



Public Health Assessment for

**NAVAL AIR ENGINEERING CENTER, LAKEHURST
(a/k/a NAVAL AIR ENGINEERING STATION, LAKEHURST)
LAKEHURST, OCEAN COUNTY, NEW JERSEY
EPA FACILITY ID: NJ7170023744
JULY 7, 2003**

**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.

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Naval Air Engineering Center, Lakehurst
(a/k/a Naval Air Engineering Station, Lakehurst)

Final Release

PUBLIC HEALTH ASSESSMENT

NAVAL AIR ENGINEERING CENTER, LAKEHURST
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LAKEHURST, OCEAN COUNTY, NEW JERSEY

EPA FACILITY ID: NJ7170023744

Prepared by:

Federal Facilities Assessment Branch
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Agency for Toxic Substances and Disease Registry

FOREWORD

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

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

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

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

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

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

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

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

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

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E60), Atlanta, GA 30333.

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List of Acronyms

AIRS	Aerometric Information Retrieval System
ATSDR	Agency for Toxic Substances and Disease Registry
BOMARC	Boeing Michigan Aeronautical Research Center
CEA	Classification Exception Area
CREG	cancer risk evaluation guide
CWM	chemical warfare materiel
DOD	US Department of Defense
EMEG	environmental media evaluation guide
EPA	US Environmental Protection Agency
°F	degrees Fahrenheit
IAS	Initial Assessment Study
IRP	Installation Restoration Program
LTA	Lighter Than Air
MCL	Maximum Contaminant Level
MRL	minimal risk level
MUA	Municipal Utilities Authority
NAAQS	National Ambient Air Quality Standard
NEHC	Navy Environmental Health Center
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
OCHD	Ocean County Health Department
NPL	National Priorities List
PCB	polychlorinated biphenyl
pCi/L	picocurie per liter
PHA	public health assessment
PM10	particulate matter having aerodynamic diameters less than or equal to 10 microns
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RMEG	reference dose media evaluation guide
TRI	Toxic Release Inventory
UXO	unexploded ordnance
US	United States
USGS	United States Geological Survey
VOC	volatile organic compound

For reference, Appendix A defines several technical terms used in this public health assessment.

Summary

Naval Air Engineering Station (NAES) Lakehurst is a 7,400-acre U.S. Navy (Navy) base located in central New Jersey's Jackson and Manchester Townships, adjacent to the Borough of Lakehurst. The base conducts research, development, and engineering activities to support the interface between aircraft and marine vessels. NAES Lakehurst's routine operations generate various wastes which are either managed on base, transferred to off-base waste facilities, or discharged according to the terms of the facility's operating permits. Some past waste disposal practices, some accidental spills, and other activities on the base released contamination directly into the environment. NAES Lakehurst has made extensive efforts to clean up or otherwise address the resulting contamination.

This public health assessment (PHA) evaluates exposure pathways and community concerns related to NAES Lakehurst's past, current, and future releases. The evaluations are intended to determine whether these releases have caused base residents, community members, or both to be exposed to unhealthy levels of environmental contamination. To prepare this PHA, the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed data from many sources. The agency also consulted with representatives from the local community, the U.S. Environmental Protection Agency (USEPA), the U.S. Geological Survey (USGS), the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Department of Health and Senior Services (NJDHSS), the Ocean County Health Department (OCHD), NAES Lakehurst, and other parties.

This assessment also discusses four health concerns communicated to ATSDR by community members, base personnel, and public officials in relation to NAES Lakehurst:

1) Drinking or contacting contaminated groundwater, either on or off base

Past operations at NAES Lakehurst have contaminated the groundwater at several locations on and near base property. This contamination has been extensively studied and is closely monitored. In the past and at this time, no one is exposed to the groundwater contamination at NAES Lakehurst—the local private and public water supplies do not pump drinking water from the contaminated areas. Also, several measures are in place to ensure that the groundwater contamination does not become a hazard in the future, including perimeter wells that would detect that contamination *before* it enters drinking water supplies. Therefore, the groundwater contamination at NAES Lakehurst did not pose a public health hazard in the past, does not currently pose a public health hazard, and is not likely to in the future.

2) Contacting unexploded ordnance (UXO) or chemical warfare materiel (CWM) while hunting, hiking, or playing on base

An unknown amount of unexploded ordnance (UXO) and chemical warfare materiel (CWM) remain on NAES Lakehurst property from past munitions testing operations and military training exercises. (The term materiel is defined as the equipment, apparatus, and supplies of a military force or other organization.) Most UXO/CWM are believed to be located in the more remote, western part of NAES Lakehurst, far from base housing. However, these areas are accessible by hunters and others, including children living on base. NAES has taken measures to prevent contact with UXO/CWM, including posting warning signs in areas believed to have the greatest amount of UXO/CWM, requiring hunters to take an annual training course about the dangers of UXO/CWM, and informing all new base personnel (civilian and military) and contractors about the specific risks these items pose. An explosive ordnance disposal team from either the Army (Fort Dix) or the Navy (Naval Weapons Station Earle) is called before digging in any areas suspected to have unexploded ordnance or chemical munitions and emergency response teams are on hand to respond to chemical releases, explosions, or fires. In addition, NAES Lakehurst has developed contingency plans and standard operating procedures for response to a release of chemicals either on base or in the community. This includes coordination with local, state, and federal agencies dealing with emergency response.

ATSDR believes that there is insufficient data to evaluate potential levels of exposure in and around the proving ground and test facilities during 1918-1921. However, there is no indication that past releases or exposures have occurred since chemical warfare testing ended in 1921. For example, there have been no reported or unexplained deaths or injuries to a wide variety of fish and wildlife, nor unexplained vegetation stress or obvious changes in the numbers and types of insects.

ATSDR recommends that NAES Lakehurst continue indefinitely administrative controls for all portions of the base that have not been otherwise cleared for safe and unlimited access and use. ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.

3) Eating deer possibly containing radiologic contamination from BOMARC

Some base personnel and base residents have expressed concern that radioactive materials might be present in deer hunted on NAES Lakehurst property. The concern is based on an explosion and fire that occurred on June 7, 1960 at the nearby BOMARC (Boeing Michigan Aeronautical Research Center) guided missile site. This accidental explosion and missile meltdown released

trace levels of radiological materials into the environment. ATSDR reviewed information on the trace levels of radioactive chemicals that remain on and near the BOMARC site and the extent to which these contaminants are expected to accumulate in plants and animals, including deer on NAES Lakehurst property. Because deer retain a very small fraction of radioactive materials that they might eat, and amounts that are retained occur primarily in body parts that people do not eat, ATSDR does not consider that deer meat harvested from NAES Lakehurst poses a public health hazard in the past, currently, or in the future.

4) Air pollution

In response to community concerns regarding air quality, ATSDR obtained data on the amount of chemicals NAES Lakehurst releases to the air. ATSDR used an air modeling analysis to evaluate this concern. The results of the model suggest that emissions from NAES Lakehurst both in the past and currently do not cause off-base air pollution to reach unhealthy levels and are therefore a no apparent public health hazard.

However, general air quality in Ocean County is sometimes poor, given the high levels of ozone that occur during the summer months. The ozone problem is regional in nature and is from industrial and motor vehicle emissions over a broad geographic area. Some people exposed to elevated ozone levels could experience health effects such as lung irritation and difficulty breathing. On days when ozone levels are expected to be high, NJDEP issues warnings that explain how people can reduce their exposure and avoid these and other ozone-related health effects. ATSDR agrees with NAES Lakehurst's recommendation that the base day care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members when air pollution reaches unhealthy levels. It is especially important for adults to convey these warnings to their children, particularly children with asthma.

I. Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) is required by law to conduct public health assessments (PHAs) for all sites on the U.S. Environmental Protection Agency's (USEPA's) National Priorities List (NPL). USEPA placed Naval Air Engineering Station (NAES) Lakehurst on the NPL in 1987. This led to the Navy conducting extensive remediation activities to reduce levels of environmental contamination on base property. This PHA evaluates whether the contamination levels at NAES Lakehurst were health hazards to base personnel, base residents, and local community members in the past, currently, or in the future.

After reviewing numerous base documents, discussing health concerns with community members, and meeting with base personnel, ATSDR identified four key concerns regarding how people might be exposed to contamination at NAES Lakehurst. These concerns are 1) groundwater contamination, 2) the presence of unexploded ordnance (UXO) and chemical warfare materiel (CWM) on base property, 3) potential radiological contamination in deer meat, and 4) air contamination. This PHA focuses on these four health concerns and also evaluates other environmental contamination in soils, surface water, sediments, and fish (see Appendix C).

Table 1 describes the exposure situations for NAES Lakehurst, ATSDR's health conclusion category for those situations, and the actions taken to limit exposure from them. ATSDR assigns conclusion categories to sites based on their level of public health hazard. Also, ATSDR has further clarified the "No Apparent Public Health Hazard" conclusion category by stating whether it is a past, current, or a future hazard. ATSDR's conclusion categories are explained in the Glossary (Appendix A).

Although ATSDR completed this PHA specifically to assess how contamination released from NAES Lakehurst might affect public health, the agency is aware that local community members have concerns about several sites throughout Ocean County and in neighboring counties. ATSDR and the New Jersey Department of Health and Senior Services (NJDHSS) have already completed PHAs for many of these other sites. Community members who would like to learn more about the public health implications of other sites near NAES Lakehurst should refer to the text box below.

What are some of the other sites and issues that ATSDR and NJDHSS have evaluated for areas near NAES Lakehurst?

Autism among children in Brick Township
Boeing Michigan Aeronautical Research Center (BOMARC) site
Cancers among children in Dover Township
Ciba-Geigy Corporation in Dover Township
Dover Township Municipal Landfill in Dover Township
Fort Dix's landfill site in Wrightstown
Jackson Township Landfill in Jackson Township
McGuire Air Force Base in Wrightstown
Reich Farm in Dover Township

Where can one obtain more information on ATSDR and NJDHSS's evaluations?

Copies of the some of the agencies' reports should be available at the Toms River Branch of the Ocean County Library: 101 Washington Street, Toms River, NJ 08753, 732- 349-6200.

Several reports are posted on ATSDR's Web site (www.atsdr.cdc.gov) and the Web site for the NJDHSS Hazardous Site Health Evaluation Program (www.state.nj.us/health/eoh/hhazweb).

Residents can contact ATSDR representatives by dialing the agency's toll free number, 1-888-42ATSDR (or 1-888-422-8737), and NJDHSS's Hazardous Site Health Evaluation Program representatives by dialing 609-584-5367.

II. Background

ATSDR obtained background information on NAES Lakehurst to understand what contaminants might have been released to the environment, where these contaminants might be found today, and whether anyone might come into contact with them. ATSDR reviewed data from many sources, including local community members, USEPA, the U.S. Geological Survey (USGS), the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Department of Health and Senior Services (NJDHSS), the Ocean County Health Department (OCHD), NAES Lakehurst, and other parties. This section summarizes the relevant background information by presenting facts and observations about NAES Lakehurst and its surroundings. Later sections document how these facts and observations factored into ATSDR's public health evaluations for this base.

A. Base Description and Operational History

NAES Lakehurst is located in central New Jersey, approximately 60 miles south of New York City, 50 miles east of Philadelphia, and 15 miles inland from the Atlantic Ocean (Figure 1). The base spans roughly 7,400 acres in Jackson and Manchester Townships of Ocean County. The base also falls entirely within the New Jersey Pinelands—a National Reserve covering more than 1 million acres.

Private industry, the U.S. Army, and the Navy have all operated on the lands that currently are NAES Lakehurst property. The following time line highlights notable past operations:

- *1915–1917: Eddystone Munitions Company.*¹ In 1915, Eddystone Munitions Company acquired lands in central New Jersey for establishing a proving ground where munitions were tested for the Russian military. Most operations occurred on what is now the western half of NAES Lakehurst property. Though limited information is available on the specific munitions that were tested, base historians believe most testing involved 3-inch shrapnel shells (Navy Environmental Support Office 1982).
- *1917–1921: US Army.* In 1917, the US Army acquired the lands previously owned by Eddystone Munitions Company, and the installation became known as Camp Kendrick. From 1918 through 1921, the U.S. Army Chemical Warfare Service operated an experimental proving ground for testing chemical warfare materiel (CWM), though testing of shrapnel shells and high explosive shells also occurred. The term materiel is

¹ The base documents use many different names when referring to the company that operated at NAES Lakehurst from 1915 to 1917. These names include Eddystone Munitions Company (the name ATSDR uses in this PHA), Eddystone Chemical Company, Eddystone Ammunition Company, and Eddystone Ammunition Corporation.

defined as the equipment, apparatus, and supplies of a military force or other organization. The total amount of chemical shells tested is not known, but the available range utilization statistics indicate that 1,841 shells were tested in 1920 alone (Navy Environmental Support Office 1982). The U.S. Army's testing also occurred at locations that are now part of the western half of NAES Lakehurst property (Navy Environmental Support Office 1982).

- *1921–Present: Navy.* In 1921, Camp Kendrick was turned over to the Navy, which purchased additional parcels of land over the following decades. The base was referred to by many different names between 1921 and today. Some of these names include Naval Air Station Lakehurst, Naval Air Engineering Center, Naval Air Warfare Center, and Naval Air Systems Command. This PHA refers to the base by its current name, NAES Lakehurst.

Since 1921 many different military support operations have taken place at NAES Lakehurst. From 1921 to 1961, NAES Lakehurst primarily supported the Navy's Lighter-Than-Air (LTA) program, by conducting research and development activities for dirigibles and blimps. After the LTA program ended in 1961, research and development activities at NAES Lakehurst shifted to supporting the Aircraft Platform Interface, or the interface between aircraft and marine vessels. Specific research activities include developing and testing catapults and arresting gear for aircraft carriers, designing visual landing aids and flight deck lighting systems, and manufacturing prototype equipment for production at other installations. When conducting these and other research and development activities, NAES Lakehurst has used many different chemicals and formulations, including fuels, lubricating oils, hydraulic fluids, solvents, and metals (Dames and Moore 1992).

Though NAES Lakehurst's research and development activities primarily supported aircraft, between 1921 and the late 1940s the Navy and its contractors also used base property as a proving ground and a bombing range. The proving ground operations took place between 1940 and 1941, when a private company tested tank guns and anti-aircraft weapons on the western part of base property. The sizes of projectiles fired on the proving ground typically ranged from 20 millimeters to 5 inches (Navy Environmental Support Office 1982).

Further, two bombing ranges periodically operated at NAES Lakehurst. One was located near the southern border of the facility, where airplanes dropped "practice bombs" on targets shaped like submarines. Practice bombs are bombs in which the main explosive contents are replaced with inert materials, such as sand or concrete. For spotting purposes, some practice bombs include small amounts of explosives. The second bombing range was located in what is currently the parachute jump circle (see Figure 2).

Here, aircraft dropped both practice and “live” bombs (i.e., high explosive bombs) during military training exercises. The Navy has attempted to recover all unexploded live bombs from this area.

- *Current uses and access: Navy.* NAES Lakehurst currently supports the Naval Air Systems Command. About 80% of the base lands are still undeveloped and unimproved. The developed and improved lands include more than 300 buildings, two aircraft runways, five tracks for testing jet propulsion with catapults, base housing, a day care center, and a golf course. Access to the base is limited to base personnel (both military and civilian), military retirees and personnel from other installations, and base residents (Michael Figura, NAES, personal communication, 2002). Visitors may access NAES Lakehurst property, but they must have an escort. On some occasions NAES Lakehurst invites large numbers of community members on base for special events (e.g., air shows), but the visitors in such cases are given access to only certain parts of the base.

B. Remedial and Regulatory History

Over the last 20 years, as part of the US Department of Defense’s (DOD) Installation Restoration Program (IRP), the Navy has conducted several environmental investigations at NAES Lakehurst. IRP was designed to identify, evaluate, and clean up contamination resulting from past operations.

In 1985 EPA proposed adding NAES Lakehurst to the National Priorities List (NPL), and the base was officially listed in 1987. From 1985 to 1987 NAES Lakehurst conducted a Phase I Remedial Investigation (RI). During this initial phase, base personnel measured levels of contamination at or near 42 areas identified in an Initial Assessment Study (IAS). NAES Lakehurst used the results of these and other investigations to make decisions on how to clean up contamination in the groundwater, soil, and sediments. These decisions include excavating areas with contaminated soils and sediments, removing or abandoning underground storage tanks, and pumping and treating contaminated groundwater.

NAES Lakehurst’s environmental investigations generated much of the sampling data that ATSDR reviewed before preparing this PHA. For detailed information on the Navy’s continuing environmental investigation and remediation plans at NAES Lakehurst, refer to documents located at the public repository: Ocean County Library, Toms River Branch, 101 Washington St., Toms River, NJ.

C. Land Use and Natural Resource Use

People use land and natural resources in many ways. ATSDR examines land and natural resource uses to determine what activities might put people at risk for exposure. This information is

important; controlling the types and frequencies of activities in those areas affects exposure to contamination. ATSDR uses the information as part of its evaluation of contamination and exposure.

Land Use

The general land use in the immediate vicinity of NAES Lakehurst is shown in Figure 2. Most of the adjacent lands are undeveloped. Colliers Mills Wildlife Management Area and wetlands are located along Ridgeway Branch, and border NAES Lakehurst to the north. The land immediately east of NAES Lakehurst is largely undeveloped, but several residential developments are less than 1 mile east of the NAES Lakehurst property. Neighboring property to the south of NAES Lakehurst includes the Manchester Wildlife Management Area, private land holders, and the Borough of Lakehurst. The Fort Dix Military Reservation borders NAES Lakehurst to the west.

Natural Resource Use

The natural resources used in this area include groundwater and biota. Two of the four main health concerns pertain to chemical or radiological contamination in groundwater and deer. For information on how contaminants might migrate in these media, ATSDR obtained background information on the local hydrogeology, terrestrial wildlife, and meteorology.

- **Hydrogeology.** Groundwater near NAES Lakehurst is found in two major aquifer systems: the shallower Kirkwood-Cohansey aquifer, and the deeper Potomac-Raritan-Magothy aquifer. Public and private water supplies throughout Ocean County pump drinking water from both aquifers. The thickness of the Kirkwood-Cohansey aquifer varies with location in Ocean County (Navy Environmental Support Office 1982). At NAES Lakehurst, the aquifer extends from near the surface (depths as low as 3 feet) to more than 100 feet. Although groundwater in this aquifer system generally flows from west to east, flow characteristics are known to vary with location and depth. At NAES Lakehurst, for example, the shallow groundwater typically flows toward streams and wetlands. Specifically, shallow groundwater in the northeastern part of the base flows north-northeast toward the Ridgeway Branch (NAES 2002a), while shallow groundwater in the southern part of the base flows southeast toward the Ruckles Branch (NAES 1999).

In the vicinity of NAES Lakehurst, the deeper Potomac-Raritan-Magothy aquifer extends from approximately 1,000 feet below ground surface down to bedrock—which occurs at depths of roughly 1,800 feet. Multiple confining units separate the deeper from the shallower aquifer (Navy Environmental Support Office 1982). Because these multiple confining units are less permeable than the shallower and deeper aquifers, groundwater in the area likely flows largely within the aquifers, rather than between them (Dames and Moore 1992).

- *Terrestrial wildlife (deer).* White-tailed deer live throughout the New Jersey Pinelands, including at NAES Lakehurst. Base surveys estimate that roughly 300 deer can be found on base property at any time (NAES 1997), with most observed in the western, more remote areas of the base. Deer have relatively broad home ranges, except during severe winters with deep snow when their movements are more limited. Because the western portions of the base are not fenced, deer in this area move freely between NAES Lakehurst, the Fort Dix Military Reservation, the Colliers Mills Wildlife Management Area, and other neighboring properties. Deer are not expected to forage on the BOMARC site; that site is completely fenced and much of its grounds are paved.

Deer hunting is permitted on NAES Lakehurst, but only base residents, base personnel, and selected other individuals (e.g., military retirees) can apply for hunting permits. Between 1991 and 1997 hunters harvested an average of 66 deer per year on base property; an additional 15 deer are killed per year from other causes, such as motor vehicle accidents (NAES 1997).

- *Climate and Meteorology.* Weather conditions and prevailing wind patterns at NAES Lakehurst vary considerably from season to season. For example, according to 30 years of weather observations made at Atlantic City, the monthly average temperature in the area ranges from 33 degrees Fahrenheit (°F) in January to 74 °F in July. The area receives roughly 40 inches of precipitation a year, primarily in the form of rain. Snowfall is most common in January and February, but the average snowfall amounts for these months is only 5 inches.

Several base documents indicate that wind patterns near NAES Lakehurst are variable and shift across the seasons (Dames and Moore 1992, Navy Environmental Support Office 1982, NAES 1997). The prevailing wind direction during the winter and early spring is from the northwest (Dames and Moore 1992), while winds tend to blow out of the southwest most commonly in the summer (NAES 1997). However, the base's close proximity to the Atlantic Ocean results in wind directions that change over the course of the day, from sea breezes during the afternoon to land breezes at night. The land and sea breeze effect is most pronounced on calm summer days. Though the wind direction varies considerably with time of year, the average wind speed is more constant; the annual average wind speed in the area is roughly 10 miles per hour, with modest changes from month to month.

ATSDR also obtained data on surface water runoff, aquatic wildlife, and geology. This data is not presented here, but was considered when evaluating levels of contamination in surface water, sediments, soils, and biota (other than deer). Appendix C summarizes ATSDR's evaluations for those media.

D. 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). Demographic data also provide details on population mobility which, in turn, helps ATSDR evaluate how long residents might have been exposed to environmental chemicals.

Figure 3 summarizes demographic data for the NAES Lakehurst vicinity, based on data compiled from the 2000 U.S. Census. According to the figure, 6,545 persons live within 1 mile of the base property line, and all are within the limits of Manchester Township, Jackson Township, or the Borough of Lakehurst.

Figure 3 also specifies the number of residents who fall into three potentially sensitive populations for environmental exposures: children, women of childbearing age, and the elderly. The proportion of people who are age 65 and older in the Lakehurst vicinity (38%) is considerably higher than that which is observed in the state of New Jersey (13%) and across the country (12%). In other words, a relatively greater number of senior citizens live in the vicinity of NAES Lakehurst than in most parts of New Jersey and the country.

Some of the environmental health issues ATSDR evaluated (e.g., the presence of UXO/CWM) may only affect those who access or work at specific locations on the base. As a result, ATSDR obtained data on the number of individuals with routine access to base property. Currently, the base employs 2,700 persons, including military, contractor, and civilian employees. Additionally, 91 persons (including 38 children) reside in on-base housing full time.² This housing, along with a day care facility, is located in the easternmost portion of base property.

E. ATSDR's Involvement

In 1991 ATSDR visited all military facilities on the NPL and ranked them in order of possible health or exposure significance. On August 12 and August 15, 1991, ATSDR conducted an initial base visit to NAES Lakehurst for a site survey. ATSDR toured the base, briefed the base commander, and met with various base activities and Ocean County Health officials to obtain health outcome and community concern information. Because ATSDR found few environmental exposure situations at NAES Lakehurst, the base was ranked as a very low priority.

² These residence figures are based on the number of people who live within the property line shown in Figures 1 and 2. NAES Lakehurst also owns and operates a housing unit, Pinehurst Estates, that is located within the Borough of Lakehurst, where 251 people live (including 91 children).

In December 2001 the Navy asked ATSDR to expedite and complete a public health assessment for NAES Lakehurst in preparation for its proposal to be removed from the NPL. From January 29 to February 1, 2002, ATSDR conducted a site visit of NAES Lakehurst. Included in this visit were meetings with base personnel from various departments, including environmental, housing, medical, health and safety, natural resources, hazardous waste management, pesticide management, and water supply. ATSDR also met with the superintendent of the Lakehurst Public Works Department and the community co-chair of the NAES Lakehurst Restoration Advisory Board (RAB). In addition, ATSDR reviewed documents at the base and at the Ocean County Library's records repository. ATSDR continues to work with base personnel and consults with public health and regulatory agencies on specific issues.

F. Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated environmental data provided in various reports prepared by NAES Lakehurst and other parties. Documents prepared for the Navy's IRP sites have Navy, NJDEP, and EPA oversight to verify that the data meets specific quality assurance and quality control measures for chain-of-custody procedures, laboratory procedures, and data reporting. These reports note any limitations to the sampling data. ATSDR evaluation of the data included looking for inconsistencies and data gaps. The validity of analyses and conclusions drawn in this PHA are based on the reliability of the information referenced in reports related to NAES Lakehurst. ATSDR believes that the quality of environmental data available in documents relating to NAES Lakehurst is sufficient for public health decisions.

