PUBLIC HEALTH ASSESSMENT

WURTSMITH AIR FORCE BASE

OSCODA, IOSCO COUNTY, MICHIGAN

EPA FACILITY ID: MI5570024278

Prepared by:

Federal Facilities Assessment Branch
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, fullscale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

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

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

Letters should be addressed as follows:

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

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ACC	Air Combat Command
AFFF	aqueous film forming foam
ASPTS	Arrow Street pump-and-treat system
ASR	Au Sable River
AST	aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, and xylene
BPPTS	Benzene Plant pump-and-treat system
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLHA	child longer term health advisory
CPF	cancer potency factor
CREG	cancer risk evaluation guide
CV	comparison value
DRMO	Defense Reutilization Management Office
EMEG	environmental media evaluation guide
EPA	United States Environmental Protection Agency
IARC	International Agency for Research on Cancer
IRP	Installation Restoration Program
J	estimated concentration
JB	estimated due to blank contamination
KOC	Knights of Columbus
LNAPL	light nonaqueous phase liquid
LTHA	Lifetime Health Advisory
MCL	EPA's maximum contaminant levels
MCLG	EPA's maximum contaminant level goal
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MDPTS	Mission Drive pump-and-treat system
mg/kg/day	milligrams per kilogram per day
MOGAS	motor gasoline
MRL	ATSDR's minimal risk level
MTBE	methyl tert-butyl ether
MWSW	main water supply well
NA	not applicable
ND	nondetect
NTP	National Toxicology Program
OBW	off-base well
OWS	oil/water separator
PAHs	polycyclic aromatic hydrocarbons

PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PHA	public health assessment
PHAP	Public Health Action Plan
PNA	polynuclear aromatics
POL	petroleum, oil, lubricant
ppb	parts per billion
ppm	parts per million
PTS	pump-and-treat system
RI	remedial investigation
RBC	risk-based concentration
RfD	EPA's reference dose
RMEG	reference dose media evaluation guide
SAFR	Small Arms Firing Range
SVOC	semivolatile organic compound
TCE	trichloroethylene
TPH	total petroleum hydrocarbons
USAF	United States Air Force
UST	underground storage tank
VEL	Van Etten Lake
VESP	Van Etten State Park
VOC	volatile organic compound
WAFB	Wurtsmith Air Force Base
WSA	Weapons Storage Area
WSD	West Shore Drive
WWTP	waste water treatment plant

SUMMARY

Wurtsmith Air Force Base (WAFB) is in Oscoda (Iosco County), Michigan, approximately 170 miles north of Detroit. The base was closed in June 1993, following seven decades of service as an aviation support facility. While the base was operational, hazardous materials were released to the environment, resulting in environmental contamination at a number of locations. Contaminants from some of these areas have migrated beyond the base's boundaries.

To date, 58 areas of potential contamination have been evaluated under the U.S. Air Force (USAF) Installation Restoration Program. The Agency for Toxic Substances and Disease Registry (ATSDR) analyzed all 58 sites to determine whether past, current, or future public health hazards are associated with them. For the vast majority of sites, no public health hazards were identified because of one or more of the following reasons: (1) no site-related contaminants were present, (2) detected contaminant concentrations were too low to pose a hazard, (3) past, current, and future exposures to the contaminated media were very infrequent and/or conducted with personal protective gear, and (4) future exposures will be prevented by land use restrictions.

ATSDR visited WAFB in 1995 and 1998. During the visits, ATSDR identified two pathways by which on-base residents and the surrounding community might have come into contact with contaminants originating at WAFB: (1) exposures to drinking water from on-base and off-base water supply wells and (2) exposures to on-base and off-base surface water bodies. ATSDR evaluated these potential exposure pathways in this public health assessment and addressed community health concerns.

Exposures to On-base and Off-base Water Supplies

ATSDR concluded that past exposures to groundwater may have posed an increased risk of developing adverse health effects. Several on-base and off-base water supply wells were used in the past to service residential areas, facility buildings, and recreational areas. Contaminants were detected in some of these wells and in samples collected from building faucets. Although trichloroethylene (TCE) concentrations in on-base water supply wells and one off-base well were high enough to warrant concern, it is unknown whether the concentrations persisted at high enough levels for long enough durations to actually pose a public health hazard.

Current and potential future exposures to groundwater are not expected to pose a public health hazard. Today, the vast majority of on-base and off-base areas receive their drinking water supplies from the Huron Shores Regional Utility Authority, a source that is not located near WAFB, and which meets all federal and state safe drinking water standards. A few wells are still in service, but exposure to the water that they provide is not expected to pose current or future health hazards because the wells do not contain high contaminant concentrations, they are only rarely used, and/or exposure durations are expected to be short. Institutional controls are in place to prevent new wells from being installed in contaminated areas in the future.

Exposures to Surface Water and Sediment

ATSDR concluded that past, present, and future exposures to surface water and sediment are not expected to pose a public health hazard. Contaminants from WAFB have been released to Van Etten Lake, the Au Sable River, Duell Lake, and a wetland area located in the southern portion of the base. Although these surface water bodies have been and continue to be used for recreational activities, contaminant concentrations are low and/or exposure is too infrequent to result in health hazards.

Community Health Concerns

Health concerns expressed by community members included:

Concern that volatile contaminants in the groundwater could migrate into subsurface housing structures (e.g., basements). ATSDR concluded that it is improbable that exposures to volatilizing materials would pose public health hazards. In the absence of actual indoor air measurements, indoor air contaminant levels were estimated using conservative mathematical models. The results suggested that indoor air levels are too low to be of health concern.

Concern that exposures to vinyl chloride could cause cancer. A community member asked ATSDR whether vinyl chloride causes cancer, and whether this chemical was identified as a contaminant of concern in on-base water supply wells or Van Etten Lake. ATSDR concluded that it is true that some health studies suggest a link between occupational exposures to vinyl chloride and brain cancer. Data on vinyl chloride were collected from on-base drinking water wells and Van Etten Lake starting in 1983 and 1990, respectively. Based on these data, ATSDR concluded that vinyl chloride concentrations have not been high enough to pose health hazards to people exposed to on-base drinking water wells during or after 1983 or to Lake Van Etten during or after 1990.

Concern that there is an increased incidence of cancer in the community. No health outcome studies were available to address this community concern. Although ATSDR concluded that people exposed to TCE-contaminated drinking water wells in the past might have been at an increased risk of developing adverse health effects, it is unknown whether high TCE concentrations persisted for long enough durations to cause these health effects to manifest. Furthermore, there is much controversy in the scientific community regarding whether TCE causes cancer in human populations. The U.S. Environmental Protection Agency (EPA) is currently reviewing the scientific literature to determine its cancer classification.

Concern that miscarriage rates increased during the time period when on-base wells were contaminated. ATSDR reviewed available literature and found very few studies that evaluated whether exposures to chlorinated solvents in groundwater pose an increased risk

of miscarriage in humans. Thus, no definitive conclusions could be made about this concern. It should be noted, however, that studies in laboratory animals show some adverse reproductive outcomes (e.g., decreased survival rates), but at doses that are significantly higher than those expected to have occurred at WAFB.

Concern that community members could be eating contaminated fish. Community members use Van Etten Lake and the Au Sable River for recreational fishing. Based on available data, ATSDR does not believe that consuming fish from these water bodies will pose health hazards. This conclusion was made, however, based on limited data.

Concern that community members could be eating contaminated deer and turkey. Community members hunt and eat game animals that live in or near a wetland that has been impacted by the base's contaminants. No samples have been collected from the animals to determine whether contaminants have accumulated within their tissues. Thus, ATSDR cannot make any definitive conclusions about whether people could be eating contaminated game animals. It should be noted, however, that game animals are not expected to spend all of their time in the wetland. In addition, hunters probably do not eat large quantities of meat that comes from animals exposed to the wetland area.

Concern that enhanced bioremediation will not adequately remediate the Northern Landfill Plume. ATSDR learned that USAF no longer plans to use this remedial approach. Instead, a dual system, consisting of a pump-and-treat and an air sparging system, will be installed. (The public was allowed to comment on this selected remedy.)

Concern that seeps could cause public health hazards and aesthetic problems. The Northern Landfill Plume discharges into Van Etten Lake at Seep #1 and Seep #2. Because exposures to the seeps are extremely limited, ATSDR does not believe that these seeps pose a health hazard. The seeps have caused an aesthetic problem, but USAF plans to address this issue in the near future.

Concern that radioactive materials were stored on site, and that the public may have been exposed to these materials. Base representatives did not know if radioactive materials had been stored at WAFB. If they were, these materials would have been stored in secure igloos in the Weapons Storage Area. A radiologic survey was conducted in this area after the base closed; no radioactive contamination was detected.

BACKGROUND

Site Description and History

Site Description

Wurtsmith Air Force Base (WAFB) is in Oscoda (Iosco County), Michigan, approximately 170 miles north of Detroit (see Figure 1). The 5,221-acre site is located less than one mile from Lake Huron. It is bounded by Van Etten Lake (to the north and east), the Oscoda and Au Sable communities (to the east and south), the Huron National Forest (to the south) and the Alpena State Forest (to the west). A variety of hazardous substances (e.g., fuels, solvents, and pesticides) have been handled, stored, and disposed at WAFB. Some of these materials were released to the environment, resulting in soil, groundwater, sediment, and surface water contamination at a number of locations.

Operational Activities

WAFB supported aviation activities for seven decades. The base was established in 1923, under the name Camp Skeel, and operated as a landing field and gunnery range. Its name changed several times before it was officially named WAFB in 1953. During different points in its history, the base served as (1) an airfield—housing, maintaining, and refueling several types of planes; (2) a training facility—offering training in overseas fighting, gunnery and combat zone fighting, and fire survival; and (3) a weapons storage area—maintaining, processing, testing, and housing a wide variety of weapons (Air Force 1995). Throughout much of the 1960s, 70s, and 80s, WAFB was on Ground Alert (i.e., continuous alert for foreign attacks), but it was placed on a base closure list following the end of the "Cold War." Congress approved the closure in October 1991 and closing ceremonies were held on June 30, 1993 (Air Force 1995).

Remedial and Regulatory History

Contaminants were first discovered at WAFB in October 1977, when an on-base resident complained that the base's drinking water supply contained peculiar tastes and odors. In response to this complaint, a tap water sample was collected from an on-base housing unit and trichloroethylene (TCE) was detected. This discovery prompted several environmental investigations and it soon became evident that a groundwater plume had formed under the base and impacted on-base water supply wells. In the years to follow, WAFB discovered that several other environmental media (i.e., surface water, sediment, and soil) had been impacted by contaminants as well. The site was proposed for the U.S. Environmental Protection Agency's (EPA's) National Priority List in January 1994 (AFBCA 2000f).

Many of the initial environmental investigations performed at WAFB were conducted by the United States Geological Services in the late 1970s and early 1980s. More extensive investigational activities were initiated in 1984, when the U.S. Air Force (USAF) began evaluating WAFB through its Installation Restoration Program (IRP). (The IRP is designed to identify, evaluate, and clean up environmental contamination resulting from past management practices.) To date, 58 areas with potential contamination have been evaluated at WAFB under the IRP (see Figure 2). (AFBCA 1999a). At some of these areas, contamination was significant enough to warrant immediate cleanup activities. Some of these cleanup activities, such as tank or soil removal, were executed expediently and have already been completed. Other activities, such as remediating groundwater plumes via pump-and-treat systems, are still ongoing because they require longer durations to achieve cleanup goals. Appendix A provides a summary of the status of all of the sites that are being evaluated under the IRP.

Several different entities have influenced environmental decision-making at WAFB through the years. For example, the Michigan Attorney General was heavily involved at one time, resulting in the signing of a Consent Decree in November 1980 that required USAF to complete hydrogeological studies, create a groundwater remediation plan, increase the productivity of their pump-and-treat system, and cap some of their landfills. At another time in WAFB's history, the courts played an important role in deciding which remedial approaches should be taken.[1] Today, most of the decisions are made by the Base Realignment and Closure (BRAC) Cleanup Team, which consists of representatives from USAF, EPA, and the state of Michigan.

Local Demographics

About 8,000 people lived and/or worked at WAFB while the base was operational (AFCEE 1998a). According to the U.S. Census, for locations within 1 mile of WAFB, 7,700 people resided in 2,961 households in 1990.

As of fall 1999, about 397 people were still working at the base, and about 230 people were living on base (USAF 2000). The base's closure has had a profound impact on the demographics of the surrounding area. There are currently only about 5,200 people living in adjacent communities (AFCEE 1998a).

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[1] The USAF and a state regulatory agency disagreed about whether aggressive treatment systems were required to prevent groundwater from impacting Van Etten Lake. In 1989, the issue was taken to the courts, which sided in favor of USAF (Bay City 1990).

Land Use and Natural Resources

Land Use

As indicated previously, WAFB was closed in June 1993. Today, the base is in a state of transition, with some areas being used for industrial and commercial purposes and others being left unused until environmental investigations or cleanups are completed. The BRAC Cleanup Team is trying to expedite cleanups so that the base property can be reused as quickly as possible. According to proposed reuse plans, the base will be used as an airfield, for aviation support, for industrial and commercial activities, and for medical, child care, and educational services. Some of the land will be designated for recreational use (Air Force 1993). Also, the on-base housing area, which is being sold to the community, will be used for residential purposes. In fact, some of the units are currently occupied by community members (USEPA 2000a).

The land beyond the base's boundaries is used mostly for residential and recreational purposes. Residential properties and camping areas abut the base to the east and northeast. Some of the residential properties serve as year-round residences, but others are only used on a seasonal basis. The camps located in close proximity to the base are Camp Nissokone and Van Etten State Park (see Figure 3). The former is operated by the YMCA and hosts several hundred children for short periods each summer (ATSDR 1998a). The latter is owned by the Michigan Department of Natural Resources (MDNR) and supports 40 rustic campsites (MDEQ 1999a).

Natural Resources

A groundwater aquifer lies below the base and extends beyond the base's boundaries. The principal aquifer in the region extends from the ground surface to a depth of approximately 65 feet (ATSDR 1996a; M&E 1987). Groundwater flow patterns have been studied and researchers concluded that a groundwater divide extends diagonally across the base, directing groundwater south of the divide toward the Au Sable River at a rate of about 0.3 feet/day and groundwater to the north of the divide toward Van Etten Lake at a rate of 0.8 feet/day (M&E 1987) (See Figure 4 for the locations of Van Etten Lake and the Au Sable River). Although subsurface geology influences flow patterns, pumping activities from several on-base purge wells have also influenced how groundwater flows under the base. For several years, the aquifer served as a drinking water source for WAFB and several nearby off-base properties. Today, nearly all of these areas receive their drinking water from municipal sources (AFBCA 1999b).

As depicted in Figure 4, lakes, rivers, and wetlands are located near WAFB. Some of these water bodies (i.e., Van Etten Lake, Au Sable River, Duell Lake, and a wetland area), which are used by residents and tourists for recreational activities, have been impacted by WAFB's contaminants.

The Agency for Toxic Substances and Disease Registry (ATSDR)'s Involvement

On December 3, 1993, the Citizen's Advisory Committee on Wurtsmith AFB Contamination, Inc., petitioned ATSDR to perform a public health assessment (PHA). One month later, the site was proposed for the National Priorities List. Once on the list, ATSDR was mandated to perform a PHA for the site. As a first step, ATSDR visited WAFB in June 1995 and met with Air Force personnel and representatives from the local community. The latter were asked to summarize their health concerns. Following the visit, ATSDR ranked the site according to its potential public health hazard and released a Site Summary. In this report, the agency concluded that WAFB posed no current public health hazards, but that past exposures to contaminated environmental media had occurred. The agency made no conclusions at this time about whether these past exposures could have caused adverse health effects (ATSDR 1996a).

In July 1998, ATSDR revisited WAFB to gather additional information for the PHA. During the second site visit, ATSDR met with Air Force personnel, community members, and representatives from Camp Nissokone. ATSDR talked at length with the latter two groups to learn more about their health concerns. In addition, after the site visit, ATSDR contacted representatives from the Michigan Department of Environmental Quality and the District Health Department to determine whether these agencies had health concerns or knew of any community concerns. Also, ATSDR was alerted to concerns that EPA had expressed about the site. All of the concerns expressed by community members or environmental agencies are addressed in the "Evaluation of Environmental Contamination and Potential Exposure Pathways" and the "Community Health Concerns" sections of this PHA.

Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Many of the reports were prepared under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program and had to meet specific standards for adequate quality assurance and control measures for chain-of-custody procedures, laboratory procedures, and data reporting. Some of the environmental data presented in this PHA were not collected under the CERCLA program, and may not have been subjected to as rigorous quality control procedures. Nevertheless, ATSDR used these data because no other data were available to help reconstruct past contamination scenarios.

EVALUATION OF ENVIRONMENTAL CONTAMINATION AND POTENTIAL EXPOSURE PATHWAYS

Introduction

In this section, ATSDR evaluated whether people are, have been, or will be exposed to contaminants originating from WAFB. In evaluating exposure pathways, ATSDR determines whether exposure to contaminated media has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation of contaminants. When exposure to contaminated media occurs, the exposure pathway is regarded as "complete." To determine whether completed exposure pathways pose a potential health hazard, ATSDR compares contaminant concentrations to health-based comparison values (CVs). CVs are calculated from available scientific literature on exposure and health effects. These values, which are defined for each of the different media, reflect the estimated maximum contaminant concentration for a given chemical that is not expected to cause adverse health effects, given a standard daily ingestion rate and standard body weight. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency) and the toxicology of the contaminant. It should be noted that because CVs do not represent thresholds of toxicity, exposure to contaminant concentrations above CVs will not necessarily produce health effects. In fact, ATSDR CVs are designed to be many times lower than levels at which no adverse health effects were observed in experimental animals or epidemiological studies. A public health hazard exists only if people come in contact with, or are otherwise exposed to harmful levels of contaminated media. The exposure evaluation process is summarized in Figure 5. To acquaint readers with terminology used in this report, a glossary and a list of CVs are included in Appendices B and C, respectively.

ATSDR analyzed all 58 IRP sites at WAFB to determine whether past, current, or future public health hazards were associated with them. The Agency's conclusions are summarized in Appendix A. For the vast majority of sites, no public health hazards were identified because of one or more of the following reasons: (1) no site-related contaminants were present, (2) detected contaminant concentrations were too low to pose a hazard, (3) past, current, and future exposures to the contaminated media were very infrequent and/or conducted with personal protective gear, and (4) future exposures will be prevented by land use restrictions.

ATSDR identified four media that have been affected by WAFB's activities: soil, groundwater, surface water, and sediment. *As indicated in Appendix A, no health hazards are associated with past, current, or future exposures to soil.* (Access to contaminated areas was highly restricted in the past. As a result, exposure to contaminated soil was infrequent. Also, over the years, many cleanup efforts have been initiated to remediate areas with high soil contaminant concentrations. Some contaminated soils are still present, but exposure to them is not expected to pose health hazards because contaminant concentrations are low and/or people are not expected to contact the contaminated soils on a frequent enough basis to warrant concern.) ATSDR's analysis of the

other three media (i.e., groundwater, surface water, and sediment) is summarized in the text that follows, Table 1, and Appendix D.

Groundwater

Groundwater underlying WAFB has been impacted by site activities. Several groundwater plumes have been identified, some of which have migrated beyond the base's boundaries (see Figure 2). Detailed information about the groundwater conditions at all 58 IRP sites is provided in Appendix A. ATSDR focused on the following plumes because they contained some of the highest contaminant levels and/or have impacted on-base or off-base drinking water supply wells:

- *The Arrow Street Plume*. In 1962, an underground storage tank (UST) was installed to store waste TCE. It was removed in 1977 after base representatives discovered a leak (AFCEE 1997a). Sampling results indicated that the leaking TCE impacted subsurface soils and underlying groundwater. Remedial activities were initiated immediately, with purging activities starting in November 1977 and the Arrow Street pump-and-treat system (ASPTS) becoming operational in 1981. Before the ASPTS became operational, the Arrow Street Plume impacted USAF's on-base water supply wells and migrated off base, flowing toward Van Etten Lake. TCE concentrations were highest in the late 1970s, with TCE reaching a high of 46,800 parts per billion (ppb) in 1978 in one on-base monitoring well (ATSDR 1996a). Groundwater remediation efforts have removed much of the TCE, but the ASPTS' pumping activity has drawn contaminants from other on-base sources (i.e., SS-06, SS-08, and SS-47 [see Appendix A]) towards it. According to results obtained during a 1996 sampling event, several contaminants remain above ATSDR's health-based drinking water CVs, including benzene, tetrachloroethylene (PCE), toluene, and TCE (AFCEE 1997a). The ASPTS will remain operational until contaminant concentrations decrease below EPA's Maximum Contaminant Levels (MCLs).

- *Petroleum, Oil, Lubricant (POL) Bulk Storage Area Plume*. In the late 1970s, investigators identified the POL Bulk Storage Area Plume when benzene was detected in on-base monitoring wells at concentrations ranging from 197 ppb to 1,000 ppb (ATSDR 1996a). The plume is being captured and treated by the ASPTS and the Benzene Plant pump-and-treat system (BPPTS). Several contaminants remain at levels that exceed ATSDR's drinking water CVs, including benzene, ethylbenzene, methylene chloride, TCE, and xylene (AFCEE 1996a). Treatment efforts are ongoing.

- *Mission Drive Plume*. The Air Combat Command (ACC) Operational Apron (Site SS-08) has been identified as the probable source of the Mission Drive Plume (AFCEE 1996b).[2] The plume extends under the on-base housing area, migrating in a southerly direction. The Mission Drive pump-and-treat system (MDPTS) was installed to treat the plume in the mid-1980s. In recent years, investigators discovered that part of the plume is bypassing the treatment system and discharging to the 3-pipes drainage ditch—a conduit that discharges directly into the Au Sable River (AFCEE 1996b). The Air Force plans to install additional purge wells to remediate this situation in the near future (AFBCA 1999a). According to results obtained from a 1994 and 1995 sampling event, the plume still contains several constituents above ATSDR's CVs, including arsenic, benzene, dichlorobromomethane, cis-1,2-dichloroethene, 1,1-dichloroethene, manganese, and TCE (AFCEE 1996b, 1996c).

- *The Northern Landfill Plume*. Hazardous materials were disposed and stored at Landfills 30 and 31. For example, two 6,000-gallon tanker trailers were buried at Landfill 30 and used to store waste jet fuels, oils, solvents, thinners, and lubricants (AFCEE 1996d). Environmental investigations indicated that a chlorinated solvent plume has formed under the landfills, migrating under off-base residents and Camp Nissokone, and discharging into Van Etten Lake (see Figure 2). According to results obtained from a 1994 sampling event, several constituents in the plume are above ATSDR's CVs, including arsenic, benzene, cadmium, manganese, methylene chloride, TCE, and vinyl chloride (AFCEE 1996d). Much controversy has been generated about how the plume should be managed. Recently, a decision was made to install a dual system, consisting of pump-and-treat and air sparging, to address the plume. The remedial system will be installed by June 2001 (AFBCA 2000a, 2000b; USAF 2001).

- *Pierce Point Plume.* Wastes generated at the Weapons Storage Area (WSA) were released to the environment via a leachfield (AFCEE 1996e). These releases resulted in a groundwater contamination plume that stretches from the WSA, traveling under off-base residential areas, and discharging to Van Etten Lake. According to results obtained from 1994 and 1995 sampling events, several contaminants in the plume are present above ATSDR's CVs, including arsenic, cadmium, heptachlor epoxide, lead, methylene chloride, PCE, and TCE (AFCEE 1996e). The USAF has not installed an active groundwater remediation system at this site. Rather, they are relying on natural attenuation—a process in which microbes degrade constituents to nontoxic forms over time—to perform the remedial work.

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[2] Although the ACC Operational Apron (SS-08) is located north of WAFB's natural groundwater divide, it is suspected that well pumping activities caused the groundwater at this site to be drawn south of the divide (AFCEE, 1996b).

Several on-base and off-base drinking water wells have been impacted by the groundwater plumes beneath WAFB. ATSDR separated these wells into three categories based on the areas that they serviced:

- USAF's main water supply wells (i.e., wells AF1, AF2, AF3, AF4, AF5, AF18, AF19, AF30, AF31, and AF32) (see Figure 6).
- USAF's area-specific wells (i.e., wells AF7, AF8, AF14, AF15, AF16, AF22, AF25, and two unnumbered wells) (see Figure 6).
- Off-base wells (i.e., wells that are located on properties that are situated between WAFB and Van Etten Lake).

For all of these wells, ATSDR evaluated available well usage information and sampling data to determine whether exposures to the wells could have posed a public health hazard.

Exposures to On-Base Water Supplies

Past Exposures

USAF's Main Water Supply Wells

In the past, USAF's main water supply wells were used to supply water to on-base housing units and several base buildings. These wells were used for both potable (drinking and other household uses) and nonpotable (industrial activities) purposes. Base residents used the water supplied by these wells until June 1993, when WAFB officially closed and the housing units were vacated. Base representatives who continued to work in on-base buildings after closure continued to use the water supplied by USAF's main water supply wells until municipal hookups were established in 1997 (AFBCA 1999b).

