Public Health Assessment for

PEASE AIR FORCE BASE
PORTSMOUTH, ROCKINGHAM, NEW HAMPSHIRE
CERCLIS NO. NH7570024847
SEPTEMBER 30, 1999

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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PUBLIC HEALTH ASSESSMENT

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CERCLIS NO. NH7570024847

Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Division of Health Assessment and Consultation
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, full-scale 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 (E-56), Atlanta, GA 30333.

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Summary

Pease Air Force Base (Pease AFB) is located in the New Hampshire Seacoast Region between the City of Portsmouth and the towns of Newington and Greenland, New Hampshire. From 1956 until its closure in 1991, the base maintained a combat-ready force for long range bombardment operations. Due to environmental contamination of soils and groundwater, Pease AFB was placed on the National Priorities List in 1990.

Under the Air Force's Installation Restoration Program, environmental investigations began in 1983. Currently, the base is in the later stages of cleanup, with Records of Decision completed for contaminated areas and all required remedial actions complete or ongoing. Base property is being transferred to the Pease Development Authority for reuse as a civilian commercial center.

The New Hampshire Department of Health and Human Services (NHDHHS) and the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) have reviewed available environmental information related to contaminated areas on the base and identified several exposure situations requiring more detailed evaluation. The situations involved past and current exposures to chemical contamination in surface water, groundwater, sediments, and fish tissue. NHDHHS also reviewed soil gas data to evaluate the possibility that groundwater contamination beneath the base might affect the indoor air quality of some buildings on the site.

Based on this review, all of the exposure situations were categorized as either no apparent public health hazard or no public health hazard due to chemical exposures at levels that are unlikely to result in adverse health effects, or limited access to chemical contamination that prevents exposure.

Exposure Situations With No Apparent Public Health Hazard

Consumption of contaminated groundwater

Past use and disposal of chemicals on the base have resulted in groundwater contamination. In 1977, trichloroethylene (TCE) was detected in the base water supply aquifers. In 1994, nitrate concentrations in the base drinking water supply were elevated. Both contaminants were at levels exceeding current drinking water standards. Although levels were above regulatory drinking water standards, people exposed to these contaminants in drinking water are unlikely to experience any adverse health effects because of the low levels of chemicals present and short duration of exposure. The contamination sources have been identified and measures taken to reduce the contaminant levels. Drinking water on base is regularly monitored, and currently meets all standards for drinking water.

Recreational Use of Peverly and Bass Ponds

Chemical contamination was found in sediments, surface waters, and fish in Peverly and Bass Ponds. These ponds were used for fishing and swimming while the base was active. Exposures to mercury, polychlorinated biphenyls (PCBs), and the pesticide DDT by past recreational users who swam, waded, and fished were below levels where adverse health effects are likely. Currently, the area is

within the Great Bay National Wildlife Refuge and access is restricted.

Exposure Situations with No Public Health Hazard

Installation Restoration Program sites

The 49 Installation Restoration Program (IRP) sites, flight line, and petroleum underground storage tanks pose no public health hazard. There is no evidence of past or current exposures to hazardous substances at these sites and future exposures are not likely to occur. Institutional controls such as restrictions on use of groundwater and limitations on construction in contaminated areas are in place to prevent exposure. Contamination is under remediation, and the migration of contaminants in the environment is being monitored and is not expected to result in future exposures for workers and visitors at Pease AFB.

Potential Exposure Situations

Potential Building Indoor Air Contamination

It is theoretically possible that some contaminants in the groundwater beneath Pease AFB may evaporate, migrate upwards through the soil gas, and eventually impact the indoor air quality of buildings in the area. While there are no data on indoor air quality at Pease AFB, limited data on soil gas do not suggest that current indoor air quality problems would be expected. However, to guard against potential future exposures, this potential pathway should be kept in mind during the redevelopment of the base.

I. Background

A. Site Description and History

Pease Air Force Base (Pease AFB) occupies 4,255 acres in Rockingham County within the City of Portsmouth and the towns of Newington and Greenland, New Hampshire (Figure 1). With the onset of World War II, the U.S. Navy used an airport at the current base location. The U.S. Air Force assumed control in 1951, and the base was completed in 1956. The mission of the base was to maintain a combat-ready force capable of long-range bombardment operations. During the Air Force's long history at Pease AFB, the handling and disposal of hazardous materials has resulted in contamination of soils, sediments, surface water, and groundwater. Pease AFB was placed on the National Priorities List (NPL) of Superfund sites in 1990 and closed as an active base in 1991 (USAF 1990).

The Air Force began an environmental clean-up program at Pease in 1983. The program is operated under Air Force's Installation Restoration Program (IRP), Superfund, and state regulatory requirements. The IRP is a Department of Defense program established to identify locations of past hazardous substance releases and minimize associated hazards to human health and the environment. To carry out IRP objectives at Pease AFB, two Preliminary Assessment/Site Investigations were conducted to determine whether sites posed risks warranting further study. At several sites that posed risks, interim remedial actions were taken that were designed to quickly reduce the threat to human health. For sites that required additional study, Remedial Investigations were carried out to assess the nature and extent of the contamination and to identify potential risks. In conjunction, Feasibility Studies were performed to examine and evaluate remedial clean-up alternatives. A proposed plan was then drafted identifying the preferred clean-up strategies. The U.S. Environmental Protection Agency (USEPA), the State of New Hampshire, and the Air Force decided upon the clean-up strategies and formalized them in Records of Decision (RODs). The remedial actions (control measures and remedies) were then designed, constructed, and put into place.

To facilitate organization of remedial actions at Pease, the area has been divided into eight zones containing several IRP sites and the flight line (Figure 2). To date, all contaminated sites have been characterized, RODs have been signed for all the zones that required remedy selection, various IRP sites within them, and necessary remedial actions have been completed or are in place and operating. All zones are under routine long-term sampling plans to monitor contamination levels and the effectiveness of control measures.

Areas of Special Notice and Groundwater Management Zones have been established within the base perimeter, and outside the property boundary into Newington town property to restrict installation of wells and excavation of contaminated soils (Figure 3). These institutional controls are designed to prevent future exposures to chemical contamination that is still in the process of being cleaned up and, in some cases, being allowed to breakdown naturally.

In 1990, an Environmental Impact Statement was performed to document environmental conditions at base closure (USAF 1990). In 1995, an Environmental Baseline Survey was performed to update and inventory base environmental conditions and to investigate the presence of contaminants

buildings before property transfer (Earth Tech 1995). Findings of Suitability to Lease that document environmental conditions and define whether designated parcels of property can be transferred have been completed. To date, all parcels have been leased to the Pease Development Authority and U.S. Department of the Interior under a long-term lease agreement with the Air Force. The base is currently supporting several agencies and commercial operations and is continuing to develop as a commercial tradeport.

B. Demographics

An evaluation of demographic statistics from the 1990 census indicates that 13,337 people live within one mile of Pease AFB. Of that total, 1,739 are children under 6 years, 1,138 are adults 65 years and older, and 3,350 are women of childbearing age (Figure 4). Commercial and residential areas bound the base to the northeast, southeast, and south. In October 1989, 3,465 military personnel were assigned to the base, accompanied by 4,746 dependents. The Air Force estimates 537 civilian employees were employed on base at that time (USAF 1990). From 1970 to 1990, an average of 3,000 personnel and their families were assigned to the base at any one time. Before 1970, the base supported a maximum of 5,000 personnel (USAF 1994).

C. ATSDR Involvement

The U.S. Agency for Toxic Substances and Disease Registry (ATSDR) has conducted site visits and met with base personnel on two occasions. The first visit occurred in 1991 following base closure when ATSDR staff toured the base to collect information needed to develop a Public Health Assessment. In response to a request from the Air Force, an assessment of contamination at Building 227 (Site 39) was performed to evaluate the potential for exposure for current and future workers inside a building that was proposed for property transfer to civilian use as a hangar. It was determined that contamination did not pose a risk, but that groundwater from the area not be used and that a health and safety plan for site construction activities be developed under the site lease (Little 1991).

Staff from the New Hampshire Department of Health and Human Services (NHDHHS) and ATSDR met with representatives from USEPA, the New Hampshire Department of Environmental Services (NHDES), and the Air Force during a second site visit performed in December 1997. The visit was conducted to collect and review available site-specific information, to visually inspect each contaminated site and other areas containing hazardous materials, and to identify whether and how people could come into contact with site contamination. Information was obtained regarding the nature and extent of site contamination and what actions had been taken to reduce exposure. Proximity of the sites to populated areas was evaluated along with types of human activities that could lead to exposures to site contaminants.

D. Quality Assurance and Quality Control (QA/QC)

In preparing this document, NHDHHS relied on the information provided in referenced documents and contacts. It is assumed that adequate QA/QC measures were followed with regard to sampling, laboratory analysis and data reporting as detailed in the analytical reports. Validity of the analyses

and conclusions drawn in this document are determined by the availability and reliability of the referenced information.

II. Evaluation of Environmental Contamination and Human Exposure

A. Introduction

The following section discusses how people might come into contact with contamination and potential health effects that may result.

For exposure to occur, all elements of an exposure pathway must be present. A completed pathway consists of five elements: source, environmental media/transport, point of exposure, route of exposure, and receptor population. If one of these five elements is missing, no exposure will occur, but the potential for exposure may still exist. The ATSDR exposure evaluation process is presented in Figure 5.

Pathways are evaluated to determine whether people have been exposed to site-related contaminants in the past, are currently being exposed, or might be exposed in the future. When an exposure pathway is considered to be complete, a determination is made whether the exposure may pose a health hazard. ATSDR uses comparison values in selecting contaminants for further evaluation within an exposure pathway. These values are derived for specific environmental media (air, water, soils, etc.), and reflect the concentration for a given chemical that is *not likely* to cause adverse health effects from long-term exposure, given standard assumptions about body weight, ingestion, and contact rates. Since comparison values do not represent thresholds for toxicity, exposure to concentrations above comparison values will not necessarily produce adverse health effects. Comparison values used in this Public Health Assessment include USEPA's Maximum Contaminant Levels (MCLs) and ATSDR's Environmental Media Evaluation Guides (EMEGs), Reference Dose Media Evaluation Guides (RMEGs), and Cancer Risk Evaluation Guides (CREGs). Additionally, NHDES's and USEPA's risk based concentration tables were used when no ATSDR comparison value was available (NHDES 1998a, USEPA 1998). MCLs are enforceable drinking water regulations developed to protect public health, but also consider economic and technological factors in setting the standard. CREGs, EMEGs, and RMEGs are strictly health-based values and are not enforceable.

Chemicals disposed or released into the environment have the potential to come into contact with people, resulting in exposures that may cause adverse health effects. However, chemical releases do not always result in exposures. People can only become exposed if they come into contact with the chemical by ingestion (eating or drinking a substance containing the chemical), inhalation (breathing air containing the chemical), or by dermal absorption (skin contact with a substance containing the chemical).

Many factors are involved that determine whether an exposure will result in health effects. The type and severity of health effects that occur in an individual from contact with a chemical depend on the exposure concentration (how much), the frequency and duration of exposure (how often and how long), the route that the chemical enters the body (such as breathing, eating, and skin contact), toxic

properties of the chemical, and interactions between other chemicals in the body. Once exposure occurs, many characteristics such as age, genetics, health, and nutritional status influence how the chemical behaves in the body. Together these factors affect the type, severity, and likelihood of health effects that may occur from exposure to hazardous substances.

B. Exposure Situations With No Apparent Public Health Hazard

NHDHHS evaluated available information and site conditions at Pease AFB to determine whether people could be coming into contact with chemical contaminants. If exposure pathways were completed, levels of exposure were evaluated to determine the likelihood of adverse health effects. Two completed exposure pathways were identified: (1) past consumption of contaminated groundwater; and (2) past recreational use of Peverly and Bass ponds (Table 1a). However, these pathways are categorized as no apparent public health hazard because the levels of exposure are not expected to result in adverse health effects.

1. Consumption of Contaminated Groundwater

(a) Hydrogeology and Groundwater Use

Groundwater typically occurs 5 to 25 feet below ground surface on Pease AFB. Water depth varies as a result of natural and human factors such as precipitation and pumping rates. Overburden (shallow) groundwater generally flows east to southeast, while bedrock (deep) predominantly moves southeast. The principal overburden aquifers on the base are the Upper Sand and Lower Sand deposits, which merge in the center of the base under the flight line to form a 40-60 foot thick section of saturated, permeable sand (USAF 1990). This aquifer is the principal base water supply. The aquifer is susceptible to water quality impacts from contamination originating on or near ground surface.

Water for Pease AFB was supplied by three major wells located on base: the Haven well, the Smith well, the Harrison well, and three smaller wells now located within an area operated by the U.S. Department of the Interior as a wildlife refuge (Figure 6). The Haven well is the primary production well with a pumping capacity of 740 gallons per minute. The Smith and Harrison wells have pumping capacities of 420 and 225 gallons per minute, respectively. Prior to 1981, the wells all fed into a common distribution system. After 1981, a treatment plant was constructed and the supply wells were piped into a common point for blending, treatment, and distribution (CDM 1994). Currently, only the Haven and Smith wells supply water to the base. Since 1996, the Smith well has also served the golf course. The Harrison well has been off-line since 1987 due to poor condition of the well casing (CDM 1996).

(b) Opportunities for Exposure to Trichloroethylene in Groundwater

(i) Nature and extent of groundwater contamination near the Haven well

In 1977, in response to complaints about fuel odors in the drinking water, water from the base wells

was tested and found to contain trichloroethylene (TCE), a volatile organic solvent widely used for cleaning and degreasing operations on the base. When first discovered in the spring of 1977, the maximum concentration detected at the Haven wellhead was 391 micrograms per liter (µg/L), and 28.5 µg/L at the Harrison well (Bradley 1982; Weston 1990). No standards for TCE in drinking water existed at that time, but this exceeded the current drinking water standard of 5 µg/L. By 1978, further sampling did not detect TCE in the Harrison or Smith wells (Bradley 1982).

Samples were only collected at the wellheads, not at the taps that supplied drinking water. Since the three wells fed into a common distribution system, blending of water from the three wells likely would reduce the actual levels at the tap.

There are many uncertainties about well operations that might have affected contamination levels at the tap. Since the wells fed into the distribution system at different locations, it is feasible that water in areas of the distribution system closest to the Haven well may have contained higher concentrations of TCE than other areas of the system closer to the Smith and Harrison wells. Another area of uncertainty is the operational schedules for individual wells. Past pumping schedules are unknown, and it is not clear whether the wells pumped in combination or were cycled one at a time. In the absence of more information about the well operational schedules, it is assumed that the wells were all on line and pumping into the distribution system simultaneously.

According to the water supply engineer for the City of Portsmouth, following discovery of the contamination, the wells were shut off and clean water was supplied to the base by the City of Portsmouth during the period of 1977-1978 (Craven 1998). During that time, the U.S. Geological Survey (USGS) investigated the contamination and identified a likely source to the north of the well (Bradley 1982).

During the investigation, the Haven well was heavily pumped, thus reducing the contaminant levels as clean groundwater entered the Haven well area. In Fall 1978, the wells went back on line. At the time, the Surgeon General established a TCE concentration limit of 280 µg/L in drinking water (USAF 1990). The concentrations of TCE in the Haven well had dropped below this level, but there was still concern regarding the safety of the drinking water. In 1981, the Air Force agreed to construct a water treatment plant. The treatment plant was finished in 1984 but never went on-line due to operational problems. Since January 1986, Haven well water samples indicate that TCE levels remain consistently below the current drinking water standard of 5 µg/L (Weston 1990).

The Air Force later determined that the likely source of TCE contamination was a leaking storm sewer line that passed in the vicinity of the Haven well (Weston 1995). This line carried TCE-contaminated wastewater that discharged into the storm sewer system from floor drains in building 227. TCE leaked from joints in the storm sewer line into groundwater in the well vicinity, where it was drawn into the well as groundwater was pumped into the water distribution system. A conceptual model of the Haven well contamination is in Figure 7. Remedial actions controlled the contamination source, and during 1985, TCE concentrations had dropped below the drinking water standard. Figure 8 and Table 2 show the contamination trends from 1977 until 1993. The declining trend in TCE concentrations indicates that the contamination has been lessened by natural breakdown, cessation of contributing sources of contamination, and infiltration of clean water into the Haven well

area. Also, it is thought that reduced water usage following discovery of the contamination allowed the water table to rise above the storm sewer system. This impeded leaks of TCE contaminated wastewater from the pipes (Weston 1993). Currently, TCE concentrations are below the drinking water standard and remain stable at low levels. The pumping rate of the Haven well is limited to 300 gallons per minute so that clean-up operations in nearby Zone 3 are not affected (CDM 1994).

Groundwater contaminant plumes exceeding drinking water standards are located in several areas around the base (Figure 9). No exposure is occurring to these contaminant plumes, and the sources and plumes are under remediation, institutional controls, and long-term monitoring.

Although a plume of contaminated groundwater from site 8 has moved off-base into Newington, the plume underlies the Newington Town Forest, and no drinking wells are located in the area. An off-base well inventory indicated that no drinking water wells were located in areas of groundwater contamination (Weston 1992).

(ii) Current Exposure

Currently, plumes of groundwater contamination at Pease AFB are not impacting any drinking water wells. All public drinking water on base meets state and federal regulations and is routinely tested according to Safe Drinking Water Act requirements.

(iii) Past Exposure

It is not known when exposure to TCE in the Haven well began. No well sampling data were available prior to 1977. Upon discovery of the contamination in 1977, the supply wells were shut off and the City of Portsmouth provided water to the base. This action stopped exposure to TCE at concentrations as high as 391 µg/L. When the Haven well was placed back on line in the fall of 1978, the TCE levels had dropped to below 115 µg/L (Figure 8). After 1985, levels of TCE in the Haven well had dropped below the drinking water standard of 5 µg/L. Therefore, exposures to TCE above current drinking water standards were possible from 1978 until 1985. Table 2 and Figure 8 show the trend of TCE contamination in the Haven well over time.

Since there are no data on TCE concentrations in the base water supply before 1977, exposures to TCE earlier than this date are unknown. To account for this uncertainty, NHDHHS used very conservative assumptions about TCE concentrations and duration in its evaluation of past exposures to TCE in the base water supply:

- Base residents were assumed to have been exposed to TCE at 122 µg/L between 1978 and 1985, even though the average concentration of TCE in the Haven well from 1977 through 1985 was 58 µg/L. This average includes data from a period in 1977-1978 when base residents were being supplied water from the City of Portsmouth and the TCE concentrations in the Haven well were near their maximum.
- The actual concentrations of TCE in water consumed by base residents was likely to be lower than the well head concentrations used in the exposure assessment because water from Haven well was diluted with water from the Smith and Harrison wells before being distributed to residential taps.
- In the 1970s and 1980s, the population on Pease Air Force Base was primarily composed of

military personnel and their dependents who were stationed on base. NHDHHS assumed that base residents lived there for nine years (the median time in one residence for U.S. citizens from USEPA 1997), which is longer than the duration of time that exposures to TCE above the current drinking water standard were known to be possible (1978-1985).

While there are uncertainties about exposures before 1977, NHDHHS chose to be protective of public health by making conservative assumptions about the ways people may have been exposed in the past that likely overestimated actual exposures to TCE from using base drinking water.

NHDHHS compared the estimated exposure levels with available health guidelines, comparison values and information from the scientific literature regarding the health effects from exposure to TCE to assess the likelihood of adverse health effects.

