations and remedial activities throughout the post. Remedial activities have included, but were not limited to, installing a leachate collection system at Michaelsville Landfill; removing underground storage tanks (USTs), debris, drums, and contaminated soil at various locations in the Other Aberdeen Areas; excavating and removing contaminated soil and water at the AFTA; and cleaning contaminated surface material along APG shorelines.

2. In 1993, the Army installed a treatment plant to remove TCE and other VOCs from the HCP wells before water entered the distribution system. Since then the treatment facilities have been expanded. The Army also works closely with the RAB and the governments of Harford County and the city of Aberdeen to identify and monitor new and existing threats to public water supplies from groundwater contamination emanating from the post.

3. In 1994, the Harford County Health Department conducted a private well survey. Active potable-water wells were found in the Forest Green neighborhood. These wells were sampled by the Harford Board of Health in 1993.

4. In 1993, the Army installed a fence on three sides around the Old Dump on Swan Creek to protect young children from access to the area. The Army also sampled soils in the nearby playground.

5. Surface soil, sediment, and seep samples have been collected at the Old Dump at Swan Creek to characterize potential contamination. In 1996, the Army conducted additional remedial activities, including removing potentially contaminated debris at the surface and covering the area with crushed rock and geotextile fabric to prevent erosion and migration of site contaminants.

6. The Army has conducted two studies assessing possible exposures to contaminants released to the air during range fires. A study modeling possible releases was completed in 1998. In 2001, the Army reported the results of a

study in which air samples were collected during a series of controlled burns designed to simulate worst-case scenario range fires.

7. To minimize possible contact with UXO, the Army installed large signs reading "DANGER, No Trespassing, Unexploded Ordnance, U.S. Army Property - Keep Out" along the shorelines of APG.

8. The Army completed studies of fish and deer consumption and contamination, and a study of snapping turtle consumption.

Ongoing and Planned Actions

9. The Army is continuing investigations throughout APG to identify and remediate sources of contamination.

10. The governments of Harford County and the City of Aberdeen, the Army, the EPA, and members of the community continue their cooperative efforts regarding the safety of drinking water supplies. These activities include regular monitoring, treatment, and blending of groundwater. Investigations to identify possible sources of groundwater contamination should continue. Sources, if identified, should be remediated by the Army as necessary.

11. The Army conducts ongoing operations and maintenance activities for selected remedial actions (e.g., a leachate collection system at Michaelsville Landfill) and continues regular monitoring as required by agreements with the EPA (e.g., groundwater monitoring associated with the HCP wells).

12. Community education and involvement activities are ongoing. The Army participates in regular meetings of their RAB to provide community members with information about ongoing activities at APG. Information is also distributed through information repositories, mailings, press releases to the media, community meetings outside the RAB, site tours, and the APG web site. The community is provided with opportunities to comment on proposed cleanup plans during public comment periods.

13. The Army continues to maintain access restrictions and educational efforts to advise and protect members of the public and the on-post community from unexploded munitions. The Army also distributes educational materials informing boaters and users of APG waters about access restrictions. Land and water patrols are operated to minimize possible trespassing in areas with UXO.

14. Environmental data is being gathered by the Army to assess the area of the pulse reactor on APG-AA. ATSDR and the Army are working together to provide ATSDR with appropriate security access to the environmental information from the area near the pulse reactor for review from a public health perspective.

15. The Army follows ordnance testing and firing restrictions designed to minimize off-post migration of smoke from testing or range fires ignited during testing activities. In addition, firefighting protocols are in place to ensure that range fires are extinguished as quickly as possible without compromising the safety of APG personnel.

16. The Army continues its efforts to decrease the potential for range fires, and to improve firefighting capabilities to extinguish range fires quickly and safely.

17. The Army is conducting ongoing studies to understand distribution of UXO at APG-AA. As these studies continue, the Army conducts remedial activities to remove UXO located throughout the post. Removals are conducted in accordance with *Annex S (UXO Operations) to the APG Disaster Control Plan*, which outlines guidelines and protocols to follow to minimize potential harm to APG personnel. Ongoing UXO removal also occurs under the DOD Military Munitions Response Program. Most areas of APG evaluated under the site investigation phase of the program are being carried into the remedial investigation phase.

18. The Army plans to sample tissue from deer harvested on APG. The sampled tissue will be taken from portions of the carcass which are not near any bullet wounds. Tissues will be analyzed for lead contamination.

19. The Army will remediate contaminated soils at the Old Dump on Swan Creek. In the interim, the Army will continue efforts to prevent trespassing and possible exposures.