Ten water supply wells served the base during different periods of the base's history (see Figure 6). Water from individual wells was pumped to a distribution center and mixed with water that was provided by other wells before being distributed for use. Wells AF1, AF2, AF3, AF4, AF5, AF18, and AF19 served as the original main water supply wells, but wells AF1 through AF5 were removed from service in November 1977 after high concentrations of TCE were detected in a tap water sample that was collected from an on-base housing unit (AFBCA 1999b, 1999c). Following their removal, wells AF18 and AF19 served as the only two main water supply wells. Their service was short-lived, however, and they were taken off line in 1978 after USAF representatives detected high levels of TCE in these wells (USGS 1983). (AF18 never returned to service, but AF19 was brought back on line during later years.) Between 1978 and 1984, AF2, AF4, and AF5 were brought back on line to serve as the main water supply wells. (Sampling

events indicated that these wells were safe to use.) In 1984, wells AF30, 31, and 32 were drilled and these took over as the main water supply wells until 1997 when the base started receiving municipal water. Once these new wells came on line, wells AF2, AF4, AF5, and AF19 were relegated to being used only on a supplemental basis when the base's water demands were very high (AFBCA 1999b; Ayres 1990). Table 2 provides more detailed information about well usage for all ten of USAF's main water supply wells.

Starting in 1977, several water samples were collected from the faucets of on-base housing units and facility buildings. These tap water samples were analyzed for a variety of contaminants. Table 3 summarizes the tap water sampling events that occurred between 1977 and 1997 and lists those contaminants that were detected above ATSDR's drinking water CVs (Air Force 1990; AFBCA 1993, 1999d, 1999e; MDEQ 1999b). ATSDR also evaluated the data that were collected from USAF's main water supply wells during the years that each was operating as a potable source (see Table 2). The well data were evaluated to ensure that ATSDR identified all potential contaminants that may have been present in on-base drinking water. In general, samples were collected from the wells more frequently than they were collected from faucets. Also, the samples collected from the wells were typically analyzed for a broader range of contaminants. Contaminants detected in the individual wells do not necessarily reflect the concentrations that people were exposed to at the tap because water from several wells was mixed prior to distribution to on-base buildings.

ATSDR's analysis indicated that eight contaminants were present in tap water and/or well samples at concentrations above ATSDR's drinking water CVs. ATSDR performed a thorough review of these contaminants to determine whether they could have posed health hazards to people who drank, bathed, or cooked with on-base water supplies in the past. Appendix D provides a detailed explanation of how ATSDR arrived at its conclusions for each chemical.

TCE was identified as the only contaminant that could have caused potential adverse health effects. This contaminant was detected at high concentrations (i.e., 1,100 ppb) in a tap water sample that was collected in October 1977 from an on-base housing unit (AFBCA 1993). ATSDR does not know how long TCE concentrations had been at this level prior to October 1977 because no samples were collected before that date. To be extremely conservative, ATSDR assumed that concentrations could have been that high since 1962, the year that Site 21's UST was installed. This UST is the suspected source of the Arrow Street Plume; investigators believe that this plume contaminated USAF's main water supply wells. High TCE concentrations were not sustained in the tap water long after October 1977. In fact, concentrations dropped very rapidly after the most contaminated wells were removed from service. For example, between November 1977 and December 1979, TCE concentrations detected in tap water samples varied between nondetect and 150 ppb, with many detections ranging between 20 ppb and 80 ppb. In the 1980s and 1990s, TCE was rarely detected above ATSDR's drinking water CVs in well or

tap water samples, and only reached a high of 25 ppb once between 1980 and 1997 (AFBCA 1993; Air Force 1990; MDEQ 1999b).

After evaluating sampling data and exposure information, ATSDR determined that it was highly improbable that exposures to TCE would have posed a public health hazard to anyone who started using USAF's main water supply wells after 1979. As for those populations that lived or worked on base prior to that time, ATSDR concluded that exposures could have posed an increased potential for developing adverse health effects. It should be noted, however, that this conclusion assumes that people were exposed to the highest TCE concentration that was detected in tap water samples for a long period of time. ATSDR cannot be certain that long-term exposures of this sort actually occurred. (While ATSDR assumed that exposures could have resulted as soon as the UST at Site 21 was installed, this assumption was probably overly conservative for several reasons. In actuality, the UST could have been in place for many years before it leaked and impacted USAF's main water supply wells. Also, ATSDR assumed that families and employees were exposed to contaminated water for nearly two decades. This probably overestimates the amount of time that most families lived at the base.) Also, it should be noted that there is much controversy in the scientific community regarding TCE's ability to pose adverse health effects in humans (see Appendix D). TCE has been shown to cause cancer in laboratory animals who receive large doses, but EPA is currently reviewing the scientific literature to determine its potential to cause cancer in humans (USEPA 2000b).

USAF's Area-Specific Wells

While water from USAF's main water supply wells was mixed together and used to service many on-base areas, some of WAFB's supply wells only serviced one particular area or building (AFBCA 1999b, 1999c, 1999d, 1999f; USGS 1983). These wells, which are referred to as USAF's area-specific wells, serviced the following buildings:

- AF7—North Cottage at Air Force Beach
- AF8—South Cottage at Air Force Beach
- AF14—Building 1135
- AF15—Procurement office
- AF16—Firing range
- AF22—Burkhart Lodge
- AF23—Air Force Beach
- AF25—Building 5098
- Unnamed well—Dog kennels
- Unnamed well—Defense Reutilization Management Office

Table 4 and Appendix D summarize available well usage information and sampling data for these wells. While much of the listed data were obtained from well samples, some were obtained from tap water samples that were collected from serviced buildings. Because each area-specific well only serviced one area and was not mixed with other water streams on its way to the faucet, ATSDR considered the contaminant concentration detected in the well to represent the level that

would have been detected in the faucet and vice versa. Contaminants were detected above ATSDR's drinking water CVs in eight of the 10 area-specific wells (Air Force 1990; AFBCA 1993).

ATSDR performed a thorough review of the contaminants detected in these eight wells. *After closely evaluating available data sets and information about the frequency and duration of potential past exposures, ATSDR concluded that exposures to these wells were not associated with public health hazards because contaminant concentrations were too low and/or exposures were too infrequent.* ATSDR's conclusions are summarized in Table 4 and described in detail in Appendix D.

Current Exposures

ATSDR concluded that on-base water poses no current public health hazards. In the spring of 1997, WAFB started receiving water from the Huron Shores Regional Utility Authority (AFBCA 1999b; District 1999a). This municipal water source, which is pumped from Lake Huron, is monitored on a regular basis to ensure that it meets all federal and state drinking water quality standards (District 1999a). All areas of the base are currently being serviced by this municipal water except for a portion of Building 5098, which is serviced by USAF's area-specific well AF25 (AFBCA 1999b). This well is the only USAF on-base water supply well that is still operational. (All of the other USAF area-specific wells and USAF main water supply wells were officially abandoned in 1998 [AFBCA 1999b].)

One IRP site, OT-16, is located relatively close to AF25. As indicated in Appendix A, groundwater contaminants associated with OT-16 are present at concentrations exceeding ATSDR's drinking water CVs. ATSDR collected information on well usage for AF25 to determine whether anyone is being exposed to the water provided by this well. AF25 services the bathroom at Building 5098, a building that does not have a permanent occupant but is being used to store equipment for base remediation efforts. The only people who might be using the building's restrooms are USAF employees or remediation contractors, and their exposure to the restrooms' water would be minimal (AFBCA 2001a). The water supplied to the restrooms is not used for drinking water purposes: signs are posted in the bathroom to advise people against drinking the water (AFBCA 1999g, 2001c).

AF25 is located crossgradient of site OT16 and lies outside of OT16's radius of impact (NCIBRD 1999a). Samples were collected from AF25 and analyzed for TCE in 1977; detected concentrations were below EPA's MCL (5 ppb) (See Table 4). Because water use in Building 5098 is restricted and TCE concentrations were low in the past, incidental exposures are not expected to cause public health hazards. Nevertheless, USAF has agreed to sample AF25 during the spring of 2001 and to analyze the sample for VOCs (AFBCA 2001b; USAF 2001).

Future Exposures

ATSDR concluded that on-base water poses no future public health hazards. As noted above, only one on-base water supply well (AF25) is currently being used. People use the water supplied by this well for nonpotable purposes and only on a sporadic basis. Even if usage is expanded in the future, exposures to AF25 are not expected to pose public health hazards: a base representative has indicated that the well would probably be abandoned if the 2001 sampling data reveal that VOCs are present at elevated levels in this well (AFBCA 2001c).

Potential future exposures to on-base groundwater are not expected to pose health hazards because (1) the groundwater under WAFB is being remediated and (2) land use restrictions will prevent new wells from being drilled in contaminated areas until contaminant levels are reduced to meet the state of Michigan's drinking water standards (AFBCA 1999b). (See Appendix A for more information about which sites will have restrictions written into their deed or lease agreements.)

Exposures to Off-Base Water Supplies

Past Exposures

As depicted in Figure 2, the Arrow Street Plume, Pierce Plume, and the Northern Landfill Plume have migrated off base, moving towards Van Etten Lake. Several parcels of private property are located between WAFB and Van Etten Lake, many of which had wells that serviced residences, campgrounds (e.g., Camp Nissokone and Van Etten State Park), and recreational buildings (e.g., the Knights of Columbus) in the past (see Figure 3).

Although the plumes at WAFB have been fairly well-defined in recent years, the shapes and extent of the plumes in past years is not as clear. At WAFB, the plumes have changed direction and size dramatically throughout its history because of the pumping activity of on-base wells. (For example, while Figure 2 suggests that the Arrow Street Plume extends off base, site representatives claim that the plume is now completely confined within the boundaries of the base.) Given the shifting directions of groundwater flow, ATSDR evaluated all of the available sampling data for nearby residential properties. Sampling data were available for 61 properties located on West Shore Drive and F-41 County Road—streets that are located between WAFB and Van Etten Lake. These data, along with available well usage information, are summarized in Table 5.

Contaminants were detected above ATSDR's drinking water CVs at nine of the 61 locations (Air Force 1990; AFBCA 1993; MDEQ 1999c, 1999d). ATSDR performed a thorough review of the contaminants detected at these nine locations. *After closely evaluating available data sets and information about the frequency and duration of potential past exposures, ATSDR concluded*

that only one of these wells—located at 6504 West Shore Drive—may have contained TCE at a high enough concentration to pose a public health hazard. This well, which serviced a residential property located at Pierce's Point, was used as a drinking water source until the late 1970s (see Figure 3). Sampling activities were initiated in May and June 1979, at which time TCE was detected at concentrations ranging from 500 to 837 ppb (AFCEE 1996e; AFBCA 1993). Immediately upon discovering the contamination, USAF started supplying bottled water to the residence. The well continued to be used for nonpotable purposes, however, until a municipal hookup was established in the early 1990s. Samples continued to be collected while the well was used for nonpotable purposes and TCE concentrations ranged from nondetect to 1,281 ppb (AFBCA 1993). Assuming that TCE concentrations had been high for an extended period of time before the 1979 sampling activities, ATSDR concluded that exposures may have posed a potential for adverse health effects. It should be noted, however, that it is unclear how long people were actually exposed to high TCE concentrations prior to 1979. Site documents did not indicate when the well was installed or when contaminants from SS-05 (the suspected source of the Pierce Plume) first migrated to the vicinity of 6504 West Shore Drive (District 1999b). (Releases at SS-05 may have been occurring as early as the mid-1950s.) If the TCE was only present in this well for a short duration before the 1979 sampling event, then exposures would not be expected to cause adverse health effects. Additionally, as noted previously, there is much controversy in the scientific community regarding TCE's ability to pose adverse health effects in humans (see Appendix D).

Current and Future Exposures

ATSDR concluded that exposures to off-base water supply wells pose no current or future public health hazards. Although many of the off-base wells located to the east of WAFB were used as potable sources in the past, the vast majority of the area now receives water from the Huron Shores Regional Utility Authority. In fact, only three properties (discussed below) are currently using their wells as potable water sources. Moreover, a system is in place to prevent new wells from being drilled in off-base areas that are impacted by contaminated groundwater. Individuals who want to install new wells must notify their District Health Department before doing so. According to health officials, the department issues advisories against installing new wells if the targeted area lies over contaminated groundwater plumes (District 1999a, 1999c).

The three properties that are currently using their wells as potable water sources are:

- *6092 F-41 County Road.* In the early 1990s, USAF offered to establish a hookup for municipal water at 6092 F-41 County Road (see Figure 3), but the offer was refused (Township Oscoda 1999). Therefore, ATSDR assumes that well water is still being used as a potable source at this property. ATSDR evaluated available data to determine whether exposures to the water from this well are expected to pose current health hazards. ATSDR concluded that no health hazards are expected because no contaminants were detected at this property during sampling events that were conducted in 1979, 1989, 1990, 1991, and 2000 (AFBCA 1993; MDEQ 1999c; Montgomery Watson 2000).

- *Van Etten State Park.* Well CG#1 is currently being used to provide potable water to Van Etten State Park, a recreational area that has 40 rustic campsites (District 1999d, 2000a). (The well services a pitcher pump.) Water extracted from the well is used for drinking, cooking, and sponge bathing, but it is not used for more extensive bathing purposes because the camp site does not have showers or plumbed bathroom facilities (MDEQ 1999a). Samples were collected from well CG#1 and tested for volatile organic compounds (VOCs) in April 2000 and more than once in 1999. No contaminants were detected during any of the sampling events (District 1999e, 2000a, 2000b). Thus, the water that is currently being supplied to campers does not appear to be impacted by plumes that are migrating from the base.

  Campers will continue to visit the Van Etten State Park for many years to come. As noted above, the entire campsite is currently being serviced by well CG#1. Samples will be collected from this well regularly to make sure that the well water remains safe to drink. (A District Health Department employee plans to recommend sampling the well annually and testing for VOCs [District 2000b].) MDNR, the park's owner, is making plans to increase the amount of water that is provided to the park.

A second well located on the property, referred to as CG#2, provided potable water to campers for many years before being removed from service in the spring of 1999. TCE was detected earlier that year at concentrations ranging from 2.4 ppb to 3.4 ppb [MDEQ 1999a; District 2000b]. Although MDNR removed the well from service immediately upon discovering TCE as a precautionary measure, MDNR does have the legal right to bring the well back into service since TCE concentrations have not exceeded Michigan's standard of 5.0 ppb [District 2000a].) At this time, MDNR has not decided whether to use CG#2 again. MDNR has started evaluating other alternatives, such as establishing a municipal hookup, to meet the camp site's water supply needs. Even if CG#2 is brought back into service, exposures are not expected to pose public health hazards. According to a representative from the District Health Department, if the well is used, MDNR would be required to sample the well monthly to make sure that TCE concentrations remain below Michigan's safe drinking water standards (District 2000a). Exposures to concentrations below the standards are not expected to pose health hazards to campers who visit Van Etten State Park.

- *A New Residence Near Pierce's Point.* In the summer of 1998, a new well was drilled at a property located on Pierce's Point (MDEQ 1999e). Although this well was installed without notifying the District Health Department, health officials have since been alerted of its presence. Based on available hydrogeological studies, health officials concluded that the well is located on the edge of a TCE and PCE plume (District 1999f). Because no samples have been collected from the homeowner's well, ATSDR could not determine whether the well is currently impacted by contaminants. ATSDR concluded, however, that it is improbable that adverse health effects could have resulted during the two years that the well has been in use. Groundwater concentrations in the Pierce's Point area are currently too low to pose health hazards over such short exposure periods.[3]

According to the District Health Department, contaminants are expected to migrate under the homeowner's property in the future (District 1999f). Thus, actions are being taken to ensure that the well is removed from service. In the summer of 1999, representatives from the District Health Department visited the homeowner and asked him to remove the well and establish a municipal hookup. The homeowner was not willing to do so. As a followup, the Department sent the homeowner a letter ordering abandonment of the well

[3] ATSDR analyzed data that were collected in 1994 and 1995 from the private well at 6504 West Shore Drive and monitoring wells R27, R28, R29, R30, and R31 (see Figure 7). No contaminants were detected above ATSDR's drinking water CVs in the monitoring wells and only TCE (180 to 240 ppb) and methylene chloride (5 to 52 ppb) exceeded these guidelines in the private well. ATSDR assumed that the concentrations at 6504 West Shore Drive are representative of conditions in the newly-drilled well. Short-term exposures to these concentrations are not expected to cause adverse health effects.

(District 1999f). The letter explained that the homeowner had three options: (1) appeal the Department's decision, (2) hook up to the municipal water supply, or (3) drill a new well. If the latter option were chosen, the letter explained, the homeowner would be required to send the Department detailed data proving that the well would not be impacted by contaminants in the future and that drilling a new well would not significantly impact the plume's flow patterns (District 1999f). The homeowner failed to respond to this letter. Thus, the county prosecutor attorney has become involved in the case to force the homeowner to address the Department's concerns about the well (District 2000c, 2000d).

Surface Water and Sediment

Van Etten Lake

Van Etten Lake, a surface water body located to the east of WAFB, is used for recreational fishing, boating, and swimming. Diffuse impacts over large areas of the lake have resulted from surface water runoff draining from the northern portion of the base. In addition, more concentrated releases have occurred at three specific locations along the lake:

- *Areas Near Pierce's Point*. The Pierce Point Plume discharges into Van Etten Lake at Pierce's Point (see Figure 2). Several sampling efforts have been conducted to determine whether the lake has been adversely affected by these discharges. Surface water samples, collected between 1980 and 1997, have been analyzed for VOCs (AFBCA 1999h; AFCEE 1996e; M&E 1987; MDNR 1992; Radian 1985). Sediment samples, collected in 1990 and 1994, have been analyzed for VOCs, chlorinated hydrocarbons, and metals (AFCEE 1996e; MDNR 1992).
- *Areas Where the Northern Landfill Plume Discharges to Van Etten Lake*. The Northern Landfill Plume migrates under Camp Nissokone's property and discharges to Van Etten Lake (see Figures 2, 9, and 10). As shown on Figure 8, Camp Nissokone's old swim area was located on the Northern Landfill Plume's migratory path. Thus, in the past, campers who visited Camp Nissokone may have been swimming in the vicinity of the discharge area for about 2 hours a day for several weeks during the summer (ATSDR 1998a). Campers no longer swim in these areas; the camp moved its beach to a more northern section of the shore in the mid 1990s (Camp Nissokone 2000a). Other community members may still be swimming in the areas that are impacted by discharges, however. Several sampling efforts have been conducted to determine whether the lake has been adversely affected by these discharges. Surface water and sediment samples were collected from Van Etten Lake in the vicinity of the Northern Landfill Plume discharges (see Figure 9) in 1990, 1994, and 1995 (AFCEE 1996d; MDNR 1992). Additional

surface water samples were also collected in 1997 and 1998 (AFBCA 1999h, 2000c). The surface water samples have been analyzed for hydrocarbons and VOCs. Sediment samples have been analyzed for VOCs, chlorinated hydrocarbons, PCBs, and metals (AFCEE 1999d; MDNR 1992).

- *Air Force Beach.* In 1990, fuel from a ruptured dispensing line was released to the lake near Air Force Beach (see Figure 2). Ice fishermen identified the release, which occurred during the winter, and notified base representatives immediately. Corrective activities were initiated quickly. Holes were chopped into the ice and sorbent pads were used to capture the product (AFCEE 1995a). In 1995, sediment samples were collected in the vicinity of the Air Force Beach, and analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX), polynuclear aromatics (PNAs), lead, and methyl tert-butyl ether (MTBE) (AFCEE 1995a). Sampling locations were chosen after site investigators determined the location where the distribution line ruptured.

ATSDR evaluated and summarized available surface water and sediment data that were collected from these three locations (see Tables 6 and 7 and Figure 9). To determine whether exposures to either of these media could pose health hazards, ATSDR compared surface water and sediment concentrations against ATSDR's drinking water and soil CVs, respectively. Most of the contaminants were detected at or below CVs and were not evaluated further.[4] For contaminants detected above CVs, ATSDR performed a more detailed analysis to determine whether swimmers, exposed via dermal contact and incidental ingestion, could be adversely affected by these media.

As indicated in Table 6, four VOCs have been detected above drinking water CVs in the surface waters of Van Etten Lake: benzene (nondetect to 9.2 ppb), methylene chloride (nondetect to 8 ppb), TCE (nondetect to 388 ppb), and vinyl chloride (nondetect to 1.0 ppb). TCE was the only contaminant that was detected significantly higher than its drinking water CV. It should be noted that high concentrations were not detected in all areas of the lake. The highest concentrations were detected in samples that were collected near Pierce's Point, an area that has some residences located upon it. TCE concentrations in samples that were collected further north (i.e., in the area where the Northern Landfill Plume discharges) never exceeded 11 ppb. It is unlikely that swimmers would be exposed to the maximum detected TCE concentration (i.e., 388 ppb) because such high values have only been detected in samples collected during the winter months.

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[4] Drinking water and soil CVs were used to screen contaminant levels because no CVs exist for surface water or sediment. Using these CVs is a very conservative [or protective] approach because the drinking water and soil CVs assume that people will have daily exposure to these media for a lifetime. Obviously, exposures to surface water and sediments will be significantly less. It can be reasonably concluded, therefore, that surface water and sediment contaminants detected at or below the CVs do not pose health hazards.

Summertime TCE concentrations have never been recorded above 20 ppb. (TCE is a volatile chemical. During the winter, a layer of ice prevents the chemical from volatilizing from the water and dispersing in the air.) Ice fishermen are the only population expected to contact Van Etten Lake's surface waters during the winter, and their direct contact with the water is too infrequent to pose a health concern. As for summertime swimmers, the concentrations detected in surface waters are too low to pose health hazards even if a swimmer (adult or child) were exposed via incidental ingestion and dermal contact to 20 ppb of TCE, 9.2 ppb of benzene, 8 ppb of methylene chloride, and 1.0 ppb of vinyl chloride for 3 hours a day for 20 weeks a year over a period of 40 years.

As indicated in Table 7, arsenic (nondetect to 4.4 parts per million [ppm]) and iron (nondetect to 30,000 ppm) were detected in the lake's sediments at concentrations exceeding ATSDR's CVs. Given the limited contact that people are expected to have with sediment and the inability of these metals to be absorbed through the skin, ATSDR concluded that no adverse health effects are expected to result from swimming in Van Etten Lake.

Au Sable River

The Au Sable River, which is located 0.5 miles to the south of WAFB, has been impacted by the base's activities, primarily through discharges from the 3-pipes drainage ditch (see Figure 4). This ditch shuttles stormwater from WAFB's flightline area to the Au Sable River. (Much of the water passes through a retention pond, which acts as an oil/water separator, before entering the ditch.) In addition, some investigations suggest that a portion of the Mission Drive Plume discharges to the ditch. The ditch empties into the Au Sable River at a specific outfall location (See Figure 4). Between 1985 and 1993, TCE concentrations in the outfall ranged from 0.8 ppb to 77 ppb (AFCEE 1996b).

The Au Sable River is quite popular among recreational fishermen and swimmers (MDNR 1992; NCIBRD 1995). To determine whether these populations could be adversely impacted by contacting the water's surface water and sediment, ATSDR evaluated available data that have been collected from the river (AFCEE 1996b; MDNR 1992). Tables 6 and 7 separate these data into three categories, based on where the samples were collected (i.e., upstream of the 3-pipes drainage outfall, at the discharge point, or downstream of the outfall). Not surprisingly, the highest contaminant concentrations were detected at the discharge point and concentrations decreased downstream of that area. ATSDR used the same approach as described under the "Van Etten Lake" section to determine whether exposures to surface water and sediment could pose health hazards to swimmers. The analysis indicated that three contaminants have been detected in surface water samples at concentrations exceeding ATSDR's drinking water CVs: arsenic (2.0 ppb), 1,1,2,2-tetrachloroethane (nondetect to 0.6 ppb), and TCE (nondetect to 15 ppb). Additionally, one contaminant—arsenic (nondetect to 0.55 ppm)—exceeded ATSDR's soil CV in sediments. The contaminants detected in surface water were too low to pose a public health

hazard even if a person (adult or child) were exposed via incidental ingestion and dermal contact to the maximum detected concentrations for 3 hours a day for 20 weeks a year over a period of 40 years. Likewise, ATSDR concluded that the arsenic concentration in the sediment was too low to warrant concern. *ATSDR concluded that no adverse health effects are expected to result from swimming in the Au Sable River.*

Duell Lake

Duell Lake, which is located to the south of the on-base housing area, is accessed by duck hunters (see Figure 4). The lake has been impacted by the Mission Drive Plume. ATSDR evaluated available surface water and sediment data to determine whether exposure to these media could pose health hazards via dermal contact or incidental ingestion, to the hunters that use this area. As indicated in Tables 6 and 7, no contaminants were detected above ATSDR's drinking water or soil CVs (AFCEE 1996b, 1996c). *Therefore, ATSDR concluded that no adverse health effects are expected to result from hunting in the vicinity of Duell Lake.*

Wetland Area South of Site LF-27

As indicated in Figure 4, a wetland area is located to the south of Site LF-27. As described in Appendix A, this wetland may have been impacted by contaminants migrating from three IRP sites (i.e., FT-02, OT-16, and LF-27). The wetland is accessed on occasion by people who hunt for deer and turkey. ATSDR evaluated available surface water and sediment data to determine whether exposure to these media could pose health hazards, via dermal contact or incidental ingestion, to the hunters that use this area. As indicated in Tables 6 and 7, contaminants were detected in surface water and sediment samples above ATSDR's drinking water and soil CVs, respectively (AFCEE 1997b). *Given that visits to this area are sporadic and of short duration and that hunters wear clothing that prevents exposures, ATSDR concluded that the contaminant concentrations in the wetland area do not pose health hazards.*

COMMUNITY HEALTH CONCERNS

The community surrounding WAFB has expressed several health concerns. Some of these have already been discussed in the preceding section of this PHA. Other health concerns expressed by the community include:

Concern: Could Volatile Groundwater Contaminants Migrate into Subsurface Structures?