III. Evaluation of Environmental Contamination, Exposure Pathways, and Public Health Implications

ATSDR reviewed the environmental data from the Navy's reports—as well as information from other sources—and used this information to determine any associated public health hazards. Four issues that people are concerned about were identified. When addressing these issues ATSDR evaluated the levels of contamination present, the extent to which individuals come into contact with the contamination, and whether this contact would result in a past, current, or future public health hazard. The four issues are discussed in the following section and summarized in Table 1. In addition, ATSDR evaluated the public health implications of environmental contamination in other media, including surface water, sediment, soil, and biota other than deer (see Appendix C).

A. Drinking or contacting contaminated groundwater on and off base

Past operations at NAES Lakehurst have contaminated the groundwater at several locations on base property. The main contaminants are chemicals found in chlorinated solvents and petroleum hydrocarbons. The groundwater contamination lies primarily within the base boundary, except in one area where it extends up to 1 mile south of the property line. NAES Lakehurst has taken steps to address this contamination, including collecting several thousand groundwater samples, delineating areas where contamination exists, and removing contamination from some plumes.

There is no indication that base residents or community members were exposed in the past or are currently being exposed to the contaminants in the groundwater plumes at NAES Lakehurst—none of the local water supplies or private wells supply drinking water from the areas with contaminated groundwater. As evidence of this, sampling data indicate that water from the base water supply, the Borough of Lakehurst Water Department, and selected nearby private wells is safe to drink.

Further, ATSDR notes that several measures are in place to ensure that groundwater contamination at NAES Lakehurst will not affect water supplies in the future. These measures include ongoing monitoring of the groundwater in several areas, establishing institutional controls (Classification Exception Areas) that restrict groundwater uses in the most contaminated areas, and routine testing of the public water supplies. Based on these observations, ATSDR concludes that groundwater contamination at NAES Lakehurst does not pose a health hazard now and likely will not pose a health hazard in the future.

Several past activities at NAES Lakehurst released contaminants to soils. Examples include leaking underground storage tanks and pipelines, fire fighting training pits where fuels were ignited, and direct release of contaminants onto the ground surface. The contaminants that were

most commonly released to the soils included jet fuels, hydraulic fluids, lubricants, and chlorinated solvents. Once released to the soils, a portion of these contaminants dissolve into the rain water and snow melt that seeps through the ground and eventually flows into groundwater resources.

People can come into contact with contaminants in groundwater different ways, but the most common route of exposure is through drinking from wells that draw from contaminated water. To evaluate this exposure pathway, ATSDR considered three separate issues: the current nature and extent of contamination, locations where groundwater wells provide drinking water to public utilities and private residences, and measures in place to prevent exposures to groundwater contamination. Each of these issues is discussed below:

What is the nature and extent of groundwater contamination at NAES Lakehurst?

NAES Lakehurst's Initial Assessment Survey identified 12 areas of potential groundwater contamination on base property. These areas are referred to by letters "A" to "L." Table 3 describes key features of these areas, such as the sources and levels of contamination and the history of how regulatory agencies and NAES Lakehurst have addressed remedial options for contaminated groundwater. Site documents suggest that groundwater contamination could have begun in the late 1950s. Contaminants continued to enter groundwater periodically until the early 1980s, when NAES Lakehurst implemented an environmental program to address groundwater contamination and other issues at the base.

NAES Lakehurst has studied the nature and extent of groundwater contamination. Currently, the base has approximately 420 groundwater wells (approximately 370 monitoring wells, 26 recovery wells, and 24 supply wells). Over the last 20 years several thousand groundwater samples have been collected from these wells. Two groundwater contamination areas—Areas A/B and I/J—have received extensive attention due to the contamination and their proximity to the base boundary. Figures 4 and 5 summarize recent data compiled by NAES Lakehurst for these areas, as do the following paragraphs:

- **Area A/B.** As Figures 2 and 4 show, Area A/B is located in the northeastern corner of NAES Lakehurst. Though several groundwater wells in this area continue to record concentrations of total volatile organic compounds (VOCs) greater than 10 parts per billion at depths up to 30 feet below the groundwater table, NAES Lakehurst has implemented aggressive treatment strategies to keep these elevated contamination levels from moving across the base boundary. For instance, NAES Lakehurst has removed soil contamination and underground storage tanks from several IRP sites within Area A/B and since 1993 has been pumping contaminated groundwater through a treatment plant. As much as 250 million gallons of groundwater are being treated per year from Area A/B (NAES 2001a, 2002a). Specifically, contaminated groundwater is pumped from the

ground through a process that removes VOCs, and the treated groundwater is pumped back into the aquifer. Monthly sampling data of the water being returned to the ground has shown that the treatment operation is highly effective at removing VOC contamination (NAES 2001a, 2002a).

- *Area I/J.* Figures 2 and 5 show the location of groundwater contamination in Area I/J, which contains the only groundwater contamination plume known to extend outside of the base property line. Groundwater in this area contains elevated levels of chlorinated solvents at depths up to 90 feet below the groundwater table. NAES Lakehurst has studied groundwater contamination in Area I/J for the last 20 years and investigated several treatment options. With concurrence from state and federal environmental regulators (NAES 1999), NAES Lakehurst is addressing the groundwater contamination in Area I/J with ongoing monitoring and natural restoration, along with the implementation of innovative treatment technologies.
- *All other groundwater contamination areas.* Table 3 summarizes current information for groundwater contamination in areas other than Areas A/B and I/J. More detailed information on these areas is not provided in this text because they have already been addressed to the satisfaction of environmental regulators (i.e., they have “no further action” selected as the site remedy) or they are located further from the base boundary than areas A/B and I/J.

In summary, although the chemicals and concentrations detected in the groundwater can vary from area to area, some key observations apply to all areas: NAES Lakehurst has thoroughly characterized levels of contamination, removed the sources of contamination in most areas, and implemented remedial actions (with concurrence from environmental regulators) to reduce levels of existing contamination.

Where do people who live at or near NAES Lakehurst get their drinking water?

In addition to evaluating the nature and extent of groundwater contamination, ATSDR also examined whether anyone who lives at or near the base is currently being exposed to the contaminants. This evaluation found that no drinking water wells draw from the groundwater contamination plumes emanating from NAES Lakehurst. Because no exposure is occurring, the contamination is not a public health hazard. For reference, the following paragraphs provide additional information on the base water supply, nearby public water supplies, and private well owners:

- *Base water supply.* NAES Lakehurst supplies drinking water to base residents and base personnel primarily from groundwater wells—but some buildings are supplied with bottled water because they are not connected to the base’s water supply. The water supply

draws from three groundwater well systems: the Helo System, the Test System, and the Hill System. Water from all three systems is treated before distribution. More information on these three water supply systems follows.

The Helo System consists of a single groundwater well that pumps water from a depth of 80 feet. This system provides drinking water to a few buildings in the western half of the base and does not serve the base residents. The well is located upgradient from the groundwater contamination plume at Area I/J (see Figure 8).

The Test System includes two deep wells that pump groundwater from depths greater than 1,500 feet below the ground surface. These wells provide drinking water to buildings near the Catapult Test Site in the western half of the base—they do not provide drinking water to base residents. Although the two wells are located near the groundwater contamination plume for Area I/J (see Figure 8), they pump from an aquifer far deeper than the depths at which the groundwater contamination is found.

Finally, the five Hill System groundwater wells supply drinking water to base residents and to most of the buildings on the eastern half of the base. These wells pump from depths between 50 and 120 feet below the ground surface. As Figure 8 shows, the five wells are located in the eastern half of the base, and two wells are adjacent to the Classification Exception Area (CEA) for Area A/B. Although the proximity of the two wells to the CEA might raise concerns about groundwater quality, ATSDR notes that the CEA shows the greatest potential area of contamination—not the area where contamination is currently found. Two other observations reassure ATSDR that the wells in the Hill System are not drawing contaminated groundwater: (1) the well depths are at least 50 feet below ground surface and the groundwater contamination is believed to occur at depths only up to 30 feet, and (2) groundwater modeling conducted in support of the base's 5-year and 12-year wellhead protection study found that the two water supply wells would draw water only from upgradient areas (NJDEP 1997).

In addition to these observations, which suggest that groundwater contamination is not affecting any of the base water supply systems, ATSDR reviewed the two most recent "Consumer Confidence Reports" to assess the quality of the base's drinking water (NAES 2001f, 2001g, 2001h, 2002f, 2002g, 2002h). These reports show that recent water samples collected from all three supply systems do not contain any contaminants at levels that would trigger corrective action by EPA's Safe Drinking Water Act. More simply, the best information available indicates that drinking water provided by the base is safe to drink.

- *Water supply utilities in neighboring communities.* Although groundwater contamination at NAES Lakehurst extends to off-base property only in Area I/J, ATSDR accessed

information on water supply utilities in the nearby communities to evaluate potential future exposures. ATSDR found the following:

- ▶ The Borough of Lakehurst Water Department provides drinking water to the entire Borough from a well nearly 1,000 feet deep, whereas the contaminated groundwater at and near NAES Lakehurst does not appear to occur deeper than 100 feet below the surface. In addition, the most recent water quality report for this system indicates that the “drinking water meets all federal and state safety requirements” (Borough of Lakehurst 2001).
- ▶ ATSDR contacted a representative from the Manchester Township Municipal Utilities Authority (MUA), who indicated that city residents either obtain their drinking water from private wells or from the city supply. According to NJDEP’s most recent drinking water quality summary report, the Manchester Township MUA did not have any Safe Drinking Water Act violations in calendar year 2000—an observation that suggests that the drinking water from this supply meets current health-based standards (NJDEP 2001a).

In short, ATSDR’s search found that the local public water supply utilities do not pump groundwater from the contamination plumes at NAES Lakehurst. Further, these utilities provide drinking water that meets state and federal water quality requirements. These utilities do not, however, supply drinking water to every resident in the area, as the next paragraphs explain.

- *Private wells.* ATSDR consulted with NJDEP’s Bureau of Water Allocation to estimate the number of residents in Jackson Township and Manchester Township who get drinking water from their own private groundwater wells. This bureau was consulted because it has copies of all groundwater-well construction permits, organized by location, that have been approved since the 1940s. Though extensive, the information available from NJDEP only allows for estimates of the actual number of private wells. Some wells previously constructed could now be out of service and the well locations are based on geographic data provided by the installation contractors, which are subject to error.³

According to the data compiled by NJDEP, 158 well-construction permits were issued for locations within 2 miles of a central point in the groundwater contamination plume of

³ As evidence of this data quality concern, a well construction permit for East Brunswick, New Jersey, was among the records that ATSDR was provided for being located within 1 mile of the NAES Lakehurst property boundary, even though East Brunswick is approximately 20 miles from the base. Because some of the data in NJDEP’s well construction database is inaccurate, this section should be viewed as providing approximate numbers of private wells near NAES Lakehurst property.

Area I/J. NAES Lakehurst obtained 65 of these permits for groundwater monitoring wells, while 26 of the permits were for construction of residential drinking water wells. It is not known how many of these residential wells are still being used to provide drinking water, but ATSDR notes that 18 of the well construction permits are more than 25 years old. The eight newly constructed wells (i.e., those installed within the last 15 years) all draw groundwater from at least 60 feet beneath the surface and their water should have been tested for contamination prior to operation.

ATSDR contacted a representative from the Jackson Township Water Department to inquire about drinking water sources for residents who live near the northeast corner of NAES Lakehurst (or near Area A/B). The representative noted that most residents in this part of Jackson Township obtain drinking water from private wells that the city does not test. However, the contamination from Area A/B remains largely on base and monitoring wells around the perimeter of the plume would detect significant off-base migration of contaminants.

ATSDR also searched NJDEP's permit records for all private wells constructed within 1 mile of the northeast corner of NAES Lakehurst property, or within 1 mile of the perimeter monitoring wells for Area A/B. Overall, 387 well construction permits were issued for this area, of which 263 were issued to NAES Lakehurst, primarily for groundwater monitoring and treatment activities. The permit records indicate that 65 of the wells were constructed to supply potable water to private well owners. The 23 wells that were constructed in the last 15 years all pump water from at least 60 feet beneath the surface. Also, before their initial installation they should all have been tested for groundwater quality.

Virtually all drinking water supplied in the vicinity of NAES Lakehurst comes from groundwater resources. However, ATSDR's review of the base water supply, municipal water supply utilities, and private wells indicates that none of the drinking water wells draw from areas with groundwater contamination from NAES Lakehurst. Because no one was or is exposed to contaminated groundwater from NAES Lakehurst, it not a public health hazard.

Are there any regional problems with groundwater?

When reviewing this issue, ATSDR found data indicating that groundwater supplies throughout central and southern New Jersey contain elevated levels of radium contamination. This is a regional issue which is closely monitored by drinking water providers. The text box below provides additional information on this contamination. The most recent sampling results indicate that the radiological contamination in drinking water provided by the base water supply and nearby public water supplies is not a public health hazard.

Radium Contamination of Groundwater in Central and Southern New Jersey: A Regional Issue

Elevated levels of radium contamination have been detected in groundwater throughout central and southern New Jersey (e.g., USGS 1998). The radium appears to originate from the decay of other elements naturally found in the local geologic formations and is not the result of operations at NAES Lakehurst. The forms of radium detected release alpha and beta radiation during their natural decay process. Consequently, alpha radiation also has been found at elevated levels in groundwater in central and southern New Jersey. The radium and alpha radiation contamination occurs primarily in the shallow Kirkwood-Cohansey aquifer.

This groundwater contamination has been extensively studied. For instance, USGS reported that groundwater from 1/3 of the wells it sampled in southern New Jersey contained total radium at concentrations higher than EPA's Maximum Contaminant Level (MCL) of 5 picocuries per liter (pCi/L) (USGS 1998). Further, NJDEP reported in 1998 that during a then-recent round of sampling 29 drinking water supply systems in the state had elevated levels of radium contamination. The water supplies of concern included those operated by NAES Lakehurst, Toms River, Manchester Township, and Lakewood Township (NJDEP 1998). Follow-up testing at the base water supply, however, has shown that average concentrations of radium and alpha radiation in the drinking water are lower than EPA's MCLs.

Will groundwater contamination from NAES Lakehurst affect drinking water supplies in the future?

ATSDR also considered the likelihood that people could be exposed to the contamination from NAES Lakehurst in the future. Though ATSDR cannot predict future conditions with certainty, several measures are in place to ensure that the groundwater contamination currently at the base will not affect water supplies in the future. These measures include:

- ***Ongoing groundwater monitoring and treatment.*** NAES Lakehurst plans to continue to monitor the spatial extent of groundwater plumes, including at locations along the perimeter of the plumes, until relevant requirements are met or until USEPA designates that no further action is needed. Figures 4 and 5 show the locations of perimeter wells for Areas A/B and I/J, which are located furthest from the source of contamination; ongoing sampling of these wells will detect unexpected migration of groundwater plumes. Further, NAES Lakehurst will continue to pump and treat contaminated groundwater in Area A/B

and investigate use of other treatment technologies in Area I/J. These measures will help reduce existing levels of environmental contamination.

- *Required testing of public water supplies.* The Safe Drinking Water Act requires every public water supply system to test drinking water routinely for contamination. The water supply systems in the vicinity of NAES Lakehurst all test the drinking water for bacterial, chemical, and radiological contamination, and this testing will continue into the future. Compliance with the Safe Drinking Water Act will help ensure that authorities detect and promptly address environmental contamination that could enter drinking water supplies, thus reducing any exposures that might occur in the future.
- *Institutional controls at groundwater plumes.* NAES Lakehurst requested that NJDEP designate several Classification Exception Areas (CEAs) that delineate areas on and near base property where groundwater contamination exceeds health-based drinking water standards or could do so in the future. NJDEP has accepted this request and established CEAs at the base's groundwater plumes, most notably in Areas A/B and I/J (see Figures 4 and 5, respectively). A CEA is required pursuant to the state of New Jersey's Groundwater Quality Standards whenever an approved remedy will not meet constituent standards for the term of the remediation. The CEA is the state's method of ensuring that the uses of the aquifer are restricted and human health is protected until standards are achieved.
- *Testing and installation requirements for private wells.* Several additional measures are in place to ensure that contamination does not affect drinking water drawn from private wells. For instance, Ocean County Health Department regulations require that no new potable wells can be constructed without having a permit approved by the Ocean County Board of Health. Also, any wells located on or adjacent to properties with private sewage disposal systems or public sanitary sewage disposal systems must be installed by licensed well drillers. All new wells must be tested for chemical contamination, and the list of chemicals that must be evaluated include many of the groundwater contaminants at NAES Lakehurst (e.g., benzene, xylene, trichloroethylene). Private wells must also be tested for chemical contamination when a property is sold (OCHD 1990). Further, for the last 5 years, NAES Lakehurst has been testing monitoring wells which are located immediately northeast of the base boundary. None of these sampling results have shown evidence of base-related contamination. NAES Lakehurst plans to continue sampling this well.

The measures listed above will help ensure that base personnel and environmental regulators know where groundwater contamination exists and whether this contamination has entered drinking water supplies. These measures will therefore ensure that groundwater contamination from NAES Lakehurst will not be a health hazard in the future.

B. Contacting Unexploded Ordnance and Chemical Warfare Materiel While Hunting or Playing On Base

From 1915 to 1921 a private company and the U.S. Army operated ammunition proving grounds on parts of the land that is now NAES Lakehurst property. Between 1921 and the late 1940s, NAES Lakehurst, known at that time as Camp Kendrick, also operated a proving ground and conducted military training exercises with aircraft dropping bombs on targets. These past operations left unexploded ordnance (UXO) and chemical warfare materiel (CWM) at various locations on the base. Past base surveys suggest that UXO/CWM are most commonly found in the western, and more remote, part of NAES Lakehurst, far from base housing; however base personnel and base residents do have access to the areas where UXO/CWM are most likely to be present.

Recognizing that disturbing UXO/CWM can have serious consequences, NAES Lakehurst has implemented several measures to help base residents and base personnel avoid the hazards posed by these items. These measures include posting warning signs in areas believed to have the greatest amount of UXO/CWM, requiring hunters to take an annual training course on the dangers of UXO/CWM, and informing all new base personnel (civilian and military) and contractors about the specific risks these items pose. An explosive ordnance disposal team from either the Army (Fort Dix) or the Navy (Naval Weapons Station Earle) is called before digging in any areas suspected to have unexploded ordnance or chemical munitions. Emergency response teams that have been trained to respond to large chemical releases are also on hand to respond to chemical releases, explosions, or fires. In addition, NAES Lakehurst has developed contingency plans and standard operating procedures for response to a release from transportation and/or storage of industrial chemicals either on base or in the community. These plans and procedures are also appropriate for use in the event of a chemical munitions release and are reviewed frequently. These measures have been effective—even though base personnel and base residents continue to locate UXO items periodically. No accidents, injuries, or other adverse outcomes have resulted from individuals disturbing UXO/CWM at NAES Lakehurst.

NAES Lakehurst has taken steps to address the dangers of UXO/CWM. However, UXO/CWM are inherently dangerous materials and pose a hazard to anyone who contacts or disturbs them. To avoid hazards in the future, NAES Lakehurst should continue to inform all hunters and base personnel of the dangers posed by UXO/CWM. ATSDR recommends that NAES Lakehurst continue indefinitely administrative controls for all portions of the base that have not been otherwise cleared for safe and unlimited access and use. ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.

What did ATSDR consider when assessing the hazards of UXO/CWM?

To assess potential hazards associated with UXO/CWM at NAES Lakehurst, ATSDR considered several factors, such as the types of munitions and weapons used, where the remnants from the past operations lie, who has access to these areas, and what measures are in place to educate people about the dangerous properties of UXO/CWM.

What types of munitions and weapons were used?

In making its evaluation, ATSDR considered the types of material that were produced by the U.S. Chemical Warfare Services. ATSDR also considered the types of chemical warfare agents known to have been tested or used by other countries during World War because they may have also been tested by the U.S. Chemical Warfare service at the Lakehurst proving grounds. In addition, ATSDR looked at the types of weapons, containers, and mortar and artillery shells that were used to identify that the range of amounts of chemicals in containers and shells (1 to 100 pounds of compound).

Both the Eddystone Munitions Company and the U.S. Army operated proving grounds on what is now the western portion of NAES Lakehurst. These past activities involved testing both high-explosive ordnance and CWM. An inventory of all ordnance suspected by the Navy to remain at NAES Lakehurst was compiled and included in the Focused Feasibility Study for Site 41 (NAES 1996). This list may be updated based on the results of additional investigations to be conducted in the next few years. In the next few years the DOD will be reevaluating the potential to encounter chemical munitions and unexploded ordnance, as well as site conditions and archival material relating to NAES Lakehurst. Between 1940 and 1941, the Navy and its contractors also operated an anti-tank proving ground on this part of the base and although conventional munition compounds may be present around areas of historical targets, the presence of chemical agents is very unlikely. Additionally, the Navy conducted air-to-ground military training exercises using both high-explosive bombs and practice bombs, or bombs whose explosive charge is replaced

**What is unexploded ordnance?
When is it a hazard?**

Unexploded ordnance (UXO) is explosive (i.e., so-called "live") ordnance that has been armed or prepared for action, has been fired, dropped, launched, or buried in a manner that can cause a hazard, and remains unexploded, whether by design or by malfunction.

For UXO to be a hazard, three conditions must be met: (1) UXO must be present, (2) people must have access to the areas where UXO is present, and (3) people's actions must detonate the ordnance.

The first two conditions are clearly met at NAES Lakehurst. The third condition can potentially occur, but the base's efforts to educate individuals on the hazards of UXO have greatly reduced that potential.

with an inert material, such as sand or concrete.⁴ Use of high-explosive bombs occurred only at the Parachute Jump Circle. Efforts have been made to retrieve bombs that did not explode (NAES 1996), but the nature of these recovery efforts is not thoroughly documented. Air-to-ground exercises were also conducted over the southern portion of the base, but the overwhelming majority of those exercises were conducted with practice bombs. Thus many different munitions and weapons have been used on the land that is now NAES Lakehurst.

A review of base records suggests, however, that the UXO are usually less than a foot in length and CWM that remain on base would contain 100 pounds or less of chemicals. An issue to consider when assessing these materials is their sensitivity to detonation. Because most of the UXO and CWM were fired more than 50 years ago, little information is available on their current sensitivities. The fact that many UXO and CWM items have been located, and some even handled, without incident implies that the original materials might not be extremely sensitive to detonation. However, as munitions age and corrode, the potential for explosion or chemical release becomes more indeterminate. Current technology cannot assure that all munitions can be found and removed.

What can happen to buried UXO/CWM?

ATSDR believes that the greatest potential for a munition to explode or release its contents would be if the munition is moved or tampered with or encountered during excavation. It can not be determined why the munitions did not explode and consequently it cannot be predicted how many times, if any, munitions can be moved or tampered with without exploding. However, chemical changes or corrosion of metal components may make the munitions unstable and subject to detonation by vibrations, shock, friction, changes in temperature/heat, or electrical fields. For example, munitions that have been exposed by freeze and thaw or erosion may also explode during brush or forest fires. It is noteworthy that corrosion of munitions that does not lead to detonation may continue to the point where the contents of the munitions are released. ATSDR has no indication that underground explosions or chemical releases from corrosion of munitions has occurred. ATSDR considers unexploded ordnance inherently dangerous and administrative controls, standard procedures, and contingency plans to protect public health and safety appear to have been effective to this point in time.

Were people injured by UXO in the past?

There are no reports of people being injured by detonations of UXO in the past.

⁴ Practice bombs can contain small amounts of explosives for purposes of spotting. Such amounts, however, are substantially lower than the amounts in high-explosive bombs.

Were people injured by or exposed to CWM in the past?

ATSDR believes that there is insufficient data to evaluate potential levels of exposures in and around the proving ground and test facilities during 1918-1921 and consider it to be an indeterminate public health hazard. However, there is no indication that past releases or exposures have occurred since chemical warfare testing ended in 1921. For example, there have been no reported or unexplained deaths or injuries to a wide variety of fish and wildlife, nor unexplained vegetation stress or obvious changes in the number and types of insects. This finding is partially supported by a review of 1) historical documents, 2) general location of ranges and storage areas, 3) types and amounts of chemicals that were known to have been tested by the Chemical Warfare Service, and 4) types of chemical munitions that were used by any country during World War I. In 1952, the U.S. Army Technical Escort Unit recovered and destroyed a number of potential chemical shells during the construction of an airstrip. In 1993, a geophysical survey was conducted in one small area suspected to have buried chemical warfare munitions based on an anecdotal report by an employee. This survey did not identify any UXO or CWM.