NHDHHS methodology is consistent with the approach used by other public health agencies in its estimation of exposures to hazardous substances. To be more concise for the general public, a detailed explanation of the assumptions and calculations used to estimate exposures and determine the likelihood of adverse health effects is not presented in this document, but is available upon request.

(iv) Public Health Implications from Past Exposure

Based upon an evaluation of exposures to TCE and information about the toxicity of this chemical from the scientific literature, adverse health effects to adults, children, and unborn infants are unlikely.

Our evaluation of exposure levels in comparison to health guidelines and information on the toxicity of TCE, showed that no adverse health effects are likely in adult and child residents and adult workers from exposure to TCE-contaminated groundwater. For children, exposure levels slightly exceeded a provisional oral reference dose (RfD) for TCE. The RfD is an estimate of the daily exposure to a substance that is likely to be without risk of adverse non-cancer health effects for a lifetime. Exposure levels for TCE in Haven well water above the RfD will not necessarily produce adverse health effects. The RfD does not represent a threshold for toxicity, but rather establishes a dose that, if exceeded, increases the possibility that adverse health effects may occur as exposure levels and duration increase. Furthermore, based on review of the toxicological literature for TCE, the levels present in the Haven well have not been shown to cause adverse health effects.

Additional information on the toxicity of TCE that was considered in our evaluation is presented in the following three subsections: (1) cancer effects from exposure; (2) systemic (non-cancer) effects from exposure; and (3) child health considerations.

Cancer Effects from Exposure

Liver and lung tumors were seen in rats and mice following high doses of TCE administered in

experimental studies. The significance to humans of the results seen in animal studies is unclear, as the mechanisms of toxicity may differ between rodents and humans (ATSDR 1997). The exposure doses of TCE causing cancer in animal studies were 4 million times higher than the estimated doses from consuming Haven well water.

The link between exposure to TCE and cancer in humans is controversial, and insufficient evidence exists to define TCE as a human carcinogen. Studies of human populations exposed to TCE in well water are contradictory. A study in New Jersey showed an association between TCE exposure and development of leukemia and non-Hodgkin's lymphoma, but a Finnish study demonstrated no association (ATSDR 1997). Both studies had several limitations, including simultaneous exposures to other chemicals and difficulties in classifying exposure levels.

In 1997, the Massachusetts Department of Public Health (MDPH) completed an epidemiologic study of childhood leukemia in Woburn, Massachusetts (MDPH 1997). In this study, MDPH observed an association between exposure to water drawn from Woburn's water supply wells G&H and the development of childhood leukemia. This association was strongest for exposures to the water that occurred *in utero*.

The water from wells G&H in Woburn was tested once for toxic substances before the wells were shut down. Contaminants detected in this sample were: trichloroethylene (TCE), tetrachloroethylene, chloroform, methyl chloroform, trichlorotrifluoroethane, 1,2-dichloroethylene, and arsenic. Other chemicals (i.e., trans-1-dichloroethyene, lead, chlordane, 1,1,1-trichloroethylene, and vinyl chloride) were also detected in the groundwater on properties presumed responsible for contaminating the wells G&H water. Since the wells were contaminated by multiple chemicals whose relative concentrations over time were unknown, MDPH could not conclude that exposure to TCE or any other specific chemical in particular was the cause of the elevated childhood leukemia incidence. Exposures to one, some, or all of the chemicals in the wells G&H water could have played a role.

As part of this Public Health Assessment for Pease AFB, NHDHHS reviewed available information on cancer incidence for the surrounding towns of Newington, Portsmouth, and New Castle (see Appendix D for details). Cancer incidence within Portsmouth and New Castle for the period between 1987 and 1991 (all the data that were available) were not statistically different from the number of cases seen in the State of New Hampshire as a whole during this same period. However, there were two cancer types that were elevated in Portsmouth: non-Hodgkin's lymphoma among males and cervical cancer among females. Environmental exposures are not thought to be the primary risk factors for the development of these cancer types. There were very few cases observed in Newington during this period which prevented further analysis.

Systemic (Non-Cancer) Effects from Exposure

Much of what is known about non-cancer effects from TCE exposure comes from animal studies and studies in humans who breathed or drank high levels of TCE. Dizziness, headache and a feeling of facial numbness have occurred in workers breathing TCE or people who have used TCE in unventilated areas. In the past, TCE was used as an anesthetic because of its effects on the central nervous system. More severe effects on the central nervous system, such as unconsciousness and

death, were found to occur at high levels of exposure (ATSDR 1997).

Some health effects may occur from long-term exposure to TCE. This information is primarily from animal studies, which have shown that exposure to TCE can produce liver and kidney damage; effects on the blood; and tumors of the liver, kidney, and possibly tissues responsible for forming white blood cells (leukemia). Drinking alcohol can make people more susceptible to liver and kidney injury from exposure to TCE (ATSDR 1997). The lowest dose of TCE at which no adverse systemic health effects were seen in long-term animal studies was at least 5,000 times greater than the estimated doses from consumption of contaminated water from the Haven well (Maltoni 1986). Therefore, adverse health effects from exposures to TCE in the drinking water at Pease AFB are unlikely.

Child Health Considerations

Infants, older children, and developing fetuses require special attention when evaluating the likelihood of adverse health effects from exposure to hazardous substances. These populations differ in their sensitivity and response to chemical exposures in relation to adults, and are often the most sensitive populations of concern for chemical injury.

This is due to many reasons, including behaviors that can lead to increased contact with substances containing chemical contaminants, smaller body weights that result in increased exposure levels, sensitivity of developing organ systems, and differences in the way children's bodies respond to chemical exposures, such as how the body breaks down and eliminates chemicals (ATSDR 1998a).

The developing fetus can experience adverse health and developmental effects at levels below those of concern for health effects in the mother. The mother's body protects the developing fetus to some extent, but chemical injuries during critical periods in fetal development can increase the risk of birth defects, low birth weight, or miscarriage (Guzelian 1992).

Trichloroethylene rapidly crosses the placenta, with subsequent exposure to the fetus. In three out of ten pregnancies, concentrations of TCE in umbilical venous blood (indicative of fetal blood concentrations) exceeded concentrations in maternal blood after 10-15 minutes of exposure to TCE (Trilene ®) and nitrous oxide anesthesia (Laham 1970).

Important reproductive and developmental effects due to TCE exposure have not been clearly identified in humans. A few human studies have demonstrated an association with TCE exposure and developmental effects (Bove 1995, Goldberg 1990, Lagakos 1986, Schendel 1996, Sonnenfeld 1997), but methodological problems and other limitations in the studies make it difficult to clarify a causal link between exposure to TCE and adverse reproductive and birth outcomes.

Animal studies indicate that TCE can act as a developmental toxicant, though often at doses that cause maternal toxicity as well. In a study involving pregnant rats exposed to TCE in drinking water, the lowest maternal exposure dose at which developmental toxicity was seen was more than 42 times higher than the estimated exposure levels to mothers consuming TCE-contaminated water from the Haven well (Dawson 1993).

(c) Opportunities for Exposure to Nitrate in Groundwater

(i) Nature and Extent of Contamination

From 1994 through early 1996, nitrate levels in the Haven and Smith wells were near or exceeded the drinking water standard of 10 milligrams/liter (mg/L) (as nitrogen in nitrate), reaching peak concentrations of 11.4 mg/L in water from the Smith well. Monitoring data from prior to 1994 showed that the nitrate concentrations had increased from low levels (less than 1 mg/L) in 1990 to near 10 mg/L in 1994 (CDM 1994, CDM 1996). The likely source of the nitrate was the use of urea-based deicing agents on the runway, the application of which presumably increased during this time.

In 1995, the use of urea-based deicing agents was discontinued, and a groundwater monitoring program began (CDM 1996). A water management strategy was also adopted whereby water from the Haven and Smith wells were mixed, in proportions determined by their nitrate levels, to ensure that nitrate concentrations in the base water supply stayed below the drinking water standard (Hilton 1999). Nitrate levels in the base drinking water are currently monitored on a continuous basis via an in-line nitrate analyzer and meet all state and federal standards for drinking water. Also, the Pease Development Authority is participating in the City of Portsmouth's Wellhead Protection Program to protect the aquifer beneath the former base.

(ii) Current Exposure

Actions taken to reduce nitrate levels have been effective, and drinking water meets current state and federal drinking water standards for nitrate contamination.

(iii) Public Health Implications from Past Exposure

It is unlikely that adverse health effects would have resulted from consumption of Haven well water contaminated with nitrates slightly exceeding the drinking water standard.

The concern for ingestion of nitrate-contaminated water is primarily due to effects on infants younger than 4 months of age who are fed formula diluted with water containing excess nitrate contamination. Nitrate consumption can result in methemoglobinemia ("blue baby syndrome"), which is a disease caused by nitrate interference with the oxygen-carrying capacity of the red blood cells. There is little evidence that breast-fed infants develop methemoglobinemia from exposure to nitrates ingested by nursing mothers (ATSDR 1991). Consuming water containing nitrates above the drinking water standard does not imply that methemoglobinemia will result, rather it indicates that with increasing concentrations the possibility of adverse health effects may also increase.

Consumption of nitrate-contaminated water has resulted in spontaneous abortion in laboratory animals and livestock (Kross 1992, Sund 1957). A report in the July 1996 issue of the Centers for Disease Control and Prevention's "Morbidity and Mortality Weekly Report" cited a case in 1993, in which the LaGrange County Health Department in Indiana identified three women who reported a total of six spontaneous abortions between 1991 and 1993 and lived near each other. All of these women obtained water from nitrate-contaminated wells (Grant 1996). The nitrate levels identified in this report were on the order of 19-26 mg/L, higher than levels found in the base water supply in

1994 (approximately 10 mg/L at maximum levels).

In human populations, spontaneous abortions occur commonly and are directly associated with increasing maternal age (Grant 1996). Cases of spontaneous abortion may cluster by chance. The LaGrange County investigation did not establish a causal link, but demonstrated a possible association between elevated nitrate levels in water and spontaneous abortion in humans.

Therefore, based on comparisons with the LaGrange County study, it is unlikely that the nitrate levels in the Haven well were high enough to pose a risk to the developing fetus of a pregnant woman consuming the water on Pease AFB. This determination is based on the fact that the nitrate levels in the Haven well were much lower than those found in the LaGrange County wells. Furthermore, the LaGrange County wells were the primary source of drinking water for the women in the study, while Haven well water would likely have been consumed in lesser amounts during a normal work day by workers and visitors on the base.

2. Recreational use of Peverly and Bass Ponds

Peverly and Bass Ponds have been used in the past for recreational activities. When people swim or wade, they may come into contact with contaminants in water and sediments. Contamination can build up in the bodies of fish to levels that can pose a health hazard to the people and animals that eat them.

(a) Nature and Extent of Contamination

Peverly and Bass Ponds were studied extensively during the Zone 2 remedial investigation. Past use of pesticides for mosquito control has resulted in detectable levels of the pesticides lindane and DDT. Products of natural DDT breakdown in the environment, DDD and DDE, were also detected. An organic form of the metal mercury, called methyl mercury, was detected in fish tissues. Other contaminants, such as PCBs, were detected in fish, sediments, and surface waters that likely were introduced into the ponds as a result of drainage via nearby Peverly Brook, which collects surface water runoff from Zone 2 IRP sites and a section of the flight line parking apron.

The origin of the contaminants is not clear, but is likely a result of past activities on the base with the exception of mercury, which is a contaminant of concern in freshwater fish throughout New Hampshire. Sediments, fish, and surface waters in Peverly and Bass ponds are under a long-term sampling program to monitor contamination levels (Bechtel 1997a). Fish tissue concentrations detected in 1996 are presented in Table 3. Contaminants in sediments and surface water that were evaluated for human health risks are presented in Tables 4 and 5.

(b) Current Exposure

No exposure is currently occurring because the ponds are within the Great Bay National Wildlife Refuge under the U.S. Fish and Wildlife Service and are off limits to swimming and fishing.

(c) Public Health Implications from Past Exposure

Based upon exposure estimates and information about the toxicity of PCBs and mercury, exposure to contaminants in surface waters, sediments, and fish of Peverly and Bass Ponds is unlikely to result in adverse health effects

In order to reach this determination, NHDHHS developed realistic, but conservative, assumptions about exposures for recreational users (e.g., monthly-to-bimonthly visits to the ponds to swim and wade during the warm half of the year). Exposure levels were then evaluated in light of available toxicological information for the compounds of concern. Special consideration was made for the unique vulnerabilities of small children to chemical exposures as described below.

Child Health Considerations

As stated previously in this document, children are usually more sensitive to chemical exposures than adults, and health risk evaluations involving children and developing fetuses require special emphasis due to this unique vulnerability. In animal studies, exposures to high levels of PCBs and mercury have been shown to result in adverse health effects in developing fetuses. Studies in humans have also demonstrated an association between exposure and effects in children and developing fetuses (ATSDR 1998b, ATSDR 1999). The exposure levels at which effects have been seen are higher than the exposure levels estimated from use of the ponds.

Currently in New Hampshire, a fish consumption advisory is in effect for finfish caught in all inland fresh water bodies. This is based on mercury levels that have been detected in the tissues of freshwater fish throughout the state. The advisory is designed to prevent adverse health effects from long-term exposure. The advice from NHDHHS is that *adults should limit consumption to four 8-ounce meals per month. Pregnant women and children should limit consumption to one 8-ounce meal per month*. It is good practice to skin and remove fatty tissues from the fish before cooking and to discard cooking juices and drippings.

C. Exposure Situations with No Public Health Hazard

The 49 IRP sites, underground storage tank sites and the flight line did not, and currently do not, present public health hazards because: (1) access to site contaminants is restricted or limited (thereby limiting exposure); and/or (2) migration of contaminants to areas where exposure might occur is not expected; and/or (3) contamination has been cleaned up. Ongoing remediation and long-term sampling is designed to prevent any future exposures. A summary of the IRP sites and an evaluation of health hazards is in Appendix C.

D. Potential Exposure Situations

After reviewing available environmental data, NHDHHS determined that some exposure pathways are not currently complete, but may be completed in the future (Table 1b). Therefore, these exposure

situations do not pose a public health hazard at present, but should be monitored to guard against potential future hazards.

1. Potential Building Indoor Air Contamination

Because groundwater in some areas beneath Pease AFB is heavily-contaminated with volatile organic compounds (Pease 1999), there is the *potential* for indoor air contamination in some nearby buildings. The only data that are relevant to this issue are the results of a soil gas survey at site 49, where contaminated groundwater underlies an occupied building (TN&A 1998). These results do not indicate appreciable migration of contaminants from the groundwater to the soil gas at this location. First, the compounds detected in the soil gas (e.g., chloroform, tetrachloroethylene, benzene) did not match the compounds in the underlying groundwater plume (i.e., primarily TCE) (TN&A 1998, Bechtel 1997b). Second, the concentrations of chemicals in the soil gas were within either reported background ranges for indoor air or health-based screening levels for ambient air. Typically, concentrations of chemicals in the soil gas are tens to hundreds of times higher than corresponding indoor air concentrations (Fitzpatrick and Fitzgerald 1996). Therefore, based on the limited available data on soil gas, there is no evidence for current indoor air quality problems on the base.

The soil gas results from site 49 provide useful information but should be interpreted with caution. First, the analytical results have not been validated. Second, the potential exists for indoor air exposures at other locations in the future as the former base continues to be redeveloped. Developers should be cognizant of the potential for indoor air contamination when choosing sites for new buildings. A comprehensive review of groundwater data to identify potential problem locations in advance would likely prove a helpful and proactive measure. To assist in evaluating the potential for indoor air quality impacts from contaminated groundwater, guidance for evaluating potential indoor air quality issues has been developed by NHDES (NHDES 1998a, 1998b).

If new data for soil gas or indoor air quality are generated, NHDHHS remains willing to provide technical assistance on a case-by-case basis.

III. Community Health Concerns

ATSDR solicits and responds to health concerns expressed by members of the community. This section addresses health concerns that have come to NHDHHS's and ATSDR's attention during the health assessment process. Pease AFB has an existing community relations plan developed by the Air Force. In addition, an information repository has been established at the Air Force Base Conversion Agency offices in the New Hampshire Air National Guard area at Pease International Tradeport (Building 151). Site fact sheets and newsletters have been developed to describe and explain the clean-up process and status of remedial actions. Copies of these and other documents related to remedial activities at Pease AFB can be found at the repository. A Restoration Advisory Board (RAB) was established to serve as a liaison between the community and the Air Force. The RAB is composed of community members and representatives from the Air Force, USEPA and NHDES. RAB meetings are generally called on a quarterly basis and are open to the public.

The following is a summary of concerns that have been expressed:

Was drinking water safe in the past? How about currently and in the future?

Use of contaminated drinking water poses no apparent health hazard. Past use of solvents and deicing agents has resulted in TCE and nitrate contamination in groundwater that has been detected in water from wells serving the base water supply. Actions have been taken to reduce the contamination, and currently base water meets all drinking water standards. The wells are regularly monitored to ensure that future drinking water will be safe to use. A discussion of the contamination in the base drinking water can be found in the Environmental Pathways and Human Exposure section.

Will contamination under the flight line impact the Haven well?

Areas of contaminated soil and groundwater under the flight line have been thoroughly studied. Based upon the distance from the contamination to the Haven well, the rate of groundwater movement, and the rate of naturally occurring degradation, it is unlikely that TCE contamination will reach the Haven well at levels that pose a health risk. Flight line contamination is under a regular monitoring program that will detect any contamination approaching the well, and enable the Air Force, USEPA, and NHDES to take action to prevent Haven well water contamination.

I heard a rumor that there was an increase in stillbirths and miscarriages in the base hospital in early 1980s. Could it be attributed to contaminated drinking water?

In the early 1980s, base drinking water contained levels of TCE above current drinking water standards. The nature and extent of contamination and possibility of adverse health effects from use of this water are discussed in the Evaluation of Environmental Contamination and Human Exposure section of this document. This evaluation of estimated exposures to past residents and workers indicated that adverse health effects from drinking and bathing in this water are unlikely.

Studies have shown that there may be an association between TCE contamination in drinking water and low birth weight babies (Sonnenfeld 1997, Schendel 1996). Other studies suggest that there may also be an increase in birth defects (e.g., cleft lip, cleft palate, and heart defects) for babies whose mothers consumed TCE-contaminated drinking water during pregnancy (Bove 1995, Goldberg 1990, Schendel 1996). Although these studies indicate possible associations, it is difficult to say for certain that TCE contamination in the water caused the observed defects because of limitations in the studies. The evidence is not sufficient to prove causality, and further research is needed. For comparison, the maximum concentrations of TCE in drinking water identified in the study at Camp Lejeune, North Carolina (1400 µg/L) were higher than the concentrations at Pease AFB in the early 1980s (82 µg/L).

The period of potential exposure to nitrates above the drinking water standard was in 1994 and 1995, which was after the anecdotal reports of miscarriages and stillbirths on the base in the 1980s.

Data on adverse pregnancy outcomes at Pease AFB are not available, because the State of New Hampshire does not have a birth defects registry.

Smoke from the fire department training areas went over the base fence into Newington. Are there any health risks from the smoke?

According to the National Climactic Data Center, the wind rarely blows from the base toward Newington (approximately 5-10% of the time) (NCDC 1978). Furthermore, the burns were of short duration, lasting only 10-15 minutes. Therefore, it is unlikely that sustained exposures to contaminants in smoke occurred.