20. The Army will sample crabs and turtles harvested on or near APG-AA.

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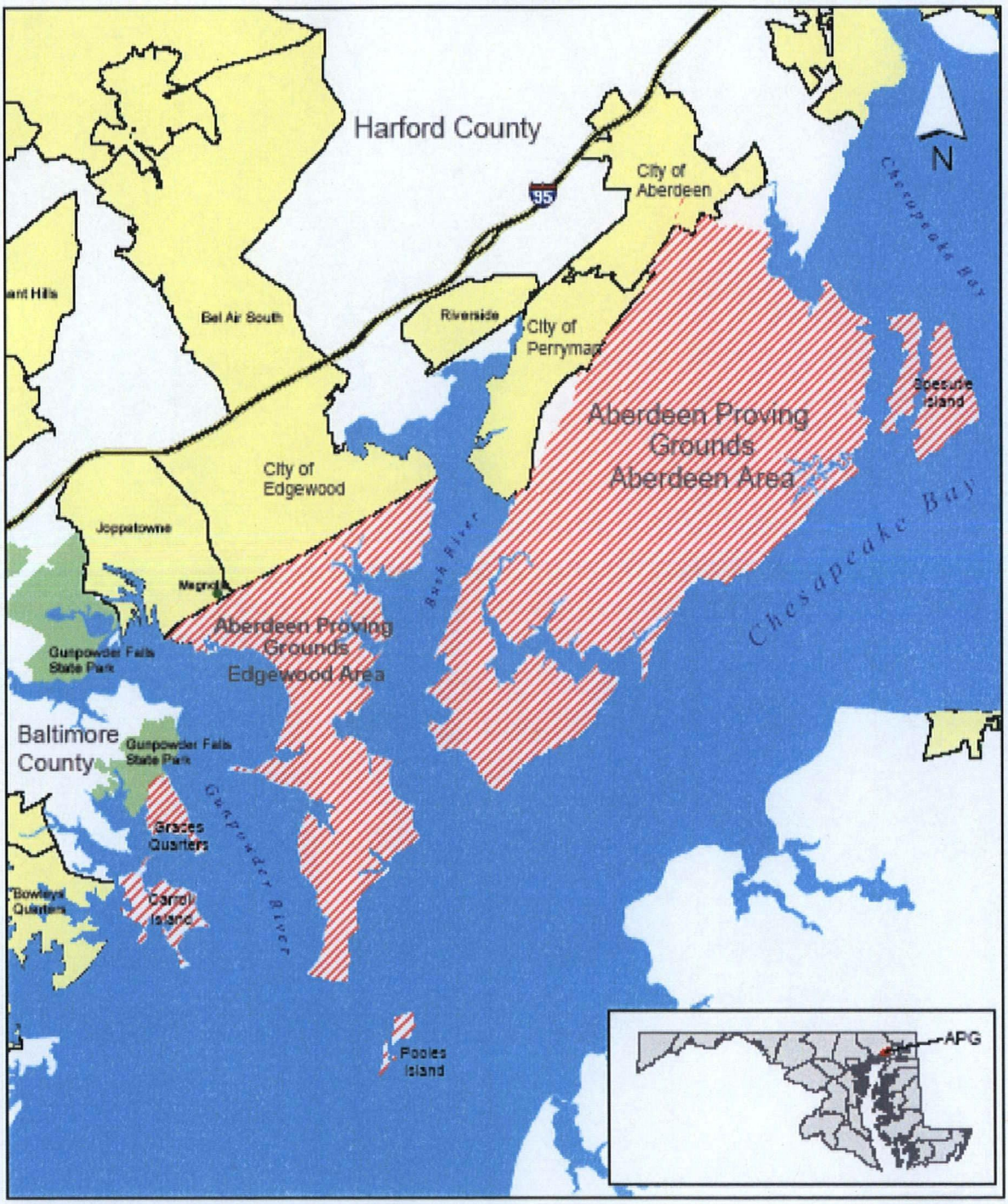
Figures