Where does the UXO/CWM most likely remain and who has access to these areas?

ATSDR consulted with the Chemical Demilitarization Branch of the National Center for Environmental Health (NCEH) at the Centers for Disease Control and Prevention (CDC) (Rogers, personal communication 2003). ATSDR concurs with CDC, the Navy, and the Army that it is prudent to assume that munitions, including explosive and chemical weapons, are likely to still be buried at NAES Lakehurst. NAES Lakehurst has identified the areas on the base where UXO/CWM will most likely be found (Figure 6). The entire western half of base property is designated either as "potentially contaminated" with UXO/CWM or as having a low probability of such contamination. These designations are generally consistent with site investigations from the early 1980s, which reported "...that the whole western portion of the base was potentially an ordnance impact area" (Navy Environmental Support Office 1982).

Contingency plans for explosive ordnance teams and fire and emergency response teams are in place and include coordination, review, and training with on and off base teams. In the next few years, the DOD will be evaluating site conditions, current technologies, and historical information on unexploded ordnance and chemical munitions. Based on this evaluation, DOD will make recommendations for additional investigations, administrative controls, and upgrades of contingency plans and standard operating procedures. ATSDR concurs that this effort should include evaluation of all areas on base to determine if the current administrative controls for disturbance or other intrusive activity in soils in some areas should be expanded to additional areas of the base. This includes the review of current size and location of warning signs.

In addition, a small area on the eastern half of the base is labeled as "potentially contaminated." According to the historical accounts of the military training exercises that occurred here, this contamination would only consist of UXO, specifically, the remnants of practice bombs.

Under current base access restrictions, only base personnel, base residents (including 38 children), contractors, and supervised visitors are expected to have access to the areas shown in Figure 6. These individuals enter the areas for various recreational and occupational purposes. Recreational uses include hunting, fishing, exercising, camping, and hiking. Occupational purposes include surveying, environmental sampling, patrolling, and providing general facility maintenance. Several base documents acknowledge that individuals have located UXO while working or recreating in these areas, but to date, no harmful incidents have resulted from these encounters.

What measures has NAES Lakehurst implemented to address this issue?

NAES Lakehurst has implemented several administrative controls to minimize the potential hazards of accidental UXO/CWM detonations. First, the base has removed all visible munitions in areas frequented by people. Second, the base has posted warning signs along the main roads and paths entering the areas shown in Figure 6. Third, contractors whose work involves digging in the areas shown in Figure 6 must obtain permits requiring qualified explosive ordnance disposal personnel to survey and clear areas before any digging or excavation begins. (These clearance projects have been limited to less than 10 acres (NAES 1996).) Fourth, hunters are required to attend a UXO/CWM training course every year before obtaining a hunting license for the base. Finally, the base informs all new personnel (civilian and military) during their orientation activities about the potential hazards of contacting UXO and CWM.

No accidental chemical exposures or detonations have occurred, suggesting that the base's administrative controls have helped to prevent incidents. Although the probability that someone in the future will be hurt or injured by contacting UXO and CWM cannot be predicted, the historical information suggests that the potential to encounter UXO and CWM is extremely low. For example, chemical munitions that were fired into trenches between 1918 and 1921, if still present, would now be buried. It would be difficult, if not impossible, to find these deeply buried munitions using current technology. Most excavations would not disturb this materiel, and yearly erosion and frost heaves throughout Lakehurst have uncovered only conventional munitions. ATSDR concludes that the UXO and possible CWM that remain on NAES Lakehurst property, if encountered and tampered with, are a health hazard, but there would be no health hazard to the general public unless munitions exploded or released their chemical contents. However, because of the standard operating procedures, contingency plans, explosive ordnance team involvement during excavations, access restrictions, and educational efforts in place at NAES Lakehurst, the chances of releases are greatly reduced, if not eliminated. The Navy is considering plans to further reduce the hazards of munitions by having containment structures or other methods in place during excavations.

ATSDR recommends that NAES Lakehurst continue indefinitely administrative controls for all portions of the base that have not been otherwise cleared as safe for unlimited access and use. ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.

It is ATSDR current understanding that as technology improves and/or munitions are discovered on base, NAES Lakehurst will continue to evaluate the existing boundaries of UXO/CWM areas to determine if detection and removal procedures are practical and if boundaries continue to be protective of public health and safety.

C. Eating Deer Meat Possibly Containing Radiologic Contamination from BOMARC Missile Residue

People have hunted at NAES Lakehurst for many years. Currently, only permitted base personnel, residents and other selected individuals (e.g., military retirees) are allowed to hunt at NAES Lakehurst. Some of these individuals have expressed concern about potential radiological contamination in deer meat (venison). The concern stems from a documented release of radioactive materials, including plutonium and uranium, during an explosion and fire that occurred in 1960 at McGuire Air Force Base's Boeing Michigan Aeronautical Research Center (BOMARC) missile site. This site is located less than 1 mile northwest of NAES Lakehurst.

Although researchers have not sampled deer meat from this part of New Jersey for radiological contamination, several factors strongly suggest that deer harvested at NAES Lakehurst do not contain unhealthy contamination levels: first, most areas at BOMARC where radiation was released are now covered with pavement; second, deer harvested at NAES Lakehurst feed on vegetation over a broad area and not just in areas where contamination might exist; and third, only a small fraction of plutonium and uranium in a deer's diet is actually retained by the animal, and primarily in body parts that most people typically do not eat (e.g., bones, liver, and kidney). For these reasons ATSDR does not consider eating deer meat from NAES Lakehurst to be a public health hazard in the past, currently, or in the future.

What happened at the BOMARC Missile Site?

On June 7, 1960, a fire and explosion occurred at the BOMARC missile site, located less than 1 mile northwest of NAES Lakehurst. The fire lasted only 30 minutes, but it destroyed a guided surface-to-air missile containing nuclear material. To prevent the fire from spreading, for approximately 15 hours emergency response personnel sprayed the area with fire hoses. Radioactive materials were thus released into the environment both in the smoke from the fire and

in the runoff from the fire suppression activities. ATSDR's PHA on the BOMARC site provides additional details on the fire and the measures taken to contain radiological contamination (ATSDR 2002).

Where is the radiological contamination now?

The U.S. Air Force has initiated several environmental investigations to characterize the extent of radiological contamination that resulted from the 1960 incident. Sampling found the highest levels of plutonium in many "hot spots" in an area known as the exclusion zone. This is the area on the BOMARC missile site where the fire occurred and where surface water runoff initially flowed. Plutonium contamination was also detected in a drainage ditch that received the runoff during the fire fighting activities. This contamination extends off the BOMARC property.

Overall, the sampling data suggest that the radiological contamination is not very mobile, and has not migrated extensively since 1960. This finding is consistent with sampling results collected by NAES Lakehurst, which found no evidence of widespread soil or groundwater contamination in the northwestern corner of base property.

What are the hunting practices at NAES Lakehurst?

According to interviews with base personnel, hunting at NAES Lakehurst is best characterized as recreational, with no evidence of individuals hunting for subsistence purposes. Again, only base personnel, base residents, and other selected individuals (e.g., military retirees) are allowed to hunt on base. Hunters are required to report all deer harvested to the Deer Check Station. Data from these reports indicate that on average, 66 deer per year are harvested during the hunting season (NAES 1997).

What is the likelihood that deer harvested from NAES Lakehurst are contaminated?

Although the U.S. Air Force and other parties have analyzed numerous groundwater and soil samples for plutonium and other radionuclides, samples of deer meat (venison) from this area have never been analyzed for these contaminants. However, limited study of vegetation near the BOMARC site has not revealed evidence of radiological contamination (USAF 2002), suggesting that deer's diet is not heavily contaminated.

Deer hunted on NAES Lakehurst probably do not frequently eat vegetation that grows on or near the soils found to contain radiological contamination. For instance, deer are known to forage over relatively broad areas and do not feed exclusively in a single location. In fact, deer in this part of the New Jersey Pinelands reportedly have a home range of 120 to 400 acres (NJDEP 2001b) and therefore do not feed just in the immediate proximity of the BOMARC site. In addition, deer cannot forage in the areas with the highest levels of radiological contamination because the

exclusion zone at the BOMARC site is surrounded by a 6-foot fence, topped with barbed wire. Finally, the U.S. Air Force is about to implement a site remediation project to dismantle structures at, and remove contaminated soils from, the BOMARC site—an action that will help prevent migration of contamination through environmental media and into the food chain.

Even if deer were to eat vegetation from these areas, scientific literature on bioaccumulation of radiological contaminants indicate that bioaccumulation from soils to plants to herbivores is minimal. For instance, the plutonium released during the 1960 fire and explosion would have been in the form of oxides, which do not readily dissolve in water and are not readily taken up by plants (Eisenbud and Gesell 1997, BOMARC EIS 1992). Even if the vegetation did contain plutonium, absorption and distribution data collected in laboratory animal studies suggests that only a small fraction of the plutonium that deer ingested would be absorbed into their systems, and most of these amounts would deposit in the bones, and, to a lesser extent, in selected organs (e.g., liver and kidney)—body parts that people do not typically consume (ATSDR 1990). Given the low amounts of plutonium, if any, that are expected to be found in deer meat, human exposures to plutonium through this pathway are believed to be insignificant.

Although ATSDR expects that exposures to plutonium through consumption of deer meat is insignificant, any potential exposure would most likely be from eating deer liver or kidney or using bones in cooking stews or soups. Eliminating consumption of these organs and eliminating the use of bones would limit any potential exposure.

ATSDR concludes that eating venison from deer harvested on NAES Lakehurst does not pose a public health hazard. This conclusion is based on the varied diet of deer, the limited evidence of radiological contamination occurring in plants, and the scientific evidence that plutonium is not readily absorbed in many animals' digestive tracts. In addition, the scheduled remediation activities at the BOMARC site will likely further limit any potential exposure through this pathway.

D. Air Pollution

During ATSDR's base visit at NAES Lakehurst, two individuals expressed concern about exposures to air pollution. First, a community member asked ATSDR if air emissions from the base cause people in the Borough of Lakehurst and other neighboring communities to breathe unhealthy levels of air pollution either now or in the past—a concern that focuses specifically on releases from the base. Second, a physician wondered if a perceived high incidence of respiratory conditions among children (e.g., asthma attacks) might result from local air pollution. This concern relates more to the general air quality of the area, because people breathe in air contaminants from a wide range of sources, not just from NAES Lakehurst. To respond to these concerns, ATSDR examined the public health implications of NAES Lakehurst's air emissions and researched the general air quality in the Ocean County area.

Most of the sources of air pollution at NAES Lakehurst have controls that greatly reduce the amount of contaminants that would otherwise be released directly to the air. In addition, statewide emission inventory data and ATSDR's air modeling analysis suggest that emissions from NAES Lakehurst do not cause off-base air pollution to reach unhealthy levels.

However, ATSDR found that residents in Ocean County could breathe potentially unhealthy levels of ozone periodically during the summer months. In fact, ozone is an environmental health problem throughout New Jersey and near most urban centers in the northeast United States.

Some people who are exposed to elevated ozone levels could experience health effects ranging from lung irritation to breathing difficulties. Children, outdoor laborers, the elderly, and people with pre-existing respiratory conditions should reduce outdoor activities on days when ozone levels are high. Healthy individuals should reduce outdoor activities that involve moderate physical exertion, such as exercising. NJDEP issues warnings on days with elevated ozone levels and these warnings are communicated to the local media. NAES recommends that the base day care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members when air pollution reaches unhealthy levels. It is especially important for adults to convey these warnings to their children, who are likely to engage in strenuous outdoor activity during the summer when ozone levels in New Jersey are their highest.

In the past, what air pollutants were released from NAES Lakehurst?

Because NAES Lakehurst has primarily been a research and development facility, the amounts of chemicals used at the base were probably less than those used at facilities engaged in large-scale chemical manufacturing and other production activities. Moreover, emissions from past operations would substantially disperse before reaching off-site locations. These observations do not prove whether the past air emissions from NAES Lakehurst caused harmful levels of air pollution, but they provide some level of assurance that the base's air quality impacts were probably not unusually high, especially in comparison to those from large-scale manufacturing and production facilities. Overall, ATSDR cannot draw firm conclusions on NAES Lakehurst's past air emissions, though qualitative observations suggest that it is unlikely that past air emissions caused local air quality to reach unhealthy levels.

Currently, what air pollutants are being released from NAES Lakehurst?

Most of the sources of air pollution at NAES Lakehurst have controls that greatly reduce the amount of contaminants that would otherwise be released directly to the air. NAES Lakehurst has also replaced several emissions sources with new processes with less toxic and harmful emissions. Examples include converting many motor vehicles used on base property to run on natural gas rather than gasoline, and eliminating most uses of chemicals that deplete the ozone layer. The base

currently operates its pollution sources according to specifications in a “pre-draft operating permit” issued by NJDEP.

An inventory of every chemical released by NAES Lakehurst is not available, but the base is required to submit annual “Emissions Statements” to NJDEP that disclose the amounts of certain contaminants released to the air. NAES Lakehurst’s 2001 “Emissions Statement” is summarized in the table below. For reference, ATSDR compared the base’s emissions data to emissions data that EPA tabulated for industrial and military facilities throughout New Jersey:

Contaminant	Emissions from NAES Lakehurst in 2001 (ton/year)	Number of Sites in New Jersey with Higher Annual Emissions
carbon monoxide	14.80	81
nitrogen oxides	44.39	98
PM10 ⁵	7.24	99
sulfur dioxide	31.69	113
VOCs	17.21	289

Sources of information:

Annual emissions data for NAES Lakehurst: NAES 2002b.

Emissions data for other sites in New Jersey were downloaded from EPA’s Aerometric Information Retrieval System (AIRS). AIRS includes estimated emission rates for many different industrial facilities and federal facilities, but does not include emissions data for other types of sources (e.g., mobile sources, natural sources). The AIRS data for individual sites are of varying quality.

Certain emissions sources at NAES Lakehurst could be exempt from reporting to NJDEP’s Emissions Statement program.

ATSDR acknowledges that simply comparing emission rates from one facility to the next does not indicate how individual sources affect air quality. Still, the table does provide insight on the base’s air emissions. Specifically, it shows that although operations at NAES Lakehurst release air contaminants, the amounts released are relatively small when compared to other industrial operations. This finding is not particularly surprising, given that NAES Lakehurst primarily conducts research and development activities rather than large-scale manufacturing activities.

To evaluate the public health implications of the air emissions data, ATSDR used an air dispersion model to estimate how the base’s operations might affect local air quality. From this model, ATSDR concludes that NAES Lakehurst’s emissions of these four contaminants pose no public health hazard. In other words, the amounts of chemicals released to the air (as summarized

⁵ PM10 refers to particulate matter with diameters of 10 microns or smaller. Particulate matter is solid particles and liquid droplets (or aerosols) in the air. EPA has focused its regulatory efforts on PM10, because particulate matter of that size is more likely to penetrate into sensitive regions of the respiratory tract than are larger particles.

in the previous table) do not cause local air pollution to reach levels of health concern. Appendix B describes the technical details of our modeling analysis.

Finally, ATSDR evaluated potential air quality impacts of VOCs—a group of chemicals that have similar physical properties (they readily evaporate), and many of which are toxic. When identifying chemical-specific air emission rates for a given source, ATSDR typically accesses EPA's Toxic Release Inventory (TRI), a publicly accessible database that documents amounts of toxic chemicals that certain industrial and military facilities release to the environment. Facilities are required to report to TRI only if they manufacture, process, or otherwise use certain toxic chemicals in amounts greater than reporting thresholds.

ATSDR's queries of the most recent TRI data (reporting year 2000) found that nearly 600 industrial and federal facilities in New Jersey submitted chemical release reports to EPA under this regulation, but NAES Lakehurst was not one of these facilities. This observation suggests that the base did not manufacture, process, or otherwise use toxic chemicals in quantities greater than the reporting thresholds. The fact that nearly 600 other facilities met these reporting thresholds further implies, but does not prove, that NAES Lakehurst's research and development activities use relatively small amounts of chemicals when compared to manufacturing, processing, and distribution facilities.⁶ As a result, ATSDR concludes that emissions from NAES Lakehurst's operations currently do not cause ambient air concentrations to reach unhealthy levels in the Borough of Lakehurst or other nearby communities.

What is the general quality of the air in Ocean County?

To address the health concern regarding a perceived high prevalence of respiratory conditions among children, ATSDR obtained data that characterize the general air quality for Ocean County. Specifically, ATSDR reviewed ambient air monitoring data that NJDEP collected at different locations in Ocean County for sulfur dioxide, ozone, and particulate matter. These monitoring locations were selected such that the measured concentrations reflect general air quality, rather than the influence from a single source or industrial facility.

Although the available data for sulfur dioxide and particulate matter indicate that ambient air concentrations for these pollutants are not a public health hazard, ambient air concentrations of ozone in Ocean County can be unhealthy. The elevated ozone levels in Ocean County result from industrial and motor vehicle emissions over a broad geographic area that extends beyond New Jersey's borders.

⁶ ATSDR acknowledges that other factors could explain why NAES Lakehurst was not required to report to TRI, while other facilities were. One possibility is that the base, could have qualified for certain exemptions (e.g., laboratory activities, motor vehicle maintenance) that do not apply to other facilities. During the site visit, however, ATSDR saw no evidence of large-scale manufacturing operations or significant air emissions sources.

EPA has been monitoring ambient air concentrations of ozone for more than 20 years. EPA's health-based National Ambient Air Quality Standard (NAAQS) for ozone is a 1-hour average ambient air concentration of 0.120 ppm.⁷ Ocean County has been designated as a severe non-attainment area for ozone because the ambient air concentrations have exceeded EPA's 1-hour standard on at least 1 day per year. Recent data collected by NJDEP indicates that ozone concentrations also exceed EPA's proposed 8-hour standard. The frequency with which ozone reaches unhealthy levels changes from year to year. On average, however, unhealthy ozone levels in Ocean County occur 3 days per summer (based on the last 10 years of sampling results), but elevated ozone concentrations are not unique to Ocean County. In fact, ozone levels throughout the state of New Jersey are, at times, potentially unhealthy.

What is Ozone?

Ozone is a highly reactive chemical that has been linked with various respiratory health effects among exposed populations. Ozone forms in the air when emissions from various sources, including motor vehicles and industry, mix together and react with sunlight. Ozone levels are typically highest during the afternoon hours of the summer months, when the influence of direct sunlight is greatest. Certain meteorological conditions, such as calm winds and a highly stable atmosphere, can cause ozone concentrations to reach very high and unhealthy levels.

Both acute (short-term) and chronic (long-term) health effects have been linked to ozone inhalation exposure. The acute effects include shortness of breath, coughing, throat irritation, and chest pains; the chronic effects include permanent damage to the lungs, reduced lung capacity, and worsening of pre-existing respiratory problems (EPA 1997). These effects do not occur in every person who is exposed to high levels of ozone. People with respiratory problems are most vulnerable to ozone exposures, but even healthy people engaged in outdoor physical activity can experience ozone-related health effects. Because children frequently play outdoors in the afternoon hours of the summer months—when ozone levels are highest—they could be exposed to higher levels of ozone than adults.

NJDEP issues air quality forecasts to notify community members when ozone levels are expected to be unhealthy. NJDEP also sends daily air quality forecasts to the local media, which usually broadcast this information to the public, especially on days when air quality is expected to be poor. On days with elevated ozone concentrations, NJDEP encourages children and those with

⁷ In 1997 EPA proposed a new NAAQS for ozone: an 8-hour average concentration of 0.08 ppm. Since 1997 this proposed standard has been the subject of extensive legal debate. According to NJDEP, EPA's 1-hour standard will remain in effect in Ocean County until attainment with this standard is demonstrated.

asthma to reduce their outdoor activities, and healthy individuals to avoid strenuous outdoor activities (e.g., jogging). ATSDR agrees with NAES Lakehurst's recommendation that the base day-care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members when air pollution reaches unhealthy levels. It is especially important for parents to communicate these air-quality warnings to children. Children are sensitive to ozone exposure and are less likely than adults to seek and understand environmental health information that is broadcast by the media.

E. Contamination in Other Environmental Media

When addressing these issues, ATSDR obtained data on other potential exposure pathways at NAES Lakehurst, including contacting soil, surface water, sediment, and biota (other than deer) contamination. The available data indicate that base personnel, base residents, and community members are not exposed to unhealthy levels of environmental contamination in these media. Therefore, ATSDR considers these exposure pathways to be no apparent public health hazard. Appendix C reviews the data ATSDR considered when reaching this conclusion.

IV. ATSDR's Child Health Considerations

Because children often are at greater risk than adults for exposure to toxic chemicals, ATSDR specifically evaluated children's health issues when preparing this PHA. As Figure 3 notes, 459 children live within 1 mile of the NAES Lakehurst property line, and 38 children live in housing within the base property. For reasons listed below, both groups of children could be at greater risk for experiencing public health hazards identified earlier in this PHA. The following paragraphs describes the unique hazards that these children could face, as well as measures that are being taken or should be taken to minimize these hazards.

- *Contacting UXO/CWM.* ATSDR believes the UXO/CWM that remains on NAES Lakehurst property is a hazard if people locate and disturb UXO/CWM. If this happens, people could be seriously injured, exposed to chemical agents, or killed. Although UXO/CWM could be in other locations, these materials are most likely located in the western half of NAES Lakehurst property (see Figure 6). ATSDR realizes that many parents fish, hunt and/or hike on base with their children, and during these times they supervise and instruct their children on health and safety matters. Because children often do not understand risk communication messages prepared for adults, such as the signs posted throughout NAES Lakehurst property, ATSDR believes that parents should continue to discuss these issue with their children. The children who live in NAES Lakehurst housing have unrestricted access to much of the base property where UXO/CWM remain and are particularly at risk for these hazards if materials are disturbed or degrade—children have a tendency to explore lands, collect items as souvenirs, and dig in soils. However, the areas are far enough from base housing that younger children, toddlers, and infants would be unlikely to explore these areas of the base during normal activities.

ATSDR recommends that NAES Lakehurst continue indefinitely administrative controls for all portions of the base that have not been otherwise cleared for safe and unlimited access and use. ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.

- *Inhalation exposure to ozone.* For many reasons, ATSDR is concerned that children who live at or near NAES Lakehurst—like children who live in many urban and suburban areas across the country—have a greater risk of suffering from ozone-related adverse health effects than do adults. This concern stems partly from the fact that ozone levels are generally highest during the afternoon hours on sunny summer days, when most children are not in school and are likely to be playing outdoors. Another reason for concern is that people with asthma have been identified as a sensitive population for ozone exposure, and asthma is more prevalent among

children than among adults (Mannino et al 2002). Finally, children might not seek or understand information on air quality forecasts. These factors are of concern because children who have asthma or who engage in moderate to strenuous exercise (e.g., swimming and running) on high-ozone days are at risk for inhaling unhealthy levels of ozone and possibly having air pollution-related breathing problems.

Fortunately, many resources are available to help prevent children from being exposed to unhealthy levels of ozone. As noted earlier, NJDEP issues air quality forecasts, and the local media usually broadcast them. Parents should encourage their children to play indoors on days when ozone levels are predicted to be unhealthy. In addition, ATSDR agrees with NAES Lakehurst's recommendation that the base day care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members when air pollution reaches unhealthy levels. For additional information, EPA has recently launched a Web site targeting health-related air pollution information to children. The site, named "Air Quality Index for Kids!", is available in English and Spanish at: www.epa.gov/airnow/aqikids/index.html.

V. Conclusions

After thoroughly evaluating environmental contamination data for NAES Lakehurst and how people might come into contact with that contamination, ATSDR has reached the following conclusions. (Refer to the Glossary (Appendix A) for definitions of the hazard categories that ATSDR uses in these conclusions, which are shown in quotes below).