Because no air samples were taken during training burns, the concentrations of contaminants in smoke are unknown. Computer models have been used to estimate the worst-case concentration levels of volatile organic compounds, using benzene as a surrogate for the chemical mixture in the smoke because it is a potent human carcinogen. Smoke can contain other contaminants such as polyaromatic hydrocarbons (PAHs) that have shown to be carcinogenic in animal studies (USEPA 1993, ATSDR 1995, Benner 1990). The estimated concentrations of benzene were below levels likely to cause adverse health effects even under worst-case conditions, such as regular exposure over many years to conditions at the fence line of the base.

A review of disease statistics for the town of Newington, did not identify any elevated cancer rates for this town in the period between 1987 and 1991. A discussion of this evaluation is presented in the Health Outcome Data Review section and Appendix D.

Are there any risks from swimming and fishing in Peverly and Bass ponds?

Low levels of pesticides and some metals were detected in fish, surface water, and sediments. The contamination levels are unlikely to result in adverse health effects from swimming and fishing. More details on this exposure pathway are presented in the Environmental Pathways and Human Exposure section.

Asbestos was removed from the Bracket School in the mid 1980s. Was there any risk to students and staff?

The most significant health threat that asbestos poses is through the inhalation of airborne asbestos fibers. Toxicity of asbestos is primarily dependent on exposure intensity and duration, along with other factors including the physical and chemical properties of the fibers. Asbestos-related lung diseases have been primarily reported after long-term exposures to asbestos in occupational settings. Exposures of such magnitude and duration are not usually experienced by the general public.

When asbestos is firmly bound up in products such as insulation, ceiling and floor tiles, roof shingles, pipe wrapping and cement that are in good condition ("non-friable asbestos"), there is little likelihood that exposure will occur. However, when asbestos containing materials (ACM) are in a crumbling or deteriorated condition ("friable asbestos"), asbestos fibers can be released and pose the greatest risk for causing harm.

Since the mid-1980s, federal law has required that public school buildings be periodically inspected and monitored for asbestos. Precautions must be taken when friable asbestos is removed from schools to insure that there is no airborne release of fibers that would pose a risk to students, staff, or other people who may subsequently access the building. Asbestos abatement projects in schools that are done in a responsible and appropriate manner should not present an increased risk to users of these facilities.

Asbestos is still present in exterior and interior portions of the Bracket School building. The risk that this material poses to the community should be minimal as long as exterior ACM is intact and access to the building interior continues to be restricted.

There is asbestos in former base housing. The housing is in close proximity to a day care center. Is there a threat of release and exposure to children?

Since 1994, the Pease Development Authority has been involved with removing ACM and demolishing old housing units in the former base housing area. These activities will continue until all ACM that poses a potential health hazard is safely removed from these units and properly disposed. The likelihood that occupants of the nearby day care center will be exposed to ACM within the remaining units is not significant. Due to the presence of physical hazards, individuals should be cautioned to stay out of these buildings until they are demolished.

A fire occurred in February 1998 in one former base housing unit located across from the day care center. At the time of the fire, only a small quantity of ACM was estimated to be within floor tiles, insulation in hot water pipes, flashing in the garage roof, and some window caulking within this unit, and it was not likely to have become airborne as a result of this event. ACM that was present in this burnt housing unit has been removed and should no longer present a health risk to the community. There is evidence of vandalism and trespassing in the base housing area. Access to the area is unrestricted. Concern remains regarding physical hazards and the possibility of additional fires occurring in the former base housing area.

Is there an increased incidence of either breast or brain cancer among former base personnel, residents, and civilian staff?

No statistically significant increases in breast or brain cancers were found. Health statistics were evaluated and presented in the Health Outcome Data Review section of this document.

Is there an increased incidence of cancers among Newington residents?

No statistically significant increases in cancers were found in Newington residents. Health statistics were evaluated and presented in the Health Outcome Data Review section of this document.

Was any radiation released from the ordnance storage areas? Can I come into contact with it?

Pease AFB, being a Strategic Air Command base, had the potential for storing and maintaining nuclear weapons. Operations at the base did not involve any maintenance on unsealed sources of radioactive material. The potential for release and contamination was very unlikely. In 1990, the Air Force conducted a radiological survey of weapons storage areas and did not detect any radioactivity above background levels (Thurlow 1990).

Can I get sick from eating game hunted on base?

It is unlikely that hunters were at any health risk associated with the consumption of game taken from these areas. Considerable effort has been made at the former Pease AFB to identify and characterize the extent of chemical contamination and pathways by which humans could have been at risk from potential exposure to chemical contaminants at the base. No sampling data are available which would allow NHDHHS to directly evaluate the health risk associated with the consumption of game taken on the base. Even without sampling data, however, it can be stated that the possibility for exposure to chemical contaminants is probably low given that game species did not range in contaminated areas. Furthermore, hunting was infrequent and did not occur in areas of the base where chemical contamination was identified.

Are there any impacts to the wildlife refuge from base contamination?

For the purpose of this Public Health Assessment, NHDHHS and ATSDR focused on human health issues. Ecological impacts to the wildlife refuge are not addressed in this document. During the remedial process, ecological risks were considered in determining where and what remediation occurred. Documents evaluating ecological risks are located in the repository at the Air Force Base Conversion Agency offices.

How do emissions from aircraft, cars, and buses currently operating on the base affect the air quality at nearby homes? Is there a plan to monitor the impact of these emissions on the residents in the local area?

There are very little data on the concentrations of hazardous substances in the air near active airports nationwide. Jet engines are regulated by emission standards, not by ambient air monitoring near the runway. Therefore, NHDHHS cannot accurately evaluate the potential health impacts from aircraft or buses operating at Pease Air Force Base at this time because measurements of toxic substances in the air are not available.

The New Hampshire Department of Environmental Services Air Resources Division (NHDES-ARD) exercises regulatory control over individual sources of ambient air pollution and is responsible for operating an ambient air monitoring network. NHDHHS has reviewed the concerns raised in this comment with NHDES-ARD, who provided the following relevant information. The ambient air quality is continuously monitored in nearby Portsmouth and Rye. Air monitoring is resource intensive, and most of what is done in the State is funded by USEPA. NHDES-ARD said that ambient air pollution concentrations do not vary a great deal over broad regions, and there are not any plans at present to conduct additional monitoring in the area around the airport. The fuel that most aircraft and bus traffic use is similar to that used in on-highway heavy duty vehicles, and emissions from aircraft and on-road engines are regulated at the federal level. The contribution of aircraft activity to the regional air pollution inventory is small, and it is not expected that increased activity at the airport such as that proposed will create exceedances of any of the National Ambient Air Quality Standards. Residents who have further questions regarding ambient air quality and monitoring should write to:

Kenneth A. Colburn, Director
NHDES - Air Resources Division
PO Box 95 - 6 Hazen Drive
Concord, NH 03301

NHDHHS and ATSDR completed and distributed the Public Comment Release of the Public Health Assessment for Pease Air Force Base on July 28, 1999. Following this, NHDHHS and ATSDR held a public meeting on August 11, 1999, to present the findings of the draft public health assessment. Comments on the document were accepted until September 10, 1999. All the written comments received by this date with responses from NHDHHS are listed in Appendix F.

IV. Health Outcome Data Review

In this section, health statistics from communities surrounding Pease AFB were evaluated to identify any elevated rates of cancer. As part of the health assessment process, ATSDR routinely conducts a review of available health data (e.g., birth and death certificates, cancer and birth defects registries) if exposures to site contaminants have occurred, or if there are community concerns regarding specific health outcomes (e.g., cancer, birth defects). This evaluation provides an overview of the general health status of a community, or it may confirm the presence of excess disease or illness in a community.

As part of this Public Health Assessment for Pease AFB, NHDHHS reviewed available information on cancer incidence for the surrounding towns of Newington, Portsmouth, and New Castle. Cancer incidence within Portsmouth and New Castle for the period between 1987 and 1991 (all the data that were available) were not statistically different from the number of cases seen in the State of New Hampshire as a whole during this same period. However, there were two cancer types that were elevated in Portsmouth: non-Hodgkin's lymphoma among males and cervical cancer among females. Environmental exposures are not thought to be the primary risk factors for the development of these cancer types. There were very few cases observed in Newington during this period which prevented further analysis.

It is important to note that elevated rates of a particular illness in a community may not necessarily be attributed to site contamination, nor does it establish a link or imply causality with environmental contamination identified at a site. Many factors influence the development of disease, including personal lifestyle, occupation, and socioeconomic status. Previously in this document, pathways of exposure to contaminants at Pease Air Force Base were evaluated. Completed exposure pathways were found exclusively for people on the base grounds. Therefore, it is unlikely that the elevated rates of non-Hodgkin's lymphoma and cervical cancer among males and females in Portsmouth, respectively, were due to chemical contamination on the base. Chemical contamination will not result in adverse health effects without there first being an opportunity for exposure.

Our current understanding of the etiology of cancer is that there can be a delay or latency period of up to decades between exposure to a carcinogen and the onset of the disease. For this public health assessment, NHDHHS reviewed cancer incidence data from the New Hampshire State Cancer Registry for 1987 to 1991, all the data that were available at the time of the evaluation. This period was nearly 15 years after the late 1970s when the highest exposures to TCE in the base water supply likely occurred and, hence, appropriate for evaluating these past exposures. Therefore, while data from the years following 1991 were not reviewed because they were not available at the time, NHDHHS considered the typical latency period of cancer in its evaluation of the available data.

The results and methodology used to evaluate health data for Portsmouth, Newington, and New Castle, New Hampshire, are presented in Appendix D.

V. Conclusions

1. Currently, there is no exposure to site-related contaminants in base drinking water above levels of concern. Base drinking water meets all state and federal requirements. Active remediation is ongoing to prevent contaminant migration and future contamination of the Haven well, and water is monitored regularly to ensure compliance with drinking water standards. Therefore, future exposure is unlikely. Past exposure to TCE and nitrates were unlikely to have resulted in adverse health effects. Based upon an evaluation of contamination and exposure levels to groundwater used as a base drinking water supply, this exposure pathway is categorized as no apparent public health hazard.

2. Past fishing, swimming, and wading in Peverly and Bass ponds posed no public health hazard from detected contamination. Currently the ponds are in a wildlife refuge, and recreational use is restricted. Should land use change, it would be wise to periodically evaluate exposure to fish contaminant levels detected under the long-term monitoring plan.

3. Currently the IRP sites do not pose public health hazards. All contaminated areas have been assessed, and necessary interim and long-term remedial actions have been completed, are ongoing, or are planned. Future exposures to contaminants at IRP sites are unlikely to occur because of institutional controls that restrict access to, and use of, contaminated soils and groundwater.

4. While there are no data on indoor air quality at Pease AFB, limited data on soil gas do not suggest that current indoor air quality problems would be expected. Based upon a review of existing data on contamination levels and potential exposures, this pathway is currently determined to pose no apparent public health hazard.

5. No exposures of concern are occurring presently, and ongoing remedial activities, environmental monitoring, and developmental oversight are in place to prevent future exposures.

VI. Recommendations

1. The former base housing area shows evidence of past vandalism. Access to the area is unrestricted and ongoing asbestos removal operations are taking place. There may be a physical hazard to trespassers in the former base housing area. NHDHHS and ATSDR suggest that access restrictions be improved and the area be more clearly posted as soon as possible to discourage unauthorized visitors.

2. NHDHHS and ATSDR recommend that groundwater monitoring programs and efforts to prevent additional contamination of the aquifer be continued, including maintaining compliance with the City of Portsmouth's Wellhead Protection Program.

3. Institutional controls established for the site should be maintained and enforced, including

restrictions on the use of the Great Bay National Wildlife Refuge.

4. If restrictions on recreational use in the wildlife refuge change to allow fishing in the area, children and adults should follow NHDHHS's state-wide freshwater fish consumption advisory, which recommends that adults should limit consumption of freshwater fish to four 8-ounce meals per month, pregnant women and children should limit consumption to one 8-ounce meal per month. Information about the advisory should be provided to anglers using the area for recreational fishing.

VII. Public Health Action Plan

The purpose of the Public Health Action Plan is to ensure that this Public Health Assessment not only identifies any current and potential exposure pathways and related health hazards, but also provides a plan of action to mitigate and prevent adverse human health effects resulting from exposures to hazardous substances in the environment. The first section of the Public Health Action Plan for Pease AFB contains a description of completed and ongoing actions taken at the base to mitigate environmental contamination. In the second section there is a list of additional public health actions that NHDHHS recommends be implemented in the future.

A. Completed, Ongoing, and Planned Actions

Significant progress has been made by the Air Force, NHDES, USEPA, and the surrounding communities in restoring the environment at Pease AFB. Following is a summary of major accomplishments, work in progress and planned actions:

1. The Air Force has completed investigations and signed eleven Records of Decision (RODs) covering all zones that required remedy selections for the various IRP sites within them.

2. Construction and implementation of all required remedial actions for IRP sites are complete or in progress. Long-term operation of remedial equipment is ongoing.

3. Investigations continue for the flight line and parking apron areas, with development of a final remedial action plan in progress.

4. Long-term monitoring of air, groundwater, surface water, sediments, soils, and fish tissue is ongoing.

5. Base property is in the process of transfer for use as a civilian commercial center under the Pease Development Authority.

6. This Public Health Assessment is based on currently available information and the likely future land use for the former Pease AFB. If land use or environmental conditions at the base change, NHDHHS and ATSDR will reevaluate the likelihood of exposures to site contaminants as warranted.

7. The limited available data on soil gas do not suggest that current indoor air quality problems would be expected on the base. Nevertheless, the potential for indoor air quality issues should be kept in mind during redevelopment of the base to guard against potential future hazards. If new data for soil gas or indoor air quality are generated, NHDHHS will provide technical assistance as needed.

8. NHDHHS will conduct a community needs assessment to determine whether additional health education activities in the surrounding community are warranted.

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Certification

The Public Health Assessment for the Pease Air Force Base, Portsmouth, New Hampshire was prepared by the New Hampshire Department of Health and Human Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Public Health Assessment was begun.

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ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Public Health Assessment and concurs with its findings.

Richard Gillig

Acting Chief, SSAB, DHAC, ATSDR

Scott D. Sudweeks for Gary Campbell

Section Chief
Federal Facilities Assessment Branch, DHAC, ATSDR

Appendix A: Tables

List of Tables

Table 1a: Completed Exposure Pathways at the Pease Air Force Base

			Exposure Pathway Elements					
	Pathway Name	*Contaminant*	*Source*	*Media*	*Point of exposure*	*Route of exposure*	*Exposed population*	*Time of Exposure and Comments*
1	Consumption of contaminated groundwater	TCE Nitrate	Zone 3 IRP sites Flighting	Groundwater	Drinking water Showering	Ingestion Inhalation	Former base residents Former base workers	Past In 1977, TCE was detected in the Haven well that exceeded current drinking water standards (MCLs). No prior sampling data available. As of 1985 TCE levels dropped below MCLs. Current and future Water from base supply wells are under a regular monitoring program and currently meeting all drinking water standards. Sources of contamination are under active remediation. Groundwater management zones and use restrictions are in place to prevent installation of wells in areas of known groundwater contamination.
2	Recreational use of Peverly and Bass ponds	DDT DDE PCB Arsenic Mercury	Surface runoff via Peverly Brook Landfill 1 (IRP Site 1)	Fish Surface water Sediment	Fish Swimming Wading	Fish consumption Ingestion of surface water Skin contact with sediment	Recreational users	Past No historical fish sampling data is available. Current and future Ponds are within a national wildlife refuge and no fishing or swimming is currently allowed. Fish, sediments and surface waters are under a long-term monitoring program.

Table 1b: Potential Exposure Pathways at the Pease Air Force Base

			Exposure Pathway Elements					
	Pathway Name	*Contaminant*	*Source*	*Media*	*Point of exposure*	*Route of exposure*	*Exposed population*	*Time of Exposure and Comments*
1	Indoor air contamination from volatile groundwater contaminants	No data on indoor air quality are available.	Groundwater contaminant plumes containing volatile organic compounds	Soil gas Air	Potentially building indoor air, but no data on indoor air quality are available.	Inhalation	Office workers	Current and Future The Air Force recently completed a soil gas survey to characterize the amount of any vapor migration from groundwater in site 49. The concentrations and composition of contaminants in soil gas did not indicate that appreciable migration of chemicals from the groundwater to the soil gas was occurring. Therefore, contamination of building indoor air quality is unlikely.

Table 2: TCE concentrations in the Haven Well, 1977-1993

Time Period	Detects/ Samples	Average TCE Concentration (µg/L)	Maximum TCE Concentration (µg/L)	Comments
May 1977 to April 1978	12/12	194	391	Following the discovery of TCE contamination in 1977, clean drinking water was supplied to the base by the City of Portsmouth until the fall of 1978 (Craven 1998).
May 1978 to July 1979	5/5	122	202	
August 1979 to July 1980	10/10	67	115	
August 1980 to July 1981	12/12	29	82	
August 1981 to May 1982	6/6	11	15	
June 1982 to May 1983	5/5	10	17	
June 1983 to May 1984	9/9	7.3	10	
June 1984 to May 1985	9/10	5.5	7.7	See Note 2
June 1985 to June 1986	5/6	3.7	7.8	See Note 2
July 1986 to December 1993	17/19	2.5	5.0	See Note 2

1. TCE data for Haven well were provided by Cornell Long, Armstrong Laboratory, Occupational and Environmental Health Directorate, Brooks Air Force Base, Texas.
2. Water samples in which TCE was not detected were not used to calculate average concentrations.

Table 3: Contaminants of concern in Bass fillet from Peverly and Bass Ponds

Contaminant	Mean Concentration (µg/kg)	Maximum Concentration (µg/kg)
Upper Peverly Pond		
Mercury	183.0	220.0
DDE	13.6	28.0
PCB (Aroclor 1260)	6.0	12.0
Lower Peverly Pond		
Mercury	104.0	110.0
DDE	7.7	16.0
PCB (Aroclor 1260)	3.3	6.3
Bass (Stubbs) Pond		
Mercury	436.0	520.0
DDT	9.0	10.0
DDD	34.8	40.0
DDE	60.2	79.0
PCB (Aroclor 1260)	46.5	51.0

Table 4: Contaminants of concern in sediments of Peverly and Bass Ponds

Contaminant	Mean Concentration (mg/kg)	Maximum Concentration (mg/kg)
Upper Peverly Pond		
MEK	0.08	0.31
DDD	0.16	0.71
DDE	0.026	0.03
Lower Peverly Pond		
DDD	0.03	0.05
DDE	0.02	0.03
DDT	0.45	4.20
Dibutylpthlalate	0.95	4.00
γ-BHC (lindane)	0.0049	0.0049
Bass (Stubbs) Pond		
DDD	0.47	1.70
DDE	0.13	0.38
DDT	0.10	0.19

Table 5: Contaminants of concern in surface waters of Peverly and Bass Ponds

Contaminant	Mean Concentration (µg/l)	Maximum Concentration (µg/l)
Upper Peverly Pond		
Nickel	12.0	29.0
Zinc	25.0	74.0
Lower Peverly Pond		
Nickel	9.2	24.0
Zinc	17.0	105.0
Bass (Stubbs) Pond		
NA		

NA= Not applicable. Either contaminants were not detected or detected below background concentrations.