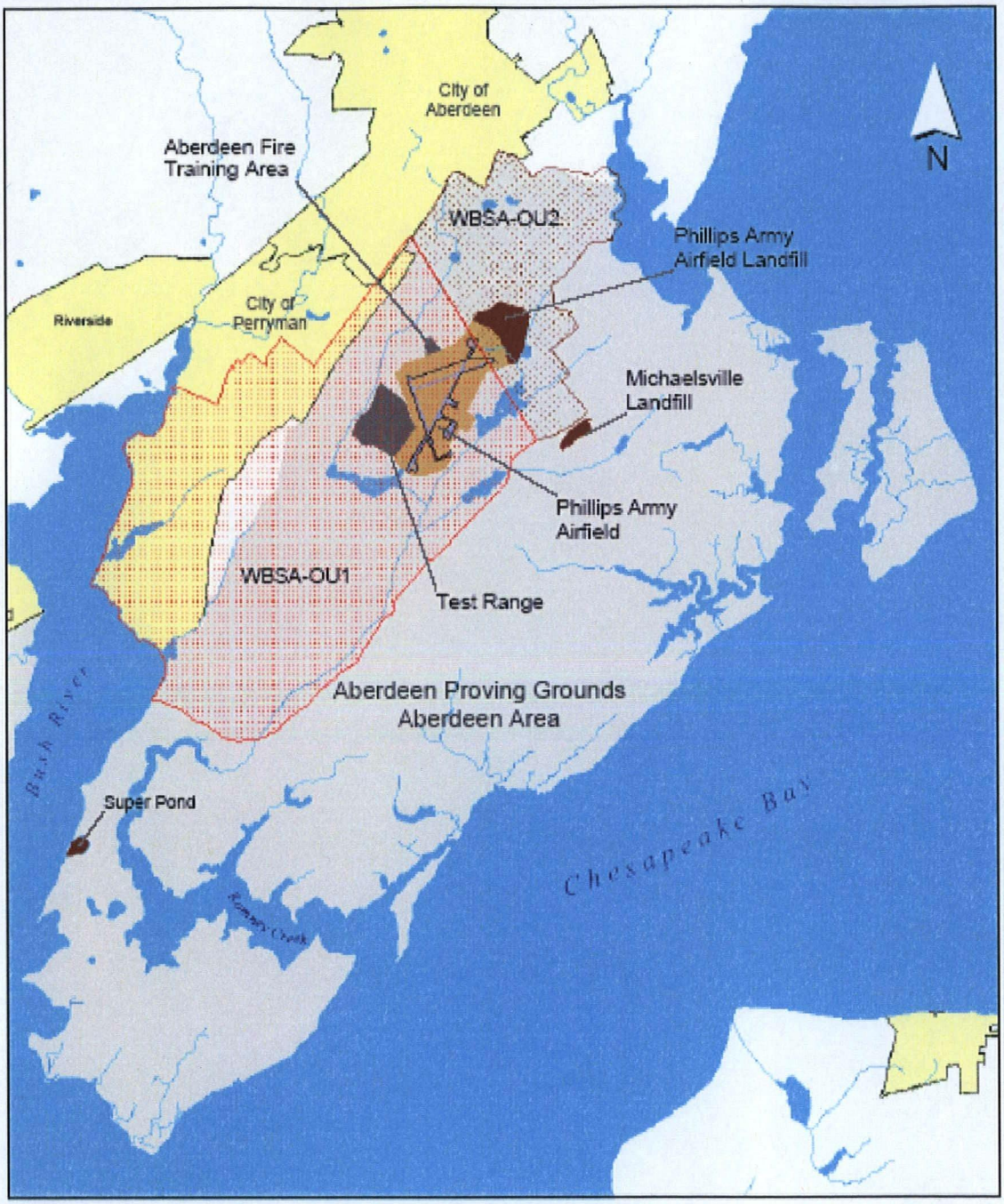


Aberdeen Proving Grounds and Surrounding Area

Hanford County, Maryland

Miles
0 1.25 2.5 5

Figure 1



Aberdeen Area

Aberdeen Proving Grounds

Harford County, Maryland