The water table at and around WAFB is relatively shallow (approximately 20 feet below ground surface). Some community members have expressed concern about the potential for certain contaminants to volatilize through the soil and into subsurface structures (e.g., basements) (NCIBRD 1995). *In the absence of actual indoor air measurements, indoor air levels were estimated using conservative mathematical models. The results suggested that indoor air levels were too low to be of health concern.*

Three plumes are currently located under structures (some with basements some without): (1) the Mission Drive Plume, (2) the Pierce's Point Plume, and (3) the Northern Landfill Plume. While no indoor air samples have been collected from the buildings that overlie these plumes, ATSDR looked at the likelihood of significant amounts of vapors migrating to indoor air. Several factors come into play when evaluating this possibility: the distance between the groundwater and the structure floor, the concentration and volatility of the groundwater contaminants, the condition of a structure's foundation, the infiltration rate, and the air exchange rate of the building, among others. Using site-specific information and making certain assumptions, it is possible to roughly predict indoor air concentrations.

In the mid 1990s, a remedial investigation was performed on the Mission Drive Plume. As part of this effort, investigators used a conservative model to predict indoor air concentrations that could result from TCE volatilizing from the Mission Drive Plume into on-base housing units (those with basements and those built on slabs) (AFCEE 1996c). The model used was conservative. That is, it assumed no degradation of the chemicals over time and assumed a relatively large flow of contaminants through building structures. Only TCE was evaluated because it was the most volatile chemical detected at the highest concentrations in shallow groundwater (110 ppb) and among the more toxic. Although ATSDR prefers actual data to modeled data when evaluating health concerns, we concur that the approach used in the modeling exercise was conservative and probably overpredicted indoor air concentrations. Even though the modeled concentrations were inflated, the predicted air concentrations of TCE were lower than those thought to result in any adverse health effects. Furthermore, many of the basements are crawl-spaces or are not areas in which people spend extended time (AFCEE, 1996c).

Similar modeling was not performed as part of the remedial investigations that were performed for the Pierce's Point Plume and the Northern Landfill Plume. ATSDR reviewed the contaminant

levels of the most shallow groundwater in the off-base areas (i.e., areas with residences and campgrounds) that overlie these two plumes. TCE, benzene, vinyl chloride, and a few other volatile organic contaminants have been detected at varying concentrations. Using the same conservative model described above for the Mission Drive Plume, ATSDR estimated indoor air concentrations. Even assuming exposure to maximum detected concentrations, ATSDR found that predicted indoor air levels were too low to be of health concern.

Concern: Is There an Increased Incidence of Cancer in the Community?

During ATSDR's site visit, several community members expressed their belief that cancer rates are high in the area surrounding WAFB. According to base representatives and county and state health officials, no health outcome studies are available to refute or validate this claim (AFBCA 1999c; District 1999a; MCDH 1999). Based on ATSDR's analysis of exposure pathways, the only people who might be at an increased risk of developing cancer are those who were exposed to USAF's main water supply wells or the well at 6504 West Shore Drive prior to 1980. As discussed in detail in the "Evaluation of Environmental Contamination and Potential Exposure Pathways" section and in Appendix D, however, there are many uncertainties about whether TCE was present in wells for long enough to pose health hazards and whether the chemical actually causes cancer in human populations. (As noted previously, EPA is currently reviewing scientific literature to determine TCE's cancer classification.)

Concern: Could Exposures to Vinyl Chloride Cause Cancer?

A community member asked ATSDR whether vinyl chloride causes cancer, and whether this chemical was found at concentrations that would have posed health hazards to individuals drinking from on-base water supply wells or swimming in Van Etten Lake (ATSDR 1997b).

It is true that at least some studies have shown that occupational exposures to vinyl chloride are associated with an increased risk of developing cancer of the brain and central nervous system, the lung and respiratory tract, and the lymphatic/hematopoietic system (ATSDR 1997c). Based on data collected from WAFB, no evidence indicates that vinyl chloride was present at concentrations high enough to cause health hazards.

ATSDR evaluated available data to determine whether vinyl chloride was present in WAFB's on-base water supply wells. Investigators started analyzing water samples for this contaminant starting in 1983, and continued to do so on a sporadic basis through 1997 (AFBCA 1993; Air Force 1990; MDEQ 1999). These data indicate that vinyl chloride was not present in the on-base drinking water wells at concentrations that would have been expected to pose health hazards. *Thus, people exposed to on-base water supplies during or after 1983 are not expected to be at an increased risk of developing adverse health effects due to vinyl chloride exposures.* ATSDR cannot determine whether people who were drinking the water prior to 1983 would have been

exposed to vinyl chloride at higher concentrations. By the time the contaminant was being evaluated, groundwater treatment efforts had already been initiated and contaminated wells had been taken offline. Thus, it is possible that groups who were exposed before these initiatives were undertaken drank water more contaminated than the 1983–1997 data would reflect.

ATSDR also evaluated available databases to determine whether vinyl chloride was present in samples that were collected from Van Etten Lake. Starting in the 1990s, water samples collected from the lake have been analyzed for vinyl chloride. With rare exception, results indicate that the chemical was not present above laboratory detection limits. When the chemical was detected in surface water samples, it was only present at concentrations of 1.0 ppb (AFCEE 1996d). Such low levels are not expected to cause harm to swimmers who use the lake during the summer or to ice fishers who use it during the winter.

Concern: Did On-base Residents Have an Increased Miscarriage Rate?

During ATSDR's site visit, one community member expressed concern that many on-base residents experienced miscarriages during the time when on-base drinking water supply wells were contaminated. As indicated in the "Evaluation of Environmental Contamination and Potential Exposures Pathways" section and Appendix D, several organic compounds (e.g., benzene, 1,2-dichloroethene, chloroform, chlorodibromomethane, dichlorobromomethane, and TCE) were detected in on-base water supplies. As discussed previously, TCE was the only contaminant detected at levels of potential health concern.

In light of the community concern regarding past miscarriages, ATSDR performed a literature search to specifically evaluate whether a link could be established between the reported miscarriages and the detected levels of TCE as well as the other contaminants reported in on-base water supplies. No definitive conclusions can be drawn because few studies are available that study pregnancy outcomes and quantify exposures to people drinking water containing these contaminants.

ATSDR did identify some studies that showed possible links between occupational exposure to certain solvents (e.g., TCE, PCE, paint thinners) and miscarriages, primarily associated with inhalation exposures (Windham et al. 1991; McMartin et al. 1998; Doyle et al. 1997; Schenker et al. 1995; Khattak et al. 1999). ATSDR also identified some studies that looked at exposures to contaminated drinking water and miscarriages. For example, an increased rate of spontaneous abortions were observed in residents drinking from wells contaminated with solvents (Deane et al. 1992; Wrensch et al 1992; Swan et al. 1998). Another study suggests increased miscarriage rates among women drinking water containing trihalomethanes (e.g., chloroform, chlorodibromomethane, dichlorobromomethane) (Swan et al. 1998; Waller et al. 1998). These findings, however, were not conclusive. The greatest limitation in all of the available studies is the lack of meaningful exposure data. That is, even in cases where elevated miscarriage rates

were reported, it is not clear what exposure levels or doses were associated with the adverse outcomes. This makes it impossible to draw comparisons to the exposure levels estimated for past on-base water supply consumption. All that these studies tell us is that a plausible link exists between solvent exposures and miscarriages, but it is not clear at what levels of exposure.

ATSDR also examined laboratory animal studies (e.g., rats/mice) to gain some perspective on dose levels that might be associated with adverse pregnancy outcomes for the chemicals that were detected in the on-base water supplies. Available studies indicated that adverse reproductive or developmental effects (including measured effects such as histological changes, decreased survival, "resorptions," and/or malformations) occurred only at doses that were about 200 to 50,000 times greater than the doses estimated for past drinking water exposures at WAFB.

Concern: Could Community Members Be Eating Contaminated Fish?

Community members use Van Etten Lake and the Au Sable River for recreational fishing. ATSDR evaluated available data to determine whether fish that live in these water bodies could be contaminated.

Van Etten Lake

Recreational fishermen use Van Etten Lake year-round to fish for rainbow trout, brown trout, walleye, crappie, bluegill, freshwater drum, large-mouthed bass, small-mouthed bass, northern pike, muskellunge, yellow perch, white bass, red-horse sucker, white sucker, channel catfish, and American eel. Community members have expressed concern regarding the safety of eating these fish. In particular, community members have expressed concern about the possibility of TCE bioaccumulating in fish (NCIBRD 1995). Although no fish tissue have been analyzed for TCE, ATSDR does not consider this chemical to pose potential health hazards because its tendency for bioaccumulating is low (ATSDR 1997a). In June 1990, MDNR sampled fish from Van Etten Lake. Polychlorinated biphenyls were detected in several fish, at concentrations averaging 0.65 ppm. Because this average did not exceed the Michigan Department of Public Health's fish consumption advisory for this contaminant, no advisory was issued against fishing in the lake (MDNR 1992). Although available data indicate that consuming fish is not expected to pose health hazards, ATSDR recommends that additional fish sampling be conducted at Van Etten Lake because samples have not been collected in several years and only a few chemical constituents were analyzed for during the 1990 sampling event.

Au Sable River

The Au Sable River is designated as a coldwater trout stream (MDNR 1992). Based on the types of contaminants that are present in the river's surface water and sediment (see Tables 6 and 7), ATSDR concluded that adverse health effects are not expected to result from eating the river's

fish. (TCE, 1,1,2,2-tetrachloroethane, and arsenic were detected in surface water above ATSDR's drinking water CVs. Arsenic was also detected in sediment samples at concentrations that exceeded ATSDR's soil CVs. TCE and 1,1,2,2-tetrachloroethane are not thought to have a high tendency for bioaccumulating in fish [ATSDR 1996b, 1997a]. Arsenic can be absorbed by fish and accumulate in their tissues, but the concentrations detected in surface water and sediment appear to be too low to pose health hazards.) No fish tissue sampling data are available, however, to confirm ATSDR's conclusion. Therefore, ATSDR recommends that fish tissue samples be analyzed for arsenic.

Concern: Could Community Members Be Eating Contaminated Deer and Turkey?

Some concern has been expressed about consuming deer and turkey that live near or in the wetland that is located south of LF-27. ATSDR acknowledges that deer and turkey may be exposed to the wetland area south of LF-27. In fact, deer may use some of the plants (e.g., white cedar, silver maple, willows, and swamp dewberry) that are located in the wetland as food sources. No samples have been collected from the game animals to determine whether the wetland's contaminants have accumulated within their tissues. Thus, ATSDR cannot make any definitive conclusions about whether people could be eating contaminated game animals. To put the issue in perspective, however, ATSDR thinks it is important to note that it is unlikely that deer and turkey would be continuously exposed to the wetland's contaminants. While some of the animals might make the wetland their home, they would probably not spend all of their time in this small area. It is also unclear whether the animal's food sources (i.e., plants) would be impacted by the wetland's contaminants. (In general, research shows little evidence of organic compounds, such as VOCs and pesticides, accumulating within plant tissues. Evidence does suggest, however, that some metals do accumulate in plants.) Because no plant tissue samples have been analyzed, ATSDR cannot determine whether the game animals are eating contaminated food. Also, hunting is considered a recreational sport and community members do not rely on game animals for subsistence. Assuming that hunters probably only kill and eat a limited number of animals a year, they would not be expected to eat large quantities of meat that came from animals exposed to the wetland area.

Concern: Will the Remediation Plan for the Northern Landfill Plume Be Protective of Public Health?

In 1998, community members informed ATSDR that USAF was planning to use enhanced bioremediation to clean the Northern Landfill Plume. Community members expressed displeasure for this remedial approach, noting that a consultant informed them that the efficacy of the technology has not been well proven (ATSDR 1998a). ATSDR contacted base representatives to learn more about the technology. Base representatives said that enhanced bioremediation is no longer being considered as a remedial option. This remedial approach was abandoned after a treatability study indicated that subsurface conditions were too anoxic (void of oxygen) to support aggressive microbial degradation (AFBCA 1999c). After re-examining remedial options and performing a Feasibility Study, base representatives decided to use a dual system, consisting of pump-and-treat and air sparging, to remediate the plume (AFBCA 2000a). (The public was invited to comment on this selected alternative.) Installation activities were initiated in August 2000 and will be completed by June 1, 2001 (AFBCA 2000b; USAF 2001).

Concern: Could Seeps Cause Public Health Hazards and Aesthetic Problems?

As noted previously, the Northern Landfill Plume discharges into Van Etten Lake. In recent years, community members identified two distinct discharge points along the lake's shores. These points, referred to as Seep #1 and Seep #2 (see Figure 8), have raised concern about:

- *Potential exposures*. The seeps represent the interface between groundwater and surface water. Thus, water samples that have been collected from Seeps #1 and #2 represent water that has not yet mixed with Van Etten Lake (AFBCA 2000b). This means that contaminant concentrations that are detected in seep samples are higher than what swimmers would be exposed to. ATSDR determined that no one would have direct contact with the seeps during the summer because groundwater from the Northern Landfill Plume discharges directly to the lake during this season, without "daylighting" upon the lake's shores first (AFBCA 2000a). In the winter, however, when the lake's water levels are lower, groundwater discharges to Van Etten Lake's shores before trickling into the lake (AFBCA 2000a). As a result, people could have direct contact with the seeps in the winter. ATSDR evaluated data, collected from the seeps between 1997 and 1999, to determine whether such contact could result in adverse health effects. The results, which are summarized in Table 8, indicate that three contaminants have been detected above ATSDR's drinking water CVs: 1,1-dichloroethene (nondetect to 2.0 ppb), vinyl chloride (nondetect to 2.0 ppb), and TCE (nondetect to 1,000 ppb) (AFBCA 2000c). *Even though contaminants are detected at elevated levels, ATSDR does not believe exposures to the seeps will result in public health hazards.* As noted above, the seeps are only exposed during the winter months, a time when Van Etten Lake's shores are not heavily used. Ice fishermen are the only people who frequent this area with any regularity

during this time of the year. This population, which wears heavy clothing and thick boots, is not expected to have extensive direct contact with the seeps (AFBCA 2000a). Furthermore, the contaminants that have been detected in the seeps have not been shown to persist at high concentrations for extended periods of time. For example, while TCE was detected at 1,000 ppb in Seep #1 in February 1997, it dropped to 6 ppb in July 1997, was not detected at all in October 1997, registered at 131 ppb in September 1998, and was recorded as 76.1 ppb in December 1999 (AFBCA 2000c).

- *Aesthetic problems.* An orange precipitate has formed in the vicinity of the seeps and has stained the lake's shores. Representatives from Camp Nissokone have expressed concern over this aesthetic problem (MDEQ 2000a). In Michigan, aesthetic problems must be eliminated if they interfere with a waterbody's usage. Because Van Etten Lake is considered a recreational water body, the staining is considered a significant problem since it makes people unwilling to use the lake (MDEQ 2000b). Thus, USAF has agreed to address the problem. According to a base representative, the staining represents iron that has precipitated out of solution (AFBCA 2000a). Precipitation rates are high in the seep areas because the groundwater that is released at these locations is anoxic. When the anoxic groundwater encounters atmospheric oxygen or dissolved oxygen, iron precipitates out rapidly. Base representatives believe that this dramatic reaction will cease once the remedial system is installed to address the Northern Landfill Plume (AFBCA 2000a). (As noted above, this system will be installed by June 2001.) The remedial system should fix the discoloration problem by:

  — *Oxygenating groundwater*. A pump-and-treat and an air sparging system will be installed in an effort to remediate the Northern Landfill Plume. The latter will oxygenate the groundwater. Thus, the water released to Van Etten Lake will not be as anoxic, and this should eliminate staining problems (AFBCA 2000a).

  — *Depressing groundwater levels*. Groundwater levels in the vicinity of the seep areas are expected to drop once the pump-and-treat system is installed. As a result, groundwater will discharge further out into the lake rather than directly at its shores. This should eliminate staining problems (AFBCA 2000a).

Concern: Could the Public Have Been Exposed To Radioactive Materials?

Community members said that they have heard rumors that radioactive materials were stored on base during some point of WAFB's history (ATSDR 1998a). ATSDR contacted base representatives to determine whether this was true. Base representatives said that these materials are not currently located at the base, but that they might have been in the past (AFBCA 1999c). Because the military must keep the location of their radioactive weapons a secret, site documents do not state whether radioactive materials were located at the base. If they were located on site,

these materials would have been stored in secure igloos in the Weapons Storage Area. A radiologic survey was conducted in this area after the base closed; no radioactive contamination was detected (AFBCA 1999c).

ATSDR'S CHILD HEALTH INITIATIVE

ATSDR recognizes that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability results from the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas. For example, children may contact and ingest soil particles at higher rates than adults.
- Children are shorter, which makes them more likely to breathe dust, soil, and heavy vapors that are close to the ground.
- Children are smaller, which can result in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

Because children depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at WAFB as part of the ATSDR Child Health Initiative.

Children were unlikely to have contacted the majority of WAFB's IRP sites while the base was operational because security measures were tight. However, children may have been exposed to:

- *Groundwater*. In the past, children were exposed to water that was supplied by:
  - — *USAF's main water supply wells*. Children who lived in on-base residential housing and visited the base's Child Care Center were exposed to water that was supplied by USAF's main water supply wells.

— *Off-base wells*. Children who may have been exposed to water that was provided by off-base wells include those who lived in nearby residential areas, and those who visited Van Etten State Park or Camp Nissokone.

Based on available sampling data, groundwater wells at Camp Nissokone were not impacted by WAFB's contaminants and the wells at Van Etten State Park did not contain TCE at high enough concentrations to pose health hazards (See Table 5). Children exposed to USAF's main water supply wells or the well at 6504 West Shore Drive prior to 1980, however, might have been exposed to high concentrations of TCE and been at an increased risk of developing adverse health effects (see the "Evaluation of Environmental Contamination and Potential Exposure Pathways" section of this PHA and Appendix D). Whether adverse health effects occurred from past exposures is unknown because it is unclear how long exposures occurred and there is much controversy in the scientific community regarding TCE's ability to cause adverse health effects in humans. Current and future potential exposures to area groundwater are not expected to pose a public health hazard.

- *Surface Water*. Children have been swimming in Van Etten Lake and the Au Sable River for many years. In fact, Camp Nissokone's old swimming area used to be located in the area where the Northern landfill Plume enters Van Etten Lake. As indicated in the "Evaluation of Environmental Contamination and Potential Exposure Pathways" section of this PHA, contaminant concentrations detected in Van Etten Lake and the Au Sable River are too low to pose a public health hazard.

CONCLUSIONS

Based on an evaluation of environmental information, ATSDR has reached the following conclusions:

1. Past exposures to TCE in on-base and off-base water supplies could have posed a public health hazard to people who were exposed to the following water supplies before 1980: (1) USAF's main water supply wells and (2) the well located at 6504 West Shore Drive. Whether actual adverse health effects occurred, however, is unknown because there are many uncertainties about whether TCE was present for long enough durations to pose health hazards. Also, there is much controversy in the scientific community regarding TCE's ability to pose adverse health effects in humans. (TCE has been shown to cause cancer in laboratory animals who receive large doses, but EPA is currently reviewing the scientific literature to determine TCE's potential to cause cancer in humans.)

2. Contaminated groundwater plumes that originated at WAFB are not expected to pose a current or future public health hazard. Today, the vast majority of on-base and off-base facilities, residences, and camps receive their drinking water from the Huron Shores Regional Utility Authority, a source that is not located near WAFB and which meets all federal and state drinking water quality standards. A few wells are still in service, but exposure to this water is not expected to pose current or future health hazards because the wells do not contain high contaminant concentrations, they are only rarely used, and/or exposure durations are expected to be short. Institutional controls are in place to ensure that new wells are not drilled in contaminated areas in the future.

3. Exposures to surface water and sediment in Van Etten Lake, the Au Sable River, Duell Lake, and a wetland area located in the southern portion of the base are not expected to pose health hazards to the populations that use these water bodies for recreational purposes because contaminant concentrations are too low and/or exposures are too infrequent.

4. Some community members expressed concern about the possibility of groundwater contaminants volatilizing and migrating into subsurface housing structures (e.g., basements). ATSDR concluded that exposures to volatilizing materials are not expected to pose public health hazards. In the absence of actual indoor air measurements, indoor air contaminant levels were estimated using conservative mathematical models. The results suggested that indoor air levels were too low to be of health concern.

5. A community member asked ATSDR whether vinyl chloride causes cancer, and whether this chemical was identified as a contaminant of concern in on-base water supply wells or Van Etten Lake. ATSDR concluded that it is true that some health studies suggest a link between occupational exposures to vinyl chloride and brain cancer. Data on vinyl chloride were collected from on-base drinking water wells and Van Etten Lake starting in 1983 and 1990, respectively. Based on these data, ATSDR concluded that vinyl chloride concentrations have not been high enough to pose health hazards to people exposed to on-base drinking water wells during or after 1983 or to Lake Van Etten during or after 1990.

6. Community members asked ATSDR whether past exposures to the on-base water supply could have caused increased rates of miscarriage. Few studies have been conducted in humans to determine whether exposures to chlorinated solvents in groundwater pose an increased risk of miscarriage. Thus, no definitive conclusions could be made about the community's concern. It should be noted, however, that studies in laboratory animals show some adverse reproductive outcomes (e.g., decreased survival rates), but at doses that are significantly higher than those which would have been present at WAFB.

7. Community members use Van Etten Lake and the Au Sable River for recreational fishing. Based on limited data, ATSDR does not believe that consuming fish from these water bodies will pose health hazards.

8. Community members hunt and eat game animals that live in or near a wetland that has been impacted by the base's contaminants. No samples have been collected from the animals to determine whether contaminants have accumulated within their tissues. Thus, ATSDR cannot make any definitive conclusions about whether people could be eating contaminated game animals. It should be noted, however, that game animals are not expected to spend all of their time in the wetland. In addition, hunters probably do not eat large quantities of meat from animals exposed to the wetland area.

9. The Northern Landfill plume discharges into Van Etten lake at Seep #1 and Seep #2. Because exposures to the seeps are extremely limited, ATSDR does not believe that these seeps pose a health hazard. The seeps have caused an aesthetic problem, but USAF plans to fix this in the near future.

10. Base representatives did not know if radioactive materials had been stored at WAFB. If they were, these materials would have been stored in secure igloos in the Weapons Storage Area. A radiologic survey was conducted in this area after the base closed; no radioactive contamination was detected.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for WAFB contains a description of actions taken and those planned by ATSDR, the USAF, and government agencies at and in the vicinity of the site subsequent to the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse health effects resulting from exposure to hazardous substances in the environment. The public health actions that have been implemented, are being implemented, are planned, or are recommended by ATSDR are as follows:

Completed Actions

1. Several of USAF's main water supply wells were taken off line when contaminants were detected in the tap water of on-base housing areas in 1977.

2. Bottled water was provided to off-base residents when contaminants were detected in off-base wells.

3. Municipal hookups have been established at WAFB and at most of the off-base properties located between WAFB and Van Etten Lake.

4. Cleanup activities have been completed at several IRP sites. For example, USTs, aboveground storage tanks, drywells, refueling systems, and contaminated soils have been removed. In addition, a landfill cap has been installed over a portion of the Northern Landfills.

Ongoing and Planned Actions

1. The District Health Department has asked a resident who lives on Pierce's Point to remove his well from service. The resident has not responded to these requests. Thus, the county prosecutor attorney has become involved.

2. Groundwater samples will be collected from Van Etten State Park's well CG#1 on a regular basis. If well CG#2 is brought back into service, MDNR will be required to sample the well monthly to make sure that TCE concentrations remain below Michigan's safe drinking water standards (i.e., 5 ppb).