Appendix B: Figures

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Figure 1: Location of Pease Air Force Base

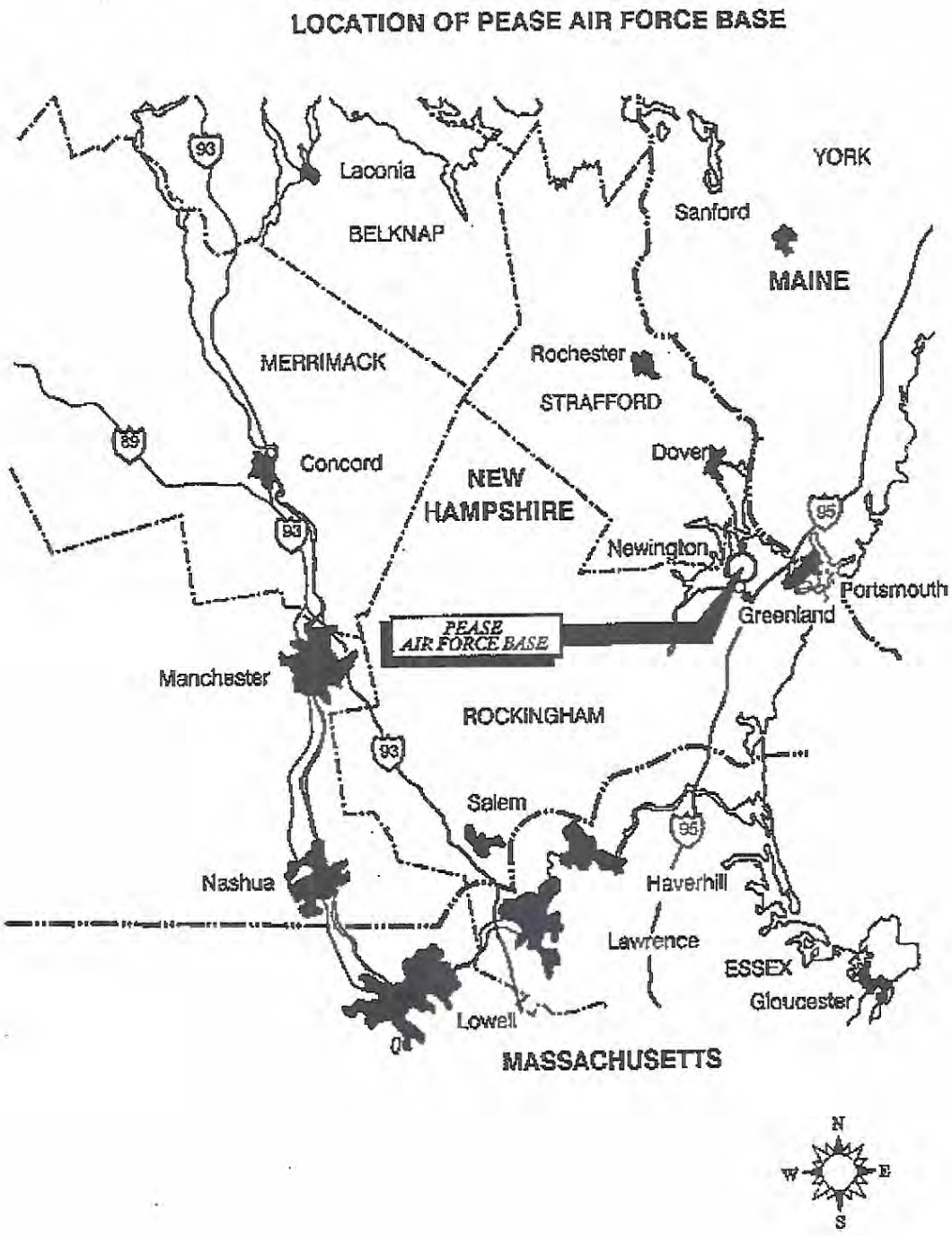


Figure 2: Pease AFB Installation Restoration Program (IRP) sites

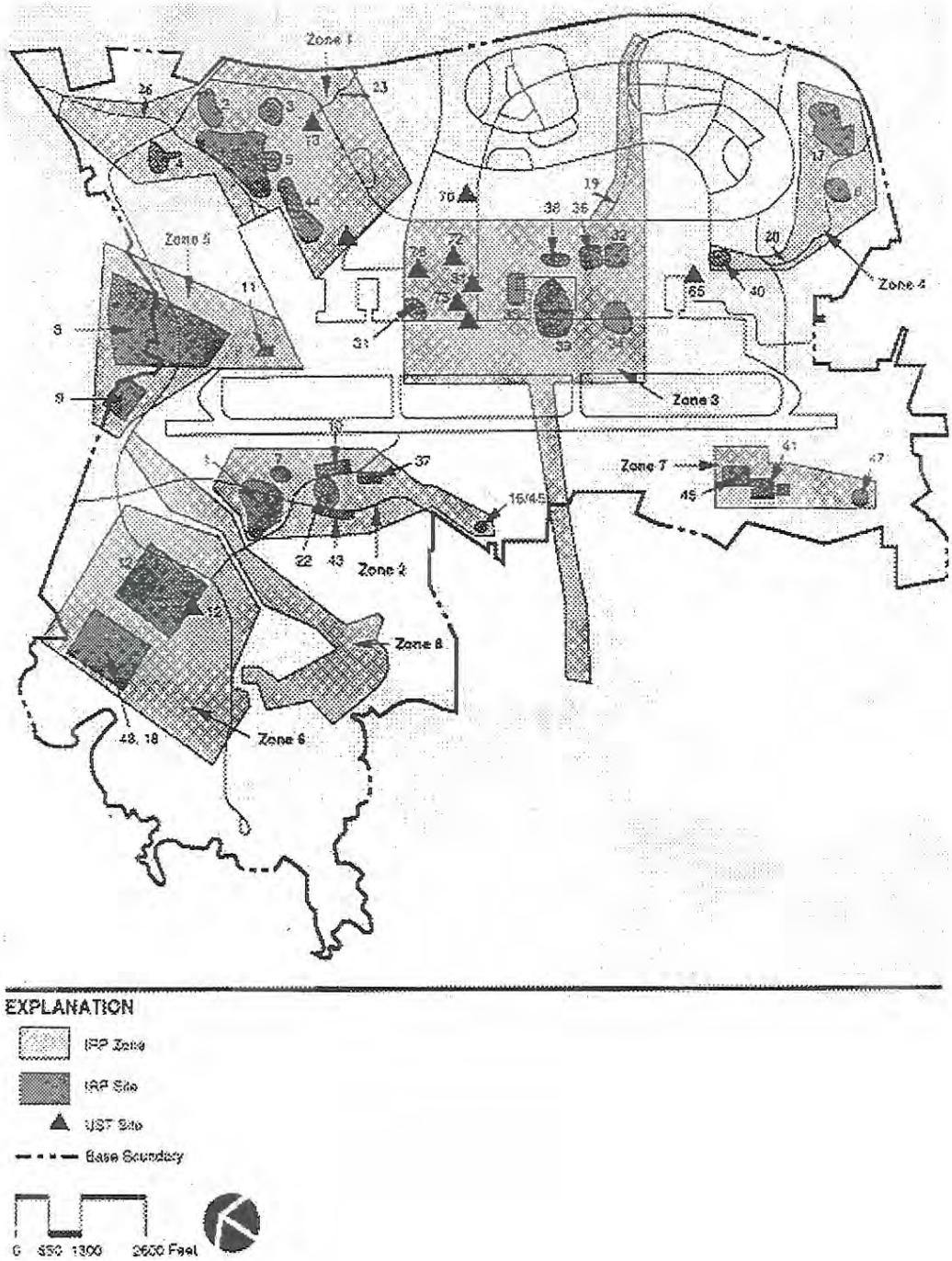


Figure 3: Areas under institutional control

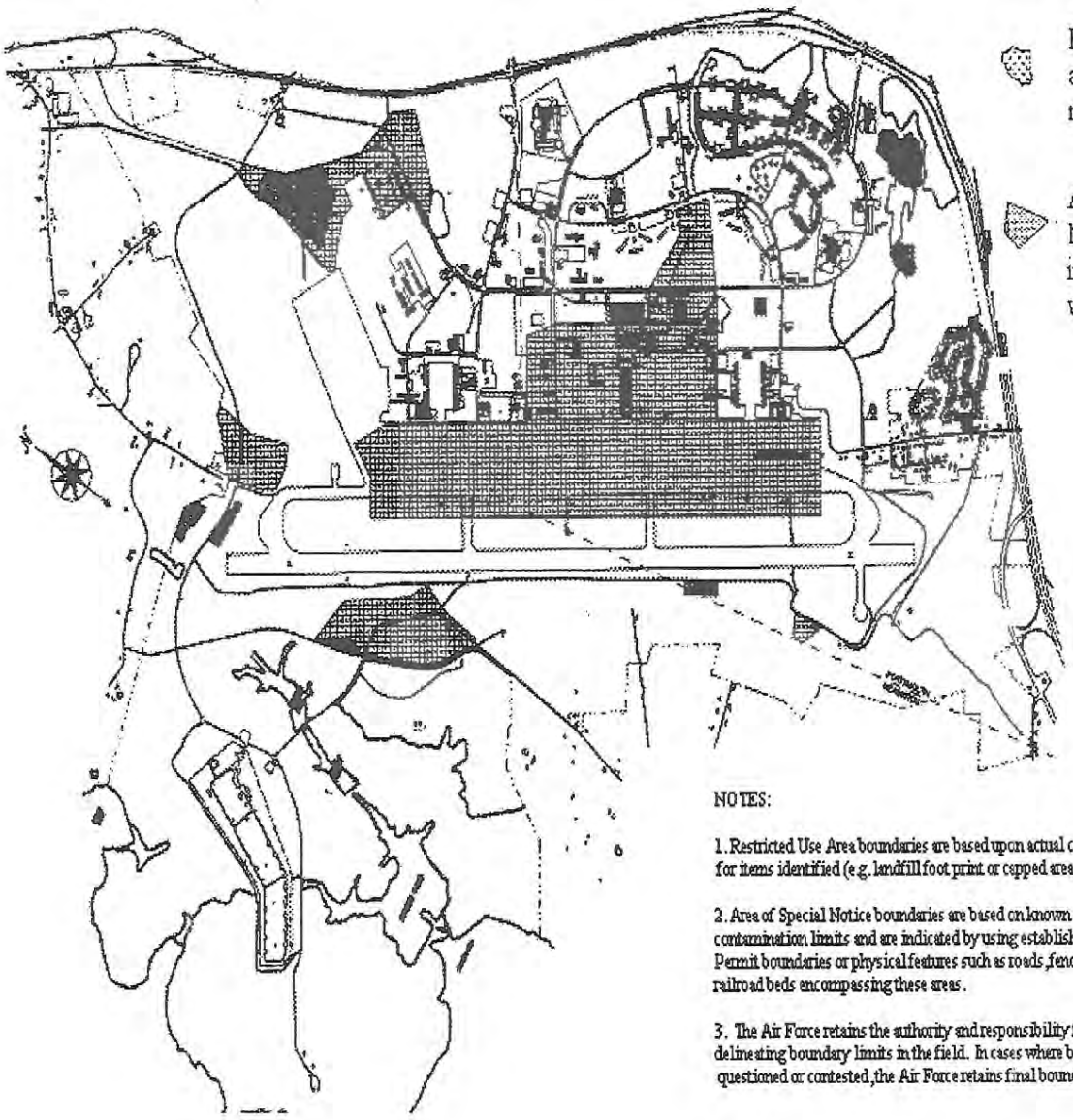
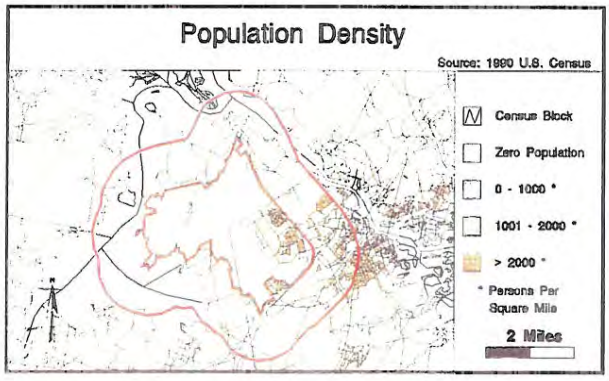


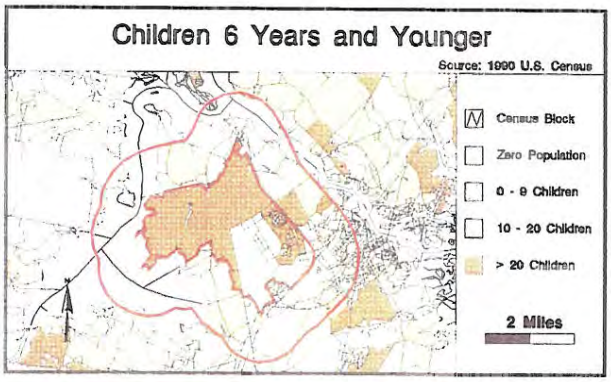
FIGURE 4.

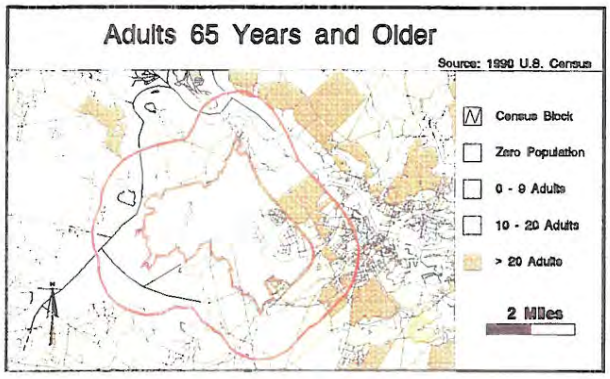
Pease Air Force Base
Portsmouth, NH
CERCLIS No. NH7570024847

Demographic Statistics Within One Mile of Site*	
Total Population	13337
White	12069
Black	856
American Indian, Eskimo, Aleut	19
Asian or Pacific Islander	250
Other race	143
Hispanic origin	338
Children Aged 6 and Younger	1739
Adults Aged 65 and Older	1138
Females Aged 15 - 44	3350
Total Housing Units	5078

*Calculated using an area-proportion spatial analysis technique







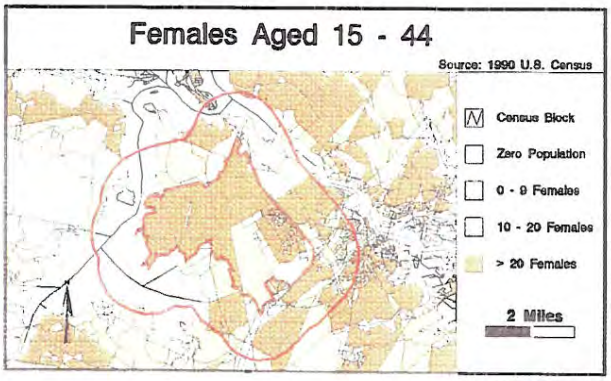


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Figure 5: ATSDR Exposure Evaluation Process