1. The public is not currently being exposed to contaminated groundwater from NAES Lakehurst, nor were they exposed in the past. Past releases of fuels and solvents at NAES Lakehurst have resulted in contaminated groundwater at several areas within the base boundary and in one area that extends south of the base. But no one obtains drinking water from the contaminated areas, nor is it likely that anyone will in the future. The groundwater contamination at NAES Lakehurst is therefore "no public health hazard."
2. ATSDR believes that there is insufficient data to evaluate potential levels of exposures in and around the proving ground and test facilities during 1918-1921 and therefore considers it an "indeterminate public health hazard" in the past. However, there is no indication that past releases or exposures have occurred since chemical warfare testing ended in 1921. For example, there have been no reported or unexplained deaths or injuries to a wide variety of fish and wildlife, nor unexplained vegetation stress or obvious changes in the number and types of insects.

An unknown amount of unexploded ordnance (UXO) and possibly chemical warfare materiel (CWM) remains on NAES Lakehurst property in areas where base personnel and base residents have access. Although the Navy has implemented several measures that have greatly reduced the possibility that someone could be injured or killed by encountering UXO/CWM, these materials are inherently dangerous and pose a hazard to base personnel and families if they encounter and tamper with them. However, administrative controls, standard operating procedures, and contingency plans are in place to protect base personnel and families as well as the general public. Public access to the base is generally restricted, and public health and safety is considered when access is allowed in limited areas during air shows and other community events.

3. Meat from deer hunted on NAES Lakehurst is not a hazard from radiological contamination currently or in the past, and is not likely to be in the future. Community members asked if meat from deer hunted on NAES Lakehurst contains unsafe levels of radiological contamination because of an explosion and fire that occurred in 1960 at the nearby BOMARC missile site. Based on the contamination levels, deer-foraging behavior, and knowledge of how radiological contamination accumulates in plants and animals, ATSDR concludes that deer meat harvested from NAES Lakehurst is not a hazard from radiological contamination. The appropriate hazard category for this issue is "no apparent public health hazard."

4. NAES Lakehurst's air emissions are not a health hazard, although regional air quality near the base is occasionally poor. NAES Lakehurst, like most research and development facilities, has several operations that release contaminants into the air. These contaminants reach locations off of base property, but not at levels associated with adverse health effects. Therefore, air emissions from NAES Lakehurst are not a health hazard to community members. Because people could be exposed, though not at unsafe levels, the appropriate hazard category for this issue is "no apparent public health hazard."

General air quality in Ocean County is sometimes poor, due to potentially unhealthy levels of ozone that occur on occasion during the summer months. Ozone is a problem in urban and suburban areas throughout the northeast United States resulting from a broad range of industrial and motor vehicle emissions, not just from a single source. The general air quality in Ocean County during some days in the summer could cause some people exposed to elevated ozone levels to experience health effects, such as lung irritation and difficulty breathing. Children, the elderly, and those with asthma are sensitive populations to ozone exposure.

5. Contamination in soils, surface water, sediment, and fish on NAES Lakehurst property are not a health hazard. ATSDR researched levels of contamination in these environmental media at NAES Lakehurst. The levels of contamination measured are not a health hazard because the Navy has already removed soils and sediments having the highest levels of contamination and because people do not live or work near the areas where contamination is currently found; the levels of contamination in these environmental media is "no apparent public health hazard."

VI. Public Health Action Plan

The public health action plan for NAES Lakehurst describes actions taken at the base and those recommended to be taken at the base after ATSDR completes this PHA. The purpose of the public health action plan is to ensure that this PHA not only identifies potential and ongoing public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects from occurring in the future. The following public health actions at NAES Lakehurst are completed, ongoing, planned, or recommended:

A. Completed Actions

As documented in the Remedial Investigation and Records of Decision, NAES Lakehurst has identified areas of environmental contamination, characterized the nature and extent of this contamination, and implemented various projects to reduce or remove this contamination.

B. Ongoing Actions

1. NAES Lakehurst continues to monitor six groundwater contamination plumes and treat contaminated groundwater from three of these plumes.
2. The base water supply and the nearby public water utilities routinely test the drinking water for bacterial, chemical, and radiological contamination.
3. NAES Lakehurst continues to inform residents, base personnel, and relevant visitors to base property (e.g., contractors) of the hazards posed by UXO/CWM that remain on base property.
4. NJDEP continues to monitor ambient air concentrations of ozone in the vicinity of NAES Lakehurst and to notify the media on days when air quality is expected to be poor.

C. Planned Actions

1. The BOMARC missile site (which was identified as a site of concern during ATSDR's visit to NAES Lakehurst) is scheduled for a removal of soils and building structures with radiological contamination.
2. The Navy plans to continue to monitor the spatial extent of contaminated groundwater in Areas A/B and I/J through routine sampling of monitoring and perimeter wells. The Navy plans to continue this sampling until applicable or relevant and appropriate requirements are met or until EPA grants a "no further action" decision.
3. DOD will re-evaluate site conditions, current technologies, and historical information on unexploded ordnance and chemical munitions. ATSDR concurs that this effort should include evaluation of all areas on base to determine if the current administrative controls for disturbance or other intrusive activity in soils in some areas should be expanded to additional areas of the base. This includes the review of current size and location of warning signs.
4. NJDEP will continue to issue air quality alerts on days when ozone concentrations are expected to reach potentially unhealthy levels. Everyone living in affected areas should heed these warnings, which typically encourage residents, especially children, outdoor laborers, the elderly, and those with pre-existing respiratory conditions to remain indoors and to avoid any moderate or strenuous exercise. It is especially important for parents to communicate these warnings to their children, who might not understand ozone warnings and who often play outdoors during the warm summer months. In addition, ATSDR agrees with NAES Lakehurst's recommendation that the base day care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members

when air pollution reaches unhealthy levels. Instructions for how to join this program can be found at: <http://www.state.nj.us/dep/airmon/maillist.htm>.

D. Recommended Actions

1. ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.
2. ATSDR recommends that NAES Lakehurst continue indefinitely administrative controls for all portions of the base that have not been otherwise cleared as safe for unlimited access and use.
3. Although ATSDR expects that exposures to plutonium through consumption of deer meat is insignificant, any potential exposure would most likely be from eating deer liver or kidney or using bones in cooking stews or soups. Eliminating consumption of these organs and eliminating the use of bones would limit any potential exposure.

ATSDR's Response to Public Comments

The NAES Lakehurst Public Health Assessment was released for public comment on April 22, 2003. The comment period ended on June 9, 2003.

Comments were received from NAES Lakehurst, Navy Environmental Health Center (NEHC), and the Ocean County Board of Health (OCHD). Comments that were editorial in nature were addressed within the document and are not discussed here.

1. **Comment:** NAES Lakehurst noted that to the best of their knowledge the Focused Feasibility Study for Site 41 dated July 31, 1996 included an inventory of all suspected ordnance remaining at the base.

Response: This information was incorporated within the document, replacing a statement that no complete ordnance inventory had been compiled.

2. **Comment:** NEHC agrees with ATSDR's statement that eliminating the consumption of deer liver and kidney and eliminating the use of deer bones in cooking will limit any potential exposure to plutonium in the deer. They do not feel, however, that it is appropriate as a recommendation because it is speculative and as one of three recommendations for the entire facility the comment is likely to be interpreted as a health risk associated with eating deer organs.

Response: ATSDR concurs that there is no evidence that deer are grazing in fenced areas of BOMARC, and that a number of conservative, worst-case scenarios evaluated overestimate the health risk associated with eating deer organs. ATSDR's health assessors would not be concerned about exposure to radioactivity based on the site-specific information provided in this report and the BOMARC PHA. Those individuals and families, however, who would like to take additional precautions should be provided sufficient information to make individual choices that would further reduce their risk.

3. **Comment:** The Ocean County Health Department believes that for the issue of unexploded ordnance and chemical warfare materiel, more emphasis should be placed upon the evaluation of historical information and health and safety measures.

Response: Information on munitions and health and safety measures to protect base personnel and the public are provided throughout this document. ATSDR believes that the NAES Lakehurst is reevaluating available historical information and health and safety measures related to munitions. Any new information or evaluations will be provided to the public. Specific details are provided in the Public Health Action Plan of this document.

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Figures

Figure 1
Location of NAES Lakehurst in Ocean County, NJ

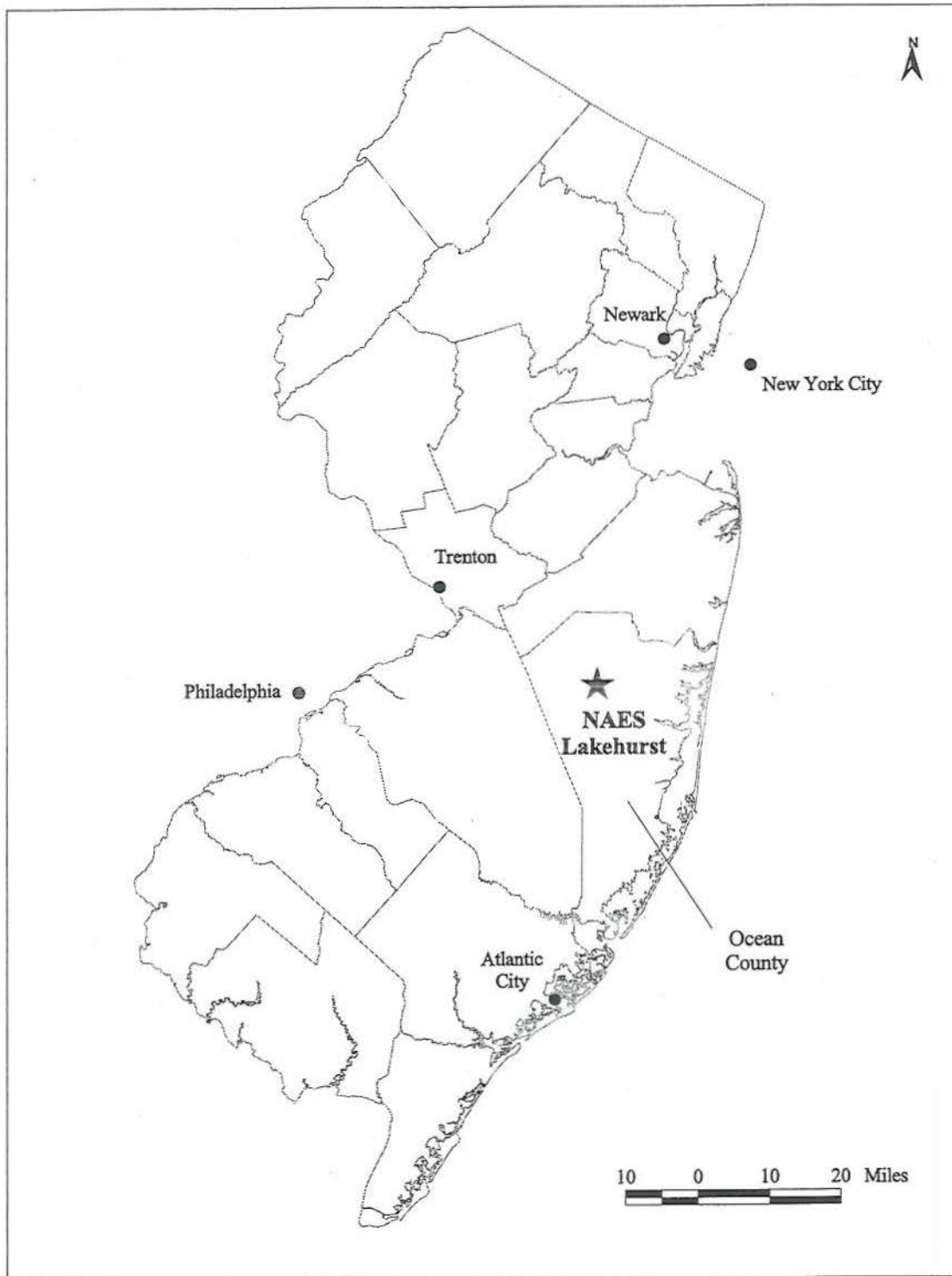
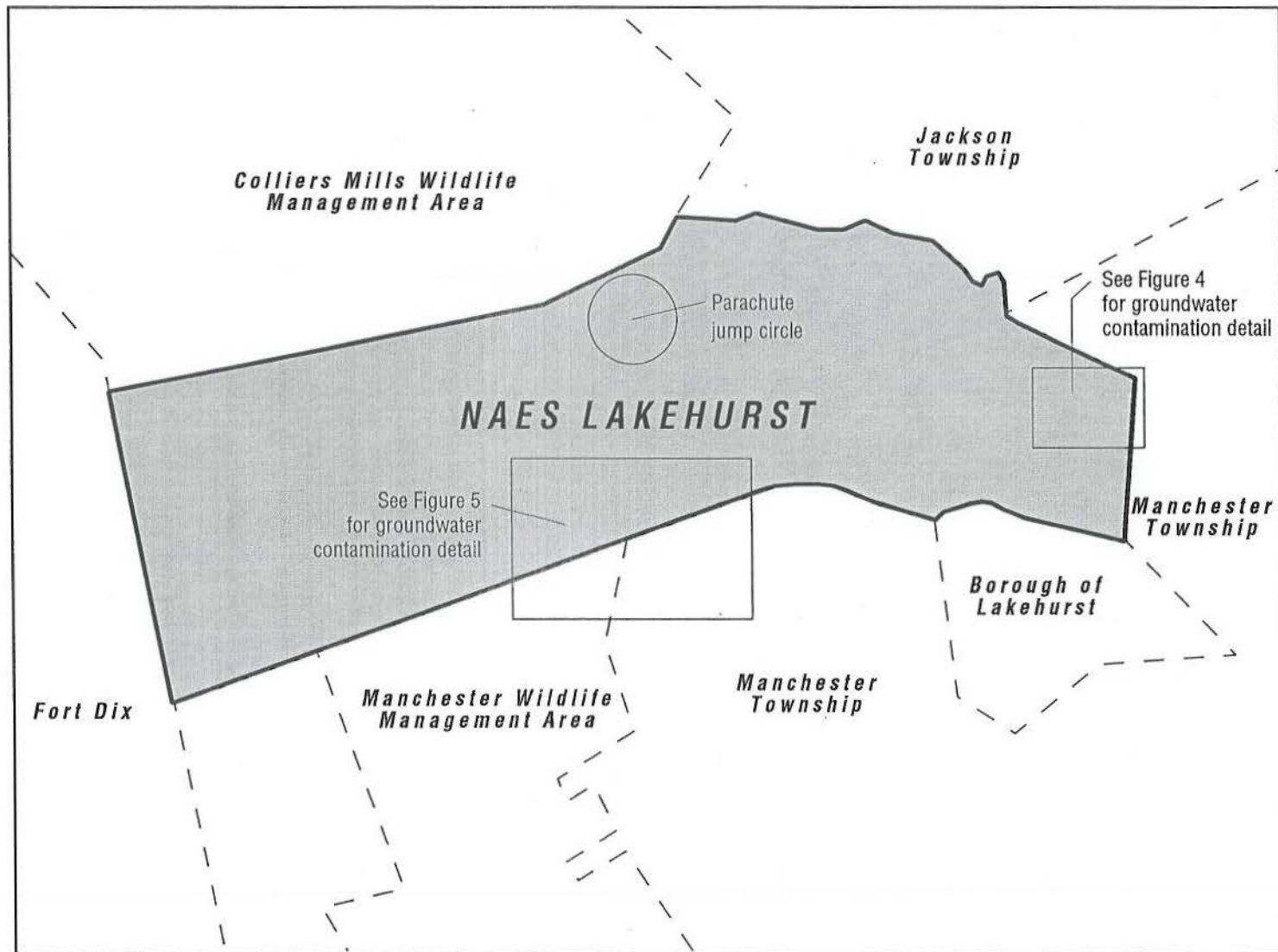


Figure 2
Immediate Vicinity of NAES Lakehurst



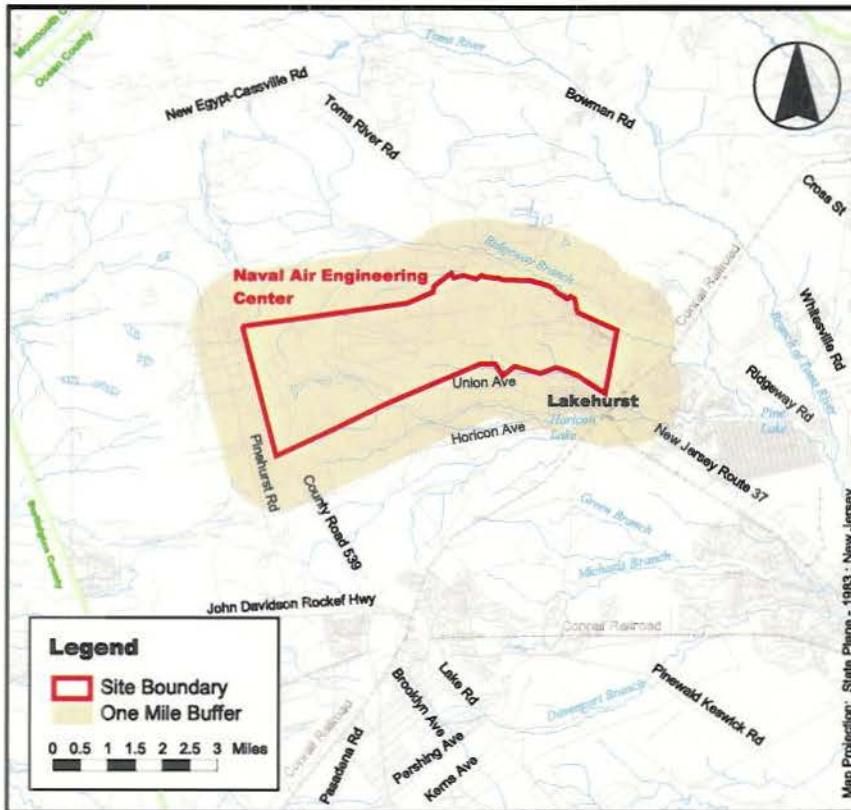
Naval Air Engineering Station

Lakehurst, New Jersey
EPA Facility ID NJ7170023744

Figure 3



Ocean County, New Jersey



Base Map Source: 1995 TIGER/Line Files

Demographic Statistics Within Area of Concern*

Total Population	6545
White alone	5921
Black alone	320
Am. Indian and Alaska Native alone	24
Asian alone	99
Native Hawaiian and Other Pacific Islander alone	5
Some other race alone	89
Two or More races	84
Hispanic or Latino	292
Children Aged 6 and Younger	459
Adults Aged 65 and Older	2460
Females Aged 15 - 44	929
Total Housing Units	3175

Demographics Statistics Source: 2000 US Census
*Calculated using an area-proportion spatial analysis technique

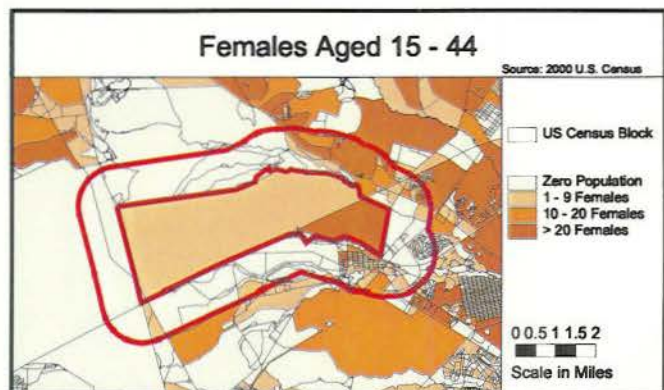
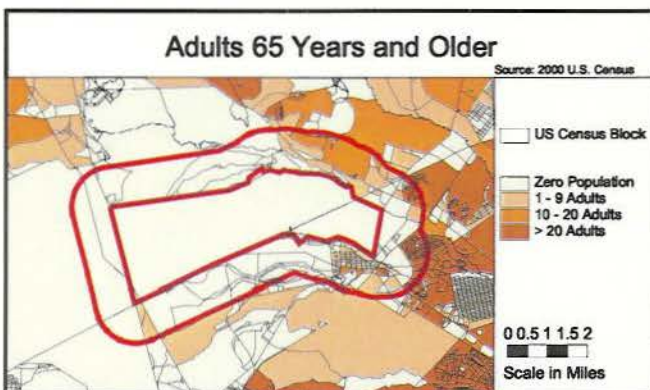
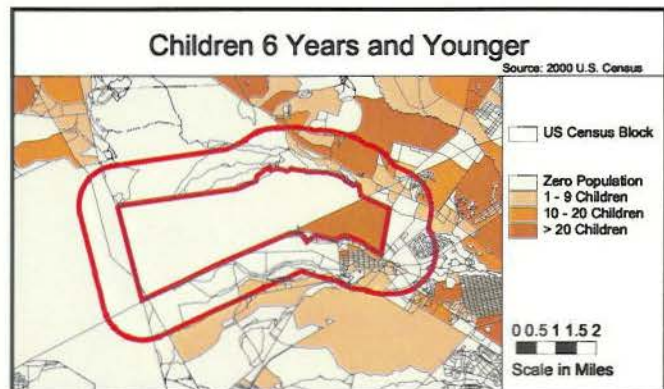
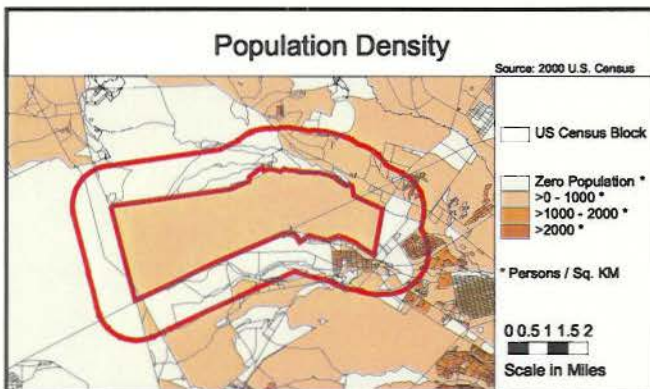