3. Groundwater samples will be collected from well AF25 in spring 2001.

4. Environmental investigations are still ongoing at some IRP sites (e.g., Site SS-55).

5. Remediation activities are ongoing at several IRP sites. For example, three pump-and-treat systems (i.e., ASPTS, BPPTS, and MDPTS) are currently operational, soil vapor extraction and air sparging systems are operating at some of WAFB's sites, and natural attenuation is ongoing at several locations. Additional remedial activities will be initiated in the near future. For example, WAFB plans to install additional purge wells at OT-24 and to optimize the efficacy of some of the base's pump-and-treat systems. Additionally, a groundwater remedial system, consisting of pump-and-treat and air sparging, will be installed at the Northern Landfill Plumes (Sites LF30/LF31) by June 2001.

6. Groundwater monitoring is ongoing at several IRP sites. In addition, surface water monitoring activities are still being conducted at Van Etten Lake. Also, seeps that discharge to the wetland area south of LF-27 are being monitored.

Recommendations

1. ATSDR recommends that WAFB and MDNR coordinate in determining the most effective means of collecting and analyzing fish tissue samples from Van Etten Lake and the Au Sable River to address the community's concern about fish contamination.

PREPARERS OF THE REPORT

Jeff Kellam, Ph.D.
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

Gary Campbell, Ph.D.
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

Emilio Gonzalez
Environmental Engineer
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

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Table 1
Potential Exposure Pathways
Wurtsmith Air Force Base, Oscoda, Michigan

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
On-base drinking water supplied by USAF's main water supply wells and USAF's area-specific wells	• Arrow Street Plume • Mission Drive Plume • Other sources	Groundwater	On-base housing areas and several USAF facility buildings	Ingestion, dermal contact, and inhalation	On-base residents and employees	**Past:** TCE concentrations may have been high enough to pose health hazards to people who were exposed to water provided by USAF's main water supply wells prior to 1980. Contaminants detected in USAF's area-specific wells, however, were too low to pose health hazards. **Current and Future:** The base was connected to municipal supply in 1997. In 1998, all of the USAF water supply wells were officially abandoned except for the area-specific well AF25. Exposures to water from AF25 are not expected to pose health hazards. New wells are not expected to be installed on base. If they are, groundwater treatment systems and groundwater-use restrictions should prevent future health hazards from resulting.
Off-base drinking water supplied by off-base wells	• Arrow Street Plume • Pierce Point Plume • Northern Landfill Plume	Groundwater	Off-base residential and recreational areas	Ingestion, dermal contact, and inhalation	Off-base residents and recreational users	**Past:** TCE concentrations may have been high enough to pose health hazards to residents at 6504 West Shore Drive. **Current and Future:** The vast majority of off-base properties receive their water supplies from municipal sources. The few wells that are still used for potable purposes are not expected to pose health hazards because concentrations detected in them are too low and/or exposure durations are expected to be short. The District Health Department will advise against installing new wells in contaminated areas.

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
Au Sable River	• 3-pipes drainage ditch • Runoff	Surface Water/ Sediment	Locations along the Au Sable River	Dermal contact and incidental ingestion while swimming, wading, boating, or fishing	Recreational users	**Past, Current, Future:** Based on available data, contaminant concentrations are too low to pose health hazards to people who swim, boat, or eat fish from the Au Sable River.
Duell Lake	Mission Drive Plume	Surface Water/ Sediment	Duell Lake	Dermal contact and incidental ingestion while hunting	Hunters	**Past, Current, Future:** Based on available data, contaminant concentrations are too low to pose health hazards to hunters who visit Duell Lake.
Wetland area south of LF-27	• FT-02 • OT-16 • LF-27	Surface Water/ Sediment	Wetland Area	Dermal contact and incidental ingestion while hunting	Hunters	**Past, Current, Future:** Based on available data, contaminant concentrations are too low to pose health hazards to hunters who visit the wetland area.

Table 2
USAF's Main Water Supply Wells
Well Usage Information and Sampling Data
Wurtsmith Air Force Base, Oscoda, Michigan

Well Identification and Well Usage History	Contamination History
AF1: Site representatives estimate that AF1 was constructed in the late 1950s (AFBCA 1999b). It served as one of USAF's main water supply wells, providing potable water to on-base residents and employees, until it was removed from service in November 1977 (USGS 1983). The well never returned to service as a potable water source (AFBCA 1999b).	ATSDR searched site files to obtain data that was collected while AF1 was being used as a potable source. Site documents only listed one sampling event prior to the well's removal from service. During this event, which took place in November 1977, TCE was detected at 895 ppb (AFBCA 1993).
AF2: AF2 was constructed in 1959 and served as one of USAF's main water supply wells for many years, providing potable water to on-base residents and employees (Ayres 1990). The well operated in this capacity until 1984 when wells 30, 31, and 32 were brought on line (USGS 1983). (There was a brief period when the well was removed from service, starting in 1977 and ending some time before 1983. Site representatives could not provide an exact date for AF2's return to service, so ATSDR assumed that it came back on line around January 1978. Between 1984 and June 1993, the well was still used, but only on a supplemental basis when the supply from other wells could not meet base demands (Ayres 1990). After the base closed in June 1993, demand was not high enough to require the use of AF2 (AFBCA 1999b).	ATSDR searched site files to obtain data that was collected while AF2 was being used as a potable water source (AFBCA 1993; Air Force 1990; MDEQ 1999b). Four contaminants were detected above ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 37 ppb. (About 45 samples were analyzed for benzene between December 1979 and March 1993. The contaminant was detected nine times; seven of the detections, all of which were recorded in 1982 and 1983, exceeded ATSDR's CVs.) • *Chloroform*. Detections ranged from nondetect to 6.7 ppb. (About 14 samples were analyzed for chloroform between March 1982 and March 1993. The contaminant was detected in more than half of the samples, but it only exceeded ATSDR's CV once, during a June 1986 sampling event.) • *Dichlorobromomethane.* Concentrations ranged from nondetect to 2.3 ppb. (About 13 samples were analyzed for this contaminant between March 1982 and March 1993. The contaminant was only detected above trace levels three times; two of the detections, recorded in May 1983 and June 1986, exceeded ATSDR's CVs.) • *TCE*. Concentrations ranged from nondetect to 1,739 ppb. (More than 175 samples were analyzed for TCE between November 1977 and March 1993. The contaminant was detected in the majority of samples, but only exceeded ATSDR's CVs 18 times. Only four of the samples contained TCE at concentrations greater than 20 ppb. These were detected in late 1977 [concentrations of about 130 ppb were detected] and February 1979 [concentrations of 1,666 and 1,739 were detected].)
AF3: Site representatives estimate that AF3 was constructed in the late 1950s (AFBCA 1999b). It served as one of USAF's main water supply wells, providing potable water to on-base residents and employees, until it was removed from service in November 1977 (USGS 1983). The well never returned to service as a potable water source (AFBCA 1999b).	ATSDR searched site files to obtain data that were collected while AF3 was being used as a potable water source. Site documents only listed one sampling event prior to the well's removal from service. During this event, which took place in November 1977, TCE was detected at 5,173 ppb (AFBCA 1993).

Well Identification and Well Usage History	Contamination History
AF4: AF4 was constructed in 1942 and served as one of USAF's main water supply wells for many years, providing potable water to on-base residents and employees (AFCEE 1996a). The well operated in this capacity until 1984 when wells 30, 31, and 32 were brought on line (USGS 1983). (There was a brief period when the well was removed from service, but this only lasted for 2 months [i.e., November 1977 to January 1978] [USGS 1983]) Between 1984 and June 1993, the well was still used, but only on a supplemental basis when the supply from other wells could not meet base demands (Ayres 1990). After the base closed in June 1993, demand was not high enough to require the use of AF4 (AFBCA 1999b).	ATSDR searched site files to obtain data that was collected while AF4 was being used as a potable water source (AFBCA 1993; Air Force 1990; MDEQ 1999b). Five contaminants were detected above ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 4.1 ppb. (More than 170 samples were analyzed for benzene between December 1979 and June 1993. Benzene was only detected above trace levels once, during an April 1982 sampling event.) • *Chlorodibromomethane*. Concentrations ranged from nondetect to 0.8 ppb. (About ten samples were analyzed for this contaminant between May 1983 and June 1993. The contaminant was only detected once, during a February 1993 sampling event. • *Chloroform*. Detections ranged from nondetect to 6.8 ppb. (About ten samples were analyzed for this contaminant between May 1983 and June 1993. The contaminant was detected four times, but it only exceeded ATSDR's drinking water CVs once, during a February 1993 sampling event.) • *Dichlorobromomethane*. Concentrations ranged from nondetect to 2.7 ppb. (About ten samples were analyzed for this contaminant between May 1983 and June 1993. The contaminant was detected twice, but it only exceeded ATSDR's CVs once, during a February 1993 sampling event.) • *TCE*. Concentrations ranged from nondetect to 14 ppb. (About 300 samples were analyzed for TCE between November 1977 and June 1993. The contaminant was only detected above trace levels in 31 samples, and it only exceeded ATSDR's CVs on three occasions (i.e., during sampling events in December 1978, December 1979, and August 1980).

Well Identification and Well Usage History	Contamination History
AF5: AF5 was constructed in 1942 and served as one USAF's main water supply wells for many years, providing water to on-base employees and residents (AFCEE 1996a). The well operated in this capacity until 1984 when wells 30, 31, and 32 were brought on line (USGS 1983). (There was a brief period when the well was removed from service, but this only lasted for 2 months [i.e., November 1977 to January 1978] [USGS 1983]). Between 1984 and June 1993, the well was still used but only on a supplemental basis when the supply from other wells could not meet base demands (Ayres 1990). After the base closed in June 1993, demand was not high enough to require the use of AF5 (AFBCA 1999b).	ATSDR searched site files to obtain data that was collected while AF5 was being used as a potable water source (AFBCA 1993; Air Force 1990; MDEQ 1999b). Seven contaminants were detected above ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 7.8 ppb. (About 160 samples were analyzed for benzene between December 1979 and June 1993. Benzene was only detected above trace levels on two occasions; it only exceeded ATSDR's CVs once, during a June 1982 sampling event.) • *Chlorodibromomethane.* Concentrations ranged from nondetect to 0.7 ppb. (About 10 samples were analyzed for this contaminant between May 1983 and June 1993. It was detected above ATSDR's CVs four times in 1993.) • *Chloroform*. Detections ranged from nondetect to 9.3 ppb. (About 10 samples were analyzed for this contaminant between May 1983 and June 1993. It was detected above ATSDR's CVs four times in 1993.) • *Dichlorobromomethane*. Concentrations ranged from nondetect to 3.0 ppb. (About 10 samples were analyzed for this contaminant between May 1983 and June 1993. It was detected above ATSDR's CVs four times in 1993.) • *1-2-Dichloroethene* . Detections ranged from nondetect to 207 ppb. (About 165 samples were analyzed for this contaminant between December 1979 and June 1993. The contaminant was detected about 20 times, but it only exceeded ATSDR's CVs once, during a December 1985 sampling event.) • *1,1,2,2-Tetrachloroethane* . Concentrations ranged from nondetect to 4.3 ppb. (About 12 samples were analyzed for this contaminant between March 1982 and June 1993. The contaminant was detected four times. All of the detections, which were recorded in 1982 and 1983, exceeded ATSDR's CVs.) • *TCE*. Concentrations ranged from nondetect to 1,174 ppb. (More than 250 samples were analyzed for TCE between November 1977 and June 1993. The contaminant was detected many times, but only exceeded ATSDR's drinking water CVs on four occasions. (The contaminant exceeded CVs three times in December 1979 [concentrations registered at 6.0 ppb on December 3, 1979; at 6.2 ppb on December 17, 1979; and at 1,174 ppb on December 31, 1979] and once in February 1981 [concentration registered at 6.0 ppb].)
AF18: AF18 served as one of USAF's main water supply wells until March 1978 when it was removed from service. The well was never brought back on line (AFBCA 1999b, 1999c; USGS 1983).	ATSDR searched site files to obtain data that was collected through March 1978. TCE was the only contaminant analyzed during that time. It was sampled 13 times between November 1977 and March 1978. It was detected above ATSDR's drinking water CVs in all of the sampling events; concentrations ranged from 48.2 ppb to 91.5 ppb (AFBCA 1993).

Well Identification and Well Usage History	Contamination History
AF19: AF19 was constructed in 1965 and served as one of USAF's main water supply wells for many years, providing potable water to on-base residents and employees (Ayres 1990). AF19 operated in this capacity until August 1978, when it was temporarily removed from service (AFBCA 1999c; USGS 1983). In later years, the well was brought back on line to provide water on a supplemental basis when the supply from other wells could not meet base demands (Ayres 1990). (Site documents do not indicate exactly when AF19 was brought back on line. ATSDR assumed that it was only off line for a couple of months and started being used again in January 1979.) After the base closed in June 1993, demand was not high enough to require the use of AF19 (AFBCA 1999b).	ATSDR searched site files to obtain data that was collected while AF19 was being used as a potable water source (AFBCA 1993; Air Force 1990; MDEQ 1999b). Four contaminants were detected above ATSDR's drinking water CVs: • *Chlorodibromomethane*. Concentrations ranged from nondetect to 1.0 ppb. (About seven samples were analyzed for this contaminant between June 1983 and March 1993. The contaminant was only detected once, during a September 1989 sampling event.) • *Chloroform*. Concentrations ranged from nondetect to 6.7 ppb. (About seven samples were analyzed for this contaminant between June 1983 and March 1993. The contaminant was detected four times, but it only exceeded ATSDR's CV once, during a September 1989 sampling event.) • *Dichlorobromomethane*. Concentrations ranged from nondetect to 2.7 ppb. (About seven samples were analyzed for this contaminant between June 1983 and March 1993. The contaminant was only detected once, during a September 1989 sampling event.) • *TCE*. Concentrations ranged from nondetect to 65.9 ppb. (About 200 samples were analyzed for TCE between November 1977 and March 1993. The contaminant was detected above ATSDR's drinking water CVs 19 times, but only five of these detections, all of which were recorded between 1977 and August 1978, were above 20 ppb. No detections were recorded above ATSDR's CVs after January 1986.)
AF30, AF31, and AF32: AF30, AF31, and AF32 were constructed in 1984 and served as USAF's main water supply wells (AFCEE 1996a). Use of AF30 was discontinued in 1992, but the other two wells were used as potable water sources until the base was hooked up to municipal supply in 1997.	Samples were collected between 1984 and 1997 (AFBCA 1993; Air Force 1990; MDEQ 1999b). The wells were analyzed for volatile organics, pesticides, and metals. Contaminants were rarely detected and when they were present they were typically below ATSDR's drinking water CVs. Only three contaminants exceeded CVs: • *Chlorodibromomethane*. Concentrations ranged from nondetect to 0.6 ppb. (Wells were sampled and analyzed for this contaminant on about 25 occasions between September 1985 and March 1997. The contaminant was only detected once, during a September 1994 sampling event.) • *Chloroform*. Concentrations ranged from nondetect to 29.4 ppb. (Wells were sampled and analyzed for this contaminant on about 25 occasions between September 1985 and March 1997. The contaminant was detected five times; two of the detections, recorded in September 1985 and September 1994, exceeded ATSDR's CVs.) • *Dichlorobromomethane*. Concentrations ranged from nondetect to 3.9 ppb. (Wells were sampled and analyzed for this contaminant on about 25 occasions between September 1985 and March 1997. The contaminant was detected three times. The detections, which were recorded in September 1985, August 1987, and September 1994, exceeded ATSDR's CVs.)

Table 3
Tap Water Samples Collected From On-Base Housing Areas and Facility Buildings That Received Water From USAF's Main Water Supply Wells
Wurtsmith Air Force Base, Oscoda, Michigan

Sample Location	Type of Building	Sampling Dates and Results
8306 Hawaii	Housing	Samples were analyzed for TCE once in December 1977. The contaminant was detected above ATSDR's drinking water CVs, registering at 148.9 ppb (AFBCA 1993).
Housing Area (Unlisted location)	Housing	Samples were analyzed for TCE about 20 times between October 1977 and April 1979. TCE was detected above ATSDR's drinking water CVs on 16 occasions. It was detected at 1,100 ppb in October 1977, at 149 ppb in November 1977, 32 ppb in December 1977, and 55 ppb in February 1978, before dropping below ATSDR's CVs for a couple months. Between June 1978 and April 1979, detections ranged between 3.0 and 78 ppb (AFBCA 1993).
Hospital	Facility	Samples were collected between 1978 and 1993 (AFBCA 1993; Air Force 1990; MDEQ 1999b). Six contaminants exceeded ATSDR's drinking water CVs: • *Benzene.* Concentrations ranged from nondetect to 38.6 ppb. (About 125 samples were analyzed for benzene between 1982 and 1993. It was detected above trace levels 22 times; all of these detections, which were recorded between February 1982 and October 1983, exceeded CVs. • *Chlorodibromomethane.* Concentrations ranged from nondetect to 4.7 ppb. (This contaminant was analyzed once in March 1982 and three times in 1993. It was detected in 1982 and once in 1993. Both detections exceeded ATSDR's CVs.) • *Chloroform.* Concentrations ranged from 1.5 to 12.5 ppb. (This contaminant was analyzed once in March 1982 and three times in 1993. It was detected on all four occasions, but it only exceeded ATSDR's CV once, during a May 1993 sampling event.) • *Dichlorobromomethane.* Concentrations ranged from 0.8 to 3.6 ppb. (This contaminant was analyzed once in March 1982 and three times in 1993. It was detected on all four occasions; all of the detections exceeded ATSDR's CVs.) • *1,1,2,2-tetrachloroethane.* Concentrations ranged from nondetect to 2.8 ppb. (This contaminant was analyzed three times in 1982 and four times in 1993. It was detected above ATSDR's CVs in all of the 1982 sampling events, but it was not detected during the 1993 sampling efforts.) • *TCE.* Concentrations ranged from nondetect to 17 ppb. (About 100 samples were analyzed for TCE between November 1978 and May 1993. The contaminant was only detected above ATSDR's CVs twice. Both detections were recorded in 1985.)
8000 Area	Housing	Samples were analyzed for TCE in 1979. The contaminant was detected above ATSDR's drinking water CVs. Concentrations ranged between 6.0 and 32.2 ppb (AFBCA 1993).
Building 8509D	Housing	Samples were analyzed for TCE many times in 1979. The contaminant was detected above ATSDR's drinking water CVs during all of the sampling events. Concentrations ranged between 12.4 and 75 ppb (AFBCA 1993).
1612 A & B California	Housing	In 1979, samples were analyzed for TCE on about 25 occasions. TCE was detected during each sampling event, ranging from concentrations of 5.8 to 73.2 ppb. All of the detections exceeded ATSDR's drinking water CVs (AFBCA 1993).
10500 Idaho	Housing	Samples were analyzed for TCE in May and July of 1979. TCE (2.2 to 6.8 ppb) was detected above ATSDR's drinking water CVs during the former sampling event (AFBCA 1993).
Barracks 502	Housing	Samples were analyzed for TCE in April 1979. The contaminant was detected above ATSDR's drinking water CVs. Concentrations ranged between 68 and 71 ppb (AFBCA 1993).

Sample Location	Type of Building	Sampling Dates and Results
8808 E N Vermont	Housing	Samples were analyzed for TCE in May 1979. The contaminant was detected above ATSDR's drinking water CVs. Concentrations ranged between 8.9 and 9.8 ppb (AFBCA 1993).
Building 9750 D	Housing	Samples were analyzed for TCE in May 1979. The contaminant was detected above ATSDR's drinking water CVs. Concentrations ranged between 22.8 and 27.3 ppb (AFBCA 1993).
9752B 8th Street	Housing	Samples were analyzed for TCE in October 1979. The contaminant was not detected above ATSDR's drinking water CVs (AFBCA 1993).
10037 8th Street	Housing	Samples were analyzed for TCE in May 1979. The contaminant was detected above ATSDR's drinking water CVs. Concentrations ranged from 22.1 to 26.6 ppb (AFBCA 1993).
10039 8th Street	Housing	Samples were analyzed for TCE about 20 times between March 1979 and August 1979. TCE was detected during each sampling event, ranging from concentrations of 2.5 to 57 ppb. The concentration exceeded ATSDR's drinking water CVs on 17 occasions (AFBCA 1993).
10000 Area; 10205 TN	Housing	Samples were analyzed for TCE in May 1979. The contaminant was detected above ATSDR's drinking water CVs. Concentrations ranged from 43.5 to 48.7 ppb (AFBCA 1993).
Barracks 225	Housing	Samples were analyzed for TCE in December 1979. TCE was detected above ATSDR's drinking water CVs in one sample, registering at 5.1 ppb (AFBCA 1993).
9750A & B 8th Street	Housing	Samples were collected between 1979 and 1983 (AFBCA 1993). Five contaminants exceeded ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 15.2 ppb. (About 25 samples were analyzed for benzene between 1980 and 1983. It was detected above trace levels seven times; all of these detections exceeded ATSDR's CVs.) • *Chlorodibromomethane*. This contaminant was analyzed once in June 1980. It was detected at 1.7 ppb. • *Dichlorobromomethane*. This contaminant was analyzed once in June 1980. It was detected at 2.2 ppb. • *1,1,2,2-tetrachloroethane*. Concentrations ranged from 2.3 to 2.7 ppb. (Three samples were analyzed for this contaminant in 1982; the contaminant was detected in all three samples at concentrations that exceeded ATSDR's CVs.) • *TCE*. Concentrations ranged from nondetect to 72 ppb. (More than 150 samples were analyzed for this contaminant between April 1979 and January 1983. TCE was detected above ATSDR's CVs on 35 occasions in 1979 and once in 1981.)
NCO Club	Facility	Samples were collected in April 1979 and November 1983. TCE (71 to 75 ppb), the only contaminant that exceeded ATSDR's drinking water CVs, was detected during the 1979 event (AFBCA 1993).

Sample Location	Type of Building	Sampling Dates and Results
Officer's Club	Facility	Samples were collected between 1979 and 1989 (AFBCA 1993; Air Force 1990). Five contaminants exceeded ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 30 ppb. (About 140 samples were analyzed for benzene between 1982 and 1989. The contaminant was detected above trace levels seven times. Three of these detections, which were recorded between February 1982 and January 1983, exceeded ATSDR's CVs.) • *Chlorodibromomethane.* This contaminant was analyzed in June 1980 and May 1982. It was detected above ATSDR's CVs during both events, registering between 1.9 and 6.1 ppb. • *Dichlorobromomethane.* This contaminant was analyzed once in June 1980. It was detected at 7.4 ppb. • *1,1,2,2-tetrachloroethane.* This contaminant was analyzed once in March 1982. It was detected at 1.2 ppb. • *TCE*. Concentrations ranged from nondetect to 27 ppb. (More than 150 samples were analyzed for TCE between 1979 and 1989. It exceeded ATSDR's CVs on 22 occasions. All of the detections that exceeded CVs occurred between September 1979 and June 1980, except for one, which was recorded in April 1985.)
Building 5008	Facility	Samples were collected between 1979 and 1989 (AFBCA 1993; Air Force 1990). Five contaminants exceeded ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 1,510 ppb. (About 150 samples were analyzed for this contaminant between 1982 and 1989. It was detected above trace levels six times; all of these detections were above ATSDR's CVs. Benzene was detected in February 1982 [4.7 ppb], March 1982 [10.9 ppb], July 1983 [13.5 ppb], August 1983 [6.4 ppb], September 1986 [1,510 ppb], and July 1987 [10.2 ppb].) • *Chlorodibromomethane.* This contaminant was analyzed once in March 1982. It was detected at 1.3 ppb. • *Dichlorobromomethane.* This contaminant was analyzed once in March 1982. It was detected at 1.0 ppb. • *1,1,2,2-tetrachloroethane.* Concentrations ranged from 1.9 to 2.9 ppb. (Three samples were analyzed for this contaminant in 1982; the contaminant was detected in all three samples at concentrations that exceeded ATSDR's CVs.) • *TCE.* Concentrations ranged from nondetect to 11.1 ppb. (More than 100 samples were analyzed for this contaminant between 1979 and 1989. TCE was detected above ATSDR's CVs on only four occasions, all of which took place in May 1979.)
1820 Cedar St.	Housing	Samples were analyzed for TCE in September 1980. The contaminant was not detected above ATSDR's drinking water CVs (AFBCA 1993).
9204A Rhode Island	Housing	Samples were analyzed for TCE in September 1980. The contaminant was not detected above ATSDR's drinking water CVs (AFBCA 1993).
Education Center	Facility	Samples were collected in 1982. No contaminants were detected above ATSDR's drinking water CVs (AFBCA 1993).
Building 5065	Facility	Samples were collected in February and March 1982. Benzene (nondetect to 2.3 ppb) exceeded ATSDR's drinking water CVs during the former event (AFBCA 1993).
10059 8th Street	Housing	Samples were collected three times (i.e., in February 1982, March 1982, and November 1983). Benzene (nondetect to 8.2 ppb) was detected above ATSDR's drinking water CVs during the first two sampling events, but was not detected during the third event (AFBCA 1993).

