

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 This finding is partially supported by a review of 1) historical documents, 2) general location of ranges and storage areas, 3) types and amounts of chemicals that were known to have been tested by the Chemical Warfare Service, and 4)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

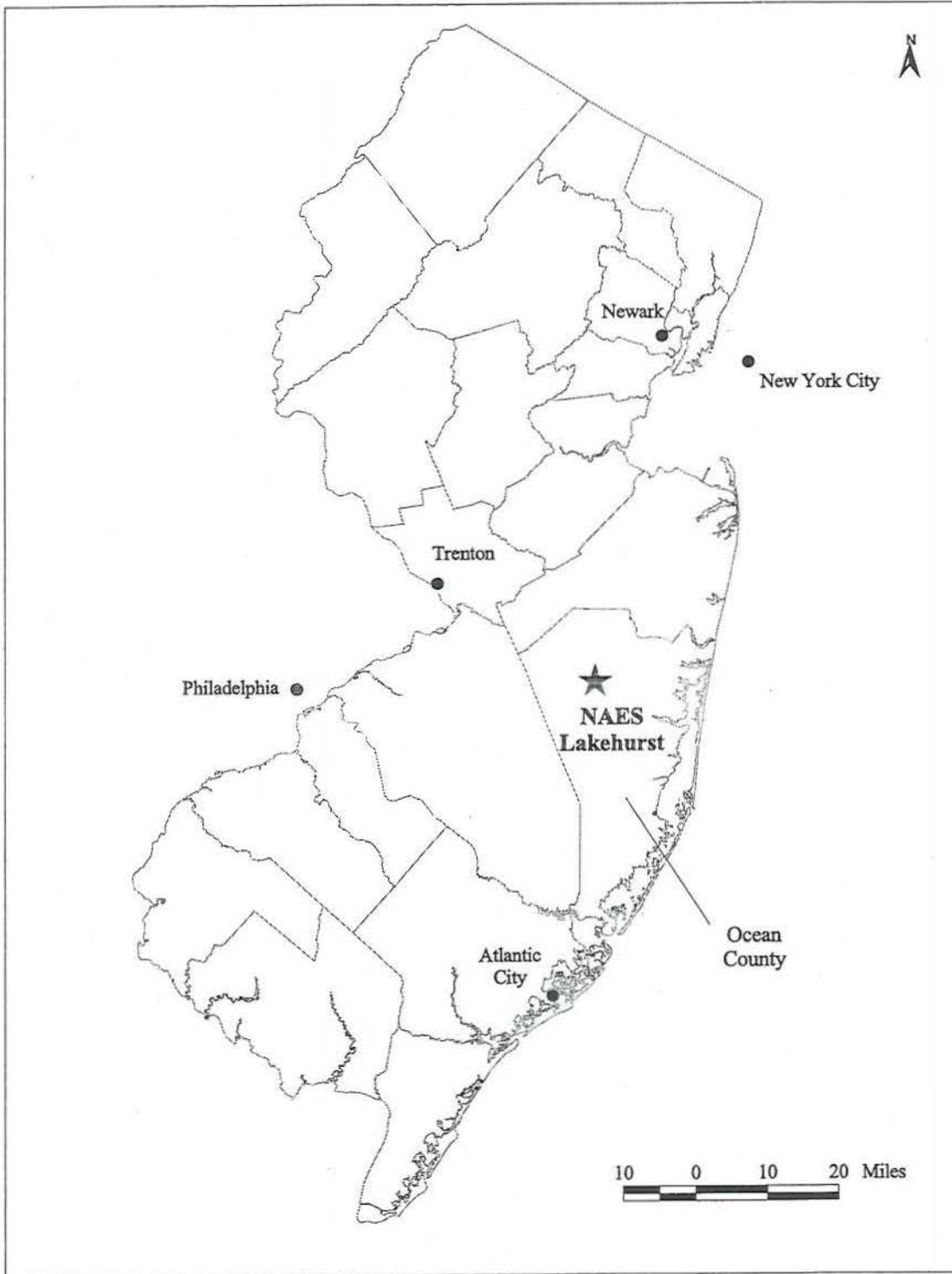
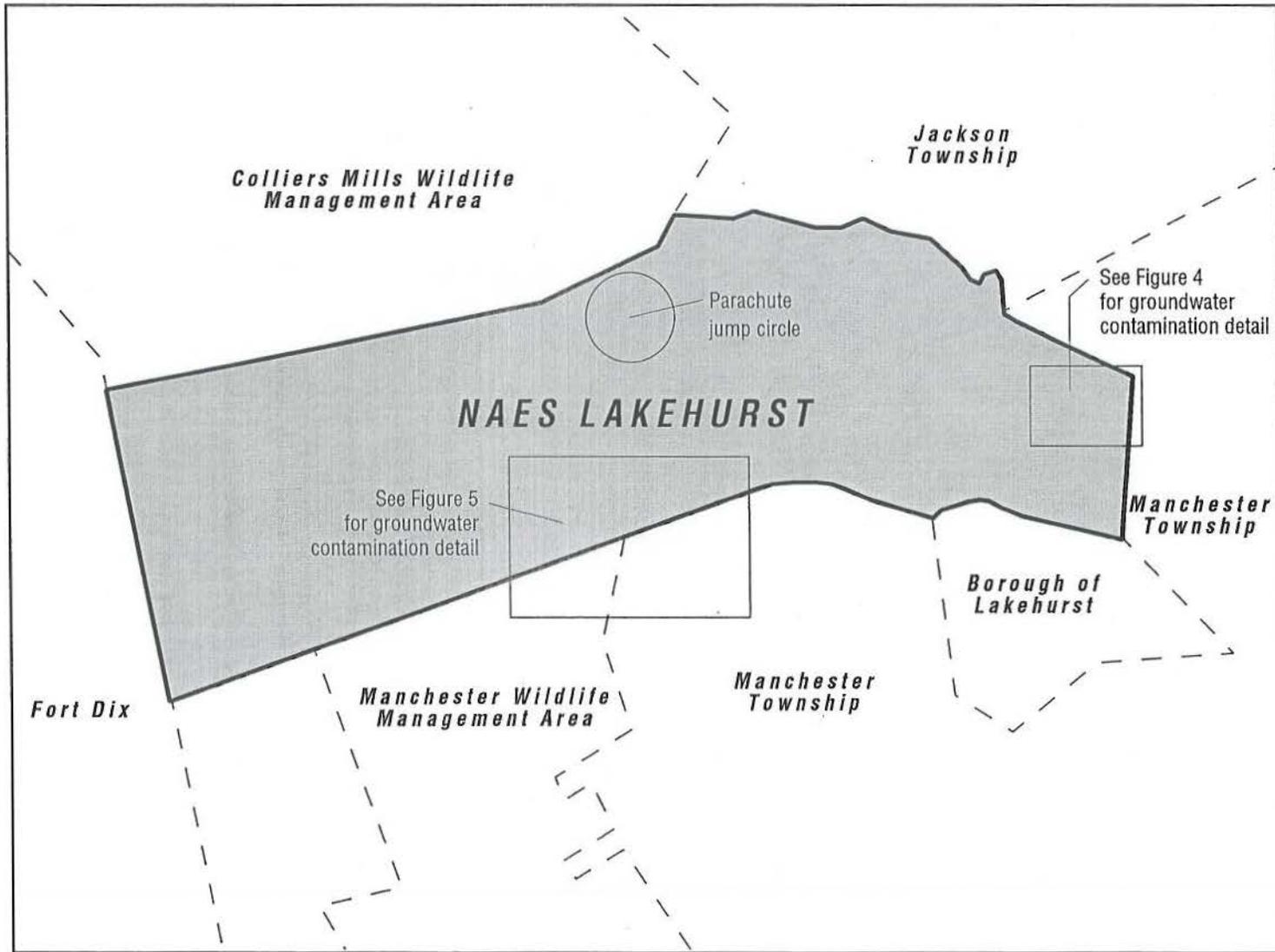