Figure 4
Groundwater Contamination in Area A/B

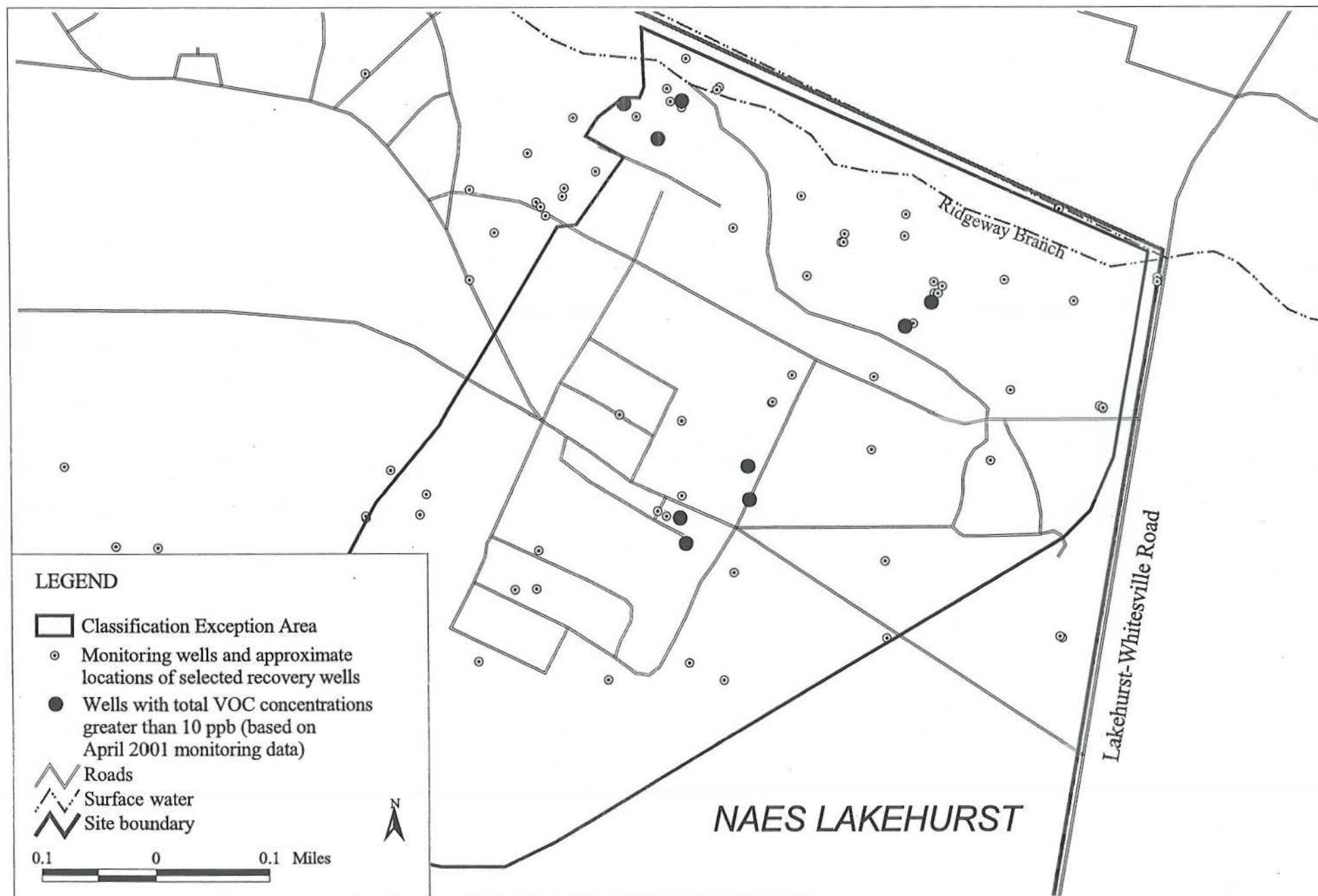
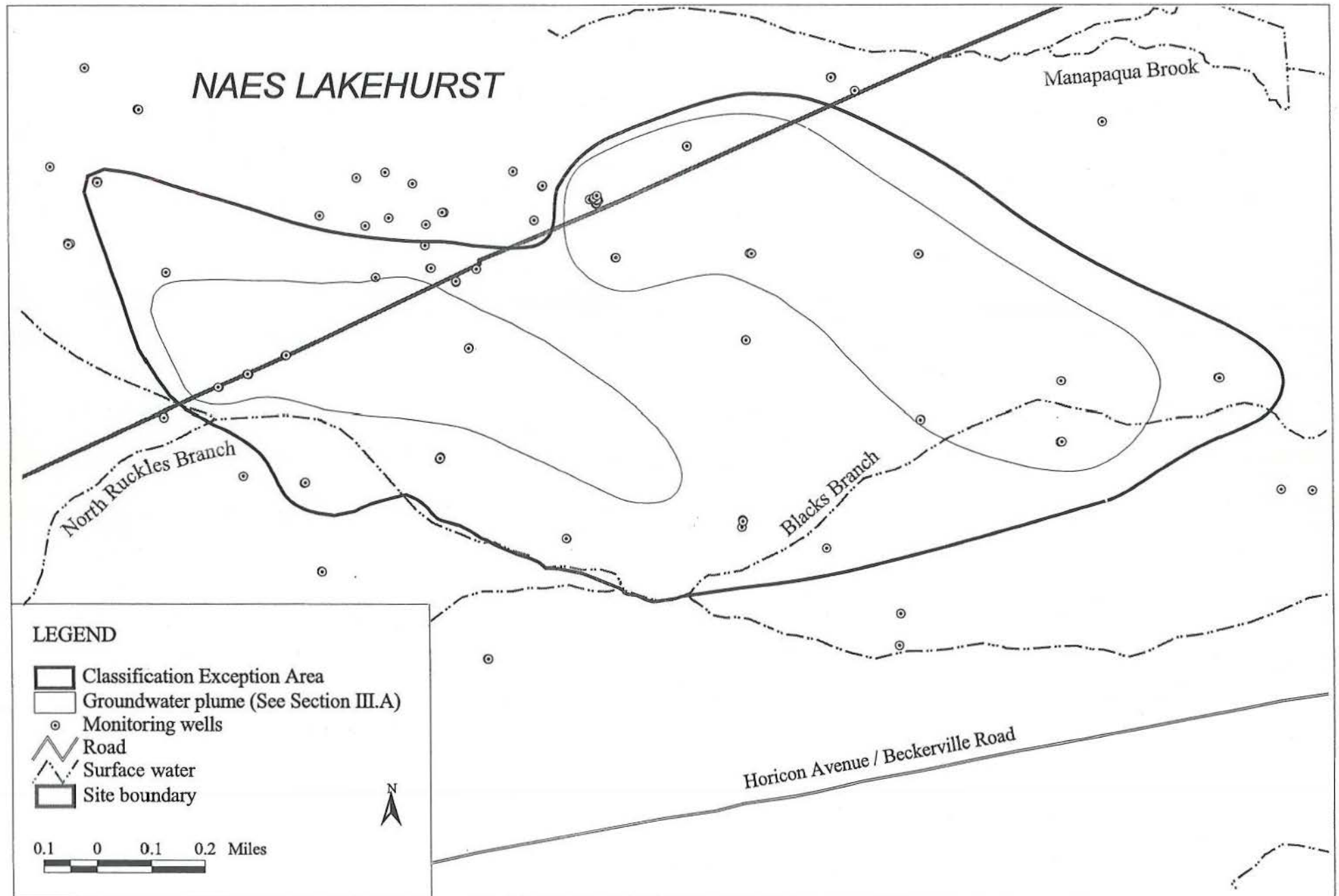


Figure 5
Groundwater Contamination in Area I/J



NAES Ordnance Contaminated Areas

May 2001

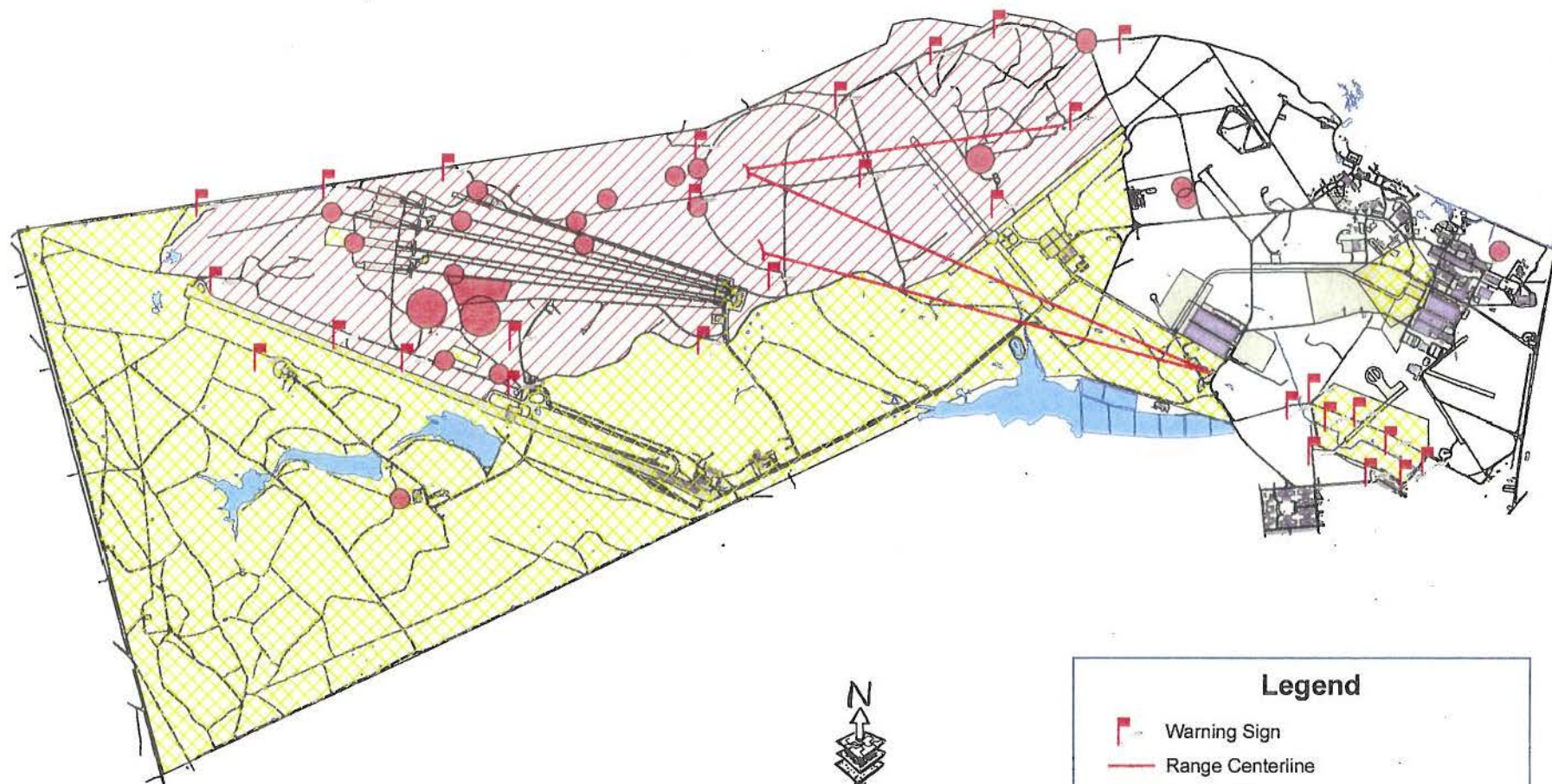


Figure 6

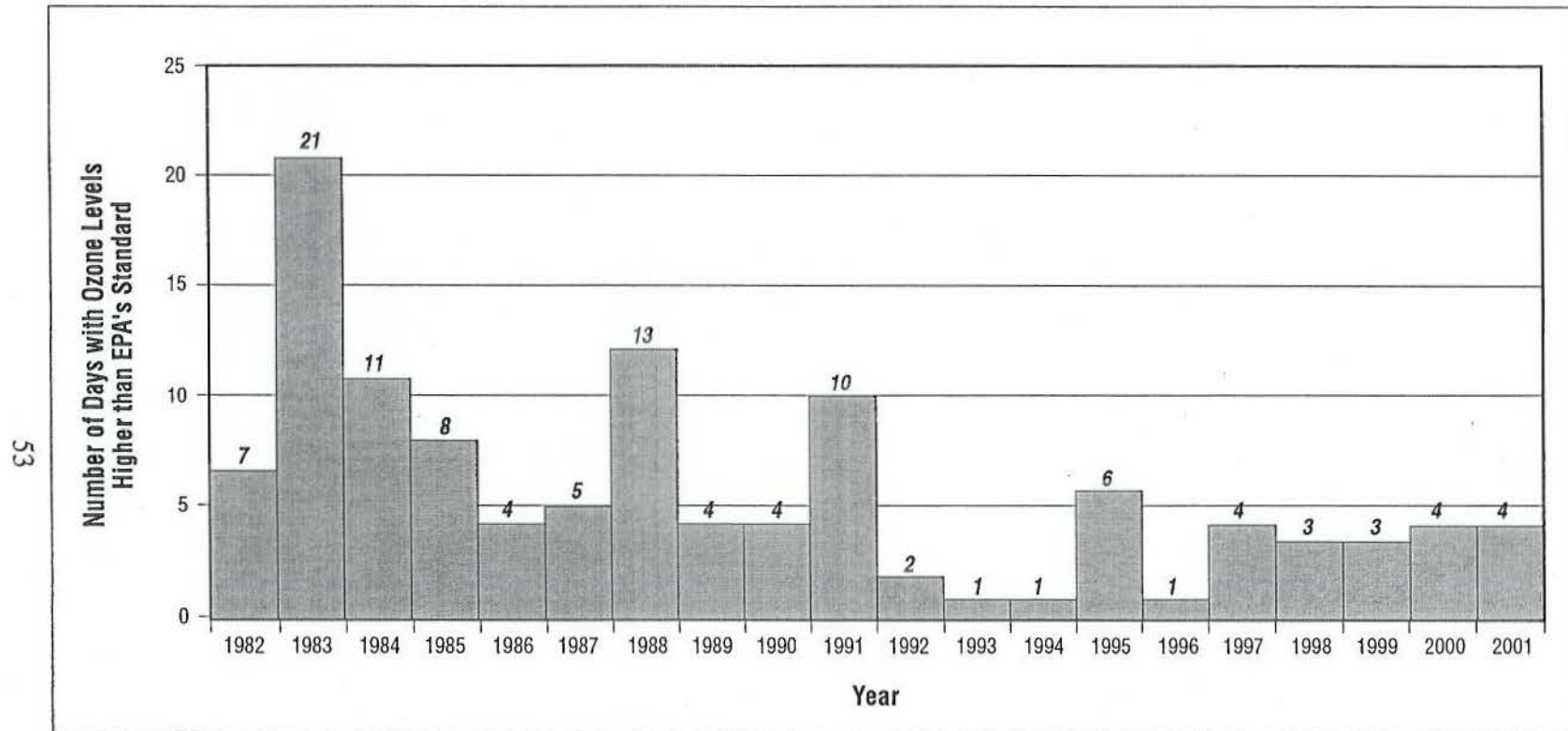
0 1,750 3,500 7,000
Feet

Legend

-  Warning Sign
-  Range Centerline
-  Surface Water
-  Ordnance Finds
- Ordnance Contaminated Areas:**
 -  Low Probability Areas: Use Caution
 -  Low Probability Areas: Use Caution
 -  Sweep Required for Ground Disturbance
 -  Building
 -  Road

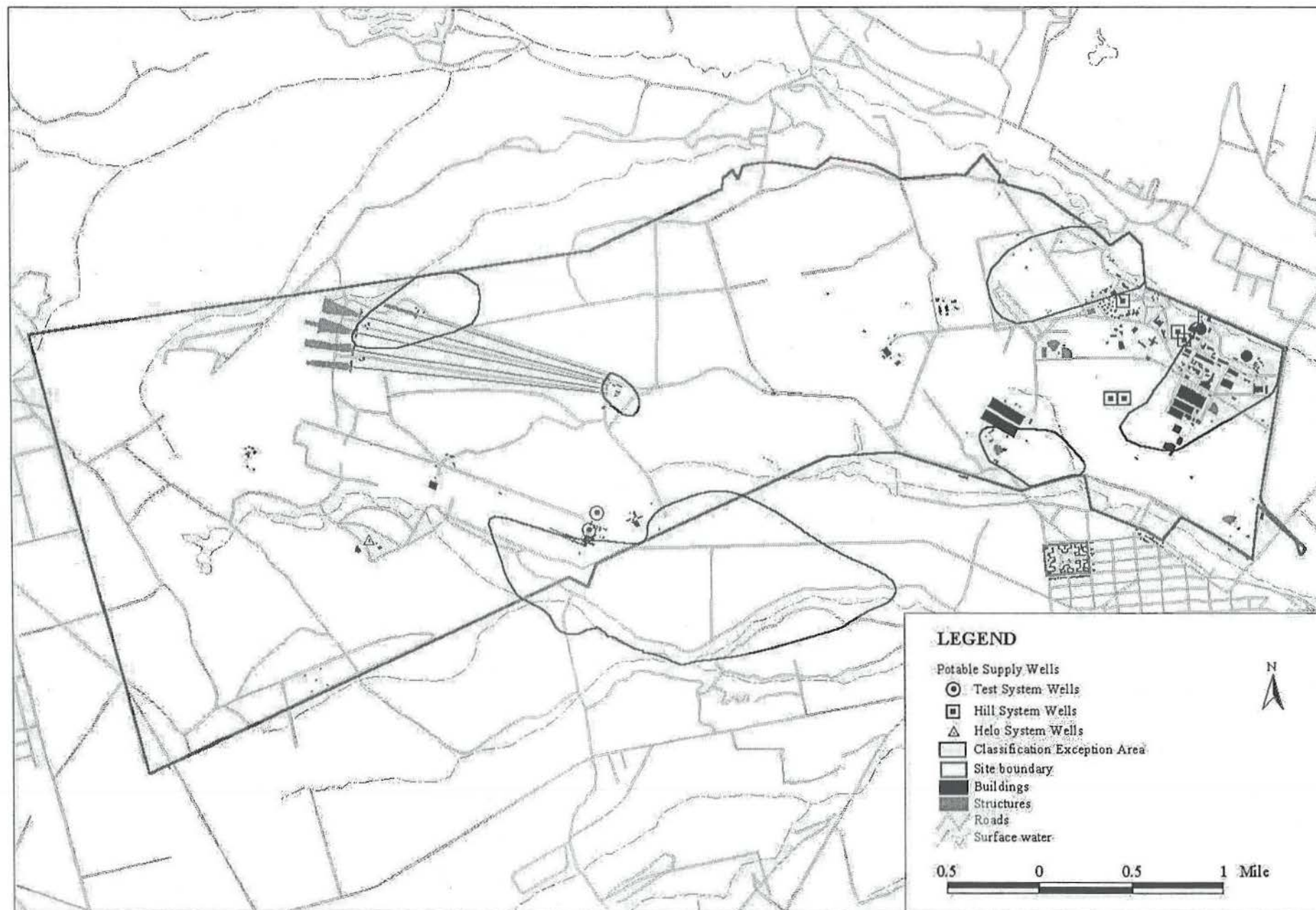
Figure 7

Number of Days on which Ozone Concentrations Exceeded EPA's Health-Based Standards near NAES Lakehurst, by Year



Notes: Based on data collected at McGuire AFB (1982-1991) and Colliers Mills (1992-2001), both are within 5 miles of NAES Lakehurst. EPA's 1-hour average National Ambient Air Quality Standard for ozone (0.12 ppm) was used in this evaluation.

Figure 8
Potable Supply Wells and Classification Exception Areas at NAES Lakehurst



Tables

Table 1: Possible Exposure Situations from NAES Lakehurst

Exposure Situation	Time Frame	Exposure?	Conclusion Category	Actions Taken to Limit Exposure
Drinking or contacting groundwater either on or off base (NAES Lakehurst water supply, Lakehurst Water Department, private wells nearest base property)	Past Current	No	No public health hazard	■ Areas of groundwater contamination are well characterized and closely monitored. ■ Administrative controls restrict installation of wells in areas known to have the highest contamination. ■ Water supplies are routinely tested for chemical, bacterial, and radiological contamination.
	Future	Possible, not likely	No public health hazard	
Contacting UXO/CWM while hunting, hiking, fishing, or playing on base (Locations on base property where UXO/CWM are most commonly found, see Figure 6)	Past: 1918 to 1921	Unknown	Indeterminate public health hazard	■ Areas where UXO/CWM most likely remain have been identified. Signs warn people entering these areas of the potential hazards. ■ Other administrative controls in place include requiring hunters to take an annual training course on the dangers of UXO/CWM and informing all new base personnel (civilian and military) and contractors about the specific risks these items pose. ■ An explosive ordnance disposal team from either the Army (Fort Dix) or the Navy (Naval Weapons Station Earle) is called before digging in any areas suspected to have unexploded ordnance or chemical munitions. ■ NAES Lakehurst has developed contingency plans and standard operating procedures for response to a release from transportation and/or storage of industrial chemicals either on base or in the community. ■ DOD will re-evaluate site conditions, current technologies, and historical information on unexploded ordnance and chemical munitions.
	Past: 1921 to 2003	No Indication	No public health hazard	
	Current Future	Possible, not likely	Hazard only if chemical release or explosion occurs.	

Table 1: Possible Exposure Situations from NAES Lakehurst

Exposure Situation		Time Frame	Exposure Yes/No	Conclusion Category	Actions Taken to Limit Exposure
Eating deer possibly containing radiologic contamination from BOMARC (Primarily deer harvested from the western half of the base property)		Past Current Future	Not likely	No apparent public health hazard	■ Hunting is restricted to base personnel, base residents, and military retirees. ■ Although ATSDR expects that exposures to plutonium through consumption of deer meat is insignificant, any potential exposure would most likely be from eating deer liver or kidney or using bones in cooking stews or soups. Eliminating consumption of these organs and eliminating the use of bones would limit any potential exposure.
Air Pollution	Pollutants emitted from NAES Lakehurst	Past Current Future	Possible	No apparent public health hazard	■ NAES Lakehurst submitted an application for a Title V air permit to the NJDEP, and received its final Title V operating permit on September 6, 2002. ■ Several base programs (i.e., conversion of fleet vehicles to natural gas, replacing fuel-oil fired boilers with natural gas fired boilers) have reduced the amounts of pollution released to the air.
	Ozone, a pollutant that is a regional air quality issue during some summer days.	Current Future	Yes	Non-site related, no category	■ NJDEP has developed a plan to reduce potentially unhealthy levels of ozone, which typically occur in the afternoon hours during the summer months. ■ NJDEP issues (and local media usually broadcast) air quality warnings when ozone levels are expected to be unhealthy. ■ NAES Lakehurst recommends that the base day-care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members when air pollution reaches unhealthy levels.

Table 2: Main Exposure Situations and Hazard Summary

Exposure Situation	Time Frame	Exposure Yes/No	Hazard	Actions Taken/Planned	Recommendations	Comments and Observations
Drinking water from the base water supply and groundwater wells in the immediate vicinity of Lakehurst. Possible contaminants include chemicals in fuels, hydraulic fluids, and solvents used to maintain aircraft and supporting equipment. These chemicals include aromatic hydrocarbons and chlorinated solvents.	Past Current Future	No Possible, not likely	No public health hazard. No public health hazard.	<u>Actions</u> ▫ Areas of groundwater contamination are well characterized and closely monitored. ▫ Administrative controls restrict installation of wells in areas known to have the highest contamination. ▫ Water supplies are routinely tested for chemical, bacterial, and radiological contamination.	<u>Recommendations</u> ▫ None.	<u>Community Questions</u> ▫ Is it safe to drink the tap water from the base water supply? <u>Observations</u> ▫ Three well systems provide the drinking water for the base. All of these systems are routinely tested for chemical, bacterial, and radiological contamination, and the current test results show no signs of potentially unhealthy levels of contamination. ▫ The majority of potable water wells at NAES Lakehurst and nearby private wells draw from the Kirkwood/Cohansey aquifer.

Table 2: Main Exposure Situations and Hazard Summary

Exposure Situation	Time Frame	Exposure Yes/No	Hazard	Actions Taken/Planned	Recommendations	Comments and Observations
Base personnel, base residents, and visitors encountering unexploded ordnance (UXO) and chemical warfare materiel (CWM) that remain on base property.	Past - 1918 to 1921	Unknown	Indeterminate public health hazard.	<u>Actions</u> - Areas where UXO/CWM most likely remain have been identified. Signs warn people entering these areas of the potential hazards. - Other administrative controls in place include requiring hunters to take an annual training course on the dangers of UXO/CWM and informing all new base personnel (civilian and military) and contractors about the specific risks these items pose.	<u>Recommendations</u> ATSDR recommends that, as new information becomes available, NAES Lakehurst continue to update its materials used to inform base residents and base personnel about the hazards associated with disturbing UXO and CWM. Providing information to residents is important to ensure that children of families who reside in housing on base understand the hazards associated with UXO and CWM.	<u>Observations</u> - The areas where most UXO and CWM are believed to remain are located far from base housing and other areas frequented by base residents. Base residents can access these areas, however, when hunting, fishing, and hiking. - Though base records and anecdotal observations indicate that on-base residents have occasionally located UXO, to date none of these contacts has resulted in injury or other adverse health effect at NAES Lakehurst.
Possible contaminants include the chemicals within UXO and CWM. Possible physical hazards may result from disturbing UXO, which are believed to be primarily artillery shells smaller than 1 foot in size.	Past - 1921 to 2003	No Indication	No public health hazard	- An explosive ordnance disposal team from either the Army (Fort Dix) or the Navy (Naval Weapons Station Earle) is called before digging in any areas suspected to have unexploded ordnance or chemical munitions. - NAES Lakehurst has developed contingency plans and standard operating procedures for response to a release from transportation and/or storage of industrial chemicals either on base or in the community. - DOD will re-evaluate site conditions, current technologies, and historical information on unexploded ordnance and chemical munitions.		
	Current Future	Possible, not likely	No apparent public health hazard			

Table 2: Main Exposure Situations and Hazard Summary

Exposure Situation	Time Frame	Exposure Yes/No	Hazard	Actions Taken/Planned	Recommendations	Comments and Observations
Eating deer or other game harvested on base. Possible contaminants include metals and pesticides, as well as radionuclides (most notably plutonium) and radiation that were previously released during a fire that occurred in 1960 at the neighboring BOMARC site.	Past Current Future	Possible	No apparent public health hazard.	<u>Actions</u> □ Hunting is restricted to base personnel, base residents, and military retirees.	<u>Recommendations</u> □ Although ATSDR expects that exposures to plutonium through consumption of deer meat is insignificant, any potential exposure would most likely be from eating deer liver or kidney or using bones in cooking stews or soups. Eliminating consumption of these organs and eliminating the use of bones would limit any potential exposure.	<u>Observations</u> □ Between 1991 and 1997, an average of 66 deer were harvested annually by hunters on NAES Lakehurst property. □ The likelihood that deer meat at Lakehurst contains unhealthy levels of radiation or radionuclides is very low. ATSDR bases this judgement on several observations: (1) much of the area at the BOMARC site where radiation was released is now paved; (2) deer feed over a broad area and likely do not feed only in the most contaminated areas; (3) when deer eat vegetation containing plutonium, only a small fraction (roughly 2%) of the plutonium remains in the animal; (4) plutonium in deer typically concentrates in bones, not in the deer meat; (5) deer and humans absorb only a small fraction of alpha radiation in their diets.