Sample Location	Type of Building	Sampling Dates and Results
Building 1700	Facility	Samples were collected between 1982 and 1989 (AFBCA 1993; Air Force 1990). Five contaminants were detected above ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 27.1 ppb. (More than 30 samples were analyzed for this contaminant between 1982 and 1989. It was detected above ATSDR's CVs 13 times; all of these elevated detections were recorded between 1982 and 1985.) • *Chlorodibromomethane.* Concentrations ranged from nondetect to 4.3 ppb. (Six samples were analyzed for this contaminant. It was detected three times. All of the detections, which were recorded in 1982 and 1983, exceeded ATSDR's CVs.) • *Dichlorobromomethane.* Concentrations ranged from nondetect to 2.5 ppb. (Six samples were analyzed for this contaminant. It was detected four times. All of the detections, which were recorded in 1982 and 1983, exceeded ATSDR's CVs.) • *1,1,2,2-tetrachloroethane.* Concentrations ranged from nondetect to 3.5 ppb. (Eight samples were analyzed for this contaminant. It was detected three times. All of the detections, which were recorded in 1982, exceeded ATSDR's CVs.) • *1,2-dichloroethane.* Concentrations ranged from nondetect to 0.5 ppb. (Five samples were analyzed for this contaminant. It was detected above trace levels twice; both detections, which were recorded in 1983, exceeded ATSDR's CVs.)
Child Care Center	Facility	Samples were collected between 1982 and 1996 (AFBCA 1993; Air Force 1990; MDEQ 1999b). Five contaminants exceeded ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 24.4 ppb. (About 180 samples were analyzed for benzene between 1982 and 1996. It was detected above trace levels 24 times. About 22 of these detections, all of which were recorded between February 1982 and October 1983, exceeded ATSDR's CVs.) • *Chlorodibromomethane.* Concentrations ranged from nondetect to 1.5 ppb. (This contaminant was analyzed about 20 times between February 1993 and December 1996. It was detected above ATSDR's CVs on nine occasions.) • *Chloroform.* Concentrations ranged from nondetect to 34 ppb. (This contaminant was analyzed about 20 times between February 1993 and December 1996. It was detected above ATSDR's CVs on 16 occasions.) • *Dichlorobromomethane.* Concentrations ranged from 0.6 to 7.0 ppb. (This contaminant was analyzed about 20 times between February 1993 and December 1996. It was detected above ATSDR's CVs on all but one occasion.) • *1,1,2,2-tetrachloroethane.* Concentrations ranged from nondetect to 1.9 ppb. (This contaminant was analyzed three times in 1982 and about 20 times between 1993 and 1996. It was detected above ATSDR's CVs during the 1982 sampling events, but it was not detected in the samples that were collected in the 1990s.)
Building 5043	Facility	Samples were collected in November 1983. No contaminants exceeded ATSDR's drinking water CVs (AFBCA 1993).
Building 5090	Facility	Samples were collected in November 1983. No contaminants exceeded ATSDR's drinking water CVs (AFBCA 1993).
Building 245	Housing	One sample was collected in October 1983. No contaminants exceeded ATSDR's drinking water CVs (AFBCA 1993).
9215B Rhode Island	Housing	Samples were collected in November 1983. No contaminants were detected (AFBCA 1993).
10060 8th Street	Housing	Samples were collected in November 1983. No contaminants were detected above trace levels (AFBCA 1993).

Sample Location	Type of Building	Sampling Dates and Results
8032 1st Street	Housing	Samples were collected in November 1983. No contaminants exceeded ATSDR's drinking water CVs (AFBCA 1993).
10031 7th Street	Housing	Samples were collected in August 1984 and February 1985. No contaminants exceeded ATSDR's drinking water CVs (AFBCA 1993).
Bioenviro. Eng. Building	Facility	Samples were collected once in 1984 and three times in 1993 (AFBCA 1993; MDEQ 1999b). Two contaminants were detected above ATSDR's drinking water CVs: • *Chlorodibromomethane*. Concentrations ranged from nondetect to 0.7 ppb. (This contaminant was not detected in 1984, but it exceeded ATSDR's CVs during all three of the 1993 sampling events.) • *Dichlorobromomethane*. Concentrations ranged from nondetect to 2.3 ppb. (This contaminant was not detected in 1984, but it exceeded ATSDR's CVs during all three of the 1993 sampling events.)
8822A 3rd Street	Housing	Samples were collected once in August 1985 (AFBCA 1993). Dichlorobromomethane (2.1 ppb) and chloroform (12.8 ppb) exceeded ATSDR's drinking water CVs.
10311 7th Street	Housing	Samples were collected between 1983 and 1989 (AFBCA 1993; Air Force 1990). Two contaminants were detected above ATSDR's drinking water CVs: • *Benzene*. Concentrations ranged from nondetect to 11 ppb. (More than 100 samples were analyzed for this contaminant between 1983 and 1989. It was only detected above trace levels twice. These detections, which occurred in March 1984 and April 1985, both exceeded ATSDR's CVs. • *TCE*. Concentrations ranged from nondetect to 13 ppb. (More than 100 samples were analyzed for this contaminant between 1983 and 1989. It was detected many times, but only exceeded ATSDR's CVs on two occasions. (TCE was detected at 8.1 ppb in April 1985 and at 13.0 ppb in February 1986.)
Building 1752	Housing	Samples were collected in July 1986. No contaminants were detected (AFBCA 1993).
Aircraft Alert Area	Facility	Samples were collected in 1989. TCE (nondetect to 25 ppb) was detected above ATSDR's drinking water CVs once out of several sampling events (Air Force 1990).
Building 291	Facility	Samples were collected in 1989. Chlorodibromomethane (0.9 ppb), chloroform (1.0 to 13 ppb), and dichlorobromomethane (1.5 to 3.9 ppb) were detected above ATSDR's drinking water CVs (Air Force 1990).
Procurement Office	Facility	ATSDR found no records of tap water samples being collected when the building was serviced by AF15. Samples were collected in 1989, when the building was being serviced by the main water supply wells. Sampling data indicated that chloroform (6.4 ppb) and dichlorobromomethane (2.0 ppb) were present at concentrations that exceeded ATSDR's drinking water CVs (Air Force 1990).
10309 7th Street	Housing	Samples were collected on several occasions in 1989. No contaminants exceeded ATSDR's drinking water CVs (Air Force 1990).

Sample Location	Type of Building	Sampling Dates and Results
10419 South Carolina Street	Housing	Samples were collected in 1993 (MDEQ 1999b). Three contaminants exceeded ATSDR's drinking water CVs: • *Chlorodibromomethane*. Concentrations ranged from nondetect to 0.8 ppb. (The contaminant exceeded ATSDR's CVs in five of the seven samples.) • *Chloroform*. Concentrations ranged from 1.7 to 7.3 ppb. (The contaminant exceeded ATSDR's CVs in two of the seven samples.) • *Dichlorobromomethane*. Concentrations ranged from 0.6 to 2.7 ppb. (The contaminant exceeded ATSDR's CVs in six of the seven samples.)
Building 5067	Facility	Samples were analyzed for several organic compounds in May and June 1993 (MDEQ 1993). Chlorodibromomethane (0.6 to 0.7 ppb), chloroform (6.5 to 8.5 ppb) and dichlorobromomethane (2.1 to 2.8 ppb) exceeded ATSDR's drinking water CVs during both sampling events.
Building 5006	Facility	Samples were collected four times between February and April 1993 and analyzed for several organics. Chlorodibromomethane (0.7 to 1.0 ppb), chloroform (6.8 to 8.9 ppb), and dichlorobromomethane (2.8 to 3.4 ppb) exceeded ATSDR's drinking water CVs during all four sampling events (MDEQ 1999b).
Building 20	Facility	Samples were collected between March and April of 1994 (MDEQ 1999b). Two contaminants exceeded ATSDR's drinking water CVs: • *Chloroform*. Concentrations ranged from 4.9 to 10.7 ppb. (The contaminant exceeded ATSDR's CVs in three of four samples.) • *Dichlorobromomethane*. Concentrations ranged from 1.9 to 3.2 ppb. The contaminant exceeded ATSDR's CVs in all four samples.)
Baker Eng. Building	Facility	Samples were collected in December 1996 (MDEQ 1999b). Chloroform (14.8 ppb) and dichlorobromomethane (1.2 ppb) exceeded ATSDR's drinking water CVs.
Civil Eng. Building (Bdg. 290)	Facility	A few samples were collected in 1982 and 1983. No contaminants exceeded ATSDR's drinking water CVs (AFBCA 1993). About 14 samples were collected between 1993 and 1997 and analyzed for a variety of organic compounds (MDEQ 1999b). Only three contaminants exceeded ATSDR's drinking water CVs: • *Chlorodibromomethane*. Concentrations ranged from nondetect to 0.8 ppb. (The contaminant exceeded ATSDR's CVs once out of 14 sampling events.) • *Chloroform*. Concentrations ranged from 3.4 to 25.5 ppb. (The contaminant exceeded ATSDR's CVs eight out of 14 sampling events.) • *Dichlorobromomethane*. Concentrations ranged from 0.5 to 3.5 ppb. (The contaminant exceeded ATSDR's CVs on all but one of the sampling events.)

Table 4
USAF's Area-Specific Wells
Well Usage Information, Sampling Data, and Potential For Past Public Health Hazards
Wurtsmith Air Force Base, Oscoda, Michigan

Well Identification and Well Usage History	Contamination History	ATSDR's Evaluation of Past Public Health Hazards
AF7: This well serviced the North Cottage. It has been officially abandoned (i.e., grouted and closed), thereby removing any potential for it being used again in the future (AFBCA 1999b).	Samples were collected from AF7 and analyzed for TCE on more than 30 occasions between December 1977 and January 1980. Detections ranged from nondetect to 17.6 ppb. TCE exceeded ATSDR's drinking water CVs on 20 occasions (AFBCA 1993).	Although contaminant concentrations were detected above ATSDR's drinking water CVs, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
AF8: This well serviced the South Cottage. It has been officially abandoned (i.e., grouted and closed), thereby removing any potential for it being used again in the future (AFBCA 1999b).	Samples were collected from AF8 and analyzed for TCE on about 40 occasions between October 1978 and September 1980. Detections ranged from nondetect to 27 ppb. TCE exceeded ATSDR's drinking water CVs on nine occasions (AFBCA 1993).	Although contaminant concentrations were detected above ATSDR's drinking water CVs, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
AF14: This well serviced Building 1135 in the past (AFBCA 1999f).The well has been officially abandoned (i.e., grouted and closed), thereby removing any potential for it to be used again in the future (AFBCA 1999b).	Well data were not available for AF14, but tap water samples were collected from Building 1135 and analyzed for TCE in June 1979. Detections ranged from 12.1 to 12.7 ppb (AFBCA 1993).	Although contaminant concentrations were detected above ATSDR's drinking water CVs, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
AF15: This well serviced the base procurement office (Building 4004) in the past. Site representatives do not have exact documentation listing when the well stopped being used, but it was removed from service sometime before 1983 (USGS 1983). (One site representative thinks that the well may have been taken off line before 1977.) The well has been officially abandoned (i.e., grouted and closed), thereby removing any potential for it to be used again in the future (AFBCA 1999b).	ATSDR reviewed available data that was collected through 1983. Although several contaminants were analyzed, only TCE (2.9 to 296 ppb) was detected above ATSDR's drinking water CVs (AFBCA 1993). (Samples were analyzed for TCE on about 100 occasions between December 1977 and December 1983. TCE was detected above CVs in all but a few of the sampling events. The majority of the detections were above 40 ppb, with concentrations reaching a high of 296 ppb in December 1978 [AFBCA 1993]).	Although TCE was detected above ATSDR's drinking water CVs, the concentrations were not expected to pose past health hazards because the population serviced by the well was not likely to be exposed to large quantities of water over a long duration. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)

Well Identification and Well Usage History	Contamination History	ATSDR's Evaluation of Past Public Health Hazards
AF16: This well serviced the small arms firing range. The well has been officially abandoned (i.e., grouted and closed), thereby removing any potential for it to be used again in the future (AFBCA 1999b).	Tap water samples were collected from the firing range and analyzed for volatiles in 1989 (Air Force 1990). None of the detected constituents exceeded ATSDR's drinking water CVs. In addition, samples were collected and analyzed for lead in April 1998, after the well had stopped being used as a potable water source. Neither total nor dissolved lead was detected (AFCEE 1999).	Although some of the groundwater in the vicinity of the firing range has been impacted by contaminants (see Appendix B-Site 55), there is no evidence that the contaminants migrated crossgradient to impact AF16.
AF22: This well serviced the Burkhart Lodge for many years. (The lodge served as a visitation center for pilots.) Later in WAFB's history, the lodge was serviced by USAF's main water supply wells (AFBCA 1999d).	Samples were collected from AF22 between 1977 and 1984. TCE (trace to 30.4 ppb) was the only contaminant that exceeded ATSDR's drinking water CVs (AFBCA 1993). (The contaminant was sampled more than 100 times between December 1977 and February 1981. It was detected above ATSDR's CVs on all but a few occasions.) Tap water samples were collected from the lodge in 1989. TCE concentrations ranged from 12 to 18 ppb (Air Force 1990).	Although TCE was detected above ATSDR's drinking water CVs, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
AF23: This well serviced the Air Force Beach in the past (AFBCA 1999d).	Samples were collected from AF23 between 1979 and 1989. TCE (1.1 to 14.7 ppb) was the only contaminant detected above ATSDR's drinking water CV (Air Force 1990; AFBCA 1993). (About 80 samples were analyzed for TCE between May 1979 and August 1987. TCE was detected above ATSDR's CVs in all but a few samples.)	Although TCE was detected above ATSDR's drinking water CV, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
AF25: This well services Building 5098. It is the only on-base supply well that is still being used. In the past, water supplied by this well was used for potable purposes. Today, it is used only for nonpotable purposes (AFBCA 1999c).	Samples were collected from AF25 and analyzed for TCE in December 1977. Contaminant concentrations ranged from nondetect to 3.1 ppb. This concentration is below ATSDR's drinking water CV (AFBCA 1993).	No contaminants were detected at concentrations that exceeded ATSDR's drinking water CVs. Thus, contaminant concentrations were too low to pose past health hazards. (Note: This well is still in use. See the main body of the text for a discussion on current and future exposures.)
Unlabeled well: One on-base well was used to service the Defense Reutilization Management Office (DRMO). The well has been officially abandoned (i.e., grouted and closed), thereby removing any potential for it to be used again in the future (AFBCA 1999b).	Well data were not available, but tap water samples were collected from the DRMO in 1989 (Air Force 1990). Chloroform (nondetect to 75 ppb) and methylene chloride (nondetect to 13 ppb) were the only contaminants detected above ATSDR's drinking water CVs.	Although contaminant concentrations were detected above ATSDR's drinking water CVs, the concentrations were not expected to pose past health hazards because the population serviced by the well was not likely to be exposed to large quantities of water over a long duration. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)

Well Identification and Well Usage History	Contamination History	ATSDR's Evaluation of Past Public Health Hazards
Unlabeled well: One on-base well was used to service the dog kennels. The well has been officially abandoned (i.e., grouted and closed), thereby removing any potential for it to be used again in the future (AFBCA 1999b).	Well data were not available, but tap water samples were collected from the dog kennels between 1977 and 1989 (AFBCA 1993; Air Force 1990). Chloroform (nondetect to 49 ppb) and methylene chloride (nondetect to 15 ppb) were the only contaminants detected above ATSDR's drinking water CVs.	Although contaminant concentrations were detected above ATSDR's drinking water CVs, the concentrations were not expected to pose past health hazards because the population serviced by the well was not likely to be exposed to large quantities of water over a long duration. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)

Table 5
Off-base Wells
Well Usage Information, Sampling Data, and Potential For Past Public Health Hazards
Wurtsmith Air Force Base, Oscoda, Michigan

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
5844 West Shore Drive	No VOCs were detected during MDEQ's January 1991 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
5884 West Shore Drive	No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
5886 West Shore Drive	Methylene chloride (1 ppb) was detected during MDEQ's May 1990 sampling event, but at concentrations below ATSDR's drinking water CV. The contaminant was not detected during a subsequent MDEQ sampling event that was conducted in August 1990 (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
5890 West Shore Drive	No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
5902 West Shore Drive	No VOCs were detected during MDEQ's January 1987 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
5908 West Shore Drive	No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
5916 West Shore Drive	No VOCs were detected during MDEQ's April 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
5936 West Shore Drive	Methylene chloride (1.7 ppb) was detected during MDEQ's January 1991 sampling event, but at concentrations below ATSDR's drinking water CV (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
5942 West Shore Drive	No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
5944 West Shore Drive	TCE (19 to 25 ppb) was detected at concentrations that exceeded ATSDR's drinking water CVs during MDEQ's May 1990 and August 1990 sampling events (MDEQ 1999c).	Although TCE was detected above ATSDR's drinking water CV, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
5968 West Shore Drive	1,1,1-Trichloroethane (0.6 ppb) was detected during MDEQ's May 1990 sampling event, but at concentrations below ATSDR's drinking water CV. The contaminant was not detected during a subsequent MDEQ sampling event that took place in August 1990 (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
5972 West Shore Drive	No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
5978 West Shore Drive	No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6010 West Shore Drive	The well at this property was constructed in 1989 (Oscoda Press, 1990a). TCE (3.0 to 3.4 ppb) was detected during MDEQ's May 1990 and August 1990 sampling events, but at concentrations below ATSDR's drinking water CVs (MDEQ, 1999c). The homeowners stopped using the well as a drinking water source in September 1990, but continued to use it for bathing until they received a municipal hookup (Oscoda Press, 1990a, 1990b). (Municipal hookups were established throughout the area in 1992 or 1993 [AFBCA 1999c].)	Contaminant concentrations were too low to pose health hazards.
6014 West Shore Drive	No VOCs were detected during MDEQ's September 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6041 West Shore Drive	TCE (0.1 ppb) and PCE (0.2 ppb) were detected during MDEQ's August 1989 sampling event, but at concentrations below ATSDR's drinking water CVs. These contaminants were not detected during a subsequent MDEQ sampling event that was conducted in September 1989 (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
6056 West Shore Drive	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6061 West Shore Drive	No VOCs were detected during MDEQ's May 1991 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6062 West Shore Drive	No VOCs were detected during MDEQ's September 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6067 West Shore Drive	No VOCs were detected during MDEQ's May 1991 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6070 West Shore Drive	Methyl tert-butyl ether (MTBE) (1 ppb) was detected during MDEQ's May 1991 sampling event, but at concentrations below ATSDR's drinking water CV. Acetone was also detected during this sampling event, but site records did not indicate the exact concentration. Neither MTBE or acetone were detected during previous MDEQ sampling events (i.e., August 1987 and September 1989) or subsequent MDEQ sampling events (i.e., October 1991) (MDEQ 1999c).	MTBE concentrations were too low to pose health hazards. Although the concentration for acetone was not listed in the laboratory report, it is unlikely that this contaminant posed a health hazard. Because it was only detected once during four sampling events, it is unlikely that the contaminant was present consistently in the private well. Also, it is possible that the detection was an error (Acetone is a common laboratory contaminant.)
6356 West Shore Drive	No contaminants were detected during sampling events conducted in 1979, November 1983, August 1989, or May 1990 (AFBCA 1993; MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
6364 West Shore Drive	1,4-Dichlorobenzene (0.7 ppb) was detected during MDEQ's May 1990 sampling event, but below ATSDR's drinking water CV. This contaminant was not detected during previous or subsequent MDEQ sampling events (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
6368 West Shore Drive	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6370 West Shore Drive	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6372 West Shore Drive	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6376 West Shore Drive	Samples were analyzed for TCE, benzene, and 1,2-dichloroethene between 1979 and 1983, but no contaminants were detected (AFBCA 1993). Benzene (3 ppb) was detected above ATSDR's drinking water CV during MDEQ's December 1986 sampling event (MDEQ 1999c). The contaminant was not detected subsequently during MDEQ's January 1987 or May 1990 sampling events (MDEQ 1999c; AFBCA 1993).	Although benzene was detected above ATSDR's drinking water CV, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
6400 West Shore Drive	No TCE was detected during an April 1979 sampling event (AFBCA 1993). In addition, no VOCs were detected during MDEQ's August 1989 or May 1990 sampling events (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6406 West Shore Drive	No VOCs were detected during MDEQ's October 1983 or May 1990 sampling events (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6414 West Shore Drive	No TCE was detected during an April 1979 sampling event (AFBCA 1993). In addition, no VOCs were detected during MDEQ's August 1989 or May 1990 sampling events (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6420 West Shore Drive	No TCE was detected during a January 1979 sampling event (AFBCA 1993). In addition, no VOCs were detected during MDEQ's August 1989 or May 1990 sampling events (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6424 West Shore Drive	Methylene chloride (3.0 ppb) was detected during MDEQ's August 1989 sampling event, but at concentrations below ATSDR's drinking water CV (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
6430 West Shore Drive	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6466 West Shore Drive	No contaminants were detected during sampling events that were conducted between 1979 and 1987 or during MDEQ's January 1987, August 1989, May 1990, or May 1991 sampling events (AFBCA 1993; MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
6504 West Shore Drive	This well was used as a drinking water source until the late 1970s. In May 1979, the homeowner collected a water sample and had it analyzed for TCE. The contaminant was detected at 760 ppb (AFCEE 1996e). Several more samples were collected in May and June 1979, revealing that TCE concentrations ranged from 500 to 837 ppb (AFCEE 1996e; AFBCA, 1993). USAF started supplying bottled water to the residence upon discovery of the contamination (AFCEE 1996e). The well continued to be used for nonpotable purposes and the Air Force installed a treatment system to reduce the amount of TCE that the residents were exposed to while the well was still used for nonpotable purposes (AFBCA 1999c). In addition, sampling continued during the period of nonpotable usage. Results indicated that TCE (nondetect to 1,281 ppb) was still present above its CV. (Air Force 1990; AFBCA 1993; MDEQ 1999c). The residence received a municipal hookup in 1992 or 1993 (AFBCA 1999c).	ATSDR concluded that TCE *might* have been present at high concentrations for an extended period of time. Thus, ATSDR concluded that past exposures to this well might have posed potential health hazards. It should be noted, however, that it is unclear how long people were actually exposed to high TCE concentrations. Also, there is much controversy in the scientific community regarding TCE's ability to pose adverse health effects in humans. (TCE has been shown to cause cancer in laboratory animals who receive large doses, but EPA is currently reviewing the scientific literature to determine TCE's cancer classification [USEPA 2000b].) (See Appendix D for additional details.)
6554 West Shore Drive	Acetone (1 ppb) and toluene (0.9 ppb) were detected during MDEQ's May 1990 sampling event, but at concentrations below ATSDR's drinking water CVs. These contaminants were not detected during previous or subsequent MDEQ sampling events (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
6558 West Shore Drive	No VOCs were detected during MDEQ's July 1985, August 1989, or May 1990 sampling events (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6559 West Shore Drive	Chloroform (33 ppb) was detected above ATSDR's drinking water CV during MDEQ's September 1988 sampling event (MDEQ 1999b). Total trihalomethanes (33 ppb) were also detected, but this concentration does not exceed EPA's recommended guidelines. No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	Although chloroform was detected above ATSDR's drinking water CV, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
6562 West Shore Drive	Chloroform (1 ppb) was detected during MDEQ's July 1985 sampling event, but below ATSDR's drinking water CV. This contaminant was not detected during a subsequent MDEQ sampling event that was conducted in May 1990 (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
Knights of Columbus Lodge	This well was used as a drinking water source until 1986 when the lodge received a municipal water hookup (Oscoda Press 1990c). More than 100 water samples were collected between 1980 and 1986 (AFBCA 1993). TCE (nondetect to 36 ppb) was the only contaminant that exceeded ATSDR's drinking water CV. It only exceeded ATSDR's screening values on four occasions (AFBCA 1993).	Although TCE was detected above ATSDR's drinking water CV, concentrations were not high enough to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
5738 F-41 County Road	TCE (1 to 4 ppb) was detected during MDEQ's November 1983 and January 1984 sampling event, but at concentrations that were below ATSDR's drinking water CVs (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
6056 F-41 County Road	TCE (45 ppb) was detected above ATSDR's drinking water CVs during a sampling event that was conducted in 1989 (Air Force 1990).	Although TCE was detected above ATSDR's drinking water CVs, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
6082 F-41 County Road	Methylene chloride (98 ppb) was detected above ATSDR's drinking water CV during a sampling event that was conducted in 1989 (Air Force 1990).	Although methylene chloride was detected above ATSDR's drinking water CV, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
6085 F-41 County Road	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6088 F-41 County Road	No VOCs were detected during MDEQ's September 1991 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6090 F-41 County Road	No VOCs were detected during MDEQ's August 1989 or September 1991 sampling events (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6092 F-41 County Road	No contaminants were detected during a May 1979 sampling event or MDEQ's August 1989, September 1990, or September 1991 sampling events (AFBCA 1993; MDEQ 1999c). Samples were also collected in late 2000 and analyzed for a wide variety of VOCs. No contaminants were detected (Montgomery Watson 2000).	There is no evidence suggesting that the well was ever contaminated. Thus, it is improbable that past exposures led to public health hazards. (Note: ATSDR believes that this well could still be in use. See the main body of the text for a discussion on current and potential future exposures.)
6112 F-41 County Road	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6116 F-41 County Road	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6122 F-41 County Road	No VOCs were detected during MDEQ's May 1990 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6124 F-41 County Road	Dichlorodifluoromethane (4.4 ppb) was detected during MDEQ's May 1990 sampling event, but at concentrations below ATSDR's drinking water CV. A freon-type compound was also detected during this sampling event, but its concentration was not listed (MDEQ 1999c). No contaminants were detected during a subsequent MDEQ sampling event that was conducted in August 1990 (MDEQ 1999c).	Dichlorodifluoromethane concentrations were too low to pose health hazards. Although the concentration for the freon-type compound was not listed in the laboratory report, it is unlikely that this contaminant posed a health hazard. Because it was not detected during a subsequent sampling event, it does not appear that the contaminant was present consistently in the private well.