Figure 2
Immediate Vicinity of NAES Lakehurst



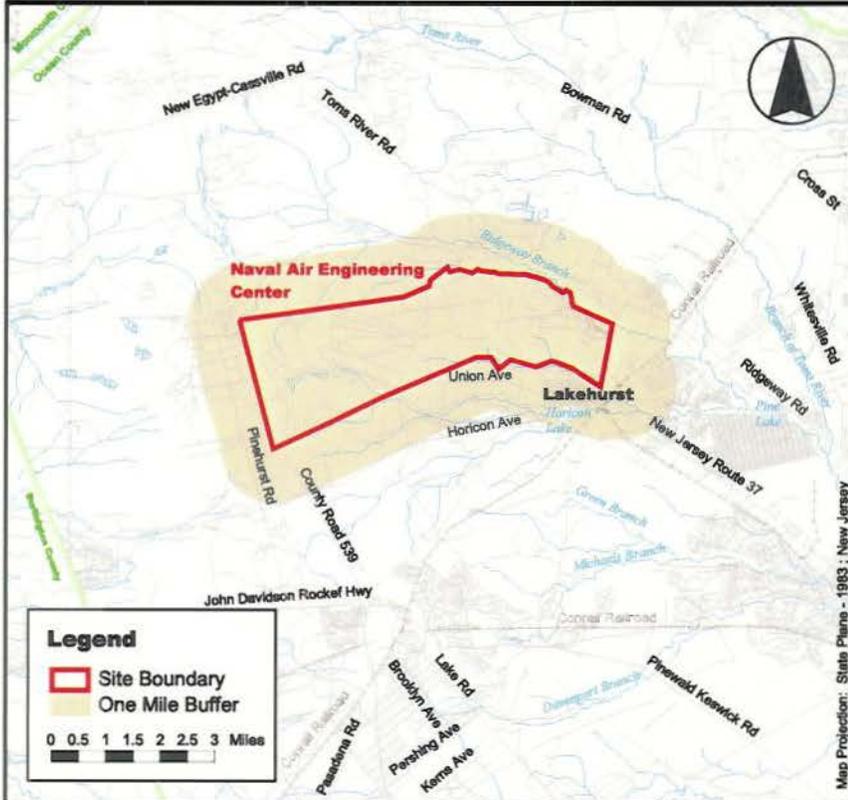
Naval Air Engineering Station

Lakehurst, New Jersey
EPA Facility ID NJ7170023744

Figure 3



Ocean County, New Jersey



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

Base Map Source: 1995 TIGER/Line Files

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

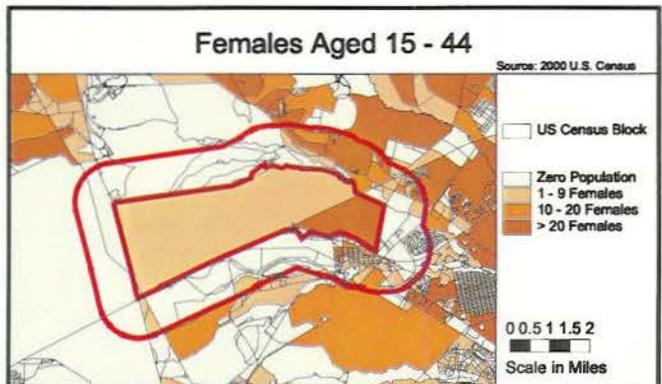
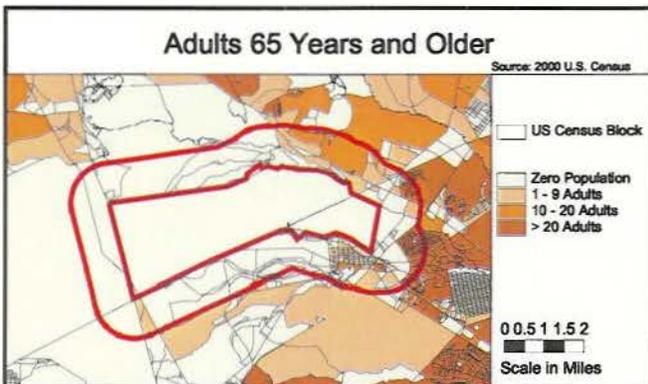
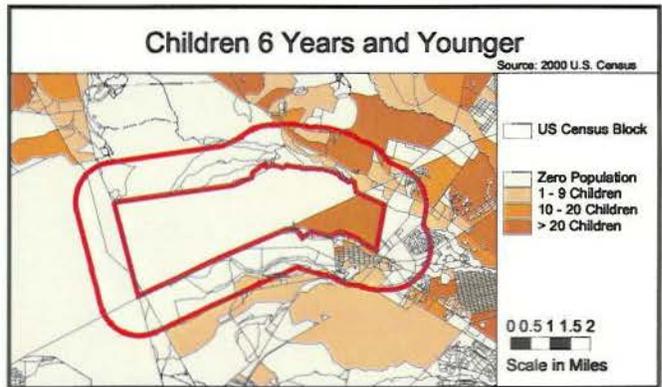
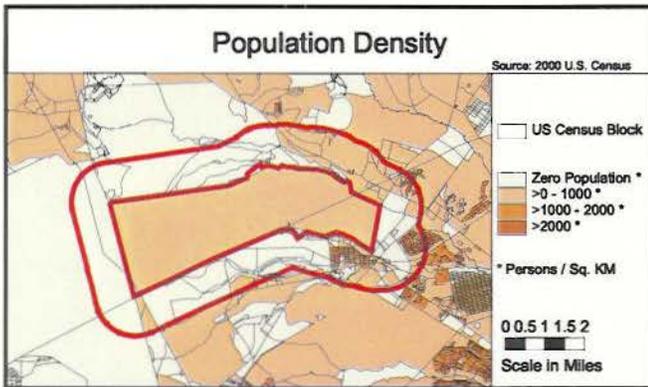