0 0.5 1 2 3 Miles

Figure 2

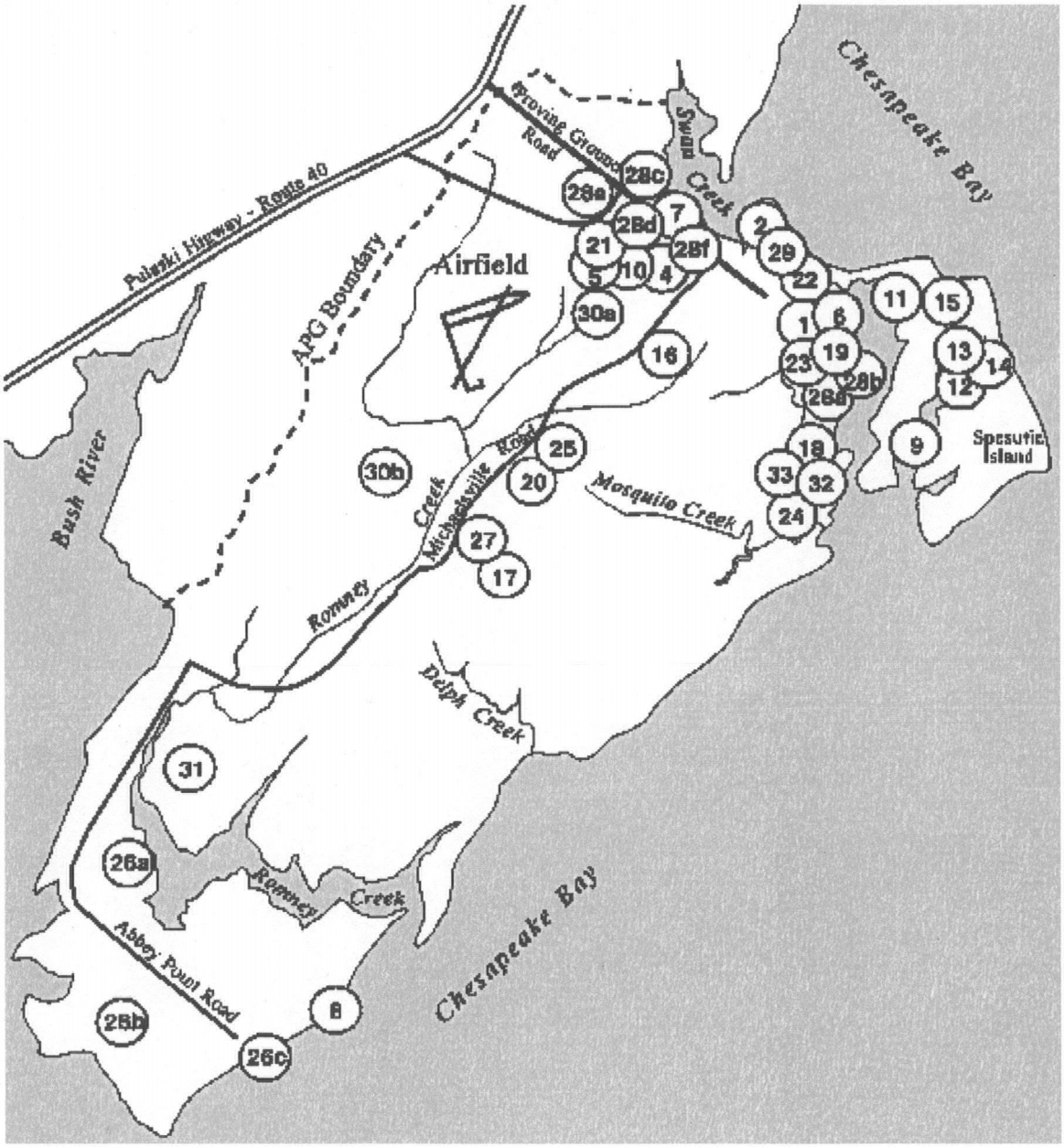
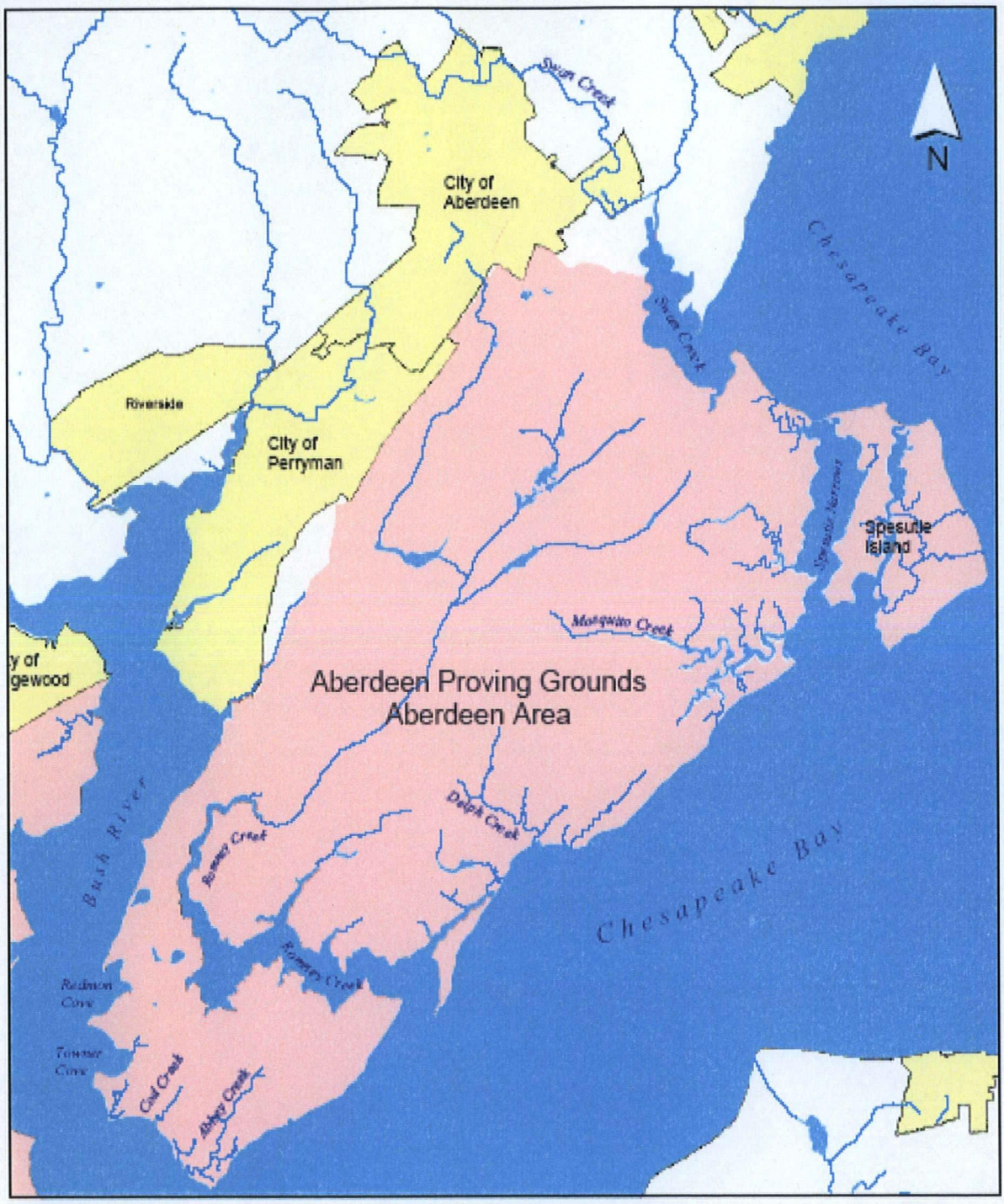


Figure 3 – Other Aberdeen Areas. Key to site names is on the following page [Adapted from USAG 2003].