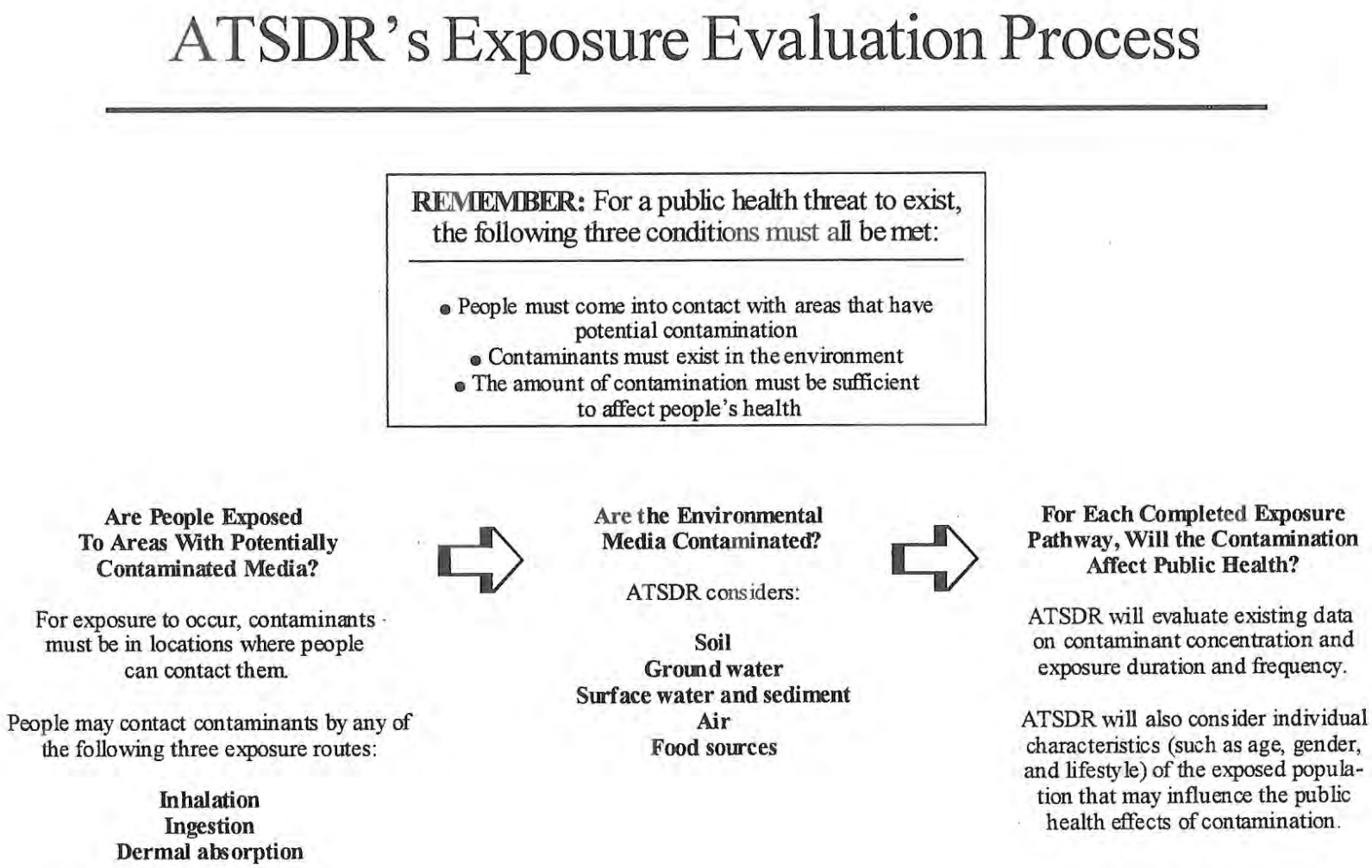


Figure 6: Base water supply wells with historic TCE contamination

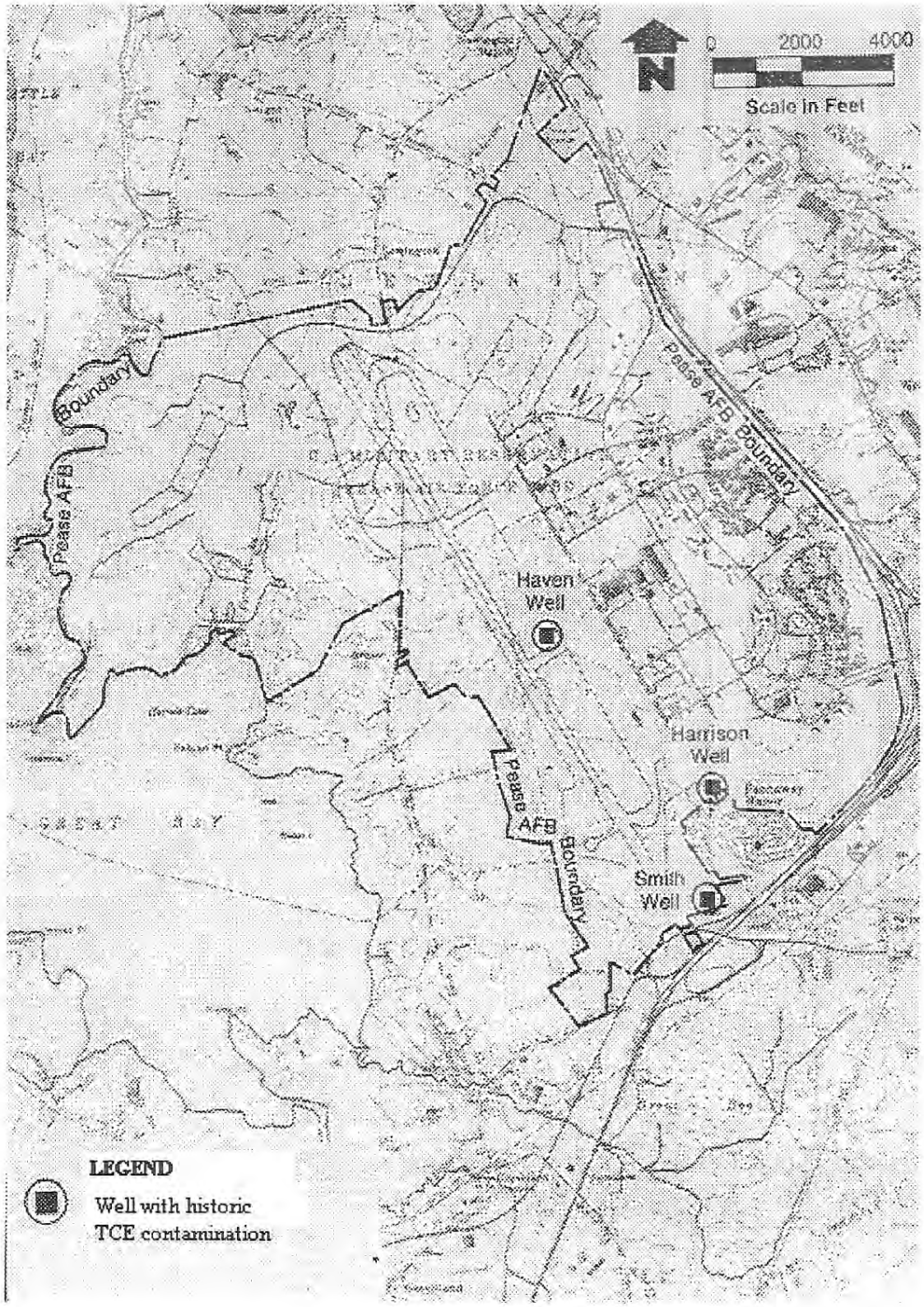


Figure 7: Conceptual model for contamination in the Haven well

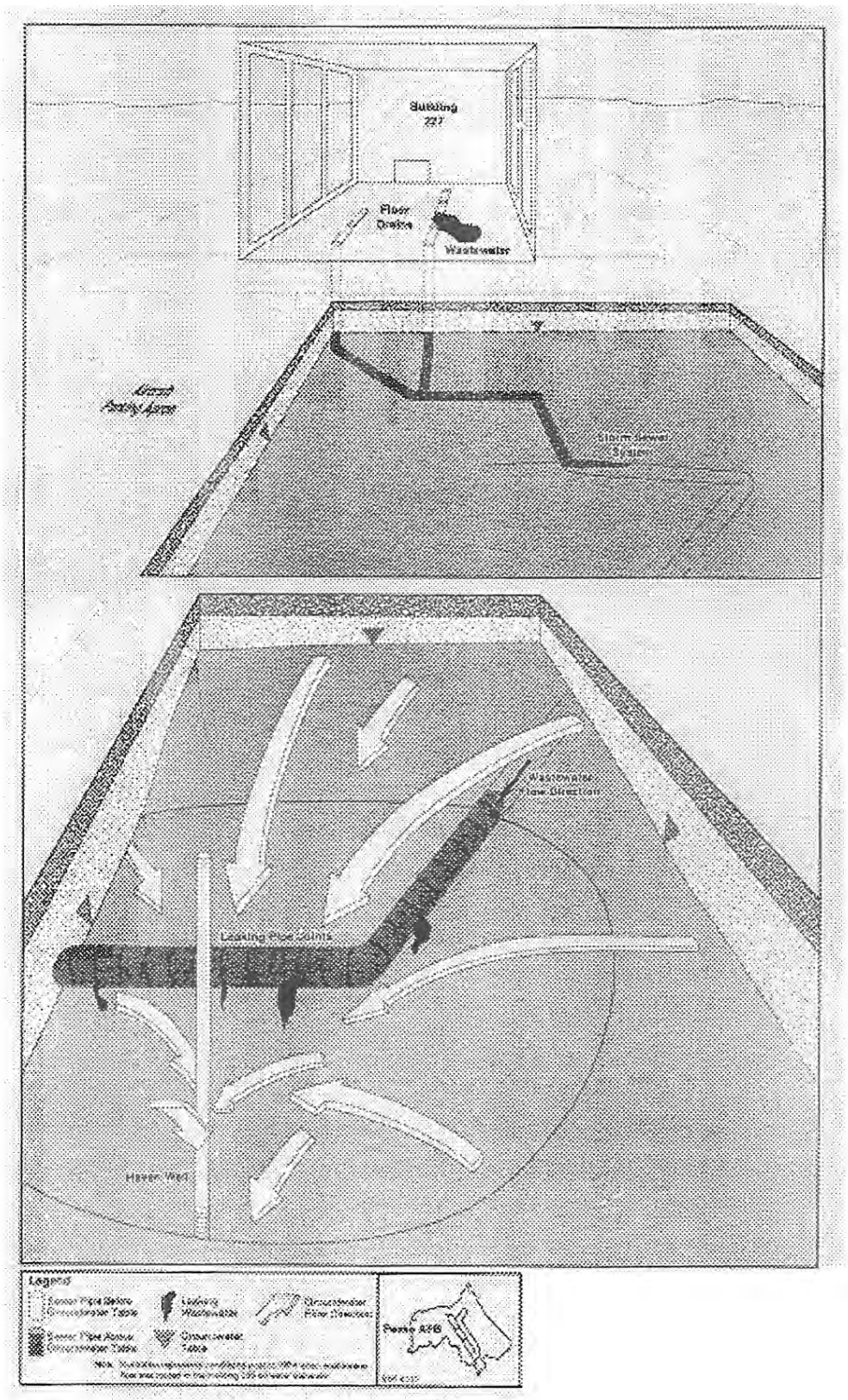
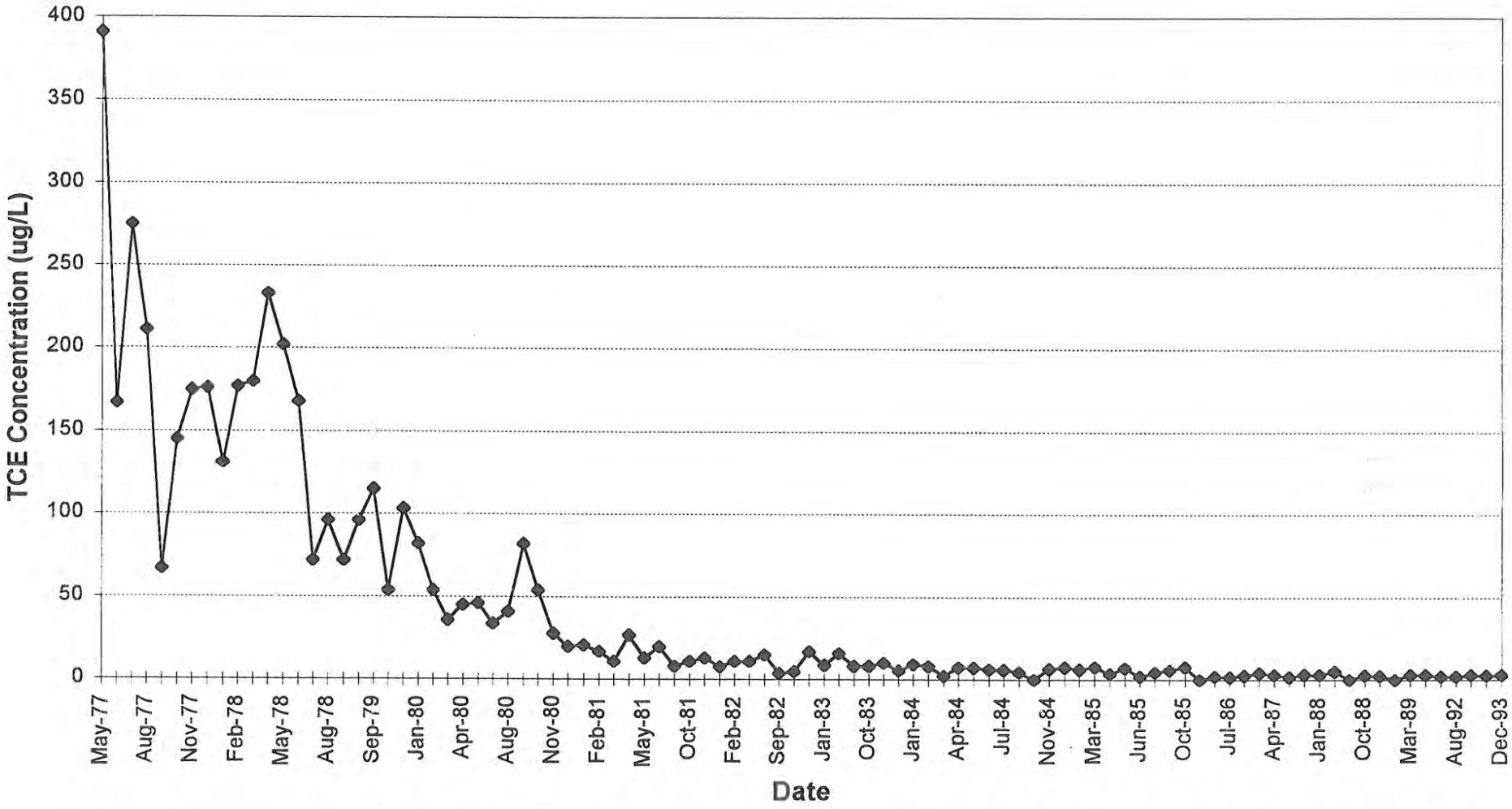
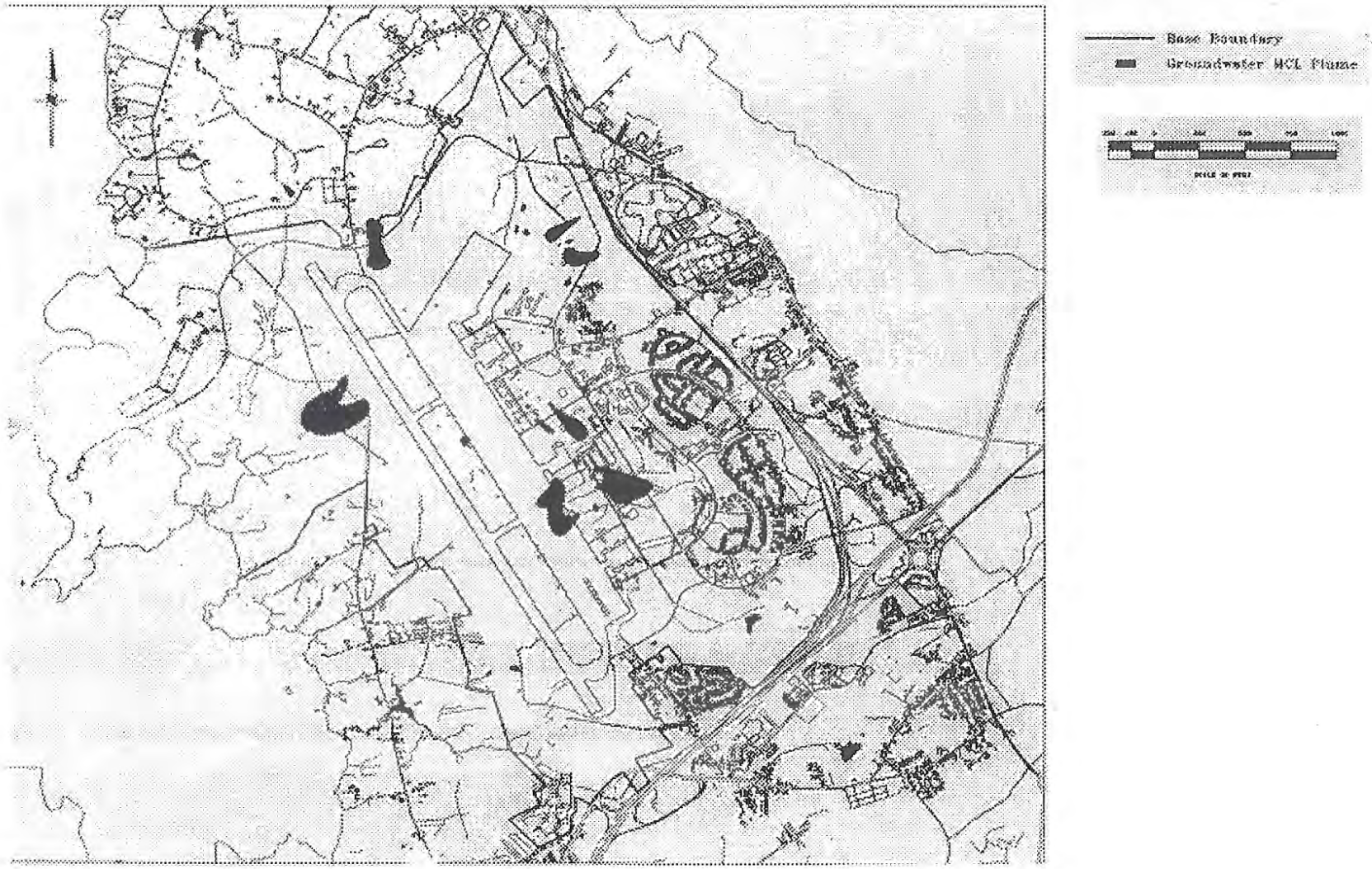


Figure 8: TCE Concentrations in the Haven well, 1977-1993



Source: TCE data for Haven well provided by Cornell Long, Armstrong Laboratory, Occupational and Environmental Health Directorate, Brooks Air Force Base, Texas

Figure 9: Base-wide groundwater contaminant plumes exceeding regulatory standards for drinking water (Note: groundwater contamination in the Flight line Refueling System area is not shown in this figure)