Figure 4
Groundwater Contamination in Area A/B

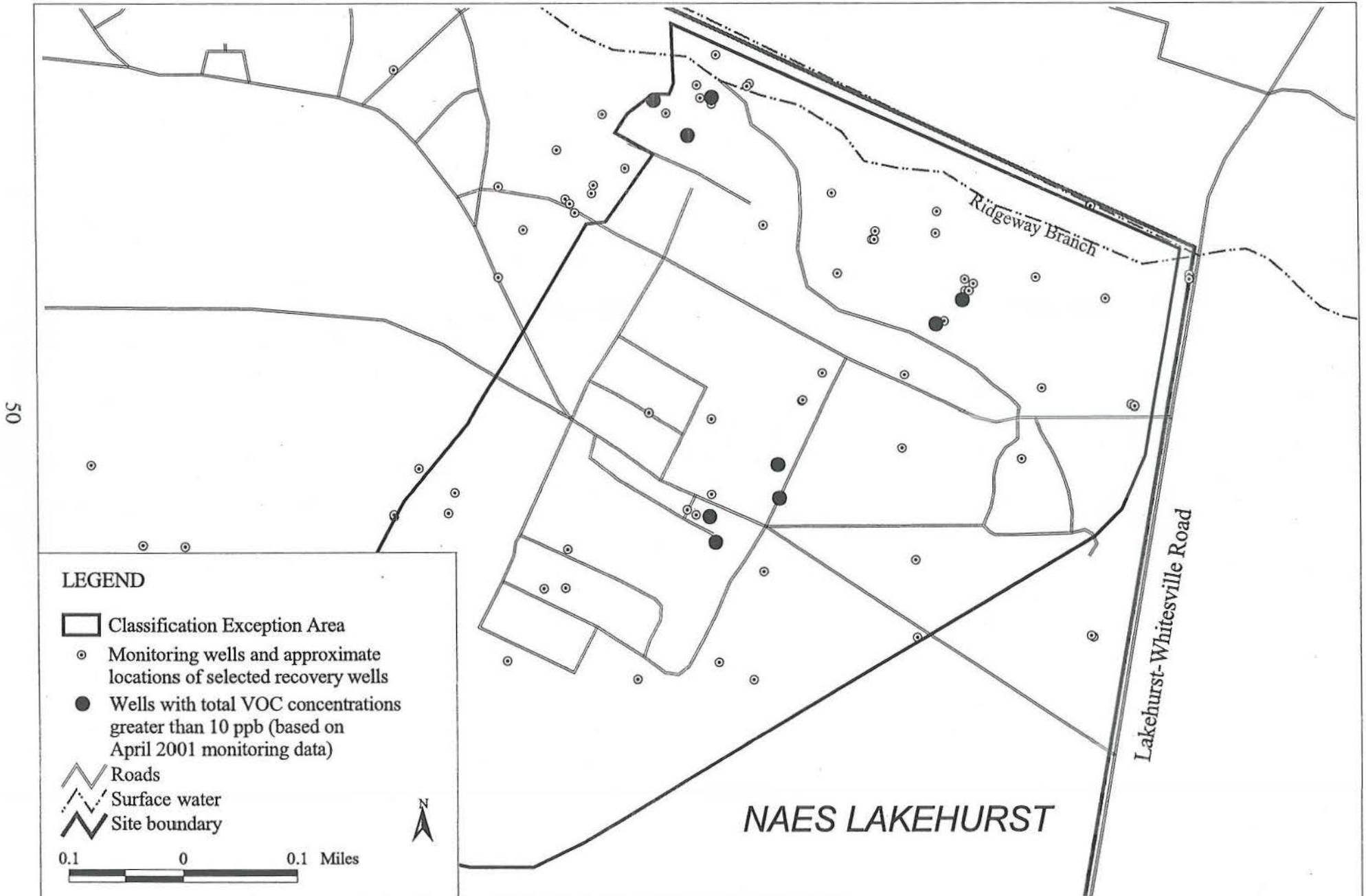
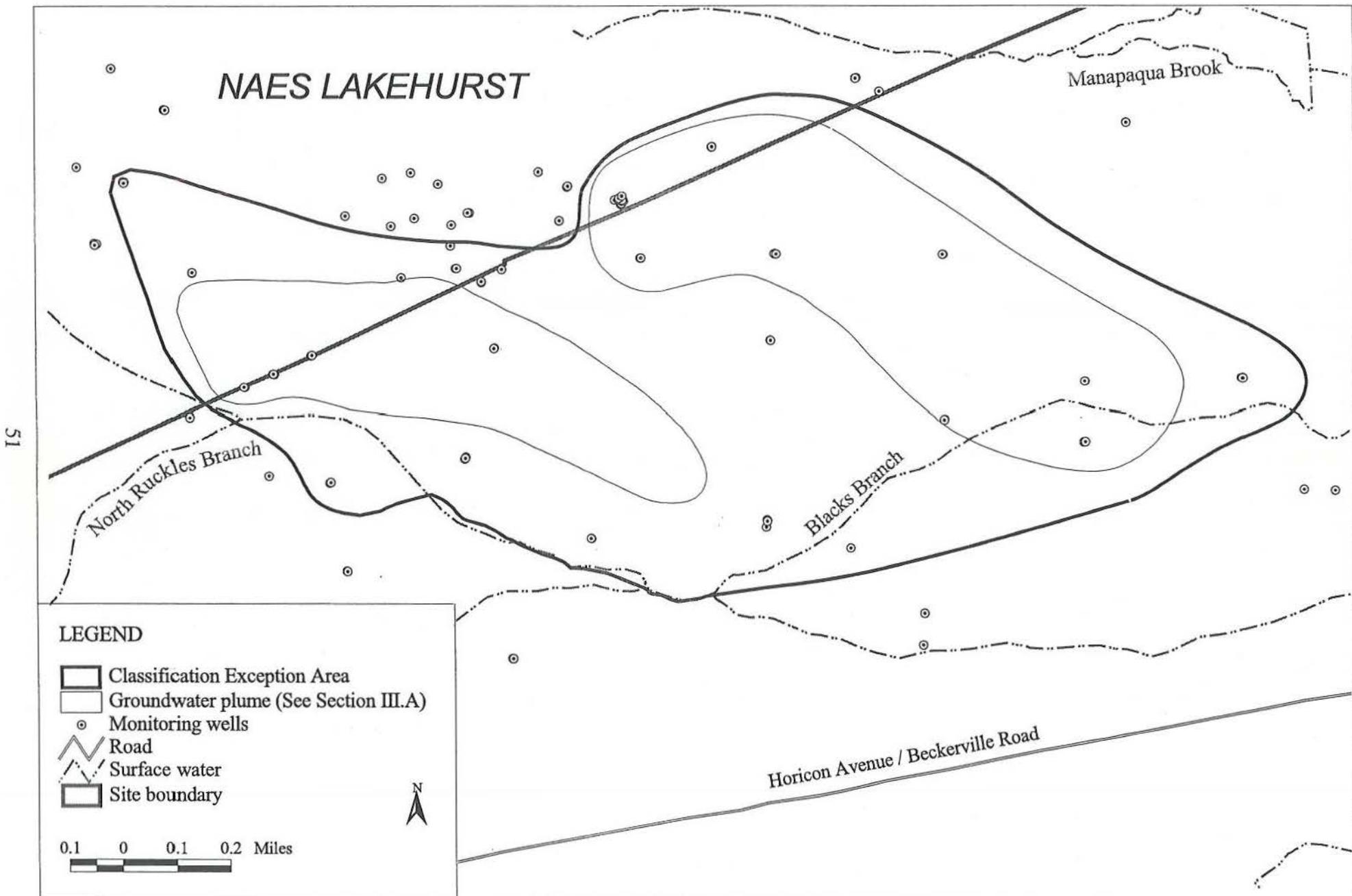