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
6136 F-41 County Road	MDEQ collected samples in August 1989, September 1989 and November 1989. Trans-1,2-dichloroethene (0.4 to 2.0 ppb), cis-1,2-dichloroethene (1.0 to 2.0 ppb), and MTBE (3 ppb) were detected, but at concentrations below ATSDR's drinking water CVs (MDEQ 1999c). Total trihalomethanes (0.4 ppb) were also detected, but below EPA's recommended guidelines.	Available data indicate that contaminant concentrations were too low to pose health hazards.
6142 F-41 County Road	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6146 F-41 County Road	No volatile aromatics or halocarbons were detected during a sampling event that took place in September 1986 (AFBCA 1993). 1,1-Dichloroethene (0.6 ppb) and TCE (13 ppb) were detected above ATSDR's drinking water CVs in May 1989 (Air Force 1990). No VOCs were detected during MDEQ's November 1983, August 1989, or May 1990 sampling events (MDEQ 1999c).	Although contaminant concentrations were detected above ATSDR's drinking water CVs, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
6150 F-41 County Road	No VOCs were detected during MDEQ's August 1989 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.
6154 F-41 County Road	1,1,1-Trichloroethane (0.1 ppb) was detected during MDEQ's August 1989 sampling event, but at concentrations below ATSDR's drinking water CV (MDEQ 1999c).	Contaminant concentrations were too low to pose health hazards.
6182 F-41 County Road	No TCE was detected during a January 1979 sampling event (AFBCA 1993), but TCE (13 to 15 ppb), 1,1-dichloroethene (0.5 ppb), and 1,1,1,-trichloroethane (37 to 43 ppb) were detected in 1989 (Air Force 1990; MDEQ 1999c). The TCE and 1,1-dichloroethene concentrations exceeded ATSDR's drinking water CVs.	Although contaminant concentrations were detected above ATSDR's drinking water CVs, the concentrations were too low to pose health hazards. (See Appendix D for a detailed explanation of ATSDR's evaluation methodology.)
6690 F-41 County Road	Acetone was detected during MDEQ's May 1991 sampling event, but site records did not indicate the exact concentration. This contaminant was not detected in a subsequent sampling event that MDEQ conducted in October 1991 (MDEQ 1999c).	Although the concentration for acetone was not listed in the laboratory report, it is unlikely that this contaminant posed a health hazard. Because it was only detected once, it is unlikely that the contaminant was present consistently in the private well. Also, it is possible that the detection was an error (Acetone is a common laboratory contaminant.)
6714 F-41 County Road	No VOCs were detected during MDEQ's May 1991 sampling event (MDEQ 1999c).	There is no evidence suggesting that the well was ever contaminated.

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
Van Etten State Park (Wells CG#1 and CG#2)	Two wells (referred to as CG#1 and CG#2) are located at Van Etten State Park. Up until 1999, both of these wells were used to provide potable water to people who visited the park's 40 rustic campsites (MDEQ 1999a). Samples were collected from the wells in May 1991. MTBE (1 ppb), chloroform (1.1 ppb), and total trihalomethanes (1.1 ppb) were detected, but at concentrations below ATSDR's drinking water CVs and EPA's recommended guidelines. Acetone was also detected, but its concentration was not recorded in site documents (MDEQ 1999c). The wells were resampled in 1999 and analyzed for several volatiles. TCE (2.4 to 3.4 ppb) was detected in CG#2, but no VOCs were detected in CG#1 (MDEQ 1999a; District 1999e, 2000a, 2000b). CG#2 was removed from service immediately upon discovery of the contamination even though detections were below ATSDR's drinking water CVs (MDEQ 1999a).	Contaminant concentrations were too low to pose past health hazards. (Note: Well CG#1 is still being used and well CG#2 could be brought back on line in the future. See the main body of the text for a discussion on current and potential future exposures.)

Well Location	Well Usage History[a] and/or Sampling History	ATSDR's Evaluation of Past Public Health Hazards
Camp Nissokone (6836 F-41 County Road)	The Camp Nissokone property has been used as a YMCA summer camp since 1914 (ATSDR 1998a). About 700 campers attend the camp each summer. Staff members live on the property for about nine weeks of the summer. Also, a caretaker and his family live on the property year round. In the past, three private wells were located upon the property. One of the wells, which was fairly large, supplied the majority of the camp's water. The other two wells serviced single structures. One supplied Staff Cabin #5 and the other supplied a maintenance shop. Neither of these two wells was ever used for potable purposes (Camp Nissokone 2000b). Site documents indicate that the Northern Landfill Plume had migrated to Camp Nissokone by 1981. To determine whether the plume had impacted the camp's water supply, tap water samples were collected from the camp's dining hall and kitchen and a house that is located at the camp. These data, which were collected in 1979, 1982, and 1984, indicated that no contaminants were present (AFBCA 1993). Well samples were collected in June 1987, September 1988, August 1990, and May 1991. No contaminants were detected (MDEQ 1999c). In October 1993, the camp was hooked up to municipal water supplies and the large well was removed from service (ATSDR 1998a). From this point on, children that visited the camp were not exposed to water that was supplied by wells. At some point in the 1990s, the large well that had supplied most of the water to the camp was officially sealed and abandoned so that it could not be brought back into service. However, the well that supplied Staff Cabin #5 remained operational until it was officially abandoned during the summer of 2000 (Camp Nissokone 2000a, 2000b). Exposure to the water that was supplied by the Staff Cabin #5 well was infrequent. As noted above, this well was never used for potable purposes. Staff members may have used the water provided to Staff Cabin #5 for bathing, but only on a very infrequent basis. The well that supplies the maintenance shop is still operational, but it will be abandoned in summer 2001 (Camp Nissokone 2001). Exposure to the water supplied by this well is also infrequent. The water supplied to the maintenance shop is only used to service a toilet and a sink. According to a Camp Nissokone representative, very few people use the maintenance shop, and those who do are aware of the groundwater problems that exist in the area (Camp Nissokone 2000b).	There is no evidence that the wells that supplied the camp were ever contaminated. (Children used water that was supplied by the camp's wells prior to 1993. No contaminants were detected during sampling events that took place in the late 1970s, 1980s, and early 1990s. Throughout the 1990s, some adults continued to use water [for nonpotable purposes] that was supplied to the Staff #5 cabin and the maintenance shop. The wells were not located in areas that were impacted by the Northern Landfill Plume [Camp Nissokone 2000a].)

a Site documents did not provide much information about the usage history of individual off-base wells. For example, site documents rarely indicated the year that wells were installed. For some of the properties, such as 6010 West Shore Drive, 6504 West Shore Drive, Van Etten State Park, and Camp Nissokone, detailed information was available, and this has been included in the table. Municipal hookups were established throughout the area in 1992 and 1993. Thus, unless otherwise specified, ATSDR assumes that off-base wells are no longer being used as potable water sources.

Table 6
Surface Water Data
Van Etten Lake, Au Sable River, Duell Lake, and Wetland Area Near Site LF-27
Wurtsmith Air Force Base, Oscoda, Michigan

Contaminant	Location of Detection[g]	Concentration Range (ppb)	Comparison Value (ppb)	Comparison Value Source
Volatiles				
Acetone	VEL (Pierce's Point)[a] Wetland Area[e]	ND–10 ND–24J	1,000 4,000	RMEG (child) RMEG (adult)
Benzene	VEL (Pierce's Point)[a] VEL (North Landfill)[b]	ND–**2.9** ND–**9.2**	2.0	CREG
Bis(2-ethylhexyl) phthalate	Wetland Area[e]	ND–**25J**	3 200 700	CREG RMEG (child) RMEG (adult)
Bromomethane	VEL (Pierce's Point)[a]	ND–6.7	10 50	RMEG (child) RMEG (adult)
Carbon disulfide	Duell Lake[d] Wetland Area[e]	ND–35 ND–80	1,000 4,000	RMEG (child) RMEG (adult)
Chloroform	VEL (North Landfill)[b]	ND–0.22	6 100 400	CREG Chronic EMEG (child) Chronic EMEG (adult)
Chloroethane	VEL (North Landfill)[b]	ND–0.9J	3.6	Region III RBC
Chloromethane	VEL (North Landfill)[b] ASR (Downstream)[c] Duell Lake[d] Wetland Area[e]	ND–0.7J ND–0.6 ND–0.8 ND–1.0	2.1 3 400	Region III RBC LTHA CLHA
1,1-Dichloroethane	VEL (North Landfill)[b]	ND–0.7J	800	Region III RBC
cis-1,2-Dichloroethene	VEL (Pierce's Point)[a] VEL (North Landfill)[b]	ND–3.5 ND–6.3	3,000 10,000	Intermediate EMEG (child) Intermediate EMEG (adult)
Dichloro-difluoromethane	VEL (Pierce's Point)[a]	ND–1.4	2,000 7,000	RMEG (child) RMEG (adult)
Di-n-butylphthalate	Wetland Area[e]	ND–1.0J	1,000 4,000	RMEG (child) RMEG (adult)
Ethylbenzene	VEL (Pierce's Point)[a]	ND–4.7	1,000 4,000	RMEG (child) RMEG (adult)
Methylene chloride	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Upstream)[c] ASR (Discharge Pt.)[c] Wetland Area[e]	ND–**8JB** ND–2B 1.6JB 1.6 ND–**6J**	5 600 2,000	CREG RMEG (child) RMEG (adult)

Contaminant	Location of Detection[g]	Concentration Range (ppb)	Comparison Value (ppb)	Comparison Value Source
PCE	VEL (Pierce's Point)[a] Wetland Area[e]	ND–4.1 ND–**19**	5.0 100 400	MCL RMEG (child) RMEG (adult)
Pentachlorophenol	Wetland Area[e]	ND–**1.0J**	0.3 10 40	CREG Chronic EMEG (child) Chronic EMEG (adult)
1,1,1,2-Tetrachloroethane	VEL (North Landfill)[b]	ND–0.66	1.0 300 1,000	CREG RMEG (child) RMEG (adult)
1,1,2,2-Tetrachloroethane	ASR (Downstream)[c] Wetland Area[e]	ND–**0.6** ND–**0.6J**	0.2 400 1,000	CREG Chronic EMEG (child) Chronic EMEG (adult)
Toluene	VEL (Pierce's Point)[a] Duell Lake[d]	ND–22 ND–1.3	200 700	Intermediate EMEG (child) Intermediate EMEG (adult)
1,1,2-Trichloroethane	ASR (Downstream)[c]	ND–0.6	0.6 40 100	CREG RMEG (child) RMEG (adult)
TCE	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] ASR (Downstream)[c]	ND–**388** ND–**11** 0.5 ND–**15**	5.0	MCL
Vinyl chloride	VEL (North Landfill)[b]	ND–**1.0**	0.02 0.2 0.7	CREG Chronic EMEG (child) Chronic EMEG (adult)
Xylene	VEL (Pierce's Point)[a] VEL (North Landfill)[b]	ND–19 ND–1.0	2,000 7,000	Intermediate EMEG (child) Intermediate EMEG (adult)
Pesticides/Polychlorinated Biphenyls				
4,4-Dichloro-diphenyltrichloro-ethane (DDT)	Wetland Area[e]	ND–**0.81**	0.1 5 20	CREG Intermediate EMEG (child) Intermediate EMEG (adult)
alpha-hexachloro-cyclohexane	Wetland Area[e]	ND–**0.53**	0.006 100 400	CREG Intermediate EMEG (child) Intermediate EMEG (adult)

Contaminant	Location of Detection[g]	Concentration Range (ppb)	Comparison Value (ppb)	Comparison Value Source
Metals				
Aluminum	ASR (Discharge Pt.)[c] Wetland Area[e]	100 ND–2,200	37,000	Region III RBC
Arsenic	ASR (Discharge Pt.)[c] Wetland Area[e]	**2.0** ND–**22.1**	0.02 3 10	CREG Chronic EMEG (child) Chronic EMEG (adult)
Barium	Wetland Area[e]	ND–244	700 2,000	RMEG (child) RMEG (adult)
Cadmium	Wetland Area[e]	ND–1.2	2 7	Chronic EMEG (child) Chronic EMEG (adult)
Calcium	ASR (Discharge Pt.)[c] Wetland Area[e]	39,100 37,000–110,000	NA	—
Copper	ASR (Discharge Pt.)[c]	340	1,300	MCLG
Iron	ASR (Discharge Pt.)[c] Wetland Area[e]	310 63J–**86,300**	11,000	Region III RBC
Lead	ASR (Discharge Pt.)[c] Wetland Area[e]	12 ND–**30.4**	15	EPA's Action Level
Magnesium	ASR (Discharge Pt.)[c] Wetland Area[e]	960 5,400–8,490	NA	—
Manganese	ASR (Discharge Pt.)[c] Wetland Area[e]	20 ND–3,840	500 2,000	RMEG (child) RMEG (adult)
Potassium	Wetland Area[e]	ND–1,700	NA	—
Silver	Wetland Area[e]	ND–1.1	50 200	RMEG (child) RMEG (adult)
Sodium	ASR (Discharge Pt.)[c] Wetland Area[e]	4,200 1,200–2,000	NA	—
Zinc	ASR (Discharge Pt.)[c] Wetland Area[e]	210 ND–314	3,000 10,000	Chronic EMEG (child) Chronic EMEG (adult)

Note: Concentrations listed in bold are above comparison values.
a Data provided by AFBCA 1999h; AFCEE 1996e; M&E 1987; MDNR 1992
b Data provided by AFBCA 1999h, 2000c; AFCEE 1996d; MDNR 1992
c Data provided by AFCEE 1996b; MDNR 1992
d Data provided by AFCEE 1996b
e Data provided by AFCEE 1997b
f Comparison value is for the hexavalent form.
g See Figure 9 for general sample locations for Van Etten Lake.

ASR	Au Sable River
CLHA	Child Longer Term Health Advisory
CREG	Cancer Risk Evaluation Guide
EMEG	Environmental Media Evaluation Guide
J	Estimated concentration
JB	Estimated due to blank contamination
LTHA	Lifetime Health Advisory
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NA	Not applicable. Calcium, magnesium, potassium, and sodium are considered essential nutrients and do not exert toxic effects at low levels.
ND	Not detected
PCE	Tetrachloroethylene
ppb	Parts per billion
RBC	Risk-based concentration
RMEG	Reference Dose Media Evaluation Guide
TCE	Trichloroethylene
VEL	Van Etten Lake

Table 7
Sediment Data
Van Etten Lake, Au Sable River, Duell Lake, and Wetland Area Near Site LF-27
Wurtsmith Air Force Base, Oscoda, Michigan

Contaminant	Location of Detection[j]	Concentration Range (ppm)	Comparison Value (ppm)	Comparison Value Source
Volatiles				
Acetone	VEL (Pierce's Point)[a] ASR (Upstream)[c] Duell Lake[d] Wetland Area[e]	ND–0.08 0.05J ND–0.082J ND–0.39	5,000 70,000	RMEG (child) RMEG (adult)
Benzene	ASR (downstream)[c]	ND–0.006	50	CREG
Bis(2-ethylhexyl) phthalate	Wetland Area[e]	ND–2.9J	50 1,000 10,000	CREG RMEG (child) RMEG (adult)
2-Butanone	VEL (Pierce's Point)[a] Duell Lake[d] Wetland Area[e]	ND–0.097 ND–0.018J ND–0.089	30,000 400,000	RMEG (child) RMEG (adult)
Chloroform	Duell Lake[d]	ND–0.021J	100 500 7,000	CREG Chronic EMEG (child) Chronic EMEG (adult)
cis-1,2-Dichlororoethene	VEL (Pierce's Point)[a]	ND–0.028	20,000 200,000	Intermediate EMEG (child) Intermediate EMEG (adult)
1,2-Dibromo-3-chloropropane	ASR (downstream)[c] Duell Lake[d]	ND–0.008 ND–0.012J	100 1,000	Intermediate EMEG (child) Intermediate EMEG (adult)
1,2-Dichlorobenzene	ASR (downstream)[c]	ND–0.003	5,000 60,000	RMEG (child) RMEG (adult)
1,4-Dichlorobenzene	ASR (downstream)[c]	ND–0.004	20,000 300,000	Intermediate EMEG (child) Intermediate EMEG (adult)
Dichloro-bromomethane	Duell Lake[d]	ND–0.011J	10 1,000 10,000	CREG Chronic EMEG (child) Chronic EMEG (adult)
Di-n-butylphthalate	Wetland Area[e]	ND–2.5J	5,000 70,000	RMEG (child) RMEG (adult)
Fluoranthene	Wetland Area[e]	ND–0.095J	2,000 30,000	RMEG (child) RMEG (adult)
Methylene chloride	Duell Lake[d] Wetland Area[e]	ND–0.0079J ND–0.031J	90 3,000 40,000	CREG RMEG (child) RMEG (adult)

Contaminant	Location of Detection[j]	Concentration Range (ppm)	Comparison Value (ppm)	Comparison Value Source
Phenanthrene	Wetland Area[e]	ND–0.21J	1,000 10,000	Intermediate EMEG[f] (child) Intermediate EMEG[f] (adult)
TCE	VEL (Pierce's Point)[a] Duell Lake[d]	ND–0.037 ND–0.0056J	58 520	Region III Residential RBC Region III Industrial RBC
Xylene	Duell Lake[d]	ND–0.01J	10,000 100,000	Intermediate EMEG (child) Intermediate EMEG (adult)
Metals				
Aluminum	ASR (Discharge Pt.)[c] Wetland Area[e]	574 785–4,010	78,000 2,000,000	Region III Residential RBC Region III Industrial RBC
Antimony	Wetland Area[e]	ND–1.4	20 300	RMEG (child) RMEG (adult)
Arsenic	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	**4.2** **4.4** **0.55** 0.10–**58**	0.5 20 200	CREG Chronic EMEG (child) Chronic EMEG (adult)
Barium	ASR (Discharge Pt.)[c] Wetland Area[e]	2.3 3.6–91	4,000 50,000	RMEG (child) RMEG (adult)
Beryllium	Wetland Area[e]	ND–1.3	100 1,000	RMEG (child) RMEG (adult)
Cadmium	Wetland Area[e]	ND–8.5J	10 100	Chronic EMEG (child) Chronic EMEG (adult)
Calcium	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	68,500 70,500 6,610J 677–45,300	NA	—
Chromium	VEL (Pierce's Point)[a] VEL (North Landfill)[b] Wetland Area[e]	37 39 ND–16	200 2,000	RMEG[g] (child) RMEG[g] (adult)
Copper	VEL (Pierce's Point)[a] VEL (North Landfill)[b] Wetland Area[e]	19 20 ND–21	3,100 82,000	Region III Residential RBC Region III Industrial RBC
Iron	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	**29,000** **30,000** 1,150J 1,370–**35,200**	23,000 610,000	Region III Residential RBC Region III Industrial RBC
Lead	VEL (Pierce's Point)[a] VEL (North Landfill)[b] VEL (SS-56)[I] ASR (Discharge Pt.)[c] Wetland Area[e]	27 28 0.9–2.0 1.4 1.7–446	400	EPA Revised Interim Guideline[h]

Contaminant	Location of Detection[j]	Concentration Range (ppm)	Comparison Value (ppm)	Comparison Value Source
Magnesium	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	19,800 21,000 687J 395–2,520	NA	—
Manganese	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	830 695 26.6J 16–3,600	3,000 40,000	RMEG (child) RMEG (adult)
Molybdenum	Wetland Area[e]	ND–4.0	300 4,000	RMEG (child) RMEG (adult)
Nickel	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	21 19 1.0 ND–5.6	1,000 10,000	RMEG (child) RMEG (adult)
Potassium	VEL (Pierce's Point)[a] VEL (North Landfill)[b]	2,180 2,070	NA	—
Selenium	VEL (Pierce's Point)[a] VEL (North Landfill)[b] Wetland Area[e]	1.3 0.6 ND–5.5	300 4,000	Chronic EMEG (child) Chronic EMEG (adult)
Sodium	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	210 230 677 ND–424	NA	—
Vanadium	ASR (Discharge Pt.)[c] Wetland Area[e]	2.3 ND–40	200 2,000	Intermediate EMEG (child) Intermediate EMEG (adult)
Zinc	VEL (Pierce's Point)[a] VEL (North Landfill)[b] ASR (Discharge Pt.)[c] Wetland Area[e]	90.5 88.5 7.8 4.8–121J	20,000 200,000	Chronic EMEG (child) Chronic EMEG (adult)

Note: Concentrations listed in bold are above comparison values.
a Data provided by AFCEE 1996e; MDNR 1992
b Data provided by AFCEE 1996d; MDNR 1992
c Data provided by AFCEE 1996b
d Data provided by AFCEE 1996c
e Data provided by AFCEE 1997b (Data represents that depicted in the appendices of the "AFCEE 1997b" document. Data presented in the main body of the "AFCEE 1997b" text is inaccurate [AFBCA 2000d].)
f Comparison value for naphthalene.

g Comparison value for hexavalent form.
h Based on the EPA 'Revised Interim Soil Lead Guidance for CERCLA sites and RCRA Corrective Action Facilities' (Directive 9355.4-12) 1994.
I Data provided by AFCEE 1995a
j See Figure 9 for general sample locations for Van Etten Lake.

ASR	Au Sable River	ND	Not detected
CREG	Cancer Risk Evaluation Guide	PCE	Tetrachloroethylene
EMEG	Environmental Media Evaluation Guide	ppm	parts per million
J	Estimated concentration	RBC	Risk-based concentration
JB	Estimated due to blank contamination	RMEG	Reference Dose Media Evaluation Guide
NA	Not applicable. Calcium, magnesium, potassium, and sodium are considered essential nutrients and do not exert toxic effects at low levels.	TCE	Trichloroethylene
		VEL	Van Etten Lake

Table 8
Data Collected From Seeps That Are Located Near Camp Nissokone
Wurtsmith Air Force Base, Oscoda, Michigan

Contaminant	Location of Detection[a]	Concentration Range (ppb)[b]	Comparison Value (ppb)	Comparison Value Source
1,1-Dichloroethene	Seep 2	ND–**2.0**	0.06 90 300	CREG Chronic EMEG (child) Chronic EMEG (adult)
cis-1,2-Dichlororoethene	Seep 1	ND–210	3,000 10,000	Intermediate EMEG (child) Intermediate EMEG (adult)
Methylene chloride	Seep 1 Seep 2	ND–4.0 ND–0.031J	5 600 2,000	CREG RMEG (child) RMEG (adult)
TCE	Seep 1	ND–**1,000**	5.0	MCL
Vinyl Chloride	Seep 2	ND–**2.0**	0.02 0.2 0.7	CREG Chronic EMEG (child) Chronic EMEG (adult)

Note: Concentrations listed in bold are above comparison values.
a Figure 9 depicts the locations of Seeps 1 and 2.
b Data provided by AFBCA 2000c.