Appendix C: Evaluation of Potential Health Hazards Associated with IRP Sites

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
1 (2)	Landfill 1 (LF-1)	Original base landfill from 1953 to 1961. Contained domestic solid wastes, construction debris as well as some hazardous and petroleum wastes	Groundwater	A groundwater management zone (GMZ) was established around the site to prevent use of groundwater. Groundwater and surface water at the site is under a long-term monitoring plan (LTM). Contaminants in groundwater will naturally attenuate over time.	No use of groundwater. Institutional controls are in place to prevent exposures. Site is categorized as no public health hazard.
2 (1)	Landfill 2 (LF-2)	Operated from 1960 to 1962. Contained domestic solid wastes, construction debris as well as some hazardous and petroleum wastes.	Groundwater, soil.	Soil and solid waste was removed and consolidated in landfill 5 to satisfy NH state landfill closure requirements.	The results of the remedial investigation indicated no contamination exceeding groundwater standards. Site is categorized as no public health hazard.
3 (1)	Landfill 3 (LF-3)	Originally thought to have been in operation from 1962-1963, but aerial photographs showed no indication that the site existed.	None	No existence of site, therefore no further action.	No use of groundwater. Soil contamination is below levels of concern. Institutional controls are in place to prevent exposures. Site is categorized as no public health hazard.
4 (1)	Landfill 4 (LF-4)	Operated from early 1950s to the 1970s to contain domestic solid and industrial wastes.	Groundwater, soil	Soil and solid waste was removed and consolidated in landfill 5 to satisfy NH state landfill closure requirements.	The results of the remedial investigation indicated no contamination exceeding groundwater standards. Site is categorized as no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
5 (1)	Landfill 5 (LF-5)	Primary base landfill, operating from 1964 to 1979 to contain domestic solid waste, industrial wastes and sludge.	Groundwater, soil.	A study of landfill 5 was completed and a remedy selected in 1993 calling for excavation and consolidation of buried wastes to a dry area above the water table, followed by construction of an impermeable cap. Construction activities were completed in 1996. The site is under a long-term monitoring plan (LTM) for surface water, groundwater and sediment. Institutional controls are in place to prevent the use of groundwater or excavation into the landfill. Contamination will naturally attenuate over time.	No use of groundwater. Soil contamination is below levels of concern. Institutional controls are in place to prevent exposures. Site is categorized as no public health hazard.
6 (4)	Landfill 6 (LF-6)	Used from 1970 to 1974 for the disposal of domestic, industrial and medical waste materials.	Groundwater, soil	Soil and solid waste was removed and consolidated in landfill 5 in accordance with the Zone 4 ROD. Institutional controls are in place to prevent use of groundwater.	No use of groundwater. Soil contamination removed.. Institutional controls are in place to prevent exposures. Site is categorized as no public health hazard
7 (2)	Fire Department Training Area 1 (FDTA-1)	Burn area used from 1956 to1961 to teach fire fighting. Training fires were fueled by waste oils, waste solvents and fuels.	Soil	Low levels of soil contamination did not pose health risks. The site was recommended for no further action.	Soil contamination is below levels of concern. Site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
8 (5)	Fire Department Training Area 2 (FDTA-2)	Burn area used from 1956 to1961 to teach fire fighting. Training fires were fueled by waste oils, waste solvents and fuels. Post 1971 recovered JP-4 fuel was burned for training fires.	Soil, groundwater	Contaminated soils were removed from the site during an interim remedial action. A groundwater extraction and treatment system was installed to treat contaminated groundwater. A soil vapor extraction system and asphalt cap were later added as part of the remedy defined in the ROD for Site 8. A GMZ was established around the site to prevent use of contaminated groundwater. Off-base migration of groundwater contamination underlies a forested area on the national registry of historic places. Groundwater is under a LTM plan.	Soil contamination is below levels of concern. No exposure to contaminated groundwater is occurring. Institutional controls are in place to prevent exposure to groundwater contaminants. No wells are or will be established in the area of contaminated groundwater beyond the base boundary. The groundwater treatment system is designed to intercept and remove contaminants moving beyond the base boundary. The groundwater plume underlying the Newington Town Forest will naturally attenuate over time. This site is categorized as no public health hazard.
9 (5)	Construction Rubble Dump 1 (CRD-1)	Disposal site for construction debris, including asphalt, concrete, wood, brush and scrap metal.	Groundwater	The results of the remedial investigation indicated that groundwater contaminants are below levels of concern for health risk. The site was designated for no further action. In 1995 the site was capped according to NH state landfill closure requirements. Groundwater is under a LTM plan.	No exposure to contaminants in groundwater is occurring. Institutional controls are in place to prevent installation of wells or excavation into the landfill resulting in exposure to site contamination. The site is categorized as no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
10 (2)	Leaded Fuel Tank Sludge Disposal Area (LFTS)	In operation from late 1950s-1978 for the disposal of sludges cleaned from leaded aviation (AVGAS) fuel storage tanks.	Soil, groundwater	As a result of the remedial investigation (RI) it was determined that soil contamination did not pose a risk. A GMZ was established to prevent exposure to groundwater contamination. Groundwater is under a LTM plan.	Soil contamination is below levels of concern. No exposure to groundwater is occurring. Institutional controls will prevent future exposure to site contaminants. The site is categorized as no public health hazard
11 (5)	FMS Equipment Cleaning Site (FMS)	Intermittent waste solvent disposal site. In use until 1971.	Soil, groundwater	No further action was selected for this site based upon the levels of soil and groundwater contamination not exceeding regulatory standards or levels of concern for health risk.	No exposure is occurring. Groundwater is not in use at this site. Contamination are below levels of concern. This site poses no public health hazard.
12 (6)	Munitions Maintenance Area (MMA)	A complex of seven buildings used for cleaning and maintenance of munitions. In operation from 1956-1991. Waste solvents disposed in this area.	Groundwater, soil	Underground storage tanks and contaminated soils were removed. Residual contaminatio*attenuated to acceptable levels. Site closed out by NHDES.	No exposure to groundwater is occurring. This site is within the boundaries of a wildlife preserve and access is restricted. This site is categorized as no public health hazard
13 (1)	Bulk Fuel Storage Area (BFSA)	Main fuel storage facility in operation from 1953. Tanks contained jet fuels, deicing fluids, heating and waste oils.	Soil, groundwater	Above ground and underground storage tanks have been removed along with contaminated soils. A passive soil venting system and asphalt cap were placed over areas of soil and groundwater contamination. Petroleum contamination will naturally degrade over time. The groundwater is under a LTM.	Access to contaminated soils and groundwater is restricted by an impermeable cap. No groundwater wells are installed in areas of contamination. Institutional controls restrict access to contaminated soils and groundwater. This site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
14 (6)	Fuel Line Spill Site	In 1959, 10,000 gallons of jet fuel were spilled as a result of a vent pipe broken during snow removal.	None detected	Fuel was washed into the storm drains which eventually discharged to Peverly drainage system. Soil and groundwater sampling detected no spill-related contaminants.	Based upon no evidence of contamination or exposure this site is categorized a no public health hazard.
15 (3)	Industrial Shop/Parking Apron	Industrial site complex involving base operations and maintenance. Converted to Zone 3 containing multiple individual sites.	See individual sites in Zone 3	See individual sites in Zone 3	See individual sites in Zone 3
16 (2)	Building 410 (PCB spill)	In 1983, roughly half a gallon of transformer oil containing 50% by weight PCB was released from a ruptured transformer.	Soil	A cleanup was performed immediately after the transformer oil spill. Stained soils were removed, and sampling indicated no residual soil contamination.	No exposure. Site is considered no public health hazard.
17 (4)	Construction Rubble Dump 2 (CRD-2)	Received construction debris similar to site 9 from 1953 to 1987.	Soil, groundwater	Based upon evidence gathered in the remedial investigation, it was determined that the health risks from site contaminants did not pose a health risk. The site was recommended for no further action under the Zone 4 ROD. Under NHDES solid waste rules, the landfill was covered by a soil cap. Groundwater is under a LTM plan, and institutional controls were established.	No exposure is occurring. Institutional controls are in place to prevent future exposures. This site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
18 (6)	Munitions Residue Burial Area (MRBA)	Inert munitions were disposed of in shallow pits from 1957-90.	Soil	During site investigation a sweep of the area was conducted with a metal detector. Subsequent excavation and sieving removed buried wastes and reside. Soils with elevated contaminants were removed. Later sampling indicated residual contamination was below levels of concern. No further action was taken at this site.	No exposure is occurring. Residual contamination is below levels of concern. This site is within a national wildlife refuge and access is restricted. This site poses no public health hazard.
19 (3,4)	Newfield's Ditch	Collects surface runoff from eastern areas of the parking apron. TCE wasted were disposed of in the ditch and in 1982, raw wastewater was released into the ditch.	Sediment	As required in the Zone 3 ROD, contaminated sediments were removed. Further sampling indicated that contaminants are below levels of concern for health risk. The site was recommended for no further action.	No exposure is occurring. Contamination is below levels of concern. This site is not considered a public health hazard.
20 (3,4)	Grafton Ditch (Test Cell Ditch)	Collects surface runoff from sites 6,17, Zone 3 industrial shop areas and former base housing. Likely received discharges of waste oils, solvents and fuels from site 34.	Sediment	As required in the Zone 3 ROD, contaminated sediments were removed. Further sampling indicated that contaminants are below levels of concern for health risk. The site was recommended for no further action. Lower Grafton ditch is under a LTM plan as required by the Zone 4 ROD.	No exposure is occurring. Contamination is below levels of concern. This site is not considered a public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
21 (3,4)	McIntyre Brook	Collects the majority of the surface runoff from the industrial shop areas, flight line and parking apron via a storm sewer discharge. Likely received waste oils, fuels, oils, metals and combustion byproducts (PAHs) as a result of flight line activities and contaminant releases.	Sediment	Sampling conducted during a remedial investigation discovered contamination at levels of concern. Contaminated sediments were excavated and removed, and the water body restored. The brook is under a LTM plan.	No public health hazard. Contamination removed.
22 (2)	Burn Area 1 (BA-1)	Used for burning spent fuel and solvents in order to conduct fire training activities between 1954 and 1976.	Soil, groundwater	Remedial activities completed at the site include installation of a soil vapor extraction and air sparging system to remediate contaminated soil and groundwater. The site is under a LTM plan, and institutional controls are in place to prevent contact with contaminated soils and groundwater.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.
23 (1)	Paul's Brook	Collects surface runoff from site 13. Likely received releases of fuel and oils from site 13.	Sediment	Contaminated sediments were detected as part of remedial investigations. Contaminated sediments were excavated and removed. The Brook is under a LTM plan.	No public health hazard. Contamination removed. No exposure occurring.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
24 (6)	Peverly Ponds/Peverly Brook	Peverly Brook collects surface runoff and groundwater discharge from sites 1, 7,9, then flows to Upper Peverly pond (UPP). UPP receives additional runoff and groundwater discharge from site 1. UPP drains to Peverly Pond, then to Bass pond before entering Great Bay. The site supports a fishery, and was used for swimming and fishing in the past. Currently the area is within a national wildlife refuge.	Sediment, surface water, fish	Sampling conducted as part of a remedial investigation determined that low levels of contamination required no further action. The ponds and brook are under a LTM plan to monitor contaminant levels.	No apparent health hazard. Contamination in sediments and surface water was evaluated to determine if recreational users of the ponds were at elevated health risk. Based upon this evaluation a determination was made that contamination was at levels below concern. No exposure is occurring. The site is within a national wildlife refuge, and access is restricted. (See discussion in section III).
26 (1)	Flagstone Brook	Collects surface runoff from Landfill 5 (IRP site 5).	Sediment	Sampling conducted during a remedial investigation indicated that contaminants are below levels of concern for health risk. The site was recommended for no further action. Flagstone Brook is under a LTM plan.	No exposure is occurring. Contamination is below levels of concern. This site is not considered a public health hazard.
31 (3)	Building 244, 157th Aircraft Maintenance Squadron (CAMS).	Used for jet engine maintenance and repair from1955 to 1965. A former 1,200 gallon underground storage tank contained waste solvents.	Soil, groundwater	Results of an in-depth remedial investigation indicated that soil and groundwater contamination associated with site 31 were below levels of concern for health risk and required no further action.	No exposure is occurring. This site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
32 (3)	Building 113	Used for aircraft maintenance activities. A 1,200 gallon waste solvent storage tank was used to store waste solvents from 1955-65. Solvents leaked from this tank via an overflow pipe. A hazardous material storage area and oil rack were located adjacent to B-113, and waste oils and solvents were spilled during maintenance activities.	Soil, groundwater	Contaminated surface soils have been removed. Construction of a physical barrier and hydraulic groundwater containment system is complete. This system is designed to prevent migration and remove groundwater contamination. Institutional controls are in place to prevent contact with contamination, and groundwater is under a LTM plan.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.
33 (3)	Building 229, Aircraft Maintenance Squadron Hangar	Used for aircraft cleaning and maintenance. Site is associated with numerous waste solvent, oil and fuel releases.	Soil, groundwater	Contaminated surface soils have been removed. A hydraulic groundwater containment system has been installed to contain and treat contaminated groundwater. Institutional controls are in place to prevent contact with residual contamination.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.
34 (3)	Building 222, Jet Engine Test Cell (JETC)	Used to test jet engine performance. Waste solvents, fuels, oils and cooling water contaminated with PAHs generated during tests were discharged to the nearby Test Cell Ditch.	Soil, groundwater	Contaminated soils have been removed. A groundwater treatment system has been installed to pump and treat contaminated groundwater. Institutional controls are in place to prevent contact with contaminated groundwater, and groundwater is under a routine LTM plan.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
35 (3)	Building 226, Industrial Waste Treatment Plant (IWTP)	Former treatment plant that housed an oil/water separator, underground storage tank for waste oils and solvents and a hazardous materials storage area.	Soil, groundwater	A groundwater extraction and treatment system was constructed to remove contamination. Soil contamination was below levels of concern and did not require remediation. The site is included within a GMZ and under LTM.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.
36 (3)	Building 119	Former jet engine maintenance and accessory shops in operation from 1955 to 1990. Hazardous materials storage including releases of waste solvents, oils and untreated wastewater.	Soil, groundwater	Contaminated surface soils have been removed. Construction of a physical barrier and hydraulic groundwater containment system is complete. This system is designed to prevent migration and remove groundwater contamination. Institutional controls are in place to prevent contact with contamination, and groundwater is under a LTM plan.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.
37 (2)	Burn Area 2 (BA-2)	Suspected former fire-training area or waste solvent/fuel burning area used in the period from 1954-1976.	Soil, groundwater	Natural attenuation processes treat contaminated soils and groundwater. Institutional controls are in place to prevent contact with contamination, and groundwater is under a LTM plan.	No exposure is occurring. Institutional controls are in place to prevent future contact with contaminated groundwater and subsurface soils. This site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
38 (3)	Building 120	Building containing several industrial shops. Contained drum storage and floor drains identified as contamination sources.	Soil, groundwater	Contaminated surface soils have been removed. Natural attenuation processes treat contaminated groundwater. This site is under a LTM, and institutional controls are in place to prevent contact with residual contamination.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.
39 (3)	Building 227	Large hangar used for storage, cleaning and maintenance of aircraft. The northern quarter of the building Ñíhoused a wash rack and hazardous materials storage area Floor drains in this area were connected to the IWTP. Floor drains from other areas are connected to the storm sewer lines discharging to McIntyre Brook. Contaminant sources are believed to be solvents oils and fuel spills on floors or outside the building, and wastes discharged through the storm sewer via floor drains.	Soil, groundwater	Contaminated surface soils have been removed. A hydraulic groundwater containment system has been installed to contain and treat contaminated groundwater. This site is under a LTM, and institutional controls are in place to prevent contact with residual contamination.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.
40 (4)	Auto Hobby Shop (AHS)	Used for light maintenance of privately-owned vehicles.	Soil, groundwater	An in-depth study of the contamination was conducted as part of the Zone 4 remedial investigation. Study results indicate that health risks were below levels of concern. No further action was decided.	No exposures are occurring. The site is covered by institutional controls that restrict development and prevent exposure to site contaminants. The site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
41 (7)	Golf Course Maintenance Area (GCMA)	Contains two sub areas used for golf cart maintenance and pesticide/fertilizer storage.	Soil	As a result of a remedial investigation, areas of contaminated soils wee identified and removed. Remaining soils were not contaminated above levels of concern, and required no further action.	Contamination is below levels of concern. No exposure is occurring. No public health hazard.
42 (3)	Building 123, Refuse to Energy Plant (RTE)	In operation from 1982-1987, the facility burned municipal solid wastes generated by the base and the city of Portsmouth to generate base heating.	Building interior, Groundwater	Interior equipment and residual wastes have been removed and the building interior cleaned. Natural attenuation is being used at this site to treat groundwater. LTM and institutional controls are in place.	Contamination has been removed. No exposure is occurring. Site is considered no public health hazard
43 (2)	McIntyre Road Drum Disposal Area (MRDDA)	Former drum disposal area.	Soil, groundwater	Wastes and contaminated soils were excavated and removed. The groundwater contamination is associated with site 22, and is under active remediation.	Soil contamination has been removed. No exposure to contaminated groundwater is occurring. Institutional controls are in place to restrict site use and potential contact with contamination. The site is not considered to be a public health hazard.
44 (1)	Paint Can Disposal Area (PCDA)	Used for storage and disposal of paint cans and drums of paint and paint residue.	Groundwater, soil	An intensive excavation operation removed soils and waste materials for disposal off-site. Sampling during a remedial investigation indicated that residual contamination at the site did not pose risks significant to warrant further action. Site closure under state rules is pending. Groundwater is under LTM.	No exposure is occurring. Institutional controls are in place to prevent future exposures from occurring. This site is considered no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
45 (7)	Old Jet Engine Test Stand (OJETS)	Operated as a jet engine testing facility from 1958-76. Site operation generated and resulted in releases of waste oils, solvents, fuels and hydraulic fluids.	Soil, groundwater	A soil vapor extraction and air sparging system was constructed to remove contamination from soils and groundwater. Institutional controls are in place and the site is under a LTM plan.	No exposure is occurring. Institutional controls are in place to prevent future exposures. This site is considered no public health hazard.
46 (1,3)	RR Track Herbicides Area (RRTH)	Herbicides including 2,4-D were used to control vegetation along tracks.	None	Sampling of soils and groundwater did not detect contamination. The site was recommended for no further action	No contamination present. Site is not a public health hazard.
47 (7)	Golf Course Pesticide Mixing/Storage (GCPA)	Mixing and storage of pesticides formerly conducted at this location.	Soil	As a result of a remedial investigation, areas of contaminated soils wee identified and removed. Remaining soils were not contaminated above levels of concern, and required no further action.	Contamination is below levels of concern. No exposure is occurring. No public health hazard.
48 (6)	EOD Burn Detonation Area	This areas was used to dispose of unusable explosives and ordnance via burning, detonation and burial.	Soil	During site investigation a sweep of the area was conducted with a metal detector. Subsequent excavation and sieving removed buried wastes and reside. Soils with elevated contamination were removed. No further action was taken at this site.	No exposure is occurring. Residual contamination is below levels of concern. This site is within a national wildlife refuge and access is restricted. This site poses no public health hazard.

IRP Site No.	Site	Description	Contaminated Media	Corrective Activities and Current Status	ATSDR Evaluation of Public Health Hazards
49 (3)	Building 22, Communications facility	Past activities resulted in releases of solvents including PCE and TCE. A plume of contaminated groundwater is underlying an office building.	Soil, groundwater	Surface buildings demolished. An underground storage tank and contaminated soils were excavated and removed. Soil gas samples detected low levels of volatile contaminants. The groundwater is under LTM. Further investigation and evaluation of cleanup alternatives is ongoing.	There is a remote possibility that volatile groundwater contamination may enter the office building from the subsurface. Evaluation of the soil gas sampling results indicate that the contaminants are unlikely to result in air levels that pose a health concern. This site is considered no apparent health hazard. (See discussion in Section III)
NA	Flight line	The flight line refueling system was installed in the mid -1950s to refuel aircraft. Fuel leaks from underground storage tanks, piping and fuel hydrants has occurred during base operations.	Groundwater, soil	Remedial investigations have characterized the extent of contamination. Underground storage tanks and contaminated soils have been removed. Residual contamination in soils and groundwater are underlying the flight line and are inaccessible. Based upon the investigation, the contamination will naturally degrade over time, and will not impact the nearby Haven well. The contaminant plumes are under an active long-term sampling plan to monitor the movement and levels of contamination, and to ensure that nothing reaches the Haven well.	The contamination is under the concrete parking apron. No exposure is occurring to contaminated soils or groundwater. Areas of contamination are under remediation and monitoring. Actions are being taken to prevent further contaminant migration and potential contamination of the haven water supply well. This site is not considered to be a public health hazard.

Appendix D: Health Outcome Data Review

Methods

The review of health outcome data in reference to Portsmouth and Newington, in addition to an individual's health concern in New Castle, New Hampshire, has encompassed an analysis of available cancer information from the New Hampshire State Cancer Registry (NHSCR). The NHSCR is located at Dartmouth Hitchcock Medical Center in Lebanon, New Hampshire. The NHSCR maintains statistics regarding 23 types of cancer in New Hampshire. The NHSCR is in the process of updating their records through 1994.

The cancer information for Portsmouth (including Newington) and New Castle, NH was requested for the years that cancer incidence rates were available (1987 through 1991) from the Bureau of Vital Records and Statistics, which maintains a close working relationship with the NHSCR. Once the data were received, a descriptive epidemiological analysis was conducted. The data were reviewed according to the following factors: sex and age (five-year age groupings; ages 0-85+) for each type of cancer reported in Portsmouth, NH (1990 census population, 25,925 persons) and New Castle, NH (1990 census population, 840 persons) between 1987 and 1991. The types of cancer reported during that time period in Portsmouth, NH are the following: cancer of the esophagus, colon, rectum, lung, melanoma, breast, cervix, uterine, ovary, prostate, testis, bladder, kidney, thyroid, non-Hodgkin's lymphoma, stomach, buccal cavity, and pharyngeal; and, in New Castle, NH: female breast was the only cancer reported over the same time period. Only four cancer (kidney, melanoma, leukemia, and cervical cancer) patients reported a residential address at Pease Air Force Base between 1987 and 1991. The small number of cancers reported at Pease Air Force Base, as well as the fact that the base population was predominantly transient prohibited further analysis.

Very few cancer cases were observed in Newington, NH (1990 census population, 990 persons) between 1987 and 1991, thus preventing further analysis. A series of calculations enabled us to review the observed number of specific cancer cases in the areas of study and compare that value to the expected number of cancer cases. This exercise compared the number of cancer cases among males and females in a variety of age groups in both Portsmouth, NH and New Castle, NH with the state of New Hampshire as a whole.

It is important to note that the quality of the NHSCR cancer data is heavily relied upon to conduct a thorough descriptive epidemiological analysis. Unfortunately, we were unable to examine the recent trend of cancer incidence in Portsmouth, Newington, and New Castle, NH due to the unavailability of more current cancer statistics from the NHSCR (*i.e.*, 1992-present).

Results

All rates are within the expected range at the 95% confidence interval in Portsmouth, NH. In general, the data reviewed do not demonstrate a statistically significant elevation of cancer incidence within this community. However, two cancers were shown to be elevated in Portsmouth, NH between 1987

and 1991: cervical cancer in females and non-Hodgkin's lymphoma in males. Although only 7.7 cervical cancer cases were expected in Portsmouth, NH during that time interval, 25.0 cervical cancer cases were observed. There were also 4.8 non-Hodgkin's lymphoma cases in males expected in Portsmouth, NH during that time interval, but 11.0 non-Hodgkin's lymphoma cases observed.