Figure 3 (continued): Key to Site Names

Category	Site No.	Site Name
Dump Areas	1	Old Dump on Woodrest Creek
	2	Old Dump on Swan Creek
	3	Churchville Test Course Dump
Pesticide-Related Areas	4	Outdoor Pesticide Mixing Area at Building 5010
	5	DPW Backyard Storage Area near Building 5262
	6	DDT Spill near Building 450
Battery Storage/Disposal Areas	7	Spent Lead Acid Battery Storage Site near Building 2351
	8	Discarded Batteries at Abbey Point Navigation Light
	9	Discarded Batteries at Spesutie Island Navigation Light
	10	Building 5039 Battery shop
Spesutie Island Areas	11	Old Burn Trench on Spesutie Island
	12	Old Chemical Dump on Spesutie Island
	13	Chemical Dump Ponds on Spesutie Island
	14	Former Burning Area Near Building 1171
	15	Metal Barricade near Building 1122
Miscellaneous Areas	16	DRMO Metal Scrap Yard
	17	Silver Contaminated Ditch in Transonic Range Area
	18	Barrels near Building 510
	19	Sandblast Area near Building 523
	20	Potential Explosives in Groundwater Area
	21	POL Facility Sand Pit near Building 5215
	22	Buildings 309 and 390 Storm Sewer Outfalls
	23	Building 525 Site
	24	White Phosphorus Munitions Land Burial Site
	25	Shell Washout Wastewater Ditch at Building 700B
	26a	Old Bombing Field OB/OD Area
	26b	New Bombing Field OB/OD Area
	26c	Abbey Point Suspected OB/OD Area
	27	German Ammunition Train Explosion Area
	28a	Building 436 UST Site
	28b	Building 456 UST Site
	28c	Building 2458 UST Site
	28d	Building 3329 UST Site
	28e	Building 3505 UST Site
	28f	Building 3327 UST Site
	29	Tower Road Site
	30a	Pistol Range
	30b	Known Distance Range
	31	Poverty Island Potential Mine Burial Site
	32	Building 507 Site
	33	Building M600 Site



Aberdeen Area Water Bodies

Figure 4

Aberdeen Proving Grounds

Harford County, Maryland

0 0.5 1 2 3 Miles

Appendix – Comparison Values

For this public health assessment, ATSDR selected contaminants for further evaluation by comparing the maximum environmental contaminant concentrations against conservative health-based comparison values. Comparison values are developed by ATSDR from available scientific literature concerning exposure and health effects. Comparison values are derived for each environmental medium (such as air, soil, water, and fish), and reflect an estimated contaminant concentration that is not expected to cause harmful health effects. This is based upon assumptions regarding exposure, body weight, and bioaccumulation (if appropriate). Because the concentrations reflected in comparison values are much lower than those that have been observed to cause adverse health effects, comparison values are considered to be protective of public health. As a result, contaminants detected at or below ATSDR's comparison values are not considered for further evaluation.

While concentrations at or below the relevant comparison value can reasonably be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. Comparison values are not thresholds for harmful health effects. The likelihood that adverse health effects will actually occur depends on site-specific conditions, individual lifestyle, and genetic factors that affect the route, magnitude, and duration of actual exposure. If contaminant concentrations are above comparison values, ATSDR further analyzes these exposure variables, along with relevant toxicological and epidemiological studies to determine whether adverse health effects might occur.

Comparison values can be generated for several different types of exposure, and for different media. Each different type of comparison value which was used in this PHA is discussed in detail below.

Ingestion of Contaminated Media

The comparison value for exposure by drinking or eating contaminated media (such as soil, water, or fish) can be chosen from many sources, depending upon which are available. Most of these are calculated by assuming various factors about the exposure and the person being exposed. Adults are assumed to weight 70 kilograms (kg) (154 pounds). Children are assumed to weigh 10 kg (22 pounds). The amount of the medium that is eaten (the ingestion rate) varies depending upon the environmental medium. The ingestion rates used in this PHA are given in the following table:

Ingestion rates used in this PHA to generate comparison values

Medium	Children	Adults
Drinking Water	1 L/day	2 L/day
Surface Water	10 mL/day	10 mL/day
Soil and Sediment	100 mg/day	200 mg/day
Fish, Crabs, Turtles or Deer	12 g/day (represents a 2 oz meal, once or twice a week)	26 g/day (represents a 4 oz meal, once or twice a week)

g gram
L liter
mL milliliter
mg milligram
oz ounce

Following are details on the types of comparison values that were used:

CREG
If the contaminant can cause cancer, detected concentrations are compared to the Cancer Risk Evaluation Guide (CREG), which is the estimated concentration of a contaminant at which a lifetime exposure could or would potentially cause cancer in less than one person out of a million people who were exposed. The CREG is based on EPA's oral cancer slope factor, which uses uncertainty factors and assumes a hypothetical or theoretical cancer risk following low-level exposure to chemicals. EPA's oral cancer slope factors are available in EPA's IRIS database at www.epa.gov/iris. Exposure is assumed to occur every day over a 70-year lifetime. CREGs are calculated as follows:

$$CREG = \frac{(\text{Target Risk}) * (\text{Body Weight})}{(\text{Ingestion Rate}) * (\text{EPA's oral cancer slope factor})}$$

Where the upper bound target risk is 10^{-6}, and represents a risk of less than one excess cancer in a population of one million people. These values are calculated for adults, since they assume a lifetime exposure.

CREGs are usually *extremely* protective of public health. Since they are based upon a target risk that is very small (0 -10^{-6} range) they are often much smaller in value than is necessary for an effective screening tool.