CREG Cancer Risk Evaluation Guide
EMEG Environmental Media Evaluation Guide
MCL Maximum Contaminant Level
ND Not detected
ppb parts per billion
RMEG Reference Dose Media Evaluation Guide
TCE Trichloroethylene

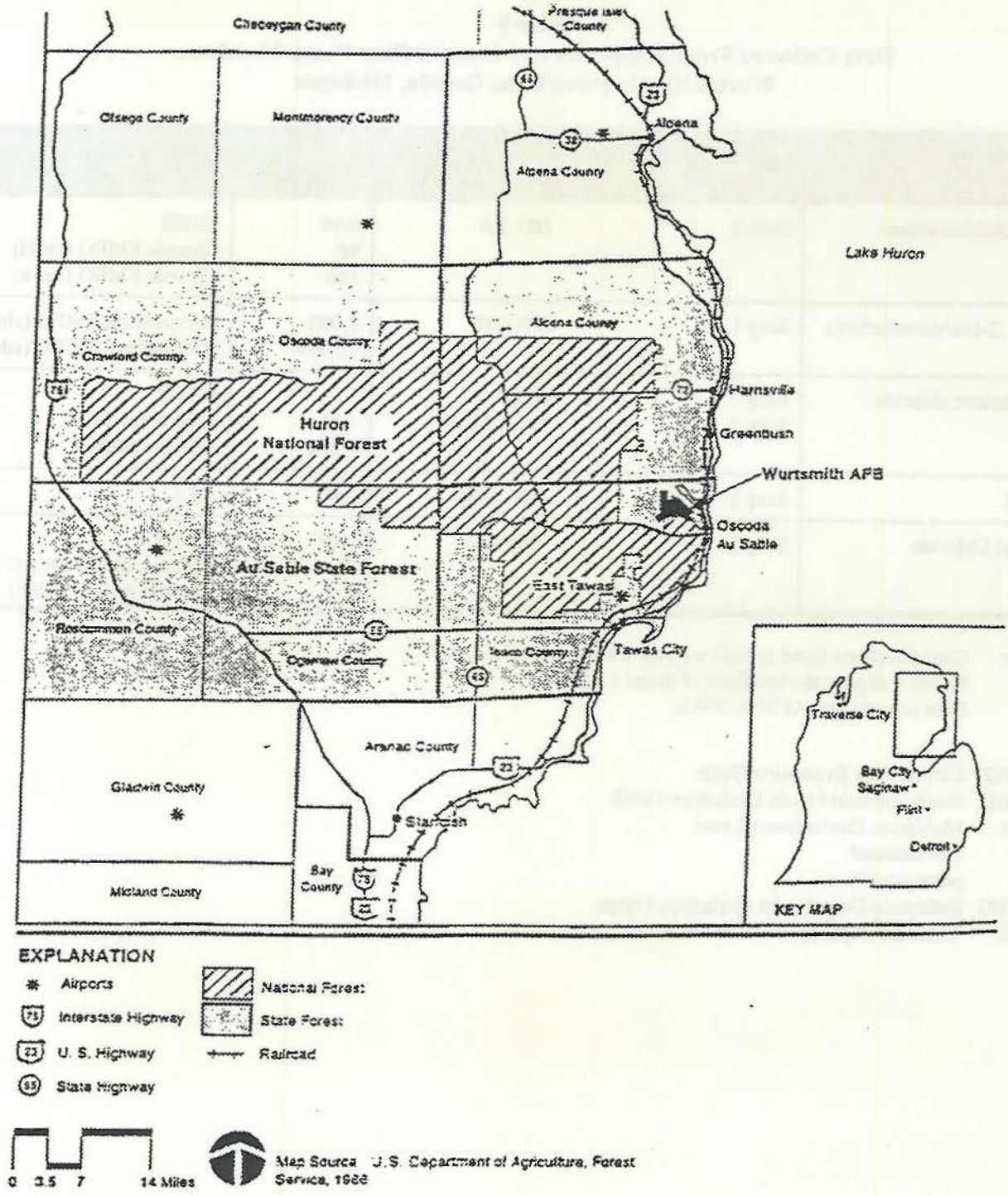

Figure 1 - Area Base Map, Wurtsmith Air Force Base, Oscoda, Michigan
(*Figure Adapted from Air Force 1993)*

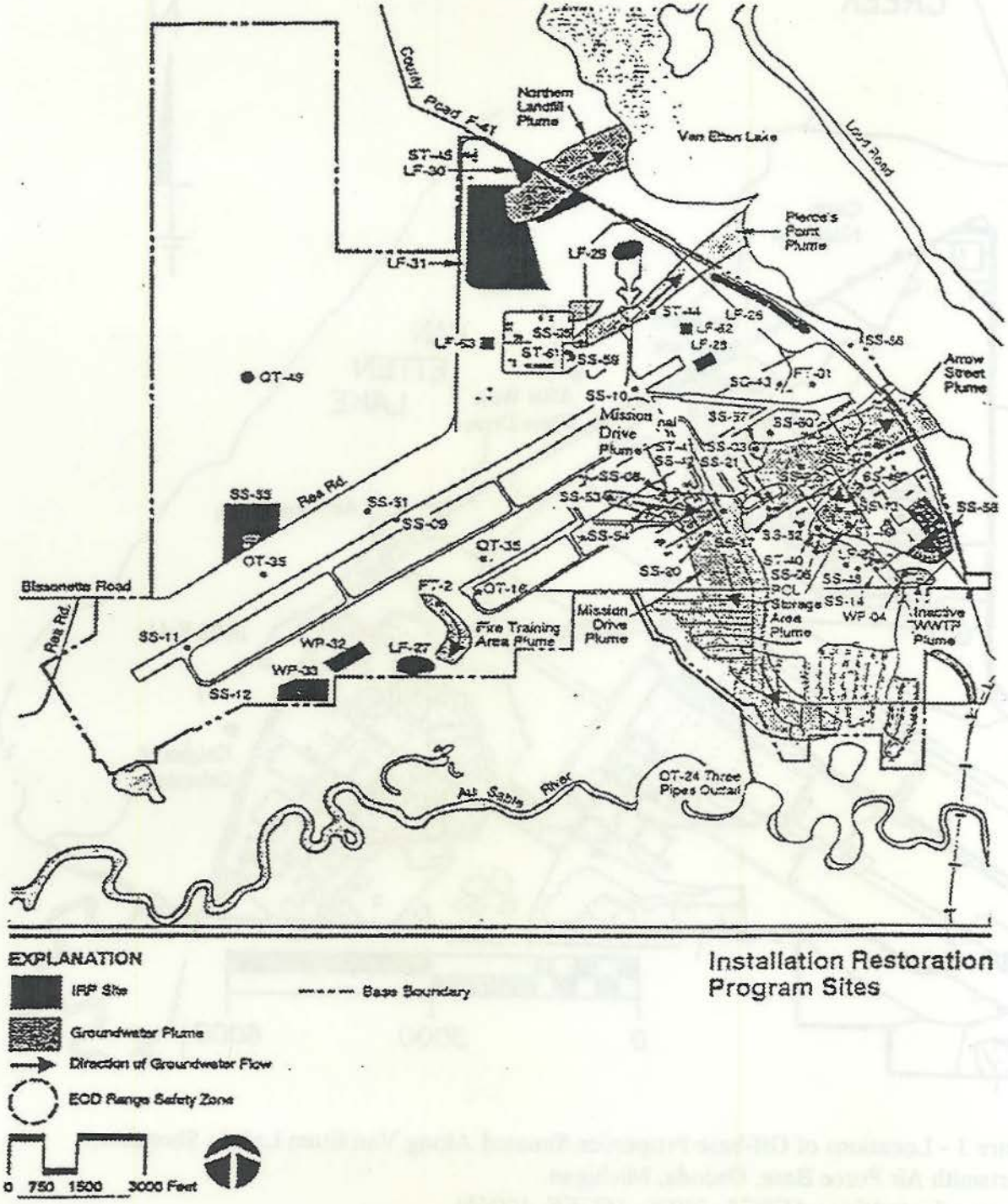

Figure 2 - IRP Sites Wurtsmith Air Force Base, Oscoda, Michigan
Figure adapted from Air Force 1993

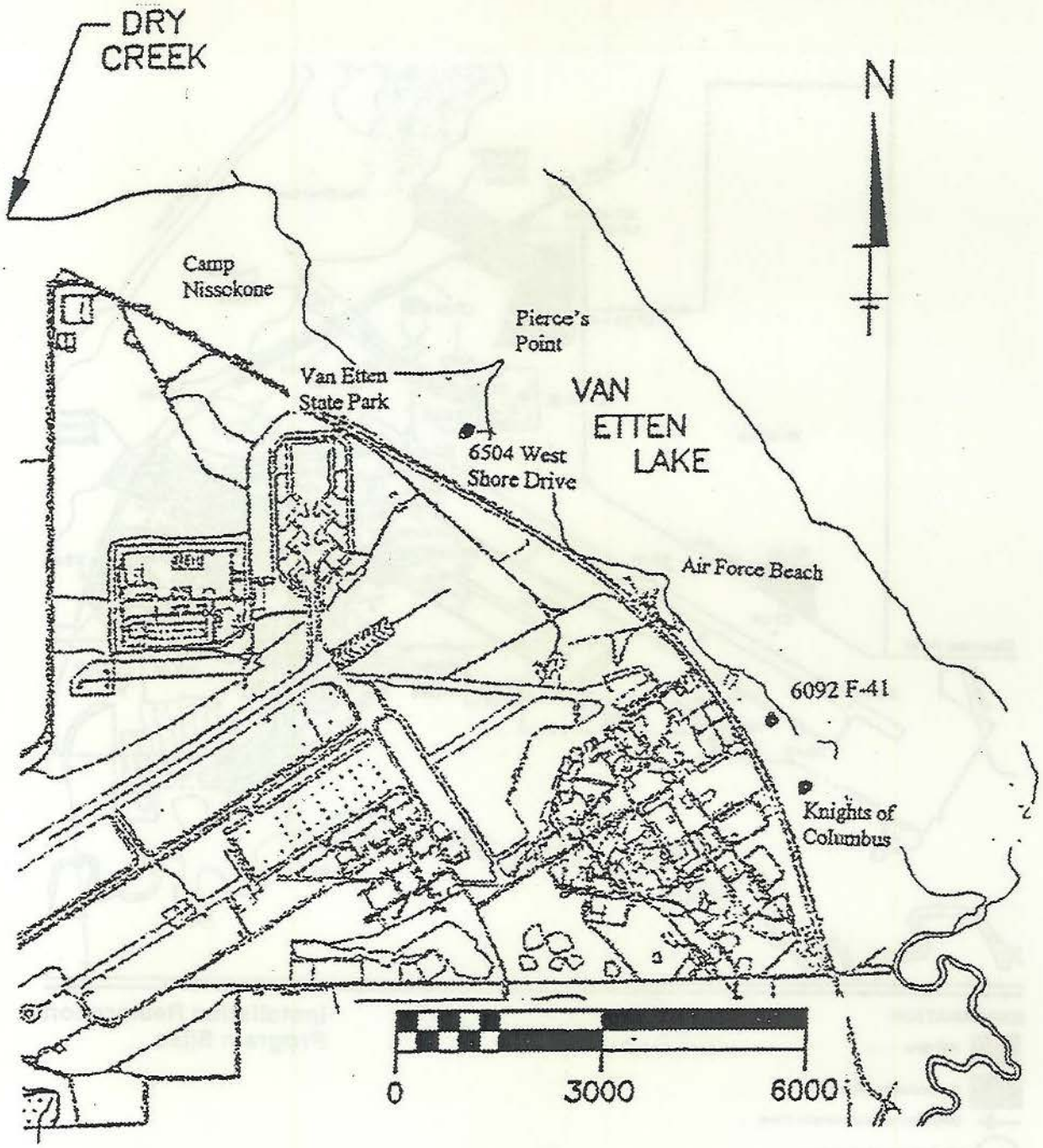

Figure 3 - Locations of Off-base Properties Situated Along Van Etten Lake's Shoreline, Wurtsmith Air Force Base, Oscoda, Michigan
Figure adapted from AFBCA, 1999j; AFCEE, 1996b)
Note: Locations depicted for off-base properties are approximate.)

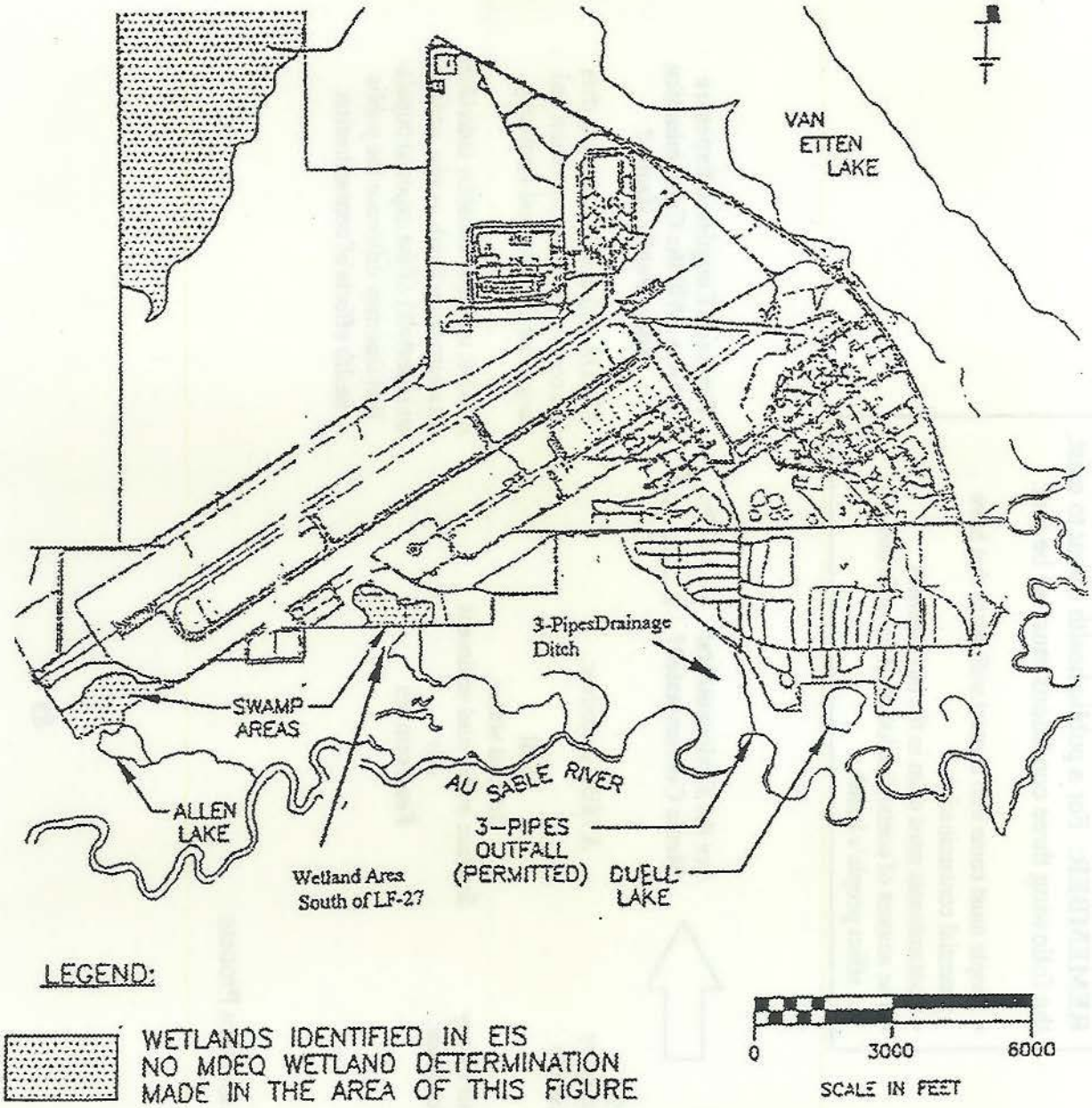

Figure 4 - Surface Water Bodies, Wurtsmith Air Force Base, Oscoda, Michigan
(Figure adapted from AFCEE 1996b)

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

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

Are People Exposed To Areas With Potentially Contaminated Media?

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

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

Inhalation
Ingestion
Dermal absorption

Are the Environmental Media Contaminated?

ATSDR considers:

Soil
Ground water
Surface water and sediment
Air
Food sources

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

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

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

Figure 5 - ATSDR's Exposure Evaluation Process

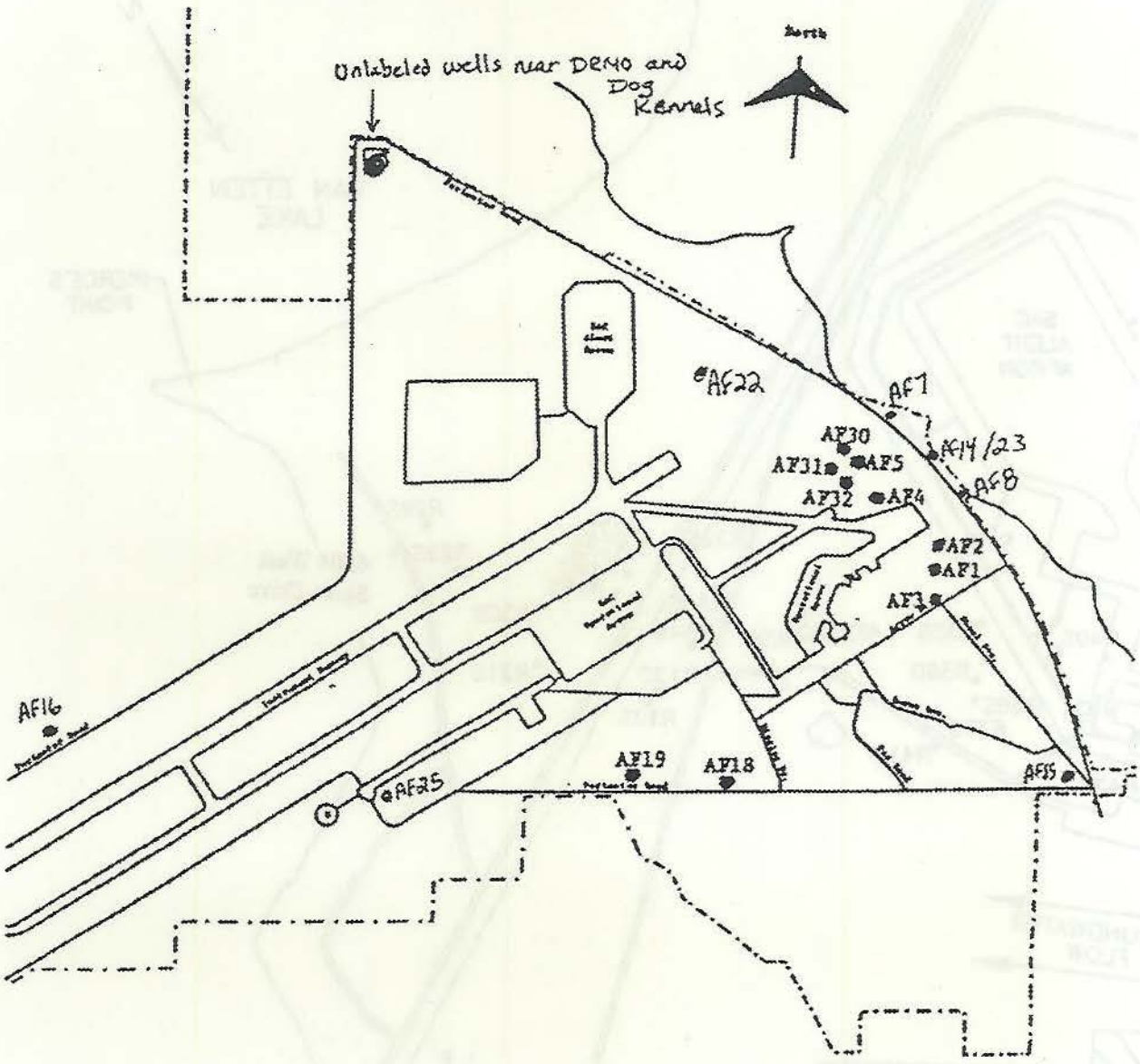

Figure 6 - USAF's Water Supply Wells, Main Water Supply Wells and Area-Specific Wells, Wurtsmith Air Force Base, Oscoda, Michigan
Figure adapted from Ayres, 1990)

Note:
1. Approximate locations of supply wells are depicted.
2. USAF's main water supply wells: AF1, AF2, AF3, AF5, AF18, AF19, AF30, AF31 and AF32.
3. USAF's area-specific wells: AF7, AF8, AF14, AF15, AF16, AF22, AF23, and two unlabelled wells.

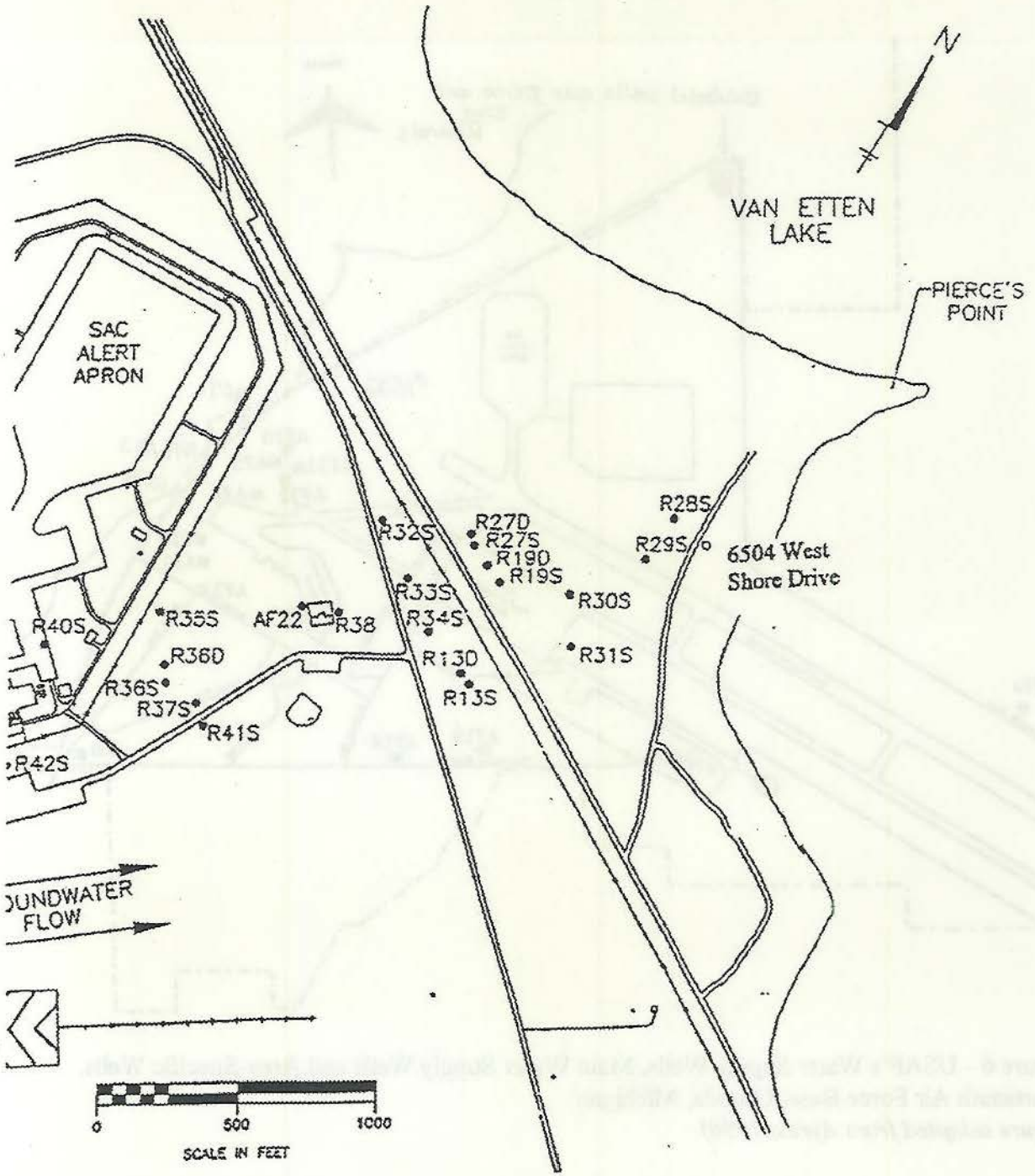

Figure 7 - Monitoring Wells Located Near Pierce's Point, Wurtsmith Air Force Base, Oscoda, Michigan