In addition, all rates are within the expected range at the 95% confidence interval in New Castle, NH. Overall, the data reviewed do not demonstrate a statistically significant elevation of cancer incidence within this community. None of the reportable cancers in New Castle, NH were statistically elevated between 1987and 1991.

Discussion

Portsmouth, NH: Cervical Cancer

According to the American Cancer Society, an estimated 13,700 cases of invasive cervical cancer were diagnosed in 1998 throughout the United States. Rates of cervical cancer incidence have steadily decreased over the past several decades, declining from 14.2 per 100,000 in 1973 to 7.8 per 100,000 in 1994. In addition, an estimated 4,900 cervical cancer deaths will occur in the United States in 1998. Death rates from cervical cancer declined 45% between 1972-1974 and 1992-1994 (American Cancer Society 1996).

Risk factors for cervical cancer are closely linked to sexual behavior and to sexually transmitted infections with certain types of human papillomavirus. Women who have first intercourse at an early age, multiple sexual partners, or partners who have had multiple sexual partners are at increased risk for developing the disease. Additional risk factors include cigarette smoking and low socioeconomic status (American Cancer Society 1996).

The American Cancer Society recommends that all women have Pap tests done by health care professionals as part of a routine pelvic exam. This test should be performed annually with a pelvic exam in women who are, or have been, sexually active, or who have reached the age of 18 (American Cancer Society 1998). New Hampshire Breast and Cervical Cancer Early Detection Program offers educational programs on breast and cervical cancer and is trying to improve access to medical care for women of all socioeconomic classes throughout the State of New Hampshire.

Portsmouth, NH: Non-Hodgkin's Lymphoma

According to the American Cancer Society, an estimated 62,500 new cases of lymphoma will occur in the United States in 1998, including 7,100 cases of Hodgkin's disease and 55,400 cases of non-Hodgkin's lymphoma. Within the last 25 years, the incidence rates for non-Hodgkin's lymphoma have nearly doubled. In addition, the American Cancer Society estimates that 24,900 deaths in the United States will be attributed to non-Hodgkin's lymphoma (American Cancer Society 1996).

The risk factors for lymphoma are relatively unknown, but are believed to involve reduced immune function and exposure to certain infectious agents. People with organ transplants are at higher risk

of developing lymphomas due to altered immune function. In addition, human immunodeficiency virus (HIV) and human T-cell leukemia/lymphoma virus-I (HTLV-I) are associated with increased risk of non-Hodgkin's lymphoma. Other possible risk factors for lymphoma include occupational exposures to herbicides and solvents. Also, the antiseizure drug Dilantin may cause noncancerous overgrowths of lymphoid tissue, but these growths usually regress if the drug is discontinued. Some patients treated with this drug may develop non-Hodgkin's lymphoma, but the risk is very small. (American Cancer Society 1996).

In addition, chemotherapy may increase a patient's risk of developing leukemia or non-Hodgkin's lymphoma 5 to 10 years following treatment. This is an important point for patients who have been treated for Hodgkin's disease, because their risk of developing non-Hodgkin's lymphoma is 4%-5% over a 10 year period. Patients treated with radiation therapy for some other cancers have a slight risk of developing non-Hodgkin's lymphoma later in life. However, it usually takes several years for this to happen, so these secondary cases of non-Hodgkin's lymphoma are more common in adults than in children. Patients treated with both chemotherapy and radiation treatment are more likely to develop secondary leukemias or non-Hodgkin's lymphomas (American Cancer Society 1996).

Furthermore, patients with transplanted organs, such as kidney, heart, and liver, are treated with drugs that compromise their immune system to prevent their immune system from rejecting the transplanted organs. This intentional immune suppression carries a significant risk for the patient of developing non-Hodgkin's lymphoma. The exact risk of developing this lymphoma is dependent upon the type of drugs used (American Cancer Society 1996).

It is important to keep in mind that most adults and children diagnosed with non-Hodgkin's lymphoma have no well-defined, known risk factors. These parents or their children could have done nothing to prevent this type of lymphoma (American Cancer Society 1996).

Conclusions

Two types of cancer had an elevated incidence rate in Portsmouth, NH, between 1987-1991: cervical cancer in females and non-Hodgkin's lymphoma in males.

First, no known risk factors for cervical cancer are associated with exposure to chemical contaminants in the environment. The known risk factors associated with cervical cancer, as previously mentioned, include the following: early age at first intercourse, multiple sex partners, human papillomavirus, and cigarette smoking. Pease Air Force Base is not likely the cause of the observed cervical cancer incidence in Portsmouth, NH.

Second, no well-defined, known environmental risk factors are associated with the development of non-Hodgkin's lymphoma. As previously mentioned, the risk factors for lymphoma are relatively unknown, but are believed to involve reduced immune function and exposure to certain infectious agents. Possible environmental risk factors for lymphoma include occupational exposures to

herbicides and other chemicals such as volatile organic solvents. A causal relationship between these risk factors and the presence of non-Hodgkin's lymphoma does not currently exist. The American Cancer Society states that parents or their children can do nothing to prevent this type of cancer (American Cancer Society, 1996).

It is important to note that elevated rates of a particular illness in a community may not necessarily be attributed to site contamination, nor does it establish a link or imply causality with environmental contamination identified at a site. Many factors influence the development of disease, including personal lifestyle, occupation, and socioeconomic status. Previously in this document, pathways of exposure to contaminants at Pease Air Force Base were evaluated. Completed exposure pathways were found exclusively for people on the base grounds. Therefore, it is unlikely that the elevated rates of non-Hodgkin's lymphoma and cervical cancer among males and females in Portsmouth, respectively, were due to chemical contamination on the base. Chemical contamination will not result in adverse health effects without there first being an opportunity for exposure.

Our current understanding of the etiology of cancer is that there can be a delay or latency period of up to decades between exposure to a carcinogen and the onset of the disease. For this public health assessment, NHDHHS reviewed cancer incidence data from the New Hampshire State Cancer Registry for 1987 to 1991, all the data that were available at the time of the evaluation. This period was nearly 15 years after the late 1970s when the highest exposures to TCE in the base water supply likely occurred and, hence, appropriate for evaluating these past exposures. Therefore, while data from the years following 1991 were not reviewed because they were not available at the time, NHDHHS considered the typical latency period of cancer in its evaluation of the available data.

Recommendations

Since regular Pap test screening is effective in reducing cervical cancer mortality, we support the American Cancer Society's recommendation that women who are 18 years of age, or who are or have been sexually active have annual Pap smear tests. Two facilities in Rockingham County that offer such medical services that are based on the woman's ability to pay: Women's Health Consortium (603-431-1669) and Planned Parenthood of Northern New England (603-352-6898). In addition, the Breast and Cervical Cancer Early Detection Program located in the Department of Health and Human Services may also provide further information regarding additional resources, education, and outreach programs (1-800-852-3345 extension 4931).

Evaluating Cancer Data and Basic Cancer Rate Terminology

Cancer incidence is the number of new cases of cancer, by specific type, that is reported for a particular area over a specific period of time. A review of the cancer incidence for selected cancers can help determine whether the community is experiencing greater than normal levels of cancer.

The American Cancer Society estimates that approximately 8 million Americans alive today have a history of cancer. For men, the lifetime risk of developing cancer is 1 in 2; for women, the lifetime risk is 1 in 3. In 1998, about 1,228,600 new cases of cancer are expected to be diagnosed.

To help determine whether a community is experiencing a greater than expected rate of cancer, cancer statistics can be reviewed. First, it is necessary to verify the number of cases of cancer that actually occurred in the community. This is referred to as the observed cases. Observed cases are found through a cancer registry, in this case, the New Hampshire State Cancer Registry. Next, it is necessary to calculate the expected cases, which are the number of cases that would be anticipated to occur. The expected cases are a mathematical prediction of the number of cases that would be expected in a particular community population based on the number of cases that have occurred in a reference population, such as a metropolitan area, a state, or the nation as a whole. Prediction of the expected cases takes into account the age, sex, and race of persons in the community and assumes that the community population is similar enough to the reference population that the same proportion of any given cancer will be reflected in the community population. In the case of those living in Portsmouth, NH and New Castle, NH, the population of the state of New Hampshire is used as the reference population.

If the reference population has 1000 persons and 25 cases of cancer, the proportion of cancer in that population would be 25 in 1000 (25/1000) or .025. If the community has a population of 100, the method to calculate the expected number of cancers in the community would be to multiply the population of the community, 100 by .025, the proportion seen in the reference population (100 x .025). The expected number of cancers in the community would be 2.5.

The observed cases are compared to the expected cases. The relationship between the observed and the expected cases is called a Standardized Incidence Ratio (SIR). If the observed number of cases is the same as the expected number of cases, the SIR is 1.0 and the community has neither a measurable increased nor decreased cancer incidence. If the observed number of cancer cases is lower than the expected number, then the SIR is less than 1.0 and the community has fewer cases than expected. If the observed number of cancer cases is higher than the expected number of cases, the SIR is greater than 1.0 and it is possible that the community is experiencing a greater than expected rate of cancer.

Standardized Incidence Ratio	What It Means
= 1.00	The number of cases in the community is neither higher nor lower than what would be expected based on the number of cases in the reference population.
< 1.00	The number of cases is lower than would be expected based on the reference population. It is possible that the community is experiencing less cancer than would be expected.
> 1.00	The number of cases is greater than would be expected based on the reference population. It is possible that the community is experiencing more cancer than would be expected.

A SIR of 1.5 indicates a 50% increase in cases over what was expected, and .90 indicates a 10% decrease in cases. Interpretation of the SIR depends not only on its size, but also on its stability. A SIR based on a few cases is considered to be unstable, or more prone to chance, than would be the same SIR calculated from a large number of cases.

For example, a SIR of 2, which indicates a 100% increase in observed cancers over expected cancers, would occur if you expected 1 case and observed 2 cases; it would also occur if you expected 100 cases and observed 200 cases. However, in the first instance the SIR is based on 1 excess case, whereas, in the second instance, the SIR is based on 100 excess cases. Both represent a 100% increase, but the latter is far more stable.

Before the conclusion that a community is experiencing an increase or decrease in cancer can be accepted, it is necessary to determine whether the increase is statistically significant. Statistical

significance takes into account, by means of a statistical test, variations in the populations and the numbers that are being compared. The SIR assumed that the populations were the same, whereas statistical significance examines the variability in the data.

When an observation is determined to be statistically significant, the association is acknowledged to be due to more than chance alone. Although this does not determine causation, it does indicate that an apparent increase in the rate is probably not due to chance alone. Scientists generally assume statistical significance when there is less than a 5% chance (probability) that a particular outcome occurred by chance alone.

One way of looking at chance is in terms of flipping a coin. Since one has a 50/50 chance of getting either heads or tails in one flip of a coin, one would expect in 10 flips of a coin to get 5 heads and 5 tails. However, it is possible to get 7 heads and 3 tails, 4 heads and 6 tails, or even 10 heads and no tails, purely by chance. The test for statistical significance helps to sort out how often one would expect two things to occur together due to chance alone. Data are said to be statistically significant when the occurrence by chance alone is found to be small.

Since the data used to determine the SIR is a product of estimates, the SIR is an average or an estimate. The "true" ratio is the exact ratio that would be found if we knew exactly how many cases to expect in the population (because a larger reference population is used to estimate the expected occurrence of cancer in a smaller population) and exactly how many cases occurred (since every case of cancer may not have been recorded).

Since it is not possible to determine the true ratio, a range is defined around the SIR and is used to estimate the true ratio. Within this range, it is possible that any number could be the true ratio. Statistical significance is determined by looking at the range around the SIR. This range is referred to as a confidence interval (CI). A 95% confidence interval (95% CI) is a range of numbers around the SIR in which the true ratio falls 95% of the time.

To determine statistical significance, a 95% confidence interval is developed for the SIR. A 95% CI which includes 1, such as (0.96 - 1.13) is not statistically significant because, it is possible that the true ratio could be any number in that range, including 1. A 95% CI which does NOT include 1, such as (1.10 - 1.25), is considered to be statistically significant because it is unlikely that the true ratio would be less than or equal to 1 strictly because of chance. As with the SIR, the stability of the confidence interval must also be evaluated. A narrow confidence interval, (1.5 - 1.7), indicates that the calculated SIR is fairly close to the true SIR for the population and is considered to be stable. A wide confidence interval, (1.1 - 5.7), indicates that the true SIR could be much higher or lower than the calculated SIR and is considered to be unstable. In this situation, even though the SIR is determined significant, the large confidence interval indicates a large amount of variability in the

Therefore, results should be interpreted with caution.

For example: if 45 cases of breast cancer are observed and 50 cases of breast cancer are expected, the SIR would be 45/50, or 0.90 (a number less than 1 which means there is not an increase in cancer incidence). However, if 50 cases of breast cancer are expected, and 60 cases of breast cancer are observed the SIR would be 60/50, or 1.20 - a number greater than 1, which means the community might be experiencing a greater rate of cancer than is expected. To determine whether the increase is statistically significant, look at the confidence interval around the SIR. If the 95% confidence interval is (.89 - 1.32), the increase is not statistically significant because it is possible that the true ratio could be any number in that range, including .96 to 1. If, on the other hand, the 95% confidence interval is (1.20 - 1.32), the increase is statistically significant because the confidence interval does not include 1, making it unlikely that the true ratio would be less than or equal to 1 strictly because of chance.

Appendix E: Glossary

List of Acronyms

ACM	Asbestos containing materials
ATSDR	U.S. Agency for Toxic Substances and Disease Registry
CREG	Cancer Risk Evaluation Guide (see definition in next section)
DDT	1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane (a pesticide)
EMEG	Environmental Media Evaluation Guide (see definition in next section)
IRP	Installation Restoration Program (U.S. Air Force)
MCL	Maximum Contaminant Level (see definition in next section)
NHDES	N.H. Department of Environmental Services
NHDHHS	N.H. Department of Health and Human Services
NPL	National Priorities List (see definition in next section)
PCBs	Polychlorinated Biphenyls
Pease AFB	Pease Air Force Base
RAB	Restoration Advisory Board
RfD	Reference Dose (see definition in next section)
RMEG	Reference Media Evaluation Guides (see definition in next section)
ROD	Record of Decision
TCE	Trichloroethylene
USEPA	U.S. Environmental Protection agency
USGS	U.S. Geological Survey

Units of Measure

mg/L Milligrams per liter (a measure of concentration in water, 1 mg/L is equal to 1 part-per-million and 1000 µg/L)

µg/L Micrograms per liter (a measure of concentration in water, 1 µg/L is equal to 1 part-per-billion and 0.001 mg/L)

mg/kg Milligrams per kilogram (a measure of concentration in soil or tissue, 1 mg/kg is equal to 1000 µg/kg)

µg/kg Micrograms per kilogram (a measure of concentration in soil or tissue, 1 µg/kg is equal to 0.001 mg/kg)

Definitions of Selected Terms

Background Level

A typical or average level of a chemical in the environment. *Background* often refers to naturally occurring or uncontaminated levels.

CERCLA

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund. This is the legislation that mandates ATSDR public health assessment activities.

Cancer Risk Evaluation Guides (CREGs)

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

Carcinogen

A substance that has the potential to cause cancer.

Comparison Values

Estimated contaminant concentrations in specific media that are not likely to cause adverse health effects, given a standard daily ingestion rate and standard body weight. The *comparison values* are calculated from the scientific literature available on exposure and health effects.

Concentration

The amount of one substance dissolved or contained in a given amount of another. For example, sea water contains a higher concentration of salt than fresh water.

Contaminant

Any substance or material that enters a system (the environment, human body, food, etc.) where it is not normally found.

Dermal

Referring to the skin. *Dermal* absorption means absorption through the skin.

Dose

The amount of a substance to which a person is exposed. *Dose* often takes body weight into account.

Environmental Contamination

The presence of hazardous substances in the environment. From the public health perspective, *environmental contamination* is addressed when it potentially affects the health and quality of life

of people living and working near the contamination.

Environmental Media Evaluation Guides (EMEGs)

EMEGs are based on ATSDR minimal risk levels (MRLs) that consider body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without noncarcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

Exposure

Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). *Exposure* may be short term (acute) or long term (chronic).

Health Consultation

A response to a specific question or request for information pertaining to a hazardous substance or facility (which includes waste sites). It often contains a time-critical element that necessitates a rapid response; therefore, it is a more limited response than an assessment.

Ingestion

Swallowing (such as eating or drinking). Chemicals can get in or on food, drink, utensils, cigarettes, or hands where they can be ingested. After *ingestion*, chemicals can be absorbed into the blood and distributed throughout the body.

Inhalation

Breathing. Exposure may occur from inhaling contaminants because they can be deposited in the lungs and absorbed into the blood.

Media

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

Maximum Contaminant Level (MCL)

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

Minimal Risk Level (MRL)

An *MRL* is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncancer) over a specified duration of exposure. *MRLs* are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration via a given route of exposure. *MRLs* are based on noncancer health effects only. *MRLs* can be derived for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.

No Apparent Public Health Hazard

This public health conclusion category is used for sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard. This category is used when exposures do not exceed an ATSDR chronic MRL or other comparable value, data are available for all environmental media to which humans are being exposed, and there are no community-specific health outcome data to indicate that the site has

had an adverse impact on human health

National Priorities List (NPL)

The Environmental Protection Agency's (EPA) listing of sites that have undergone preliminary assessment and site inspection to determine which locations pose immediate threat to persons living or working near the release. These sites are most in need of cleanup.

Plume

An area of chemicals in a particular medium, such as air or groundwater, moving away from its source in a long band or column. A *plume* can be a column of smoke from a chimney or chemicals moving with groundwater

Potentially Exposed

The condition where valid information, usually analytical environmental data, indicates the presence of contaminant(s) of a public health concern in one or more environmental media contacting humans (i.e., air, drinking water, soil, food chain, surface water), and there is evidence that some of those persons have an identified route(s) of exposure (i.e., drinking contaminated water, breathing contaminated air, having contact with contaminated soil, or eating contaminated food).

Parts per billion (ppb)/ Parts per million (ppm)

Units commonly used to express low concentrations of contaminants. As example of each, one part per billion (ppb) of trichloroethylene (TCE) equals one drop of TCE mixed in a competition-size swimming pool and one part per million (ppm) equals one ounce of trichloroethylene (TCE) in one million ounces of water.

Public Health Assessment

The evaluation of data and information on the release of hazardous substances into the environment in order to assess any current or future impact on public health, develop health advisories or other recommendations, and identify studies or actions needed to evaluate and mitigate or prevent human health effects; also, the document resulting from that evaluation.

Public Health Hazard

Sites that pose a public health hazard by increasing the likelihood that adverse health effects will occur as the result of exposures to hazardous substances.

Reference dose

The value used by EPA as an estimate of daily exposure (mg/kg/day) to the general human population (including sensitive populations) that is likely to be without appreciable risk of harmful effects during a lifetime of exposure.

Reference Media Evaluation Guides (RMEGs)

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

Risk

In risk assessment, the probability that something will cause injury, combined with the potential

severity of that injury.

Route of Exposure

The way in which a person may contact a chemical substance. For example, drinking (ingestion) and bathing (skin contact) are two different *routes of exposure* to contaminants that may be found in water.

Superfund

Another name for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), which created ATSDR.