Table 2: Main Exposure Situations and Hazard Summary

Exposure Situation	Time Frame	Exposure Yes/No	Hazard	Actions Taken/Planned	Recommendations	Comments and Observations
Breathing air containing pollutants released from NAES Lakehurst operations as well as pollutants released by numerous sources throughout central New Jersey and beyond. Possible contaminants include combustion byproducts, chemicals in solvents, metals, ozone, particulate matter, and sulfur dioxide. See Section III.D.	Past Current Future Current Future	Possible Yes	For pollutants other than ozone: No apparent public health hazard. Regional ozone: Is a health concern when levels are high especially in summer months.	<u>Actions</u> On Base □ NAES Lakehurst submitted an application for a Title V air permit to the NJDEP, and received its final Title V operating permit on September 6, 2002. □ NAES Lakehurst has implemented several measures (e.g., conversion of fleet vehicles to natural gas, replacing fuel-oil fired boilers with natural-gas fired boilers, elimination of ozone depleting substances) to reduce the amounts of air emissions. Regional ozone □ NJDEP routinely measures airborne ozone in Ocean County and measures other pollutants in the area. □ NJDEP has developed a plan to reduce potentially unhealthy levels of ozone in New Jersey's air. □ NAES Lakehurst recommends that the base day-care center and medical facilities subscribe to the NJDEP's Bureau of Air Monitoring air advisory program which directly notifies members when air pollution reaches unhealthy levels.	<u>Recommendations</u> None.	<u>Community Questions</u> □ Does NAES Lakehurst release unhealthy levels of air contaminants? Do respiratory conditions (e.g., asthma) among children in the area result from air emissions from NAES Lakehurst? <u>Observations</u> □ Ocean County is a severe non-attainment area for ozone, which means that air concentrations of ozone are periodically measured at potentially unhealthy levels. □ The elevated ozone levels result from industrial and motor vehicle emissions over a broad area. Emissions from NAES Lakehurst account for a small fraction of the ozone in the Ocean County air. □ Ozone levels are typically highest in the summer months. Children, the elderly, and people with pre-existing respiratory conditions should remain indoors and avoid strenuous activity, to the greatest extent possible, on days when NJDEP warns that ozone levels will be high.

Table 3: Overview of VOC Groundwater Contamination at NAES Lakehurst

Area	Sources of Contamination (See Appendix C)	Contaminants Detected and Concentrations Recently Measured (see footnotes at end of table)	Reported Spatial Extent of Contamination	Regulatory and Remedial History (see footnotes at end of table)
A/B	Past releases were from fire fighting training, fuel storage and handling, and landfills. Some solid and liquid wastes were disposed of directly on soils.	Contaminants of concern are petroleum hydrocarbons and chlorinated solvents. The five organic contaminants detected at the highest levels were: Toluene—710 ppb Total xylenes—445 ppb Tetrachloroethylene—250 ppb Ethylbenzene—230 ppb <i>cis</i> -1,2-Dichloroethylene—160 ppb	A 2001 report for Area A/B shows that the plume of total VOC concentrations greater than 10 ppb lies entirely within the base boundary. Contamination is limited to the first 30 feet below the groundwater table.	In 1992, a Record of Decision implemented an interim groundwater treatment action. Since October 1993, the base has pumped contaminated groundwater from Area A/B, removed contaminants using an air stripper, and returned the “clean” groundwater to the aquifer. Recent data suggest that the base is treating approximately 250 million gallons of contaminated groundwater from this area per year. Other treatment technologies are also being employed, and NAES Lakehurst has occasionally modified the groundwater treatment system to optimize the system performance. A 1997 Record of Decision required that the groundwater treatment operations continue.

Table 3: Overview of VOC Groundwater Contamination at NAES Lakehurst

Area	Sources of Contamination (See Appendix C)	Contaminants Detected and Concentrations Recently Measured (see footnotes at end of table)	Reported Spatial Extent of Contamination	Regulatory and Remedial History (see footnotes at end of table)
C	Contaminants originated from past spills, releases from an oil/water separator, leaking fuel storage equipment, and a waste lagoon where fire fighting training was conducted.	Contaminants of concern are petroleum hydrocarbons; chlorinated solvents have also been detected, but generally in lower amounts and in localized areas. The five organic contaminants detected at the highest levels were: Naphthalene—200 ppb Total Xylenes—142 ppb 2-Methylnaphthalene—130 ppb 1,3,5-Trimethylbenzene—66 ppb Tetrachloroethylene—63 ppb	Elevated contamination levels occur within the base boundaries, with no detections occurring at the perimeter monitoring well. Contamination is limited to the first 30 feet below the groundwater table.	In 1990, a Record of Decision was signed to implement an interim action of pumping and treating contaminated groundwater. This system first operated in June 1991, and has been supplemented with vapor extraction and bioventing systems. A subsequent Record of Decision in 1996 required that the groundwater treatment operations continue. Recent data suggest that the base is treating approximately 70 million gallons of contaminated groundwater from this area per year. NAES Lakehurst has occasionally modified the groundwater treatment system to optimize the system performance.
D	Contaminants originated from leaks and leachate from the base's former sanitary landfill, which spans 34 acres. Most of the landfill contains household wastes, but some industrial wastes were disposed of at this site.	Paint thinner, waste solvents, and other chemical wastes have contaminated the groundwater with various compounds, mainly aromatic hydrocarbons and chlorinated hydrocarbons. Between 1997 and 2000, elevated concentrations were noted for the following VOCs: 1,4-Dichlorobenzene—35.5 ppb <i>cis</i> -1,2-Dichloroethylene—25 ppb Chlorobenzene—24.9 ppb Vinyl chloride—17.84 ppb 1,2,4-Trichlorobenzene—14.3 ppb	Groundwater contamination (total VOC levels greater than 10 ppb) has extended roughly 1,000 feet northeast of the former landfill, but not to locations outside base property. Contamination is limited to the first 30 feet below the groundwater table.	In 1993, a Record of Decision was signed for this groundwater area. The selected remedy was no clean-up action, with continued groundwater monitoring. The monitoring locations included four pairs of perimeter monitoring wells, with each pair consisting of a shallow and deep monitoring well.

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Area	Sources of Contamination (See Appendix C)	Contaminants Detected and Concentrations Recently Measured (see footnotes at end of table)	Reported Spatial Extent of Contamination	Regulatory and Remedial History (see footnotes at end of table)
E	The main source of contamination is IRP Site 28, which is contaminated soils caused by a leaking fuel line.	Groundwater was primarily contaminated with petroleum hydrocarbons. VOC contamination in recent years was limited to the following chemicals: 2-Methylnaphthalene—2.4 ppb Naphthalene—1.2 ppb Toluene—0.4 ppb	As of 2001, all groundwater contaminant levels in this area met applicable or relevant and appropriate requirements.	From 1993 to 1998, NAES Lakehurst pumped and treated contaminated groundwater from Area E. Because the groundwater contained relatively low concentrations of chemicals, EPA and NJDEP allowed NAES Lakehurst to shut down its groundwater pump-and-treat system for Area E in October 1998.
F	Contamination occurred when Navy contractors pumped liquid wastes into an open pit between 1966 and 1974. As much as 40,000 gallons of wastes were discharged.	Contaminants were suspected to be those found in oily wastes, lubricants, and anti-freeze, such as hydrocarbons and chlorinated solvents. Groundwater sampling during all three phases of the RI found no VOC contamination at levels greater than applicable or relevant and appropriate requirements. Groundwater is no longer monitored in this area.	NAES Lakehurst collected groundwater samples from Area F during three field investigations. No significant groundwater contamination has been detected.	Without evidence of significant groundwater contamination, a Record of Decision signed in 1993 by NAES Lakehurst and environmental regulators proposed no further action for Area F.

Table 3: Overview of VOC Groundwater Contamination at NAES Lakehurst

Area	Sources of Contamination (See Appendix C)	Contaminants Detected and Concentrations Recently Measured (see footnotes at end of table)	Reported Spatial Extent of Contamination	Regulatory and Remedial History (see footnotes at end of table)
G	Three IRP sites are located within Area G. Contamination resulted from a blimp crash, buried solid wastes, and discharge of used fuel onto soil surfaces.	During initial investigations, petroleum hydrocarbons and metals were detected in the groundwater at two of the IRP sites, but the measurements were of questionable quality. Follow-up investigations revealed no evidence of groundwater contamination at these sites. At the third site (the blimp crash site), trace levels of petroleum hydrocarbons and chlorinated solvents were detected in samples collected through 1992.	NAES Lakehurst collected groundwater samples during several field studies near the three IRP sites in Area G. No significant groundwater contamination was found in the most recent sampling events.	Records of Decision signed in 1991 and 1993 required no further action to address soil contamination at the three sites within Area G. The 1993 Record of Decision required continued groundwater monitoring, which has not revealed evidence of contamination levels above applicable or relevant and appropriate requirements.
H	Waste fuels and oils were discharged to unlined dry wells. Some chemicals seeped from these wells into the groundwater. Leaks from fuel storage and transfers also released chemicals to the soils.	Contaminants of concern are primarily petroleum hydrocarbons associated with waste fuels, though chemicals found in chlorinated solvents have also been detected. The five organic contaminants detected at the highest levels were: Total xylenes—560 ppb Naphthalene—270 ppb 2-Methylnaphthalene—250 ppb Ethylbenzene—190 ppb 1,3,5-Trimethylbenzene—180 ppb	Groundwater contamination has been found to extend at least 800 feet downgradient from the source. Contamination is limited to the first 30 feet below the groundwater table.	In 1991 a Record of Decision called for construction of a pump-and-treat system to reduce groundwater contamination levels. The treatment operation commenced in May 1992. A final Record of Decision issued in 1996 required continued operation of the treatment system and ongoing groundwater monitoring. NAES Lakehurst has modified the groundwater treatment system occasionally since 1996 to optimize the system performance.

Table 3: Overview of VOC Groundwater Contamination at NAES Lakehurst

Area	Sources of Contamination (See Appendix C)	Contaminants Detected and Concentrations Recently Measured (see footnotes at end of table)	Reported Spatial Extent of Contamination	Regulatory and Remedial History (see footnotes at end of table)
I/J	Contamination was caused by chemicals released in the area where NAES Lakehurst tests catapult launching equipment. The waste streams included process wastewater and industrial solvents.	The contaminants found at highest levels in Area I/J between 1996 and 2000 are chlorinated hydrocarbons. The highest levels of detection (shown below) occurred at on-base locations, with far lower levels detected outside the base boundary. <i>cis</i> -1,2-Dichloroethylene—579 ppb Trichloroethylene—291 ppb Methylene chloride—278.4 ppb Tetrachloroethylene—233 ppb 1,1,1-Trichloroethane—139 ppb	As Figure 5 shows, groundwater contamination is believed to extend up to 1 mile south of the property boundary at Area I/J. Contamination in this area extends up to 90 feet below the groundwater table.	In the early 1990s the Navy studied groundwater contamination at Area I/J extensively and investigated the effectiveness of several treatment technologies. A 1999 Record of Decision indicated that groundwater contamination in Area I/J will be addressed by natural restoration and ongoing groundwater monitoring. Bioremediation techniques and other novel treatment technologies also are being investigated for their ability to reduce levels of groundwater contamination.
K	All sources of contamination at Area K have been cleaned up. These included solvent storage facilities and wastes from equipment maintenance activities.	Groundwater contamination in Area K has been monitored for at least 18 years. The primary contaminants of concern are chlorinated hydrocarbons typically found in industrial solvents. The highest levels of groundwater contamination found in recent years are: Trichloroethylene—23.89 ppb Tetrachloroethylene—19.8 ppb <i>cis</i> -1,2-Dichloroethylene—11.1 ppb Vinyl chloride—4.37 ppb 1,1,1-Trichloroethane—0.934 ppb	Contamination in shallow groundwater has been detected up to 900 feet away from the suspected release sources. Contamination is limited to the first 30 feet below the groundwater table.	In 1997 a Record of Decision called for "limited pumping of groundwater with sprinkler irrigation" to remove VOCs, and called for ongoing groundwater monitoring. NAES Lakehurst periodically presents findings from this monitoring to regulatory agencies at technical review meetings.

Table 3: Overview of VOC Groundwater Contamination at NAES Lakehurst

Area	Sources of Contamination (See Appendix C)	Contaminants Detected and Concentrations Recently Measured (see footnotes at end of table)	Reported Spatial Extent of Contamination	Regulatory and Remedial History (see footnotes at end of table)
L	This area is the extreme northwestern corner of NAES Lakehurst. The IAS noted that contamination could exist in this area from the fire and explosion that occurred at the BOMARC site..	Groundwater samples were collected from Area L during three different phases of the RI. The RI documents conclude that "no significant levels of radiological contamination in groundwater" were observed in Area L.	NAES Lakehurst collected groundwater samples from Area L during three field investigations. No significant groundwater contamination has been detected.	In 1991, a Record of Decision for Site L reported that "no contamination was detected that would require remedial action to protect human health and the environment." Accordingly, no further action was required to address contamination in this area.

Notes: Various base documents were considered to identify the highest levels of contamination that have been detected. Data from both monitoring wells and recovery wells were considered when generating this table. Groundwater monitoring data were also available for metals, but these data are not summarized in this table because the focus on site cleanup efforts has been almost entirely on VOCs. The data sources for each area are listed below:

Area A/B: Two most recent semi-annual data reports available during the site visit (NAES 2001a, 2002a).
Area C: Two most recent semi-annual data reports available during the site visit (NAES 2001b, 2002c).
Area D: Data compiled in the most recent five-year review (NAES 2001c).
Area E: Two most recent semi-annual data reports available during the site visit (NAES 2001d, 2002d).
Area F: The Record of Decision for Site 38 (NAES 1993a).
Area G: The Record of Decision for the IRP site within Area G (Site 1) identified as being a source of contamination (NAES 1993b).
Area H: Two most recent semi-annual data reports available during the site visit (NAES 2001e, 2002e).
Area I/J: Data compiled in the most recent five-year review (NAES 2001c).
Area K: Data compiled in the most recent 5-year review (NAES 2001c).
Area L: The Record of Decision for Area L (NAES 1991).

Appendices

Appendix A: ATSDR Plain Language Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

General Terms

Absorption

The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute

Occurring over a short time [compare with chronic].

Acute exposure

Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect

A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect

A change in body function or cell structure that might lead to disease or health problems

Aerobic

Requiring oxygen [compare with anaerobic].

Ambient

Surrounding (for example, ambient air).

Anaerobic

Requiring the absence of oxygen [compare with aerobic].

Analyte

A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study

A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect

A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level

An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation

Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study

A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring

Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake

The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing

Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota

Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden

The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel.]

Cancer

Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk

A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen

A substance that causes cancer.

Case study

A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study

A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number

A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system

The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic

Occurring over a long time [compare with acute].

Chronic exposure

Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation

A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)

A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)

Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration

The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant

A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect

A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal

Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact

Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology

The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit

The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention

Measures used to prevent a disease or reduce its severity.

Disease registry

A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD

United States Department of Defense.

DOE

United States Department of Energy.

Dose (for chemicals that are not radioactive)

The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)

The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship

The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media

Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism

Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA

United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology

The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure

Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment

The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction

A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation

The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway

The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry

A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study

A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)

A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds

Training sessions for physicians and other health care providers about health topics.

Groundwater

Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life (t)

The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard

A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)

The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste

Potentially harmful substances that have been released or discarded into the environment.

Health consultation

A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education

Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation

The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion

The process of enabling people to increase control over, and to improve, their health.

Health statistics review

The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard

The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence

The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion

The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation

The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure

Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro

In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo

Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)

The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring

A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism

The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite

Any product of metabolism.

mg/kg

Milligram per kilogram.

mg/cm²

Milligram per square centimeter (of a surface).

mg/m³

Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration

Moving from one location to another.

Minimal risk level (MRL)

An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity

State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality

Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen

A substance that causes mutations (genetic damage).

Mutation

A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)

EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)

Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard

A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)

The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard

A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)

A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica

A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume

A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure

The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population

A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)

A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb

Parts per billion.

ppm

Parts per million.

Prevalence

The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey

The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention

Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session

An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period

An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action

A list of steps to protect public health.

Public health advisory

A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)

An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard

A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories

Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement

The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance

The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting

A public forum with community members for communication about a site.

Radioisotope

An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide

Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population

People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)

An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry

A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation

The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)

This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA

RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk

The probability that something will cause injury or harm.

Risk reduction

Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication

The exchange of information to increase understanding of health risks.

Route of exposure

The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample

A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size

The number of units chosen from a population or an environment.

Solvent

A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination

The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations

People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder

A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics

A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance

A chemical.

Substance-specific applied research

A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)]

Superfund Amendments and Reauthorization Act (SARA)

In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water

Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey

A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect

A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen

A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent

Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile

An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology

The study of the harmful effects of substances on humans or animals.

Tumor

An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor

Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard

A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)

Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:

Environmental Protection Agency (<http://www.epa.gov/OCEPAterms/>)

National Center for Environmental Health (CDC)
(<http://www.cdc.gov/nceh/dls/report/glossary.htm>)

National Library of Medicine (NIH) (<http://www.nlm.nih.gov/medlineplus/mplusdictionary.html>)

For more information on the work of ATSDR, please contact:

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Appendix B: Air Modeling Assumptions and Results

In Section III.D of this PHA, we concluded that NAES Lakehurst's air emissions of four contaminants (carbon monoxide, nitrogen oxides, PM10, and sulfur dioxide⁸) pose no apparent public health hazard. This conclusion was based largely on two observations: (1) NAES Lakehurst is primarily a research and development facility, which tends to have relatively low emission rates when compared to large-scale manufacturing installations and many industrial facilities, and (2) air emissions data reported for the installation are considerably lower than those from manufacturing and production facilities located throughout New Jersey. Another observation that factored into this conclusion was the findings of an air dispersion modeling analysis that ATSDR conducted, which the rest of this appendix describes.

In cases where no air sampling data are available, ATSDR will often use air dispersion models to assess potential inhalation exposures to air contaminants. Air modeling analyses can be classified into two very general categories: screening evaluations and refined evaluations. A screening modeling evaluation is typically used to gain initial insights on potential levels of air contamination resulting from a single source or from multiple sources. Refined evaluations are often conducted when screening applications suggest that a more detailed review of air dispersion is necessary.

ATSDR conducted a screening analysis of air emissions from NAES Lakehurst to assess whether the air emissions sources have the potential for causing air pollution at off-site locations in excess of EPA's health-based air quality standards. To conduct such an analysis, assumptions must be made regarding the air emission sources and the model inputs. The following paragraphs describe the assumptions we made in completing this analysis:

- ▶ *Approach to characterizing emissions.* When evaluating this site, ATSDR obtained annual emissions data for NAES Lakehurst from the installation's 2001 "Emissions Statement" submitted to NJDEP. That statement reports the total air emissions of the four contaminants of interest for the entire installation. Source-specific emission rates were not included in the summary of the Emissions Statement that NAES Lakehurst provided to ATSDR. For an initial assessment of air quality impacts, ATSDR assumed that the installation's overall air emissions are released from a single source at a location central to the operations. This assumption essentially concentrates all of NAES Lakehurst's air emissions at a single point—an approach that likely overstates air quality impacts because emissions actually occur from locations across the entire installation. ATSDR believes this assumption is sufficient for an initial evaluation of the air exposure pathway, and we will update the modeling analysis if source-specific emissions data are provided. Emission rates ATSDR considered in this analysis are documented below, both in units of tons per year and grams per second. The latter units are commonly used for inputs into most air dispersion models.

⁸ Emissions data are available for volatile organic compounds, but this pollutant was not modeled because it is a mixture of many individual contaminants, all with different toxicologic implications. Chemical-specific emissions data for these individual contaminants were not available in the data reviewed by ATSDR.

<u>Pollutant</u>	<u>Emission Rate (tons/year)</u>	<u>Emission Rate (grams/second)</u>
Carbon monoxide	14.8	0.427
Nitrogen oxides	44.39	1.28
PM10	7.24	0.209
Sulfur dioxide	31.69	0.914

- *Approach to evaluating dispersion.* Many different models have been developed to assess atmospheric dispersion of air emissions—ATSDR used SCREEN3 for this evaluation. The SCREEN3 model is a screening tool designed to assess worst-case air quality impacts from typical continuous emissions sources, like stacks (EPA 1995). All air emissions from NAES Lakehurst were evaluated using a single point source at a location central to the installation's operations. As stated previously, this assumption does not represent the actual configuration of air emissions sources, but most likely overstates air quality impacts by concentrating in a single location emissions that occur over a broad area. The central location was selected in the eastern half of the installation, at a point $\frac{3}{4}$ of a mile from the nearest residential receptor outside the base. It should be noted that air emissions sources on the western half of the installation (i.e., emissions associated with the jet test tracks and catapults) are more than 4 miles away from this location. Therefore, concentrating all air emissions at this single point clearly overstates the air quality impacts from these sources. Although a refined modeling evaluation would clearly account for source-specific data, ATSDR believes the approach taken for this screening analysis is useful for predicting the magnitude of air quality impacts from the installation's overall air releases.

ATSDR used the following stack parameters to model dispersion from the hypothetical source placed at the center of the installation's operations: stack height and diameter of 15 meters and 1 meter, respectively, with releases occurring at 5.0 meters per second at ambient temperature. These parameters were selected to reflect common source parameters for boilers that ATSDR has evaluated at other sites. We note that the boilers at NAES Lakehurst accounted for the largest portion of the installation's air emissions. The SCREEN3 model was run assuming dispersion occurs in a rural setting (an assumption that leads to higher estimated concentrations than in urban settings) and in simple terrain.

For all pollutants, SCREEN3 output is an estimate of the maximum 1-hour average ambient air concentration at the nearest off-site receptor, located $\frac{3}{4}$ of a mile from the emissions source considered in this evaluation. To estimate annual average air concentrations, ATSDR multiplied the estimated 1-hour average value by a factor of 0.1—consistent with procedures EPA published for screening analyses (EPA 1992).

- *Modeling results.* Table B-1 presents the estimated maximum 1-hour average and annual average air concentrations predicted for the four pollutants, along with EPA's corresponding air quality standards. All of the predicted short-term and long-term average air concentrations were considerably lower than air quality standards, which indicates that

NAES Lakehurst's contribution to air pollution in Ocean County is not of public health concern. ATSDR acknowledges that this finding is based on a screening evaluation of air emissions from NAES Lakehurst, which could understate or overstate actual air quality impacts. The fact, however, that predicted concentrations were all at least 5 times lower than health-based air quality standards (rather than marginally lower than the standards) provides some comfort that the modeling analysis is not failing to identify air quality impacts of public health concern.

ATSDR's conclusion regarding the air exposure pathway is that any exposures to site-related contaminants are likely not at levels that would be associated with adverse health effects. This conclusion is based on the results of this modeling analysis, the fact that NAES Lakehurst is primarily a research and development facility (rather than a chemical manufacturing or materials processing plant), and the fact that air emissions from NAES Lakehurst are considerably less than emissions reported for numerous other sites across the state of New Jersey.

Table B-1
Results of Screening Analysis of Air Contaminants Released from NAES Lakehurst

Pollutant	1-Hour Average Concentrations		Annual Average Concentrations	
	Estimated Concentration ($\mu\text{g}/\text{m}^3$)	EPA's National Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$)	Estimated Concentration ($\mu\text{g}/\text{m}^3$)	EPA's National Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$)
Carbon monoxide	59	40,000	5.9	None available
Nitrogen oxides	180	None available	18	100
PM10	29	150	2.9	50
Sulfur dioxide	130	1,300	13	80

Notes: The "estimated concentrations" are based on ATSDR's screening analysis of air emissions from NAES Lakehurst. These concentrations are estimates of the increase of air contamination that might result from the installation's emissions. Other emissions sources of these same pollutants are found throughout Ocean County and also contribute to actual levels of air pollution.