EMEG, iEMEG, aEMEG, and RMEG
The EMEGs and the RMEG are calculated from values that consider only non-cancer adverse health effects. These values can be available for substances that don't cause cancer, as well as for those that do. EMEGs are calculated from ATSDR's Minimal Risk Levels (MRLs). MRLs are available for different exposure timeframes:

- chronic, lasting a year or longer;
- intermediate, lasting from two weeks to a year; and

- acute, lasting up to two weeks.

RMEGs are calculated from EPA's oral Reference Dose (RfD), which considers only the chronic exposure timeframe. RfDs are available in EPA's IRIS database.

EMEGs and RMEGs are caluculated as follows:

$$EMEG\ or\ RMEG = \frac{(MRL\ or\ RfD) * (\text{Body Weight})}{(\text{Ingestion Rate})}$$

These values can be derived for exposure to either adults or children. In the case of EMEGs, different exposure timeframes can be used.

Additional Values
A few substances do not have sufficient information to derive a CREG, EMEG, or RMEG. For these substances, a few additional sources have been used to provide screening comparison values.

- For drinking water, EPA's Maximum Contaminant Level (MCL), which can be found at www.epa.gov/safewater/mcl.html
- For soil, EPA's Soil Screening Level (SSL), which can be found at www.epa.gov/superfund/resources/soil

Ingestion of Food Living in a Contaminated Environment
For this PHA, comparison values were derived to consider whether contamination in the environment might bioaccumulate to levels of concern in the food chain. Specifically, fish and deer were considered. Each of these special environmental comparison values began with a comparison value based on the ingestion of the fish or deer (as calculated in the previous section). A value is then estimated in the environment which would cause that concentration to bioaccumulate in the fish or deer.

Effects of Sediment on Fish
To derive a sediment comparison value based on fish ingestion, EPA's Biota to Sediment Accumulation Factor (BSAF) was used. These values can be found on EPA's website [EPA 2005b]. The comparison value is calculated as follows:

$$CV_{\text{sediment}} = \left(\frac{CV_{\text{fish}}}{\text{BSAF}}\right) * \left(\frac{\text{Organic carbon fraction in sediment}}{\text{lipid fraction in fish}}\right)$$

The organic fraction in the sediment, and the lipid fraction in the fish are not always known, but are usually of the same magnitude, so this parameter was considered to be equal to 1, simplifying the equation to:

$$CV_{\text{sediment}} = \left(\frac{CV_{\text{fish}}}{\text{BSAF}}\right)$$

Effects of Surface Water on Fish
To derive a surface water comparison value based on fish ingestion, EPA's Fish Bioaccumulation Factor (BAF) was used. These values can be found on EPA's website [EPA 2005b], but are conveniently available at [ORNL 2005]. The comparison value is calculated as follows:

$$CV_{\text{surface water}} = \left(\frac{CV_{\text{fish}}}{\text{BAF}}\right)$$

Effects of Surface Water on Deer
No data are available for the bioaccumulation in deer of contamination in surface water. However, this may be estimated for beef, which is then used as an estimate for bioaccumulation in deer. The comparison value for surface water based on deer (beef) ingestion is based on EPA's Beef Transfer Coefficient (BTC), which can be found on EPA's website, but is conveniently available at [ORNL 2005]. The comparison value is calculated as follows:

$$CV_{\text{surface water}} = \frac{(CV_{\text{deer}})}{(\text{BTC}) * (\text{surface water ingestion rate})}$$

where the surface water ingestion rate for beef is 53 L/day. Although this is much higher than the surface water ingestion rate for deer, it is balanced by the fact that cattle are larger than deer.

Effects of Surface Soil on Deer
No data are available for the bioaccumulation in deer of contamination in surface soil. However, this may be estimated for beef, which is then used as an estimate for bioaccumulation in deer. The comparison value for surface soil based on deer (beef) ingestion is based on EPA's BTC and the Soil-to-Plant-Dry uptake (Bv_{dry}), also found at [EPA 2005b] and [ORNL 2005]. The comparison value is calculated as follows:

$$CV_{\text{surface soil}} = \frac{(CV_{deer})}{(BTC) * [Quantity\ of\ pasture\ ingested * (Bv_{dry} + Plant\ mass\ loading\ factor)]}$$

where the quantity of pasture ingested is 11.77 kg/day, and the plant mass loading factor is 0.25. Based on the difference in feeding habits between cattle and deer, this value may be overly protective.

Inhalation of Contaminated Air
The comparison value for exposure by inhaling contaminated air may be chosen from many different sources. Assumptions about exposure variables such as inhalation rates are built into these values. Separate values are *not* derived for children and adults.

CREG
If the contaminant can cause cancer, a CREG can be derived for inhalation in a similar manner as it was derived for ingestion. The CREG for air is based on the EPA's

Inhalation Unit Risk (IUR), which is available in EPA's IRIS database, www.epa.gov/iris. It is calculated as follows:

$$CREG = \frac{(\text{Target Risk})}{(\text{IUR})}$$

Where the upper bound target risk is 10^{-6}, and represents a risk of less than one excess cancer in a population of one million people.

CREGs are usually *extremely* protective of public health. Since they are based upon a target risk that is very small (0 -10^{-6} range) they are often much smaller in value than is necessary for an effective screening tool.