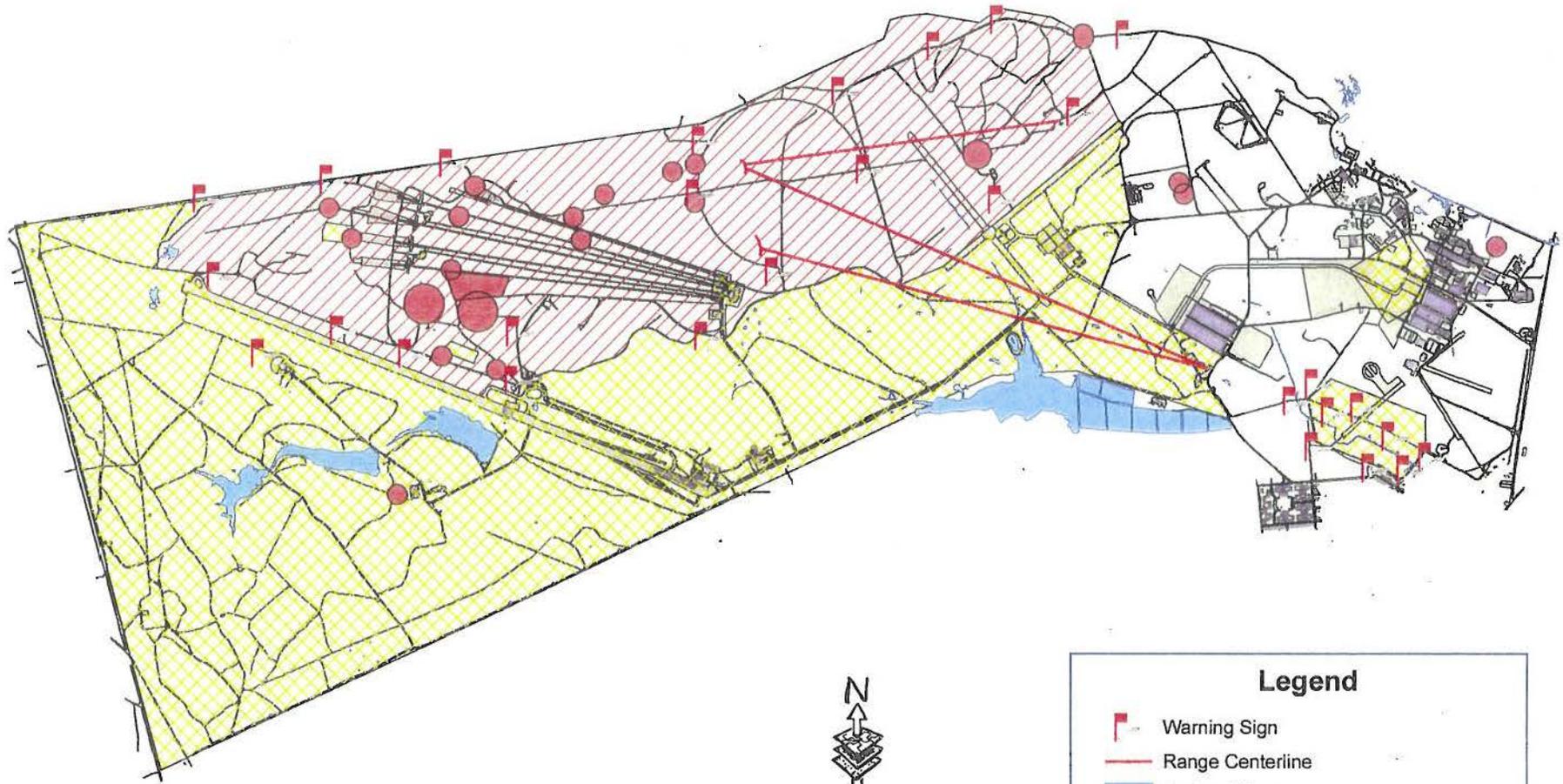