The National Ambient Air Quality Standards listed in this table are concentration limits EPA developed to protect human health and our environment from harmful levels of air pollution. Specific notes on the selected values follow: For carbon monoxide, EPA has published health-based air quality standards for 1-hour average and 8-hour average concentrations, but not for concentrations of longer averaging times. For nitrogen oxides, the estimated annual average concentration is compared to EPA's health-based standard for nitrogen dioxide, a toxic chemical that is part of "nitrogen oxides"—no short-term air quality standards are available for this pollutant. For PM10, the predicted 1-hour average concentration is compared to EPA's 24-hour average health-based standard; EPA has not published PM10 air quality standards for shorter averaging times. For sulfur dioxide, the predicted 1-hour average concentration is compared to EPA's 3-hour average air quality standard, which is not health-based, but rather was promulgated to protect things we value other than our health (e.g., vegetation, property, visibility).

Appendix C: ATSDR's Evaluation of Potential Contamination in Soil, Surface Water, Sediment, and Locally Caught Fish

This appendix presents ATSDR's review of data on potential contamination in soil, surface water, sediment, and locally caught fish at NAES Lakehurst. It focuses largely on the sites of environmental contamination identified through the base's Installation Restoration Program (IRP). However, the appendix also evaluates additional known or suspected waste sites not evaluated during the IRP. Table C-1 documents the information ATSDR obtained and interpreted for each of the sites of concern. Most of the information in this appendix draws from the Records of Decision entered between NAES Lakehurst, the U.S. Environmental Protection Agency, and the New Jersey Department of Environmental Protection. A list of these Records of Decision appears at the end of this appendix.

At most sites, contamination was known or expected to occur in multiple media. This appendix does not, however, address groundwater contamination because Section III.A of this PHA is devoted entirely to that issue. For the remaining media, Table C-1 documents conclusions stated in the RODs and in other site documents. ATSDR found no public health hazards associated with current conditions at the sites listed in the table. This finding was generally based on three factors:

- ▶ Environmental contamination levels at many sites were not at levels that would pose a health concern to individuals who access this site. This trend was observed at sites of suspected contamination, for which future sampling events revealed no evidence of actual contamination, and at sites where cleanup efforts had already addressed past environmental releases.
- ▶ For most sites, NAES Lakehurst and regulatory agencies have already entered into RODs that found no human health risks associated with various land use scenarios. The majority of sites had RODs requiring no further action to address contamination in media other than groundwater.
- ▶ Limited access to the sites prevented extensive exposures to any environmental contamination that remained at the sites. Most sites are located in or near industrial areas at the installation, and no sites are found in the immediate vicinity of housing, the day care center, and recreational facilities. Therefore, base residents and base personnel are expected to have extremely limited contact with areas where contamination remains.

The remainder of this section is Table C-1, which documents the information available for the waste sites that ATSDR evaluated.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 1 - Blimp Crash Site	In 1931, a blimp crashed at this site and released roughly 1,000 gallons of liquid wastes (fuel and hydraulic fluid). Remnants of the crash and empty drums were also found at this site. In 1981, the empty drums were removed, along with 100 cubic yards of stained soil. Contaminated soils were also excavated in 1991 (7 cubic yards) and 1992 (230 cubic yards).	Soil: The soil contaminant of greatest concern at this site was total petroleum hydrocarbons (TPHC). After the removal actions were completed, TPHC levels in soil were all lower than 5,760 ppm. Groundwater: Addressed as part of groundwater contamination area G (see Section III.A).	In 1993, this site's ROD was signed, which required "no action" for the soils contamination. No soil sampling results were found at levels associated with unacceptable human health risks. This finding was based on a military land-use scenario, because the contamination area is far from areas where base residents live and work.	ATSDR finds no public health hazards associated with this site. The site is located in a remote area on base property, and limited (if any) contact with the remaining contamination is expected.
Site 2 - Recovery Systems Track Sites	Between 1967 and 1970, NAES Lakehurst used this site to operate experimental machinery. At least 200 cubic yards of visually contaminated soils were removed from the site in the early 1980s. The soil contamination was believed to contain jet fuel, hydraulic fluids, and ethylene glycol.	Soil: Soil samples collected during Phase II of the remedial investigation identified only one chemical of concern: alpha-BHC (a component of pesticides) had a soil concentration of 29 ppb. Groundwater: Addressed as part of groundwater contamination Area H (see Section III.A).	In 1993 this site's ROD was signed, which required "no action" for the soils contamination, because levels of contamination were lower than action levels that would trigger further cleanup to protect human health.	ATSDR agrees with the results of the ROD and finds no public health hazards associated with this site. The site is located far from where base residents live in a remote area of the base, where limited contact with remaining contamination is expected.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 3 - Drainage Ditch at Runway Arrested Launching Site	From 1958 to 1986, discharges from industrial operations at the Runway Arrested Launching Site released contaminants into a drainage ditch. The discharges were caused when groundwater and rainwater flowed into the underground facility and carried contaminants to the ditch. Wastes mixed with the water include chlorinated solvents, hydraulic fluid, and ethylene glycol.	Soil: Contaminants of concern identified for this site include Aroclor-1254 (0.09 ppm), beta-BHC (0.021 ppm), and mercury (1.2 ppm). Sediment: Prior to site cleanup, the following contaminants were detected at levels greater than preliminary remediation goals: 1,4-dichlorobenzene (0.84 ppm) and several polycyclic aromatic hydrocarbons (PAHs) (highest level detected was for chrysene and benzo[a]anthracene, both at 11 ppm). Groundwater: Addressed as part of groundwater contamination Area J (see Section III.A).	According to the 1993 ROD for this site, "no action" was needed to address soil contamination (based on light industrial land uses), but the most highly contaminated sediments had to be excavated and removed to address potential ecological risks. These sediments were removed in 1993, and EPA now considers actions at this site complete.	ATSDR finds no public health hazard associated with the current conditions of this site. The highest levels of contamination have been removed, and contact with remaining contamination would be limited to those who work at or who visit the Runway Arrested Launching Site, which is located in the more remote western half of the installation.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 4 - Deadload Maintenance Shop	From 1958 to 1980, Site 4 was used for storing drums of cleaning solvent and lubricants, among other purposes. An unknown amount of these materials leaked from these drums and contaminated soils near the site. In the early 1980s, visibly stained soils were removed and replaced with clean soils.	Soil: The ROD for Area K indicates that soil samples collected from Site 4 during Phase II of the remedial investigation "revealed no contamination." Groundwater: Addressed as part of groundwater contamination Area K (see Section III.A).	A ROD has not been prepared specifically to address human health risks for exposure to soil contamination, if any, at Site 4. The ROD for Area K did not require soil cleanup at Site 4 to prevent future groundwater contamination.	ATSDR finds no public health hazards associated with contacting soils at Site 4. This conclusion is based on the fact that no contamination was detected during the Phase II remedial investigation.
Site 5 - Arresting Engine, Track Number 2	Between 1958 and 1980, this site was reportedly used to store liquid wastes. Limited information is available on the amount and type of wastes stored at the site, and on the extent of spills to the soil; 19 cubic yards of contaminated soils were removed from the site in 1991.	Soil: After the soil excavation, confirmation sampling found the highest level of TPHC to be 26 ppm. Groundwater: Addressed as part of groundwater contamination Area K (see Section III.A).	In 1991, a ROD for this site was signed that required "no action" for the soil contamination at Site 5, because no contaminants were found to exceed state or federal cleanup levels.	ATSDR finds no public health hazard associated with current conditions at Site 5, because confirmation sampling following the soil removal found contamination to be less than state and federal cleanup levels and because few individuals are expected to routinely contact any contaminants that remain.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 6 - Catapult Test Facility	Multiple industrial operations occurred in this site and released waste to soils. These included: a solvent storage area, where an unknown amount of solvents leaked onto soils; a lift station where more than 1,000 gallons of oil and grease were spilled onto soils; and storage tanks that have had minor leaks.	Soil: Contaminants of concern in soil were cadmium (1.2 ppm) and lead (20.1 ppm). Sediment: Prior to site cleanup, multiple PAHs were detected at levels greater than preliminary remediation goals. The PAH with the highest detected level was chrysene (47 ppm). Groundwater: Addressed as part of groundwater contamination Area I (see Section III.A).	According to the 1993 ROD for this site, "no action" was needed to address soil contamination (based on light industrial land uses). Sediments within holding ponds were found to have potential human health risks, but only if the water levels became low enough to expose the sediments. The ROD required sediment excavation to address these risks; the excavation was completed in 1993.	ATSDR finds no public health hazard associated with the current conditions of this site. The highest levels of contamination were removed in 1993. Contact with any remaining contamination would be infrequent and limited to those who work at or who visit the Catapult Test Facility, which is located in the more remote western half of the installation.
Site 7 - Catapult Test Facility Storage Area	Site 7 is an area (approximately 50 feet by 100 feet) where base personnel reportedly disposed of waste solvents and oil. Disposal occurred between 1958 and 1973, but the exact amount of material disposed of is not known.	Soil: Multiple rounds of soil sampling during the remedial investigation found only two contaminants of concern: cadmium (5.4 ppm) and lead (22 ppm). Groundwater: Addressed as part of groundwater contamination area I (see Section III.A).	In 1993, this site's ROD required "no action" for the detected levels of soil contamination. This decision was based on an evaluation of human health risks for a light industrial land use scenario.	ATSDR finds no public health hazards associated with the soil contamination at this site. In short, we concur with the main finding of the ROD: "Site 7 does not pose unacceptable levels of risk to human health."