EMEGs and RfCs
Non-cancer adverse health effects are considered in ATSDR's EMEGs and EPA's Reference Concentrations (RfCs). Since each of these values is already in the form of a concentration in air, no additional calculations are necessary. ATSDR's EMEGs are available for chronic, intermediate, and acute exposure timeframes. EPA's RfCs are available only for the chronic timeframe.

Additional Values
Additional values were used in this PHA when no aEMEG was available. These values were for occupational exposures, and included the Permissible Exposure Limit (PEL) from the Occupational Safety and Health Agency, and the Recommended Exposure Limit (REL) from the National Institute of Occupational Safety and Health. These values are derived to be protective of workers exposed over the course of their working life for 8 hours (PEL) or 10 hours (REL) a day during a 40-hour work week.

Appendix B – Responses to Public Comments

The Agency for Toxic Substances and Disease Registry (ATSDR) received the following comments during the public comment period (December 19, 2007 to February 15, 2008) for the U.S. Army Aberdeen Proving Ground, Aberdeen Area (APG-AA) Public Health Assessment (PHA). For comments that questioned the validity of statements made in the public health assessment, ATSDR verified or corrected the statements. The list of comments does not include editorial comments, such as word spelling or sentence syntax.

	Comment	*How Addressed*
1	General comment: Data and site summaries in the report are old with the most recent data collected in 2002/2003. Additional studies and investigations have been conducted at these sites since the generation of this report	ATSDR revised the text throughout the PHA, as appropriate, that conclusions presented in the PHA were based on data collected prior to 2003, which was the data set available to ATSDR during the PHA process. ATSDR also added information about completed and ongoing remediation activities that would minimize or eliminate potential exposures and health effects.
2	The Known Distance Range, Old Dump on Swan Creek, and The Old Chemical Dump on Spesutie Island are in the process of remediation. A soil removal action was conducted at the Old Chemical Dump on Spesutie Island in 2007 and a removal action is scheduled for the Known Distance Range in 2008. A ROD for the Old Dump on Swan Creek is currently being prepared with the remedial action scheduled for late 2008 and 2009.	
3	Page 33: and Summary box: Note remediation, ROD with soil removal in 2008.	
4	Page 34: Same note as page 33 on Known Distance Range remediation.	
5	Recommendation 1: Additional work has been accomplished at Swan Creek.	
6	Recommendation 5: Soil removal is planned in 2008 at the Known Distance Range; a ROD is in place.	

	Comment	How Addressed
7	Public Health Assessment (PHA) Summary Section: 1) The Old Chemical Dump on Spesutie Island -A ROD [Record of Decision] was issued to remove sediments contaminated above safe levels for industrial and ecological exposure. The sediments have already been removed. EPA is waiting for a remedial action completion report from the Army. 2) The Old Dump on Swan Creek -A Feasibility Study is being finalized and a ROD to address the levels of lead contamination at the dump is planned for this year. 3) The Known Distance Range and the Pistol Range -A ROD was issued last summer for excavation and removal of soils contaminated with lead and other heavy metals. The bullets will be separated and recycled. The excavated soils will be stabilized on-site and will be sent to an offsite landfill. Land Use Controls will limit the use of this site to industrial/commercial uses. The remedial design for this project has been submitted and is under review by EPA and MDE [Maryland Department of the Environment].	
8	Swan Creek Dump: Again a ROD will be issued soon to address the site risks shortly.	
9	PHA Recommendations Section: See comments above.	
10	Reference to Figure 2: Figure 2 shows WBSA OU1 [Western Boundary Study Area Operable Unit 1] (sentence after reference) and does not show the seven wells in Perryman.	ATSDR moved the reference to Figure 2 to the following sentence mentioning WSBA OU1.
11	Table 5, as stated in the text and table title, does not just address contaminants with CVs. (2-Amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, and 2-nitrotoluene do not have CVs, yet are in the table.) An explanation or criteria for inclusion in the table should be explicit in the text. See also Tables 7, 10, 12, 13, 14, 15, 16, and 17.	ATSDR revised the table titles and the supporting text, as appropriate, to indicate that the tables include contaminants that exceed CVs, if available, as well as contaminants that lack CVs.
12	EPA also notes that the highest level in any of the City of Aberdeen production wells was less than 5 ppb perchlorate. EPA currently considers drinking water containing less that 24 ppb to be safe for consumption unless there are other sources of perchlorate in the diet. Even if the well water wasn't blended or treated, the water supplied to the public would still be far below 24 ppb.	ATSDR agrees that detected perchlorate concentrations are below levels of concern. ATSDR, however, included a discussion of exposure to perchlorate in drinking water due to public concerns about this contaminant. To emphasize the rationale for including the perchlorate discussion, ATSDR added the following text box to the "Evaluation of Potential Public Health Hazards:" Although perchlorate was detected at concentrations below CVs, ATSDR included the following detailed evaluation of perchlorate due to public concerns about this contaminant.