Figure 5
Groundwater Contamination in Area I/J



NAES Ordnance Contaminated Areas

May 2001



52



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 6

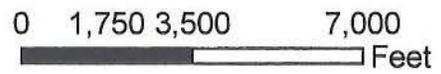
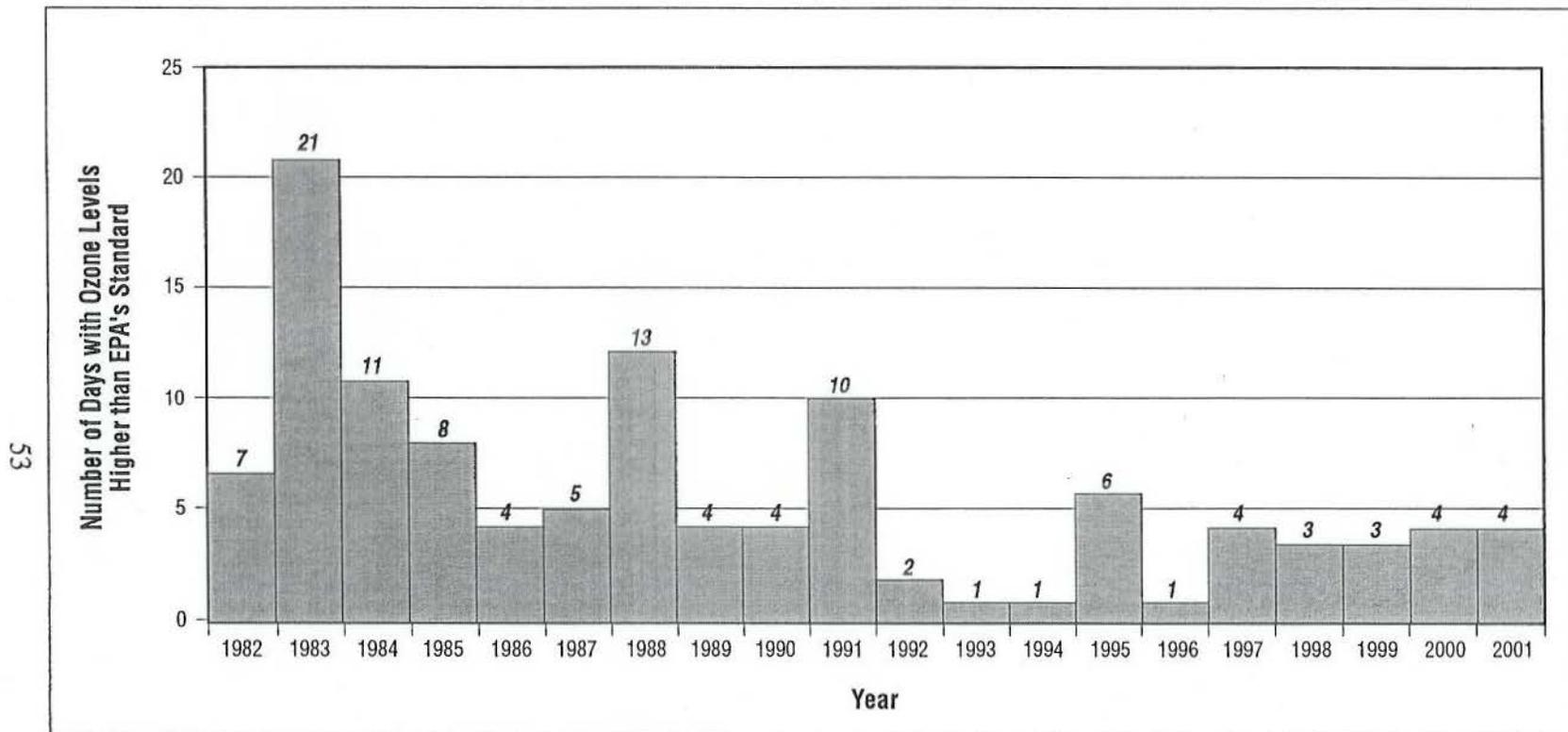