Superfund Amendments and Reauthorization Act (SARA)

The 1986 legislation that broadened ATSDR's responsibilities in the areas of public health assessments, establishment and maintenance of toxicologic databases, information dissemination, and medical education.

Volatile organic compounds (VOCs)

Substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen; these substances easily become vapors or gases. A significant number of the *VOCs* are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry cleaning fluids).

Appendix F: Written Comments on the Public Comment Release

NHDHHS and ATSDR completed and distributed the Public Comment Release of the Public Health Assessment for Pease Air Force Base on July 28, 1999. Following this, NHDHHS and ATSDR held a public meeting on August 11, 1999, to present the findings of the draft public health assessment. Comments on the document were accepted until September 10, 1999. All the written comments received by this date with responses from NHDHHS are listed in the following section.

Comment 1: How do emissions from aircraft, cars, and buses currently operating on the base affect the air quality at nearby homes? Is there a plan to monitor the impact of these emissions on the residents in the local area?

Response:

There are very little data on the concentrations of hazardous substances in the air near active airports nationwide. Jet engines are regulated by emission standards, not by ambient air monitoring near the runway. Therefore, NHDHHS cannot accurately evaluate the potential health impacts from aircraft or buses operating at Pease Air Force Base at this time because measurements of toxic substances in the air are not available.

The New Hampshire Department of Environmental Services Air Resources Division (NHDES-ARD) exercises regulatory control over individual sources of ambient air pollution and is responsible for operating an ambient air monitoring network. NHDHHS has reviewed the concerns raised in this comment with NHDES-ARD, who provided the following relevant information. The ambient air quality is continuously monitored in nearby Portsmouth and Rye. Air monitoring is resource intensive, and most of what is done in the State is funded by USEPA. NHDES-ARD said that ambient air pollution concentrations do not vary a great deal over broad regions, and there are not any plans at present to conduct additional monitoring in the area around the airport. The fuel that most aircraft and bus traffic use is similar to that used in on-highway heavy duty vehicles, and emissions from aircraft and on-road engines are regulated at the federal level. The contribution of aircraft activity to the regional air pollution inventory is small, and it is not expected that increased activity at the airport such as that proposed will create exceedances of any of the National Ambient Air Quality Standards. Residents who have further questions regarding ambient air quality monitoring should write to:

Kenneth A. Colburn, Director
NHDES - Air Resources Division
PO Box 95 - 6 Hazen Drive
Concord, NH 03301

This comment and response has been added to the Community Health Concerns section of the public

health assessment.

Comment 2: TCE was first used on the base in 1956, but measurements of TCE in the Haven well only began in 1977. It is possible that contamination of the Haven well water with TCE started earlier than 1977, perhaps as early as 1956. Moreover, the trend of TCE concentrations in the Haven well shown in Figure 8 indicates that the TCE levels in the drinking water could have been higher than those detected in 1977 or at least at levels of health concern before monitoring began in 1977. Therefore, the exposures evaluated in the public health assessment may have underestimated both the duration and levels of the actual exposures to TCE in the base water supply.

Response:

Since there are no data on TCE concentrations in the base water supply before 1977, exposures to TCE earlier than this date are unknown. To account for this uncertainty, NHDHHS used very conservative assumptions about TCE concentrations and duration in its evaluation of past exposures to TCE in the base water supply.

- First, base residents were assumed to have been exposed to TCE at 122 µg/L between 1978 and 1985, even though the average concentration of TCE in the Haven well from 1977 through 1985 was 58 µg/L. This average includes data from a period in 1977-1978 when base residents were being supplied water from the City of Portsmouth and the TCE concentrations in the Haven well were near their maximum.
- Second, the actual concentrations of TCE in water consumed by base residents was likely to be lower still because water from Haven well was diluted with water from the Smith and Harrison wells before being distributed to residential taps.
- Third, in the 1970s and 1980s, the population on Pease Air Force Base was primarily military personnel and dependents who were stationed there for a few years at a time. Nevertheless, NHDHHS assumed that base residents lived there for nine years (the median time in one residence for U.S. citizens from USEPA 1997*), which is longer than the duration of time that exposures to TCE above the current drinking water standard were known to be possible (1978-1985).

Therefore, while there are uncertainties about exposures before 1977, NHDHHS is confident that its evaluation took these uncertainties into account and erred, where necessary, on the side of overestimating exposures to TCE in its evaluation of public health implications.

This enhanced discussion of uncertainties regarding past exposures and the conservative assumptions used in the NHDHHS evaluation to compensate for them has been added to the public health assessment.

*USEPA (1997) *Exposure Factors Handbook*, EPA/600/C-99/001, U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, August 1997.

Comment 3: The estimate by Bradley (1982) that TCE first arrived at the Haven well in the late 1970s relied on an assumed rate of groundwater flow and the distance from likely sources of TCE. However, it was later determined that the source TCE to the Haven well was a leaking storm sewer in the vicinity of the Haven well (Weston 1995). Therefore, TCE could have arrived at the Haven well earlier than the end of the 1970s.

Response:

As discussed in the response to Comment 2, it is not known when contamination of the Haven well began because there are no data from before 1977. See the response to Comment 2 for information on how NHDHHS dealt with this uncertainty in its evaluation of exposures.

The estimates of how long it would have taken for TCE to move through the groundwater from potential source areas in nearby buildings to the Haven well (Bradley 1982) were included for completeness. However, they are obviously inconsistent with the theory that the source of TCE to the Haven well in the 1970s was a leak from a storm drain near the well.

The sentence describing the travel time estimates in Bradley (1982) has been removed from the public health assessment to avoid confusion.

Comment 4: It is possible that the TCE concentrations in the Haven well were at some point similar to the levels of TCE found in the water supply system for Woburn, Massachusetts, where an association between TCE exposure and the development of leukemia and non-Hodgkin's lymphoma was observed. This is especially important because the incidence of non-Hodgkin's lymphoma among males in Portsmouth between 1987-1991 was found to be elevated relative to the state-wide averages.

The statement that the highest TCE level found in the Woburn water supply was "more than two times higher" than the levels used to estimate Pease exposures is inappropriate given that the highest TCE concentrations measured in Pease were almost 50% higher than the highest Woburn level.

Response:

In 1997, the Massachusetts Department of Public Health (MDPH) completed an epidemiologic study of childhood leukemia in Woburn, Massachusetts (MDPH 1997*). In this study, MDPH observed an association between exposure to water drawn from Woburn's water supply wells G&H and the development of childhood leukemia. This association was strongest for exposures to the water that occurred *in utero*.

The water from wells G&H in Woburn was tested once for toxic substances before the wells were shut down. Contaminants detected in this sample were: trichloroethylene (TCE), tetrachloroethylene, chloroform, methyl chloroform, trichlorotrifluoroethane, 1,2-dichloroethylene, and arsenic. Other chemicals (i.e., trans-1-dichloroethyene, lead, chlordane, 1,1,1-trichloroethylene, and vinyl chloride) were also detected in the groundwater on properties presumed responsible for contaminating the wells G&H water. Since the wells were contaminated by multiple chemicals whose relative

concentrations over time were unknown, MDPH could not conclude that exposure to TCE or any other specific chemical in particular was the cause of the elevated childhood leukemia incidence. Exposures to one, some, or all of the chemicals in the wells G&H water could have played a role.

The findings of the Woburn study are important, but must be interpreted with caution. In the draft public health assessment, NHDHHS compared central tendency TCE concentrations in the base water supply with the single test result for water from wells G&H in Woburn to provide the reader with a perspective on the findings from the Woburn study. However, in response to comments received, NHDHHS agrees that this comparison is not appropriate given that water from wells G&H in Woburn was only tested once and the fact that MDPH did not find an association between leukemia and TCE in particular. The sentence comparing the TCE levels in Wells G&H and the Haven well has been removed and replaced with a more detailed discussion of the findings from the Woburn study.

Statistically significant elevations of non-Hodgkin's lymphoma were not reported for Woburn residents between 1987 and 1994, the latest data available from the Massachusetts Cancer Registry**. NHDHHS reported in the draft public health assessment that this cancer type had been found to be elevated in the Woburn study. The reference has been corrected to show that this association was observed by a study in New Jersey (Cohn et al. 1994***, as cited in ATSDR 1997). Please see the response to Comment 11 for more information on NHDHHS' evaluation of the incidence of non-Hodgkin's lymphoma among males in Portsmouth.

*MDPH (1997) *Woburn Childhood Leukemia Follow-Up Study*, Final Report, Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA, July 1997.

***Cancer Incidence in Massachusetts, 1987-1994: City/Town Supplement*, Massachusetts Department of Public Health, Bureau of Health Statistics, Research, and Evaluation, Boston, MA, November 1997.

***Cohn, P., Klotz, J., Bove, F., et al. (1994) Drinking water contamination and the incidence of leukemia and non-Hodgkin's lymphoma, *Environ. Health Perspect.*, **102**: 556-561.

Comment 5: No discussion was presented on what is considered the latency period for these types of cancers. What is the probability of future cancers as a result of past exposure to TCE from say 1956 to 1985?

Response:

Our current understanding of the etiology of cancer is that there can be a delay or latency period of up to decades between exposure to a carcinogen and the onset of the disease. For this public health assessment, NHDHHS reviewed cancer incidence data from the New Hampshire State Cancer Registry for 1987 to 1991, all the data that were available at the time of the evaluation. This period was nearly 15 years after the late 1970s when the highest exposures to TCE in the base water supply likely occurred and, hence, appropriate for evaluating these past exposures. Therefore, while data from the years following 1991 were not reviewed because they were not available at the time, NHDHHS considered the typical latency period of cancer in its evaluation of the available data.

It is important to remember that the conclusions of the public health assessment were not exclusively based on the review of cancer incidence data. An evaluation of chemical exposures and toxicology also concluded that adverse health effects from past exposures would not be expected. Therefore, NHDHHS is confident in the conclusions of the public health assessment. For clarity, this language about the typical latency period of cancer has been added to the public health assessment.

Comment 6: When were urea-based products first used to de-ice planes at Pease Air Force Base? Is it possible that nitrate concentrations in the base water supply could have been higher than the drinking water standard before 1994? The assumption that nitrate exposures were not high enough to pose a risk for the developing fetus is not appropriate without better information on the levels of nitrates in the drinking water before 1994.

Response:

From 1994 through early 1996, nitrate levels in the Haven and Smith wells were near or exceeded the drinking water standard of 10 milligrams/liter (mg/L) (as nitrogen in nitrate), reaching peak concentrations of 11.4 mg/L in water from the Smith well. Monitoring data from prior to 1994 showed that the nitrate concentrations had increased from low levels (less than 1 mg/L) in 1990 to near 10 mg/L in 1994 (CDM 1994, CDM 1996). The likely source of the nitrate was the use of urea-based deicing agents on the runway, the application of which presumably increased during this time.

In 1995, the use of urea-based deicing agents was discontinued, and a groundwater monitoring program began (CDM 1996). A water management strategy was also adopted whereby water from the Haven and Smith wells were mixed, in proportions determined by their nitrate levels, to ensure that nitrate concentrations in the base water supply stayed below the drinking water standard (Hilton 1999*). Nitrate levels in the base drinking water are currently monitored on a continuous basis via an in-line nitrate analyzer and meet all state and federal standards for drinking water. Also, the Pease Development Authority is participating in the City of Portsmouth's Wellhead Protection Program to protect the aquifer beneath the former base.

This more detailed discussion regarding the nature and extent of nitrate contamination of the base water supply has been added to the public health assessment.

*Hilton, S. (1999) NHDES, Waste Management Division. Concord, NH. Personal communication.

Comment 7: The response to a community concern about miscarriages and stillbirths on the base in the early 1980s should discuss exposures to nitrates in the base drinking water supply, not just exposures to TCE.

Response:

As discussed in the response to Comment 6, the period of potential exposure to nitrates above the drinking water standard was in 1994 and 1995, which was after the anecdotal reports of miscarriages and stillbirths on the base in the 1980s.

This information has been added to the Community Health Concerns section of the public health

assessment.

Comment 8: Would the death registry provide insight into the number of stillbirths on the base?

Response:

The NHDHHS' Bureau of Vital Records maintains information on all births, deaths, marriages, and divorces that have occurred in the state. Stillbirths or spontaneous abortions that occur after a gestation period of 20 weeks or when the fetus weighs more than 350 grams are reported to the Bureau as fetal deaths*. However, there is evidence that many fetal deaths are not reported, especially ones that occur earlier in the gestational period**. In 1997, 51 fetal deaths were reported for the entire State of New Hampshire. In contrast, 14,520 live births and 5,100 new cases of cancer were reported for the state in this same year. Therefore, because of the low rate of reported fetal deaths, this registry could not be used for meaningful evaluations of small geographic areas such as the communities on or around Pease Air Force Base.

**New Hampshire Vital Statistics Report: 1992-1997*, New Hampshire Department of Health and Human Services, Office of Community and Public Health, Concord, NH, January 1999.

**Wilcox, L.S., and Marks, J.S., eds. (1994) From Data To Action: Public Health Surveillance for Women, Infants, and Children, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Atlanta, GA, 1994.

Comment 9: Why were reproductive and birth outcome data from the base hospital and Portsmouth Hospital not gathered and evaluated for this public health assessment? Would not such data be more extensive and more accessible than that for cancer rates in the area?

Response:

According to state law (RSA141-B:7), all facilities in New Hampshire must report cases of cancer diagnosed or being treated. New Hampshire does not have a similar birth defects or reproductive outcomes registry. Information on adverse birth or reproductive outcomes could not be obtained from local hospitals without the consent of the patients themselves. While data on birth weights are available, they are of limited value because this outcome is not known to be a major developmental concern relative to TCE exposures (ATSDR 1997).

Comment 10: It is clearly regrettable that health data on the predominant population exposed to these contaminants (the base personnel and dependents) appears to be unavailable, both due to the transient nature of military personnel and the fact that they were dispersed when the base closed in 1991. Yet, given the military's propensity for regimentation and paperwork, it seems conceivable that more such data could be retrieved. At the very least, this major gap in the health effects analysis

would appear to preclude any definitive statements about the results of past toxics exposure on the base.

Response:

One of the objectives of a public health assessment is to identify additional evaluations or health studies that could resolve uncertainties or datagaps in the readily-available environmental and health outcome data. Before recommending additional studies, however, the value of the additional information that might be gained must be weighed against the feasibility of the project.

Since the population with greatest exposures to contamination at Pease Air Force Base was the base personnel and dependents, NHDHHS considered a health study for this group. Two factors led to the conclusion that such a study was not warranted. First, a conservative evaluation of exposure to TCE in the base water supply and available toxicological information for the chemical concluded that adverse health effects would not be expected. Second, between 1987 and 1991, four people living on the base were diagnosed with cancer, each one with a different cancer type. Hence, the available evidence was relatively strong and did not indicate that a health study would lead to appreciably different conclusions.

Comment 11: The conclusion that there is no association between the contamination on Pease Air Force Base and the elevated incidence of non-Hodgkin's lymphoma in Portsmouth is too definitive given the considerable uncertainties about the causes of this type of cancer. The risk factors for non-Hodgkin's lymphoma are relatively unknown. Some possible risk factors for this type of cancer include occupational exposures to herbicides and chemicals such as volatile organic compounds (e.g., TCE). Given all this, it seems a stretch to logically conclude that such exposures are not a primary risk factor and that there is "no public health hazard" from past exposures, rather, all we can say is that the "jury is out", that we do not have enough information to make a definitive conclusion.

Response:

In this public health assessment, pathways of exposure to contaminants at Pease Air Force Base were evaluated. Completed exposure pathways were found exclusively for people on the base grounds. Therefore, it is unlikely that the elevated rates of non-Hodgkin's lymphoma among males in Portsmouth were due to chemical contamination on the base. Uncertainty in the risk factors for this cancer type does not undermine the basic premise that chemical contamination will not result in adverse health effects without there first being an opportunity for exposure.

Comment 12: Was there any attempt to compare the health outcome review data with Primary Care Access Data from Portsmouth Hospital?

Response:

NHDHHS periodically publishes an analysis of primary care access data (PCAD) for the State of New Hampshire as a whole and for Hospital Service Areas (HSAs) within the state*. These analyses examine data pertaining to births, deaths, economic status, cancer incidence, and hospital discharge

data.

In order to construct HSAs, hospital discharge data from all New Hampshire hospitals were examined by the town of the patient's residence. A town is considered part of an HSA when the modal number of town residents who were discharged from hospitals were discharged from one hospital in particular (usually the hospital is located within close proximity to the town). For example, the towns of Greenland, New Castle, Newington, Portsmouth, and Rye are considered the HSA labeled Portsmouth since Portsmouth Regional Hospital is the hospital of choice for people in these towns. Therefore, it is important to remember that an HSA is a geographic area, and the data pertaining to the HSA does not necessarily reflect characteristics of the hospital, or hospitals in the area.

For this public health assessment, it was necessary to review cancer incidence data at a smaller geographic scale than the five-town Portsmouth HSA. Therefore, NHDHHS exclusively used the more area-specific data from the New Hampshire State Cancer Registry.

**Primary Care Access Data, Accessing New Hampshire's Communities, Third Edition 1990-1994*, Office of Health Management, New Hampshire Department of Health and Human Services, Concord, NH (on the internet at www.dartmouth.edu/~ahechome/PCADTOC.html)

Comment 13: Page 24, Lines 742-743, "...including maintaining compliance with the City of Portsmouth's Wellhead Protection Program.": Modify to read "...including formal adoption and promulgation of a written Wellhead Protection Program Plan jointly by the City of Portsmouth and Pease Development Authority."

Response: The formal aspects of the wellhead protection program are beyond the scope this public health assessment. NHDHHS will forward this comment to the parties responsible for this program.

Comment 14: Appendix D (Health Outcome Data Review) does not include tables behind the summary and relies on outdated data; statistics through 1994 are available.

Response:

State law (RSA 141-B:9) precludes public disclosure of information on individual cancer cases reported to the New Hampshire State Cancer Registry. In order to comply with this law, NHDHHS only reports cancer data as aggregate summaries for towns or other geographic areas that do not disclose the identity of an individual and cannot be used to surmise an identity.

The health outcome data review considered cancer cases diagnosed between 1987 and 1991, all the years that were available from the New Hampshire State Cancer Registry at the time NHDHHS conducted its evaluation.

Comment 15: Data on health effects only summarized, not presented.

Response:

Detailed descriptions of the toxicological properties of chemicals are available in ATSDR's

toxicological profiles. These documents were used to complete the public health assessment and are cited in the References section. Toxicological profiles can be obtained from ATSDR's Division of Toxicology (404-639-6300, www.atsdr.cdc.gov) or the National Technical Information Service (800-553-6847 or 703-605-6000, www.ntis.gov).

Comment 16: Geographic area too restricted. Region surrounding Great Bay should be studied.

Response:

In this public health assessment, pathways of exposure to contaminants at Pease Air Force Base were evaluated. Completed exposure pathways were found exclusively for people on the base grounds. Furthermore, in response to community concerns about cancer, NHDHHS reviewed cancer incidence data for some communities near the base, Portsmouth, Newington, and New Castle, for the years between 1987 and 1991. This evaluation did not discover elevated rates of cancer that were thought to be related to contamination on the base. These two findings argue against expanding the scope of the public health assessment to the entire Great Bay region. Concerned residents in the area around the Great Bay should contact NHDHHS if they would like more information.