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 8 - Building 529, Arresting End of Track 1	Starting in 1957, multiple maintenance activities occurred at Building 529. An unknown amount of liquid waste was reportedly poured onto soils adjacent to the building, and unknown amounts of solvents leaked from a storage area.	Soil: Multiple soil samples collected during Phase III of the remedial investigation found multiple contaminants, all of which were detected at levels lower than the state's soil cleanup criteria. Groundwater: Addressed as part of groundwater contamination Area K (see Section III.A).	A ROD has not been prepared specifically to address human health risks for exposure to soil contamination, if any, at Site 8. The ROD for Area K did not require soil cleanup at Site 8 to prevent future groundwater contamination.	ATSDR finds no public health hazards associated with exposure to soil contaminants at Site 8. This finding is based on two observations: measured soil concentrations were lower than state cleanup levels, and base residents and base personnel have limited access to this site, which is adjacent to one of the base's high-speed jet test tracks.
Site 9 - Former Hangar 2 Disposal Area	Interviews with installation personnel suggest that wastes from the installation's hangars were disposed of on soils. In 1981, approximately 200 drums of liquid waste were emptied on these soils. No information is available on the waste contents disposed of at Site 9. In 1981, the Navy removed roughly 40 cubic yards of stained soil and all empty drums from the site.	Soil: Multiple rounds of soil sampling identified the following contaminants of concern: xylenes, PAHs, lead, and mercury. Concentrations of these chemicals were not listed in the ROD. Groundwater: Addressed as part of groundwater contamination area B (see Section III.A).	In 1993, a ROD was signed by EPA and the Navy that required "no action" to address soil contamination at Site 9. This evaluation was based on a light industrial land-use scenario.	ATSDR finds no public health hazards associated with soil contamination at Site 9. Because soil contamination data are not documented in the ROD or the copy of the risk assessment that ATSDR received, our finding is based on EPA's concurrence that contamination levels do not present a significant human health risk.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 10 - MOGAS Station	Site 10 includes three distinct areas: (1) Drums were stored in the area of Site 10 between 1960 and 1970, and some drums reportedly leaked liquids containing petroleum hydrocarbons. (2) An area covered by sand and gravel was used by fuel trucks; up to 34,000 gallons of waste oils were sprayed on this area for dust control. (3) A MOGAS station's underground storage tanks were removed from the area in 1988; signs of limited leaking were apparent.	Soil: Soil contaminants detected at the site include: TPHC (10,819 ppm), toluene (7.8 ppm), ethylbenzene (17 ppm), xylenes (190 ppm), naphthalene (4.3 ppm), 2-methylnaphthalene (8.4 ppm), pyrene (0.27 ppm), and lead (7.5 ppm). Groundwater: Addressed as part of groundwater contamination area C (see Section III.A).	In 1996, EPA and the Navy signed the ROD for this site, which required "no action" to address soil contamination remaining at Site 10. This decision was based on the fact that no soil concentrations (measured during confirmation samples) were greater than the state's soil cleanup criteria.	ATSDR finds no public health hazards associated with the soil contamination that remains at Site 10. Few base residents and base personnel are expected to contact soils in this part of the installation, because no recreational facilities and limited base support operations are located at this site.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 11 - Hangar 5 Storage Area	Little information is on the history of this site, other than an area (200 feet by 100 feet) had been used for drum storage. In the early 1980s 350 cubic yards of visually stained soils were removed from this site. An additional 81 cubic yards of contaminated soils were excavated based on the results of confirmation sampling. In 1993 all excavated areas were filled with clean soil.	Soil: The soil contaminant of greatest concern at this site was TPHC. After the removal actions were completed, TPHC levels in soil were all lower than 3,790 ppm. Groundwater: Addressed as part of groundwater contamination area C (see Section III.A).	In 1993, this site's ROD was signed, which required "no action" for the soils contamination, because no soil contaminants were found at levels above state and federal clean-up standards. This finding was based on a light industrial land-use scenario.	ATSDR finds no public health hazards associated with this site. The site is located in an industrial area on base property, and only transient contact with the remaining contamination is expected.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 12 - Abandoned Fuel Storage Facility	Underground storage tanks at Site 12 were used between 1923 and 1980. The tanks held both heating oil and diesel fuel. Fuel spills of unknown magnitudes reportedly occurred at Site 12. In 1988, the Navy removed the underground storage tanks.	Soil: Concentrations of contaminants of concern were: TPHC (4,294 ppm), selected PAHs (up to 850 ppb, for phenanthrene), tetrachloroethylene (34 ppb), xylenes (8 ppb), and 2-methyl naphthalene (2,100 ppb). Sediment: Nickel (234 ppm) and vanadium (1,293 ppm) were found to have localized contamination. Some PAHs were identified, but at levels below their detection limits. Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	In 1993, the record of decision for Site 12 required "no action" to address contamination in soil and sediment. This decision was based on a risk assessment involving a light industrial land use scenario for contacting soils and a transient scenario for contacting sediments.	ATSDR finds no public health hazards associated with levels of contamination at and near Site 12. The site is located in an industrial part of NAES Lakehurst that is expected to be frequented primarily by military and civilian personnel. Frequent contact with soils in this area are not expected. No contamination extends beyond the site boundary.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 13 - Former Fuel Farm Number 125	This site includes two sets of underground storage tanks: (1) five tanks that stored various petroleum products between 1930 and 1989, when they were removed, and (2) five tanks that "were found by accident" in 1984 and subsequently removed.	Soil: The highest levels of soil contamination were found at depths greater than 20 feet below ground surface. Contaminants detected include: 2-hexanone (25 ppm), toluene (23 ppm), ethylbenzene (11 ppm), xylenes (39 ppm), and TPHC (8,700 ppm). Groundwater: Addressed as part of groundwater contamination area B (see Section III.A).	In 1993, the Navy and EPA signed the ROD for Site 13, which found no human health risks associated with contacting soil contamination. This was evaluated for a construction scenario. The ROD required that the Navy implement a soil vapor extraction system to avoid future groundwater contamination from the subsurface soil contamination. The soil vapor extraction system was installed in May 1996.	ATSDR finds that subsurface soil contamination at Site 13 does not pose public health hazards because the most heavily contaminated soils are at depths well below the soils that residents and workers typically encounter.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 14 - Old Fire Fighting School	Fire fighting training exercises occurred at two pits at Site 14. The year when exercises began at the site is unknown, but may be as early as the 1920s; exercises at Site 14 ended in 1980. The Navy has estimated that no more than 600,000 gallons of flammable wastes were burned at this site.	Soil: Contaminants with at least one detection higher than state soil cleanup criteria were: trichloroethylene (1.8 ppm), xylenes (58 ppm), and TPHC (85,472 ppm). Many additional chemicals were detected as well. Sediment: Contaminants detected at levels greater than 1 ppm in sediments include: lead (22.7 ppm), nickel (11.5 ppm), and TPHC (88,000 ppm). Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	The 1993 ROD concluded that human health risks associated with soil and sediment contamination levels would not require remedial action. This finding was based on a light industrial land-use scenario for soils, and transient exposures to sediments. To protect against future groundwater contamination, however, the ROD required excavation of contaminated soils and sediments. This excavation has already been completed.	ATSDR finds no public health hazards associated with the soil and sediment contamination at Site 14, because the highest levels of contamination have been removed and because few people access this site, which is located in the northeastern corner of NAES Lakehurst.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 15 - Disposal Area Near Building 562 Parking Lot	In 1981, a base employee indicated that machine cuttings were periodically disposed of in an area near the Building 562 parking lot. This disposal reportedly occurred for 20 years. The Navy has not been able to confirm this lone report of waste disposal at Site 15.	Soil: During the second phase of the remedial investigation, three test pits were excavated and a soil sample collected. According to the ROD, "no contamination [was] detected" during this phase of the remedial investigation. Groundwater: Addressed as part of groundwater contamination area B (see Section III.A).	In 1991, the Navy and EPA signed the ROD for Site 15, which required "no action" for addressing potential soil contamination. This conclusion was based on the fact that no contaminants of concern were identified during the field investigations.	ATSDR finds no public health hazards associated with past waste disposal activities, if any, at Site 15. This finding is based on the fact that field investigations revealed no evidence of contamination, both by visual inspection of test pits and by chemical analysis of samples.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 16 - NATTC Fire Fighting Training Area	Two fire fighting pits in this area were used for training, during which mixtures of water and fuel were intentionally ignited. Wastes from igniting and extinguishing the fires had the potential to contaminate soils and groundwater. In 1993, roughly 2,000 cubic yards of contaminated soils were removed from the site. A bioventing system was installed in 1994 to further reduce soil contamination levels.	Soil: Soil contaminants detected at the site include: TPHC (29,000 ppm), toluene (0.009 ppm), 2-methylnaphthalene (220 ppm), and phenanthrene (0.41 ppm). Groundwater: Addressed as part of groundwater contamination area C (see Section III.A).	The 1996 ROD for this site requires the Navy to continue operating the bioventing system at Site 16. This action was selected to reduce the potential of future groundwater contamination, not because surface soil contamination posed a human health risk.	For two reasons ATSDR finds no public health hazards associated with the soil contamination that remains at Site 16,. First, in 1993 the areas with documented surface soil contamination were removed from Site 16. Second, few base residents and base personnel are expected to contact soils in this part of the installation because no recreational facilities and limited base support operations are located at this site.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 17 - Fuel Farm 196	The fuel farm at Site 17 contained four underground fuel storage tanks and four dry wells that were installed in the mid-1940s. For nearly 40 years, condensate and spills from the fuel transfer area poured into dry wells, and overflow from these wells flowed into a nearby unlined lagoon. Multiple fuel spills were documented for this site, and more than 10,000 gallons of fuel have been recovered from the subsurface at this site. A bioventing system and soil vapor extraction system were installed in 1994 to further reduce soil contamination levels.	Soil: Soil contaminants detected at the site include: TPHC (15,000 ppm), toluene (0.009 ppm), ethylbenzene (0.066 ppm), xylenes (0.98 ppm), naphthalene (30 ppm), 2-methylnaphthalene (52 ppm), and lead (99 ppm). Groundwater: Addressed as part of groundwater contamination area C (see Section III.A).	The 1996 ROD for this site requires the Navy to continue operating the bioventing system and soil vapor extraction system at Site 17. These actions were selected to reduce the potential of future groundwater contamination, not because surface soil contamination posed a human health risk.	For two reasons ATSDR finds no public health hazards associated with the soil contamination that remains at Site 17. First, soil contamination at this site occurs primarily at depth. Second, few base residents and base personnel are expected to contact soils in this part of the installation, because no recreational facilities and limited base support operations are located at this site.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 18 - Naval Exchange Gas Station	A gasoline and service station operated at this site since 1958. Wastes generated at the site (e.g., battery acid, solvents, fuels) were disposed of in a dry well, which was removed in 1988. The underground storage tank at the station was removed in 1990, and showed no signs of leakage at that time.	Soil: Soils at the base of the dry well contained many metals and semi-volatile organic compounds, as well as TPHC (508,470 ppm). After removal of the dry well, soils were found to contain TPHC only at 226 ppm. Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	The 1991 ROD for Site 18 concluded that "no action" was needed to address any soil contamination that remained at Site 18. It concluded that conditions at the time pose no unacceptable risks to human health.	ATSDR concludes that no public health hazards are associated with the soil contamination at Site 18. This conclusion is based on the fact that the major source of contamination (i.e., the dry well) has been removed and that few people routinely contact soils, especially subsurface soils, at this site.
Site 19 - "SATS" Catapult	This site was used to test a catapult device during the 1960s and 1970s, after which it was a storage area for 55-gallon drums of waste, some of which could have leaked. Waste materials stored at the site include oils, hydraulic fluids, and jet fuel. In 1991, 35 cubic yards of contaminated soil was excavated and removed from the site.	Soil: Prior to the soil excavation, elevated contamination levels were noted for alpha-BHC (11.7 ppb), silver (94 ppm), and TPHC (21,071 ppm). TPHC were not detected after the excavation was completed. Groundwater: Addressed as part of groundwater contamination area J (see Section III.A).	In 1991 a ROD for this site was signed that required "no action" for the soil contamination, because no contaminants were found to exceed state or federal cleanup levels after the excavation was completed.	ATSDR finds no public health hazard associated with current conditions at Site 19, because confirmation sampling found contamination to be less than state and federal cleanup levels and because few individuals are expected to routinely contact any contaminants that remain in this remote part of the base.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 20 - Tetraethyl Lead Disposal Site	Interviews with base personnel indicated that unknown amounts of aviation gasoline, which contains tetraethyl lead, was disposed of at Site 20 during the 1960s, and possibly into the 1970s. Steel and rubber materials buried at the site were removed in 1992.	Soil: Samples collected during the most recent site investigations revealed the following soil contaminants at Site 20: TPHC (2,400 ppm), lead (21.5 ppm), acetone (1.1 ppm), and methyl ethyl ketone (0.71 ppm). Groundwater: Addressed as part of groundwater contamination area G (see Section III.A).	The 1993 ROD for Site 20 indicates that "no action" is needed to address the soil contamination that remains at Site 20. This finding is based on a light industrial land-use exposure scenario.	ATSDR finds no public health hazards associated with soil contamination at Site 20. Debris remaining at the site has been removed and exposure to soils is believed to be extremely limited, because Site 20 is located in the remote, western half of the installation.
Site 21 - Jet-car Maintenance Shop	From 1958 to 1981, base personnel stored solvents and jet fuel in front of this maintenance shop, and some wastes were disposed of on the soils behind the shop. Additionally, the Navy tested jet engines on a concrete pad near the site. Finally, drums containing liquid waste were stored near the maintenance shop. No information is available on the amount of wastes that leaked into the soils. In 1991, 22 cubic yards of contaminated soils were removed from the site.	Soil: The contaminant of concern for this site was TPHC. Levels as high as 26,000 ppm were detected prior to the excavation project, and TPHC were not detected after the removal was complete. Groundwater: Addressed as part of groundwater contamination area H (see Section III.A).	In 1991 a ROD for this site was signed that required "no action" for the soil contamination, because no contaminants were found to exceed state or federal cleanup levels after the excavation was completed.	ATSDR finds no public health hazards associated with the current conditions of this site. This finding is based on the sampling data, which found no levels of contamination greater than state and federal cleanup standards, and on the fact that few people, if any, routinely contact soils at this industrial location in the remote western half of the installation.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 22 - Jet Blast Deflector	This site is used to test how effectively jet blast deflectors redirect jet engine exhaust. Site investigations in 1981 and 1985 found areas with stained soils, and the 1985 investigation found 15 empty drums, which have since been removed.	Soil: The only contaminant of concern detected for this site was mercury (0.19 ppm). Groundwater: Addressed as part of groundwater contamination area J (see Section III.A).	In 1993, the ROD for this site required "no action" to address the trace levels of soil contamination found at the site. The evaluation in the ROD was based on a military land-use scenario.	ATSDR agrees with the finding in the ROD that soil contamination at Site 22 does not pose a health hazard. This finding is based on the levels of contamination detected and the fact that few people would routinely contact soils in this remote part of installation property.
Site 23 - Inactive Disposal Area at Building 524	During a site investigation in 1981, base personnel identified four localized areas of surface soil contamination near Building 524. These included areas with stained soil, an area with nine 55-gallon drums, and an area where boxes of non-hazardous resin "beads" were abandoned. The stained surface soil, drums, and boxes were all removed from the site before 1985.	Soil: Soil sampling at Site 23 occurred during Phase II of the remedial investigation. According to the ROD, "no contamination [was] detected." Groundwater: Addressed as part of groundwater contamination area I (see Section III.A).	The 1991 ROD for Site 23 concluded that "no action" was needed to address any soil contamination that remained at the site. It concluded that conditions at the time pose no unacceptable risks to human health.	ATSDR agrees that Site 23 poses no public health hazard. The Navy has removed solid waste disposed of at Site 23, and visibly stained surface soils. Further, the site is located in the remote, western half of NAES Lakehurst, in an industrial area that few residents routinely access.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 24 - Catapult Test Site 7419	From the mid-1960s to the early 1970s, the Navy tested a catapult device at Site 24 atop a concrete pad, during which some liquid wastes leaked from the experimental equipment. These wastes included hydraulic fluid, lubricants, and jet fuel, but the amount that leaked is not known. All equipment from this site has been removed.	Soil: Multiple rounds of soil sampling found the following contaminants: acetone (0.13 ppm), bis(2-ethylhexyl)phthalate (3.8 ppm), di-n-octylphthalate (0.46 ppm), isophorone (0.87 ppm), toluene (0.26 ppm), and TPHC (4,600 ppm). Groundwater: Addressed as part of groundwater contamination area I (see Section III.A).	In 1993 the ROD signed for this site required "no action" to address the localized areas with soil contamination. This decision was based on an evaluation of human health risks for a military land-use scenario.	ATSDR finds no public health hazards for this site. Though trace amounts of soil contamination likely remain, the site is located adjacent to an area where high-speed catapult testing is performed and few people access this location. Exposures to soil, if any, are expected to be of short duration.
Site 25 - Test Department Disposal Area	In 1981, environmental staff noted a 450-square-foot area with dark patches of soil. Military personnel indicated that the area had been used to dispose of wastes generated by the "Test Department," but the amount of material disposed of is not known. The wastes poured on the soils are believed to include chlorinated solvents.	Soil: According to the ROD, all soil samples collected at this site during the remedial investigation did not contain volatile organic compounds and concentrations of metals were not elevated, when compared to background levels. Groundwater: Addressed as part of groundwater contamination area I (see Section III.A).	In 1993 the ROD signed for this site required "no action" to address potential soil contamination at Site 25. This finding is based on soil sampling from three pits, and sediment sampling in an area that would have been affected by surface water runoff from the site.	ATSDR finds no public health hazards for this site. Sampling data have provided limited evidence of environmental contamination for the site, which is located in the remote western half of the installation, which few residents routinely access.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 26 - Contractor Disposal Area	This site is a drainage swale near the northern property boundary. For an unspecified time frame, contractors disposed of waste oil, roofing materials, and other building debris at the site. The total amount of materials disposed of is not known. In 1981, all debris visible at the site was removed.	Soil: Contaminants detected in the surface soil samples included: multiple PAHs (highest level detected was 320 ppb, for pyrene); benzoic acid (130 ppb); DDE (635 ppb); DDT (4,700 ppb); DDD (360 ppb); and TPHC (474.5 ppm). Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	The 1991 ROD for Site 26 concluded that exposure to soil contamination did not pose unacceptable human health risks. The levels of pesticides detected in the soils were below state and federal cleanup levels at the time. Accordingly, "no action" was required to address levels of soil contamination.	ATSDR finds no public health hazard associated with levels of soil contamination at Site 26. The site is located near the northern site boundary of NAES Lakehurst, where residents and employees rarely access. There is no evidence of off-site contamination.
Site 27 - Recovery System Test Site Scrap Dump	From 1958 to 1990, solid waste from the Recovery System Test Site was disposed of on this site, which is approximately 400 feet by 700 feet. The waste was primarily scrap steel cable. There are no reports of liquid waste having been disposed of at Site 27.	Soil: An EPA contractor conducted a field survey using an organic vapor analyzer and found no evidence of soil contamination in 25 analyses. An additional soil gas screening survey found no evidence of surface soil contamination. Groundwater: Addressed as part of groundwater contamination area K (see Section III.A).	In 1991 the ROD for Site 27 required "no action" to address potential soil contamination. Although no surface soils were subject to chemical analyses, the field surveys and chemical analyses of groundwater samples at the site suggest that soil contamination is limited.	ATSDR finds no public health hazard associated with levels of soil contamination at Site 27. The site is located along a recovery system track in an area where people (including base personnel) rarely access.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 28 - Westfield Hangar Area	Site 28 includes several operations near the Westfield Hangar. In August 1990 the Navy discovered a leak in subsurface piping that was releasing gasoline into the soils. More than 65 cubic yards of visually stained soils were removed from the site late that year.	Soil: The ROD identifies the following contaminants of concern but does not present measured concentrations: benzene, ethylbenzene, toluene, xylenes, 2-methylnaphthalene, and naphthalene. Groundwater: Addressed as part of groundwater contamination area E (see Section III.A).	The 1997 ROD for Site 28 found that levels of groundwater contamination might pose health concerns if people were to use it for drinking water. The ROD required installation of a soil vapor extraction system to reduce levels of soil contaminants that might affect groundwater in the future. The soil vapor extraction system was installed in March 1998. Based on the success of the system in treating the site, the system was turned off in June 2001.	ATSDR finds no public health hazards associated with soil contamination at Site 28. Contamination apparently is limited to subsurface soils, where the original gasoline leak occurred. Base residents and personnel are expected to contact these subsurface soils rarely, if ever.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 29 - Original Base Landfill	The unlined landfill at Site 29 spans roughly 20 acres and received wastes from the early 1920s until 1960. Municipal and industrial wastes were disposed of at Site 29, including metal scrap, asbestos, light bulbs, ash, and contaminated fuels. After closing the landfill, the Navy covered it with clean fill, which is now partially covered with vegetation. Between 1992 and 1993, approximately 500 waste drums and more than 1,000 cubic yards of soil were removed from the landfill.	Soil: Numerous soil samples were collected during the drum removal activities at Site 29, but these all reflect contamination levels within the landfill, which is completely covered with clean soils. Sediment: Sediment contamination near Site 29 was attributed primarily to wastes from Site 14. The ROD for Site 14 addresses this issue. Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	In 1994 the ROD for Site 29 concluded that "no action" is needed to address levels of soil contamination in the former landfill. The ROD found no unacceptable human health risks, based on a light industrial land-use scenario.	ATSDR concludes that contaminated soils at Site 29 do not present public health hazards. This conclusion is based on the following observations: soil contamination was detected only in the subsurface samples, where one would expect to encounter waste material at a landfill site; the surface soil at the landfill is reportedly clean fill; and few base residents or personnel are expected to come into contact with any soils at the former landfill.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 30 - Recovery System Track Number 4	The Navy intentionally crashed four aircraft at this site to test how effectively certain fuel additives prevent fires. The aircraft were crashed in an area approximately 75 feet by 800 feet. Crashes occurred on a mound of soil, which was removed before 1985. The four aircraft each held approximately 1,000 gallons of fuel during the crashes.	Sediment: Sediment samples were collected from a ditch that drains runoff from Site 30. The samples were analyzed for organic and inorganic contamination. Only chromium (110 ppm) exceeded a "State action level," but this level of contamination was not consistently detected. Groundwater: Addressed as part of groundwater contamination area K (see Section III.A).	The 1991 ROD for Site 30 concluded that exposure to soil contamination did not pose unacceptable human health risks. Accordingly, "no action" was required to address levels of soil contamination.	ATSDR agrees that potential exposures to soils at Site 30 do not present public health hazards. This finding is based on the limited evidence of contamination, as well as the fact that the site is located in an area of the base visited primarily by employees (civilian and military), and rarely by residents.
Site 31 - Former Sanitary Landfill	From 1960 through 1980 the unlined landfill at Site 31 received primarily household wastes, but also small quantities of industrial wastes, including oils, hydraulic fluids, solvents, and scrap metal. In 1980 the Navy covered the 34-acre landfill with at least 6 inches of clean topsoil during closure. The landfill area is now covered with grass and other vegetation.	Soil: Soils from Site 31 were not sampled during the remedial investigation for several reasons, but largely because the landfill is covered with enough clean topsoil to prevent exposures to the waste material within the landfill. Groundwater: Addressed as part of groundwater contamination area D (see Section III.A).	The 1993 ROD for Site 31 required continued monitoring to assess groundwater contamination, but "no action" to address contaminated soils.	ATSDR finds no public health hazards associated with contaminated soils at Site 31. Because previously disposed wastes are covered with at least 6 inches of clean topsoil, base personnel and residents are not expected to contact contamination at this site.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 32 - Launch End of the Test Tracks	In 1958 the Navy constructed the facilities at the launching end of the recovery system test tracks. The tracks have drainage swales that collect waste liquids, such as oils and fuels. Prior to 1986, these wastes flowed from the swales into multiple dry wells. The amount of waste material that overflowed from the dry wells is not known. The dry wells were excavated and removed in 1988. Also at Site 32 was an underground fuel storage tank, which was removed in 1989. Some soil adjacent to the tank removal site were found to contain fuel contamination.	Soil: Multiple site investigations showed that soils at Site 32 were contaminated with various chemicals associated with petroleum hydrocarbons. The 1993 ROD reported only two of these contaminants having soil concentrations greater than NJDEP's soil cleanup criteria: xylenes (210 ppm) and TPHC (84,000 ppm). Groundwater: Addressed as part of groundwater contamination area H (see Section III.A).	The 1993 ROD for Site 32 concluded that levels of soil contamination do not pose a health risk for a light industrial land-use scenario. The ROD required, however, that areas with elevated soil contamination be excavated and removed to avoid future groundwater contamination. Confirmation sampling following this removal action, and the sampling found that soil concentrations were below designated cleanup levels.	ATSDR finds no public health hazards associated with the contamination that might remain at Site 32. This finding is based largely on two observations: the highest levels of soil contamination have been removed, and the areas that may still be contaminated are drainage swales along the recovery tracks—areas that base residents and personnel are not expected to frequent.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 33 - Former Refueler Repair Shop	Site 33 was an unlined dry well that was located adjacent to a refueler repair shop, which was first constructed in 1959. An unknown amount of wastes from this shop—including solvents, lubricants, and oils—were disposed of in the dry well. The well, which was about 8 feet deep, was excavated in 1988.	Soil: Multiple contaminants have been detected in the soil at Site 33, including: methyl ethyl ketone (470 ppb), TPHC (5,700 ppm), benzene (22 ppb), toluene (4 ppb), ethylbenzene (100 ppb), xylenes (990 ppb), naphthalene (980 ppb), and 2-methylnaphthalene (4,100 ppb). Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	The 1993 ROD for Site 33 required “no action” to address levels of soil contamination at the site. This decision was based on an evaluation of human health risks for a light industrial land-use scenario.	ATSDR finds no public health hazards associated with contaminated soils at Site 33. Exposure to contaminated soils is believed to be extremely low because the site is located in an industrial area and because soil contamination is believed to be limited to subsurface soils, which people do not routinely contact.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 34 - Parachute Jump Circle	The parachute jump circle is 4,000 feet in diameter, currently used to practice parachute landings. In the past, fuel trucks disposed of used fuel oil on surface soils throughout the jump circle. As much as 2,000,000 gallons of fuel oil were disposed of on the site. The area may have unexploded ordnance and associated munition compounds or their breakdown products.	Soil: Surface soils and subsurface soils were sampled at selected locations in the jump circle. The ROD reports contamination for one analyte (TPHC, 2,264 ppm). Groundwater: Addressed as part of groundwater contamination area G (see Section III.A).	The 1991 ROD for this site required "no action" to address levels of soil contamination. This was based on the limited evidence of contamination from limited soil sampling and extensive groundwater sampling. The Navy suspects that much of the fuel disposed of at Site 34 evaporated before seeping into soils and groundwater.	ATSDR finds no public health hazards associated with soil contamination from fuel oil at this site. The parachute jump circle is used for training activities and not for recreational purposes. Accordingly, exposures to soil contaminants, if any are present, would be of extremely limited duration. However, there is a possibility that UXO/CWM can be encountered in this area.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 35 - Helicopter Defueling Area	Site interviews conducted during the IRP indicated that some helicopters and aircraft could have discharged fuels onto the grassy surface in this area. The amount of fuel potentially released is not known, and in the early 1980s fuel discharge from aircraft to ground surfaces ceased at NAES Lakehurst. An unspecified volume of contaminated soils was removed in the early 1990s and replaced with clean soil.	Soil: The soil contaminant of greatest concern at this site was TPHC. After the removal actions were completed, TPHC levels in soil were all lower than 4,360 ppm. Groundwater: Addressed as part of groundwater contamination area C (see Section III.A).	In 1993 this site's ROD was signed, which required "no action" for the soils contamination, because no soil contaminants were found at levels above state and federal clean-up standards. This finding was based on a light industrial land-use scenario.	ATSDR finds no public health hazards associated with this site. The site is located in an industrial area on base property, and only transient contact with the remaining contamination is expected.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 36 - Former Hangar 1 Waste Disposal Area	From 1921 to 1974, personnel working in Hangar 1 reportedly disposed of approximately 6 gallons of liquid waste per day onto soils outside the structure. The wastes likely included kerosene, various volatile organic compounds, and some inorganic acids. The total amount of liquid wastes disposed of at this site could be as high as 83,000 gallons. The site also includes a tank and a dry well, both of which were removed in 1988.	Soil: Soil sampling at Site 36 detected various chemicals, including: multiple PAHs (highest level observed was 708 ppb, for fluoranthene); Aroclor 1254 (360 ppb); chromium (275 ppm); nickel (119 ppm); TPHC (57 ppm); and multiple pesticides (highest level observed was 66 ppb, for DDT). Groundwater: Addressed as part of groundwater contamination area B (see Section III.A).	The 1993 ROD for Site 36 concluded that "no action" was required to address contaminated soils. This decision was based on a human health risk evaluation for a light industrial land-use scenario. None of the contaminants found in the soils exceeded state cleanup levels.	ATSDR finds no public health hazards associated with this site. The levels of contamination are limited to the areas immediately surrounding Hangar 1, where few people frequent. Moreover, the highest levels of PAHs were detected in subsurface soils (i.e., at the bottom of the former dry well) which people do not contact.
Site 37 - Former Fuel Disposal and Drum Storage Area	From 1957 to 1967, personnel at the plumbing shop routinely drained gasoline and jet fuel from trucks before servicing them. Base records suggest that up to 48,000 gallons of fuel were disposed of at the site, which might have included 512 pounds of elemental lead.	Soil: Soil samples were collected during different investigations of the site. No contaminants were detected above cleanup levels, and the only contaminant with a concentration reported was TPHC (25 ppm). Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	The 1993 ROD indicates that "no significant organic or inorganic contamination" was detected at Site 37 and that no human health risks are apparent. The ROD reports that "no action" is required to address soil contamination.	ATSDR finds no public health hazards associated with soil contamination at Site 37. The site is located near the eastern fenceline of NAES Lakehurst, where few people access. Levels of soil contamination at the site are reportedly not significant.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 38 - Oil Skimming Pond and Sewage Disposal Area	Site 38 is a remote, wooded area of NAES Lakehurst. Between 1966 and 1974, contractors reportedly poured as much as 40,000 gallons of liquid wastes directly onto the soil at Site 38. The wastes included septic sewage and oily wastes from Site 6 (see listing earlier in this table).	Soil: Sampling during phase III of the remedial investigation contained trace amounts of semi-volatile organic compounds and two pesticides, but these contaminants were not detected in split samples analyzed by EPA. Groundwater: Addressed as part of groundwater contamination area F (see Section III.A).	In 1993, the ROD for this site required "no action" to address the soil contamination. This action was based on the most recent soil sampling from pits, which found no evidence of contamination that would require cleanup to protect human health.	ATSDR finds no public health hazards associated with this site. Not only is there limited evidence of soil contamination, but the site is also located amid a heavily wooded area far from structures and paved roads. Thus, contact with soils at Site 38 is believed to be limited.
Site 39 - Former Petroleum Oils and Lubricants Disposal Site	In the 1950s and 1960s, this site was used to steam clean aircraft and equipment. The cleaning was believed to release waste mixtures onto soils, including fuels, solvents, lubricants, and oils. The site has since largely been covered with asphalt or seeded with grass.	Soil: The primary contaminants of concern at the site were PAHs. Concentrations of individual PAHs varied from sample to sample, with the highest detected level being 106,390 ppb total PAHs. Groundwater: Addressed as part of groundwater contamination area B (see Section III.A).	The 1993 ROD for this site required "no action" to address the soil contamination. This conclusion was based on a light industrial land-use scenario, and considered the fact that most of the elevated levels of contamination were detected in subsurface soils.	ATSDR finds no public health hazards associated with this site. PAHs were found at elevated levels, but only in a sample collected at a depth of 2 feet and not at concentrations exceeding state cleanup levels for subsurface soils.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 40 - Soil Stabilization Field Test Site	In 1969 the Navy conducted a test at Site 40 to determine if a chemical mixture could stabilize soils and inhibit dust formation. During the test, aniline, ferric chloride, and furfural were applied to, and mixed into, the surface soils of an area that spans 4,000 square feet. No vegetation was observed growing at the site for nearly 20 years after the tests were completed.	Soil: Soils from Site 40 were sampled during Phases I and II of the remedial investigation. Chemicals detected at levels requiring further review included 1,2,4-trichlorobenzene (218 ppb) iron (4,280 ppb). Soil samples were analyzed for aniline and furfural, but these contaminants were never detected. Groundwater: Addressed as part of groundwater contamination area J (see Section III.A).	The 1991 ROD for Site 40 concluded that "no action" was needed to address any soil contamination that remained. It concluded that site conditions at the time pose no unacceptable risks to human health.	ATSDR finds no public health hazards associated with soil contamination at Site 40. Though trace amounts of soil contamination likely remain, the site is located adjacent to an area where high-speed catapult testing is performed and few people access this location. Exposures to soil, if any, are expected to be of short duration.
Site 41 - Ordnance Impact Area	This site address past uses of high explosive ordnance and chemical warfare materiel. ATSDR's evaluation of this site is described in detail in Section III.B of this public health assessment.			

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 42 - Former Base Landfill	This site was reportedly used as a landfill from the late 1920s until the late 1930s. Both residential and industrial wastes were believed to be disposed of at the site. Materials that are likely in the landfill include metal scrap, asbestos, paint thinner, and ash. Most of the land covering the landfill has since been developed.	Soil: Elevated levels of soil contamination were detected in several subsurface borings, as is common for landfill sites. Sediment: Nickel (151 ppm) and vanadium (935 ppm) were detected in sediments adjacent to the landfill. Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	The 1993 ROD evaluated human health risks assuming light industrial land use for contacting soils and transient exposures for contacting sediments. "No action" was required to address the levels of soil contamination found at the site.	ATSDR finds no public health hazards associated with soil contamination at Site 42. Because soil contamination data are not documented in the ROD or the copy of the risk assessment that ATSDR received, our finding is based on EPA's concurrence that contamination levels do not present a significant human health risk.
Site 43 - Advanced Underwater Weapons Storage Site	From 1960 to 1976 the Navy used this site to store, maintain, and transport weapons. The site documents do not specify the type of weapons that were stored at this location.	A 1985 survey of the working area found no radiological hazard in the buildings where weapons were stored. Conducted by the Naval Sea Systems Command Detachment Radiological Affairs Support Office, the survey examined levels of alpha, beta, and gamma radiation in two buildings. The Navy neither confirms nor denies that any radiological material was stored here.	This site is not addressed by any ROD and has no reported corrective actions.	ATSDR finds no public health hazards associated with Site 43. This conclusion is based on the understanding that the building where weapons were stored does not contain levels of radiation at public health concern. (ATSDR was not provided a copy of the 1985 survey of radiological hazards conducted for this site.)

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Site 44 - PCB Storage and Test Areas	Site 44 comprises two areas where electrical transformers were stored and tested over a 34-year period. Testing involved collecting a sample of the transformer fluid, which was eventually disposed of on the soil. Much of the transformer fluids contained polychlorinated biphenyls (PCBs). The Navy estimates that up to 26 gallons of oils containing PCBs were disposed of at Site 44. In 1991, 13 cubic yards of contaminated soil were removed from the site.	Soil: The primary contaminant of concern at this site was PCBs. Prior to the soil removal action, PCBs were detected in the surface soil at concentrations as high as 2,000 ppm. After the removal action, however, the highest measured PCB concentration was 0.22 ppm. Groundwater: Addressed as part of groundwater contamination area A (see Section III.A).	The 1992 ROD concluded that soil contamination at Site 44 poses "no unacceptable risks to human health and the environment," and therefore required "no action" to address any soil contamination remaining at the site.	Based on the results of the confirmation sampling, which found limited evidence of PCBs remaining in surface soils, ATSDR finds no public health hazards associated with soil contamination at Site 44.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Potential fish contamination	According to the installation's Fish and Wildlife Management Plan, base personnel and residents are known to fish in several surface water bodies on site, but primarily in Bass Lake, Clubhouse Lake, Pickerel Lake, Island Pond, and Rainbow Pond. NAES Lakehurst annually stocks most of these surface water bodies with fish.	No fish tissue samples have been collected or analyzed at NAES Lakehurst.	None.	ATSDR believes potential hazards from eating fish caught on base property are minimal because: (1) Most on-site fishing occurs in ponds annually stocked with fish. These fish likely do not live in base waters long enough to accumulate unhealthy levels of chemicals, even if such chemicals were present in the base's surface waters or sediment. (2) Fishing appears to be limited to recreational users, who consume much smaller amounts of fish than do subsistence fishers. (3) The base waters where most fishing occurs (e.g., Bass Lake, Clubhouse Lake, Pickerel Pond) are not downstream from surface water discharges or areas of significant contamination. (4) There is no evidence of widespread or elevated sediment contamination with chemicals known to bioaccumulate in fish.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Small arms range	The Navy operated a small arms firing range near the western border of the base property. Limited information is available on the activities that occurred at this site, other than the fact that it was used to train military personnel on firing small arms. The top 1 foot of soils was excavated from a large area on the range. To recover residual lead, soils were sieved and more than 21 tons of lead materials were collected for recycling.	Soil: Multiple rounds of confirmation soil sampling followed the excavation. Overall, more than 70 confirmation samples were collected. Only one of these samples had a lead concentration greater than EPA's soil-screening level (400 ppm). Because follow-up sampling at this location (6 samples collected) did not find the same contamination levels that were reported previously, site investigators concluded that the one elevated result was an anomalous detection.	The site was not addressed under the NPL actions.	Based on the information provided by NAES Lakehurst, the levels of lead contamination at the former small arms firing range are not a public health hazard under current use. ATSDR notes that this site is located near the western boundary of the installation, where base residents and base personnel rarely frequent.

Table C-1
Evaluation of Sites at NAES Lakehurst with Known or Suspected Environmental Contamination

Site	Site Description and History	Environmental Sampling Results	Corrective Action Status	Evaluation of Public Health Hazards
Cranberry bogs	Commercial cranberry bogs are adjacent to the southern boundary of the base. The Manapqua Brook flows from the base into the cranberry bogs. There is a wastewater outfall from NAES Lakehurst at a point upstream of the bogs and the Manapqua Brook flows back on base after exiting the bogs.	NAES Lakehurst routinely samples the wastewater outfall that flows into Manapqua Brook at a point upstream from cranberry bogs. Those samples are within the NJDEP standards for their permit. There is no surface water sampling information for the Manapqua Brook after it re-enters the base. Therefore, it is unknown whether the brook picks up chemicals from bog operations (i.e., agricultural chemicals).	None.	Evaluation is based on the information about surface water sampling for the wastewater outfall into Manapqua Brook. There is no indication that elevated levels of agricultural chemicals or metals would exist in the surface water that runs to the cranberry bogs.

References for Appendix C:

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Letter from Thomas Lewis (Louis Berger and Associates) to NAES Lakehurst. November 13, 1998.