	Comment	How Addressed
13	Page 21: Surface water and sediment samples for perchlorate analysis have been collected in the drainage area of OU2, adjacent to areas of perchlorate detected in soil and groundwater. Perchlorate was not detected.	ATSDR added the following text to the paragraph: Perchlorate has been found in soil (but not surface water or sediment) collected from drainage areas adjacent to locations with perchlorate in groundwater [USAG 2008].
14	Page 27: The fences around the Old Dump at Swan Creek have been extended into the water on the northern side of the site, and extended to the south of the site, to connect with existing fencing around the Building 120 facility to the south.	ATSDR added the following text to the paragraph: This fence extends north into Swan Creek and south to connect with a fence associated with the Building 120 facility [USAG 2008].
15	Page 38: The Army continues efforts to minimize range fires.	ATSDR added the following text to the paragraph: In addition, the Army continues to implement procedures that minimize range fires.
16	Page 43: Snapping turtle studies were also conducted by CHPPM around the same time. We are having trouble finding them since they do not appear to be in the APG overall portion of the administrative record. From memory, the snapping turtles were collected from the Edgewood Area, and thus results may not apply to the ATSDR report.	ATSDR added the following text to the paragraph: The PHA for APG-EA, however, includes an assessment of potential health hazards resulting from ingestion of crab and snapping turtle collected from areas within APG-EA. For the APG-EA PHA, ATSDR evaluated snapping turtle data provided in the following reference: [AEHA 1994] U.S. Army Environmental Hygiene Agency. 1994. Draft, Aberdeen Proving Ground Snapping Turtle Consumption Health Risk Assessment. Project Number: 39-26-L173-91.

	Comment	How Addressed
17	Page 46-48: To the best of our knowledge, the 1995 deer data are the most current data that are available. In 1995, CHPPM conducted a risk assessment of deer meat and found no risks from lead. The ATSDR report reviews the same data, and findings show that a few of the maximum concentrations are of potential concern. The following must be considered: • As footnoted in the report, the CHPPM study used a different method to evaluate risks; this was the most current version available in 1995. Since then, the EPA has generated new lead models that consider accumulation in the blood. This accounts for the difference in findings. • The ATSDR report singles out the maximum concentrations of lead as a concern; most samples had concentrations below their benchmarks. If it is assumed that a hunter brought home multiple deer, the mean concentration consumed would most likely be less than the maximum. The ATSDR scenario applies best where someone consumes only one or two deer that happen to have the maximum concentrations of lead.	ATSDR added the following to the evaluation of potential public health hazards from lead in deer: This scenario applies to children who consume meat from one or two deer with the highest lead levels. If children were to consume meat from multiple deer (assuming exposure to an average concentration of lead in deer meat), their exposures would be lower. ATSDR added the following text to the footnote: The determination for this PHA is based on EPA's IEUBK for Lead in Children, which considers accumulation of lead in blood based on site-specific conditions. This model is freely available from EPA [EPA 2005b]. The difference in evaluation methods—a comparison with shellfish guidelines versus modeling blood lead levels using site-specific information—accounts for the difference in findings.
18	Page 48, Paragraph 1 under "Nature and Extent of Contamination," Line 3: APG should be APG-AA. Note this sampling did not include Edgewood Area	ATSDR modified the text as follows: In 2000, the Army completed a random statistical sampling of APG-AA firing records. The Army reviewed 7,500 records, which reported the firing of approximately 12 million rounds of ammunition from APG-AA.
19	Page 49: Access restrictions continue to be maintained to protect the public from unexploded munitions.	ATSDR added text to the summary text box and the "Evaluation of Potential Public Health Hazards" section to highlight the Army's ongoing access restrictions.
20	Page 50: The Pulse Reactor (APRF) has been decommissioned with final turnover of the facility scheduled for Spring 2008. Extensive 2007 sampling has been conducted as part of decommissioning the reactor facility.	ATSDR modified the text as follows: The Army decommissioned the reactor. Decommissioning involved the removal of radioactive material and extensive sampling of the surrounding environment, which was completed in 2007. Final release of the site is scheduled for Spring 2008 [USAG 2008].
21	Page 55: Source Water Protection Plan (APG Regulation #200-07, Jan 2007) is in place and protections on-post recharge areas for the City of Aberdeen and Harford County well fields. Semi-annual sampling of monitoring wells and quarterly inspections occur.	ATSDR added the following text to the "Ingestion of Contaminated Groundwater" and the "Conclusions" sections: The Army currently conducts semi-annual sampling of monitoring wells and quarterly inspections under the Source Water Protection Plan, which serves to protect on-post recharge areas for drinking water wells.

	Comment	How Addressed
22	PHA Recommendations Section: EPA agrees that the fence around the Swan Creek Site is only on three sides. However, the fourth side is Swan Creek, and the fence extends into the water. Trespassers would need to wade into the creek and go around the fence, or climb the fence to gain access to the contaminated soils and sediments at the site.	Based on information regarding the fence extension and planned remediation, as provided by the Army and EPA-Region III in their comments, ATSDR replaced the recommendation with the following text: The Army is currently preparing a ROD for the Old Dump on SWAN Creek. This ROD outlines remedial actions that are scheduled for late 2008 and 2009. This remediation is expected to eliminate exposures. In the meantime, APG should continue efforts to prevent trespassing and possible exposures.
23	Recommendation 6: The Army has sampled a surface water pond for perchlorate near areas with soil and groundwater perchlorate contamination. Perchlorate was not detected.	ATSDR modified the recommendation as follows: The Army should sample crabs and turtles, which are harvested on or near the post, for site-related contamination.

Notes:
* Army comments provided by the Aberdeen Proving Ground-Directorate of Safety, Health and Environment