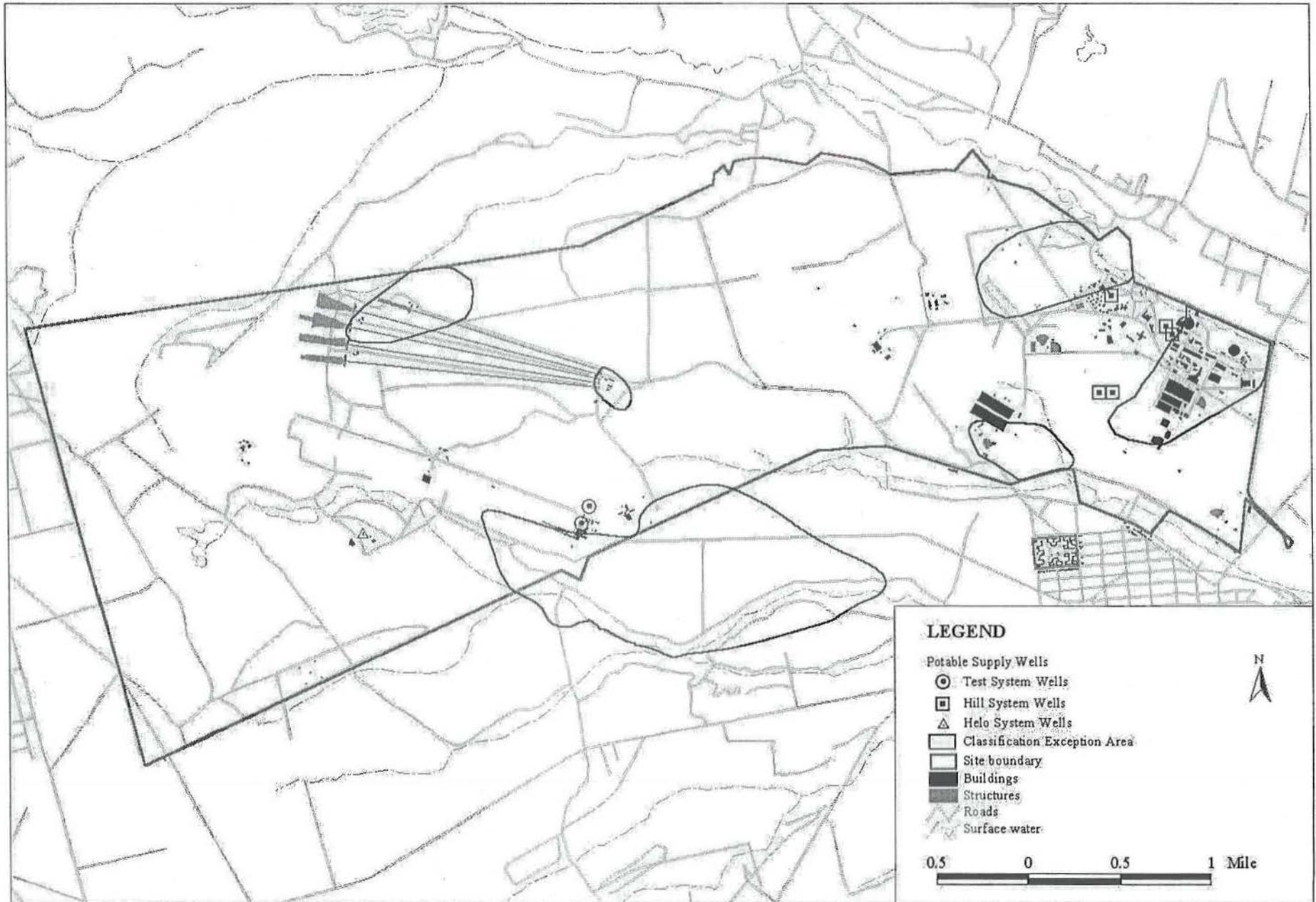
Figure 7

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	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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	<ul style="list-style-type: none"> ■ 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
<p>Drinking water from the base water supply and groundwater wells in the immediate vicinity of Lakehurst.</p> <p>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.</p>	<p>Past Current</p> <p>Future</p>	<p>No</p> <p>Possible, not likely</p>	<p>No public health hazard.</p> <p>No public health hazard.</p>	<p><u>Actions</u></p> <ul style="list-style-type: none"> □ 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. 	<p><u>Recommendations</u></p> <ul style="list-style-type: none"> □ None. 	<p><u>Community Questions</u></p> <ul style="list-style-type: none"> □ Is it safe to drink the tap water from the base water supply? <p><u>Observations</u></p> <ul style="list-style-type: none"> □ 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
<p>Base personnel, base residents, and visitors encountering unexploded ordnance (UXO) and chemical warfare materiel (CWM) that remain on base property.</p> <p>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.</p>	<p>Past - 1918 to 1921</p> <p>Past - 1921 to 2003</p> <p>Current Future</p>	<p>Unknown</p> <p>No Indication</p> <p>Possible, not likely</p>	<p>Indeterminate public health hazard.</p> <p>No public health hazard</p> <p>No apparent public health hazard</p>	<p><u>Actions</u></p> <ul style="list-style-type: none"> □ 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. 	<p><u>Recommendations</u></p> <ul style="list-style-type: none"> □ 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. 	<p><u>Observations</u></p> <ul style="list-style-type: none"> □ 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.

Table 2: Main Exposure Situations and Hazard Summary

Exposure Situation	Time Frame	Exposure Yes/No	Hazard	Actions Taken/Planned	Recommendations	Comments and Observations
<p>Eating deer or other game harvested on base.</p> <p>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.</p>	<p>Past Current Future</p>	<p>Possible</p>	<p>No apparent public health hazard.</p>	<p><u>Actions</u></p> <ul style="list-style-type: none"> □ Hunting is restricted to base personnel, base residents, and military retirees. 	<p><u>Recommendations</u></p> <ul style="list-style-type: none"> □ 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. 	<p><u>Observations</u></p> <ul style="list-style-type: none"> □ 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 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.