Figure adapted from AFCEE, 1996e

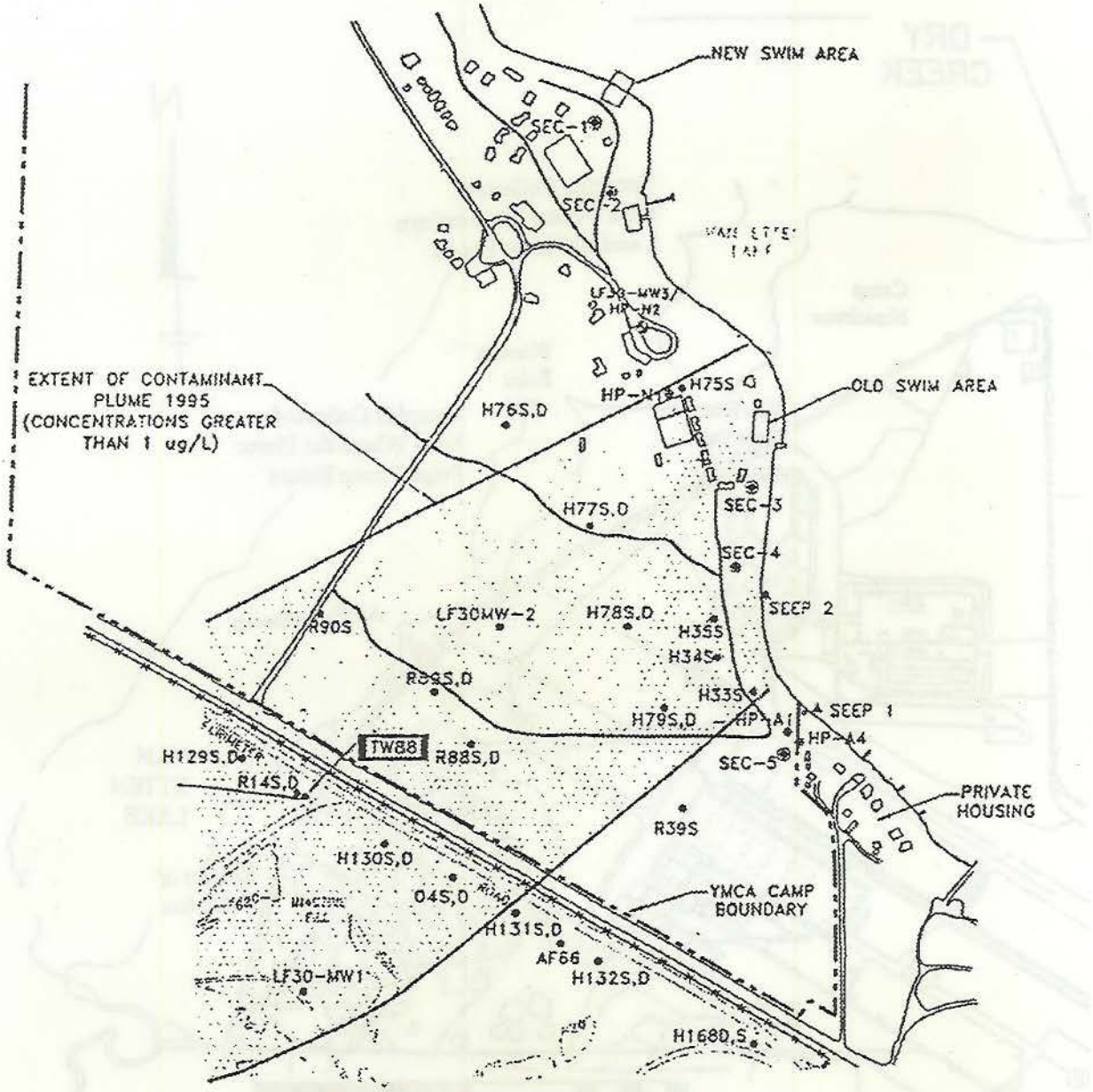

Figure 8 - Camp Nisskone's Swimming Areas and Seep Areas, Wurtsmith Air Force Base, Oscoda, Michigan
Figure adapted from AFBCA 1999h

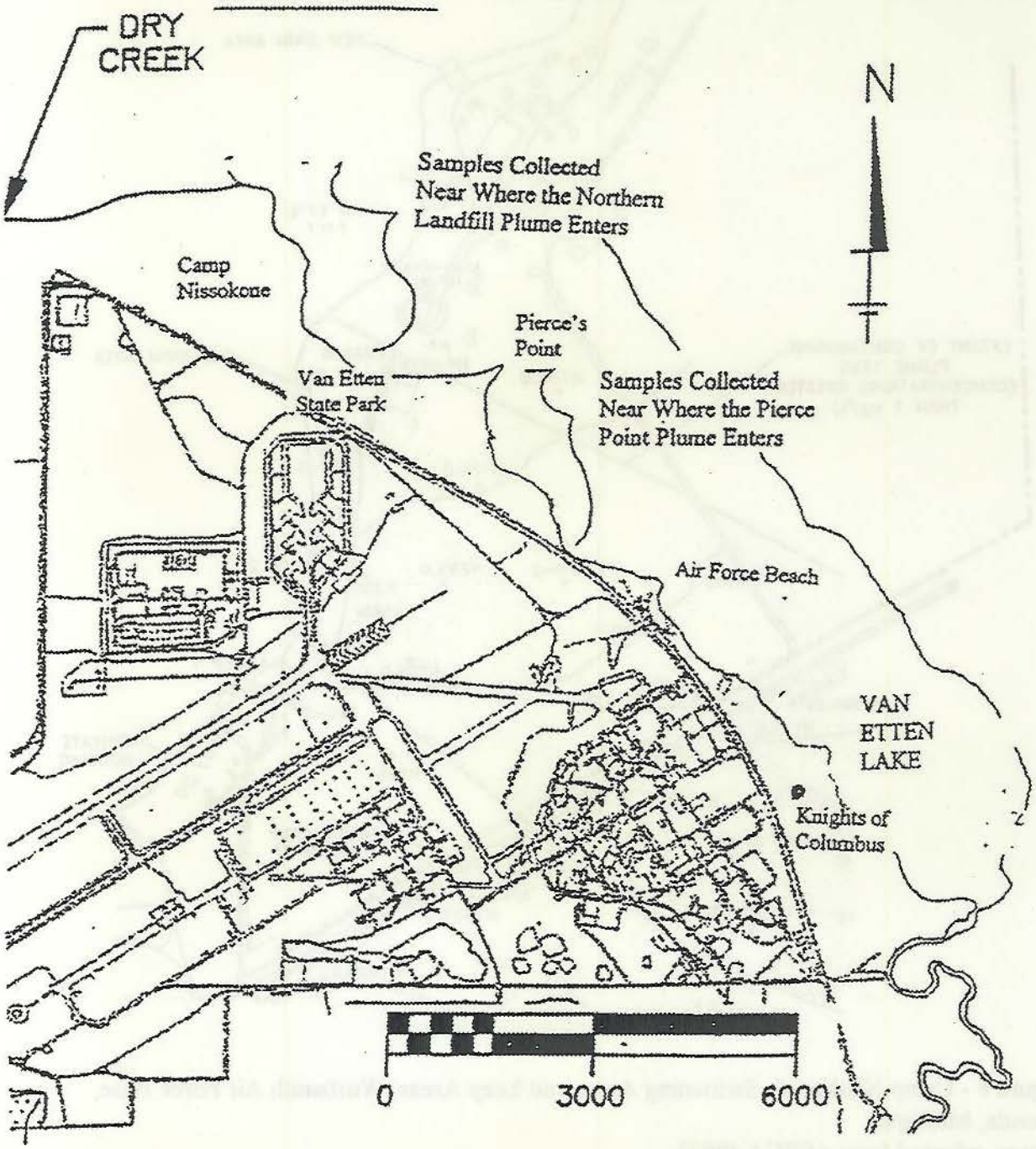

Figure 9 - Sampling Locations at Van Etten Lake, Wurtsmith Air Force Base, Oscoda, Michigan
Figure adapted from AFCEE, 1996b

Appendix A. Evaluation of Potential Public Health Hazards Associated With the IRP Sites at Wurtsmith Air Force Base (WAFB)

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
FT-01: Inactive Fire Training Area, Northeast End of Runway Between 1951 and 1958, this area was used as a fire training area. Drums of waste fuels and solvents (400 to 500 gallons per fire) were poured onto the ground and ignited. Water and foam were used to extinguish the flames.	**Soil**: In 1995, surface and subsurface samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and lead. No contaminants exceeded the Michigan Department of Environmental Quality (MDEQ)'s Generic Industrial Criteria. Some did exceed MDEQ's residential criteria, but these were below ATSDR's soil comparison values (CVs). **Groundwater**: In 1991, groundwater samples were analyzed for VOCs. No contaminants were detected above detection limits. In 1995, as part of a Remedial Investigation (RI), additional groundwater samples were analyzed for VOCs, SVOCs, and lead. Trichloroethylene (TCE), bis(2-ethylhexyl) phthalate, and lead were detected, but below MDEQ's health guidelines.	**Current Status**: No further action required.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils at FT-01 while the base was operational because access to the area was restricted. Base employees may have contacted these soils in the past, but exposures were likely infrequent. Also, these employees probably wore thick fireman suits and boots. This would minimize their direct contact with the site's soil. Current and projected future use for this site is industrial/commercial. Available data indicate that surface and subsurface soil concentrations are too low to pose current or future health hazards. **Groundwater**: Several of the U.S. Air Force (USAF)'s main water supply wells are located near FT-01, but FT-01 is not thought to have impacted them. No one is currently using the groundwater in the vicinity of FT-01. Any potential future exposures are not expected to pose health hazards because (1) current contaminant concentrations are too low and (2) the groundwater conditions under FT-01 are not expected to worsen in the future. (Soil contaminants are not leaching appreciably and contaminated water located upgradient of the site is being treated.)

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
FT-02: Active Fire Training Area, Southwest Section of the Base Between 1958 and 1991, FT-02 was used as a fire training facility. Fires were started using waste fuels and solvents and extinguished using foams. The fuels were supplied by a nearby fuel tank. Starting in 1982, all fires were lit within a concrete lined pit. Water that collected in the pit was drained to an oil/water separator (OWS). FT-02 contaminants have not been detected in the OWS.	**Soil**: In 1995, as part of a RI, samples were analyzed for VOCs, SVOCs, polynuclear aromatics (PNAs), and metals. Arsenic (0.9–1.9 parts per million [ppm]) was detected in the surface soil above ATSDR's soil CV. It was also detected at elevated concentrations (0.41–2.0 ppm), along with lead (ND–121 ppm), in the subsurface. (Note: Although site documents indicated that several additional subsurface contaminants exceeded MDEQ's standards, their concentrations were below ATSDR's soil CVs.) **Groundwater:** In the late 1980s, a groundwater plume was identified, migrating from FT-02 toward a wetland area. In 1995, as part of a RI, several contaminants were detected above ATSDR's drinking water CVs, including benzene (nondetect [ND]–96 parts per billion [ppb]), vinyl chloride (ND–28 ppb), arsenic (ND–18.7 ppb), and manganese (ND–409 ppb). **Surface Water/Sediment**: Contaminated groundwater has migrated to a wetland area. Data collected from the wetland are summarized in Tables 6 and 7.	**Current Status**: • Groundwater and seep monitoring is conducted biannually. • A monitored natural attenuation system is being designed for the site to address groundwater contamination. • Soils will be remediated either through air sparging or soil vapor extraction.	**Soil:** It is unlikely that on-base residents or the general public were exposed to surface soils at FT-02 while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Also, these employees probably wore thick fireman suits and boots. This would minimize their direct contact with the site's soil. The area will be used for recreational activity in the future. Based on available data and ATSDR's exposure evaluation, current and future exposures to surface and subsurface soils are not associated with health hazards. **Groundwater**: No on-base water supply wells are located in the vicinity of FT-02; therefore, no past or current exposures to groundwater have occurred. Groundwater conditions under FT-02 could worsen in the future if groundwater under SS-51 migrates to the FT-02 area, but any potential future exposures are not expected to pose health hazards because (1) the groundwater under FT-02 will be remediated, (2) soil treatment activities will prevent additional contaminants from impacting the groundwater, and (3) groundwater restrictions will ensure that the groundwater under FT-02 is not used until contaminants are reduced to safe levels. **Wetland Area South of LF-27**: The wetland area south of LF-27 is used by people who hunt deer and turkey. As explained in the main body of the text, hunters are not expected to experience adverse health effects by coming into contact with the wetland's surface water and sediment. No tissue samples have been collected from game animals that might be exposed to the wetland's contaminants. Thus, ATSDR cannot make definitive conclusions about whether people could be eating contaminated game animals.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-03: JP-4 Spill, Southwest of Building 43 Refueling Maintenance Shop Between 1956 and 1957, JP-4 tank trucks were drained in a paved parking area. Several JP-4 spills were reported.	**Soil:** In 1991, investigators concluded that no significant contamination remains in the soils. **Groundwater**: In 1991, groundwater samples were analyzed. Some contaminants, including tetrachloroethylene (PCE) (up to 44 ppb) and TCE (up to 220 ppb), were detected above ATSDR's drinking water CVs. (Investigators believe these contaminants are migrating from SS-21.)	**Current Status**: No further action required.	**Soil:** It is unlikely that on-base residents or the general public were exposed to surface soils at SS-03 while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Current and potential future exposures to soils at SS-03 will not pose health hazards because no significant contamination remains in the area. **Groundwater**: Groundwater under SS-03 has been impacted by the Arrow Street Plume (see Site SS-21), but no one is currently using the groundwater. Potential future exposures are not expected to pose health hazards, however, because (1) the groundwater under this site is being remediated by the Arrow Street pump-and treat system (ASPTS) and (2) groundwater restrictions imposed under Site SS-21 will prevent people from using the water under SS-03 if contamination persists in this area in the future.
WP-04: Inactive Waste Water Treatment Plant (WWTP) Between 1959 and 1983, the WWTP received all of the base's sanitary waste water. For a short time, it also received water from an interim water treatment plant that aerated TCE-laden groundwater. The WWTP consisted of a settling tank, trickling filters, clarifiers, sludge digesters, and sludge beds.	**Soil/Sludge**: In 1980, samples were analyzed for TCE, dichloroethene, benzene, and toluene. Then, in 1995, surface and subsurface soil samples were analyzed for VOCs, SVOCs, and metals. No contaminants exceeded MDEQ's health guidelines during either sampling event. **Groundwater**: In the early 1980s, TCE (up to 65 ppb) was detected in samples near the sludge beds. In 1995, as part of a RI, additional samples were analyzed for VOCs, SVOCs, and metals. Several constituents were detected, but TCE (up to 6.9 ppb) and PCE (up to 14 ppb) were the only contaminants that exceeded MDEQ's health guidelines. The RI concluded that a TCE plume is migrating in a northeasterly direction.	**Corrective Activities**: The structures associated with WP-04 have been removed and the area has been backfilled with sand. **Current Status**: • Groundwater monitoring is conducted on a regular basis. • Natural attenuation is ongoing.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils at WP-04 while the base was operational because access to the area was restricted. Base employees may have contacted surface materials in the past. Based on limited sampling, however, contaminant concentrations have never been high enough to pose health hazards. **Groundwater**: In the past, groundwater under WP-04 flowed toward USAF's area-specific well AF15. As noted in the main body of the text, past exposures to AF15 did not pose health hazards. No one is currently exposed to the groundwater in the vicinity of WP-04. Potential future exposures are not expected to pose health hazards because (1) the groundwater is being treated by the ASPTS and (2) restrictions will ensure that the groundwater under WP-04 is not used until contaminants are reduced to safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-05: TCE Spill (Pierce's Plume) Bombs and air launch cruise missiles were stored and maintained in this area between 1956 and 1993. Throughout the 1950s, 60s, and 70s, TCE was used as a cleaning solvent in the buildings. Wastes from the buildings traveled through drain pipes to a septic tank, and then into leachfields.	**Soil**: In 1994, as part of a RI, subsurface samples were collected. Arsenic (ND–0.8 ppm) was the only constituent that exceeded ATSDR's soil CV. **Groundwater**: SS-05 is the suspected source of the Pierce Point Plume, where several groundwater contaminants (e.g., TCE and PCE) have been detected above ATSDR's drinking water CVs. Contaminant concentrations are decreasing over time, however. **Surface Water/Sediment**: Groundwater from SS-05 discharges to Van Etten Lake. Sediment and surface water data have been collected on numerous occasions. Data are summarized in Tables 6 and 7.	**Current Status**: • Natural attenuation is ongoing. • Groundwater and surface water monitoring is ongoing.	**Soil**: All soil contaminants associated with the leachfields are in the subsurface. These subsurface soils could be contacted if the area is excavated in the future, but concentrations are too low to pose health hazards. **Groundwater**: The Pierce Plume has migrated off base, impacting areas with private wells. Past and current health hazards associated with exposures to these wells are discussed in the main body of the text of this public health assessment. Future health hazards are not expected to occur because (1) most of the surrounding area now receives municipal water and (2) advisories will be issued against drilling new wells into contaminated areas. Because the plume extends underneath off-base residences, ATSDR evaluated the potential for groundwater to volatilize into subsurface structures. As noted in the main body of the text, health hazards are not thought to be associated with this pathway. **Surface water/Sediment**: Contaminants from the Pierce Point plume discharge into Van Etten Lake. As explained in the main body of the text, swimmers, fishers, and people who consume fish are not expected to experience adverse health effects.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-06: Fuel Spill in the Petroleum, Oil, and Lubricant (POL) Bulk Storage Area Site SS-06 was used as a POL storage area. Four aboveground storage tanks (ASTs) were located in the area. Reports indicate that one of them, a 1.2-million gallon jet fuel AST, leaked.	**Soil**: In 1994, as part of a RI, surface and subsurface soil samples were analyzed for volatiles, PNAs, and lead. No contaminants exceeded ATSDR's soil CVs (Note: Although site documents indicated that some subsurface contaminants were above MDEQ's Generic Residential Criteria, their concentrations did not exceed ATSDR's soil CVs. **Groundwater**: SS-06 has been identified as the source of the POL Bulk Storage Area Plume, an area consisting of three distinct benzene plumes and a free product plume. A 1994 sampling event indicated that several constituents exceed ATSDR's drinking water CVs, including benzene (ND–1,200 ppb), ethylbenzene (ND–1,300 ppb), TCE (ND–13 ppb), and xylene (ND–4,600 ppb).	**Current Status**: • The leaking AST was removed in 1992. • Remediation is ongoing. (The Benzene Plant pump-and-treat system [BPPTS] was installed in 1992 to prevent the northward migration of the POL Bulk Storage Area Plume.) Also, air sparging, soil vapor extraction, and bioventing are underway.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Current and projected future use for this site is industrial/commercial. Available data indicate that surface and subsurface soil concentrations are too low to pose current or future health hazards. **Groundwater**: No on-base water supply wells are located in the vicinity of SS-06; therefore, no past or current exposures to the groundwater in the POL Bulk Storage Area have occurred. Also, no one is currently using the groundwater in the vicinity of SS-06. Potential future exposures are not expected to be associated with a health hazard because (1) restrictions will ensure that the groundwater under SS-06 is not used until contaminant levels are reduced to safe levels and (2) the groundwater is not expected to migrate to off-site areas because it is being captured by the BPPTS and the ASPTS.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-08: TCE and Fuel Spills at the Nose Dock Area and Air Combat Command (ACC) Operational Apron Site SS-08 includes the ACC Operational Apron, nose dock, and maintenance areas. The area was used to park, clean, maintain, and refuel aircrafts. Sources of potential contamination include OWSs, the Southern Blast Fence (where small amounts of solvents were dumped), the refueling system (where a leaking fuel line was found in September 1988), and Parking Spot #19.	**Soil**: In 1993, 1994, and 1995, surface and subsurface samples were collected, but no contaminants exceeded ATSDR's soil CVs. In the mid-1990s and 1996, additional subsurface samples were collected along excavated areas. Some polycyclic aromatic hydrocarbons (PAH)s (e.g., benzo[a]pyrene at 3.7 ppm) and arsenic (ND–1.1 ppm) exceeded ATSDR's soil CVs. **Groundwater**: SS-08 has been identified as the probable source of the Mission Drive Plume, a plume that was pulled in a southward direction by the pumping activities of AF18 and AF19. Several groundwater samples were collected in the vicinity of SS-08 between 1979 and 1996. The more recent sampling events indicate that several contaminants are present above ATSDR's CVs, including benzene [ND–1,400 ppb], chloroform [ND–40 ppb], methylene chloride [ND–22 ppb], PCE [ND–9 ppb], and TCE [ND–28 ppb]). **Surface Water Bodies**: Some reports indicate that the Mission Drive Plume has migrated to Duell Lake and the Au Sable River. These migration pathways are discussed under the "OT-24" site.	**Corrective Activities**: • Contaminated soil was excavated near a leaking fuel line in October 1988. • Components of the refueling system have been removed or cleaned. • Several underground storage tanks (USTs) have been removed. **Current Status**: Remediation is ongoing. (Groundwater is being remediated by the ASPTS, the BPPTS, and the Mission Drive pump-and-treat system (MDPTS). An air sparging/ soil vapor extraction system will be operational in the near future.)	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils at SS-08 while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. This area is currently being used as an airfield and it is expected to continue to be used for this purpose in the future. Exposures to surface soils are not expected to pose current or future health hazards because detected concentrations are too low. Subsurface soils could be contacted if the area is excavated in the future. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low, however. **Groundwater**: USAF's main water supply wells AF18 and AF19 have been impacted by the Mission Drive Plume. The potential for USAF's main water supply wells to have posed past health hazards is evaluated within the main body of the text. No one is currently using the groundwater in the vicinity of the Mission Drive Plume. Potential future exposures are not expected to be associated with a health hazard because (1) the groundwater is currently being treated and (2) restrictions will ensure that groundwater associated with SS-08 is not used until contaminant levels are reduced to safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-09: JP-4 Spill, Center of SAC Instrument Runway In November 1978, a KC-135 lost an engine before take-off and spilled an estimated 125 gallons of JP-4. Some of the fuel burned when the plane caught fire and the rest was foamed and washed off the runway.	**Soil**: In 1987, subsurface soil samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX), chlorobenzene, dichlorobenzenes, and total petroleum hydrocarbon (TPH). TPH was detected at 470 ppm. Additional subsurface soil samples were analyzed in 1991 for VOCs, PNAs, and methyl tert-butyl ether (MTBE). No contaminants were detected above ATSDR's soil CVs. **Groundwater**: In 1987, groundwater samples were analyzed for BTEX, chlorobenzene, dichlorobenzenes, and TPH. TPH was detected at concentrations ranging from nondetect to 5,300 ppb. Additional groundwater samples were collected in 1991, but from locations that were hundreds of feet crossgradient of where the high TPH values had previously been detected. During this second sampling event, samples were analyzed for VOCs, PNAs, and MTBE. No contaminants were detected.	**Current Status**: No further action required.	**Soil**: It is highly unlikely that the general public or on-base residents accessed this area while the base was operational because access to the area was restricted. Base employees may have contacted the area, but exposures would have been infrequent. Future exposures are not expected because the contamination is found in subsurface soils that are inaccessible to the public. **Groundwater**: No on-base water supply wells are located near SS-09; therefore, no past or current exposures to groundwater have occurred. Even though there are no deed restrictions in place to prevent someone from drilling a well at SS-09 in the future, ATSDR does not believe that potential future exposures will be associated with a health hazard. ATSDR was concerned that TPH levels could be high in this area. (As noted in previous columns, TPH was detected at 5,300 ppb in 1987, and the location that had this detection was never resampled.) Thus, ATSDR called the District Health Department to determine whether provisions are in place to ensure that wells will not be drilled into contaminated areas. ATSDR was assured that this would not be allowed to happen. (The District Health Department representative said that his department must be notified when someone wants to drill a new well. Because SS-09 is located near contaminated plumes, the department would require samples to be collected to make sure the new well would not draw from contaminated areas. The representative said that the department has jurisdiction over areas that are not federally owned. [In the near future, SS-09 will be transferred to Oscoda Airport and will no longer be considered federal property.])

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-10: JP-4, Northeast End of SAC Instrument Runway In 1978, a B-52 blew a fuel vent and spilled 400 to 500 gallons of JP-4 on Taxiway E. The spill was washed off the taxiway onto oil sorbent pads and into the storm sewer. Sorbent pads were also used at the storm sewer discharge.	**Soil**: In 1987 and 1988, subsurface soil samples were analyzed for BTEX, chlorobenzene, and TPH. TPH (490 ppm) was detected once at a depth of 15 feet. In 1991, additional soil samples were collected. Contaminant concentrations did not exceed Michigan Department of Natural Resources (MDNR)'s health guidelines. **Groundwater**: In 1987 and 1988, groundwater samples were analyzed for BTEX, chlorobenzene, and TPH. No contaminants were detected. In 1991, additional groundwater samples were collected. None of the contaminants exceeded MDNR's health guidelines or EPA's maximum concentration limits (MCLs).	**Current Status**: No further action required.	**Soil**: It is highly unlikely that the general public or on-base residents accessed this area while the base was operational. (Site 10 is located along the flight line: access was highly restricted while the base was operational.) Base and grounds maintenance employees may have contacted and may continue to contact surface soils in the area. In addition, construction or remedial workers could access the site in the future. Because exposures would be so infrequent, however, current and future exposures to TPH concentrations are not expected to pose health hazards. **Groundwater**: No on-base water supply wells are located near SS-10; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because there is no evidence that groundwater underlying the site was impacted by site activities.
SS-11: JP-4 Spill, Southwest End of SAC Instrument Runway In May 1984, an A-7 training plane crashed. Some of the JP-4 fuel was spilled, but the exact quantity is unknown.	**Soil**: In 1988, subsurface samples were analyzed for BTEX, chlorobenzene, dichlorobenzenes, and TPH. No contaminants were detected. **Groundwater**: In 1988, groundwater samples were analyzed for BTEX, chlorobenzene, dichlorobenzenes, and TPH. No contaminants were detected.	**Current Status**: No further action required.	There is no evidence that this area was adversely affected by the spill. (No contaminants were detected.)

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-12: JP-4 Spill, Southwest to South Central Part of Taxiway In March 1982, a B-52 hit a snowbank and broke open fuel tanks on one wing. The quantity of fuel spilled is unknown.	**Soil**: In 1988, subsurface samples were analyzed for BTEX, chlorobenzene, dichlorobenzenes, and TPH. No contaminants were detected. **Groundwater**: In 1988, groundwater samples were analyzed for BTEX, chlorobenzene, dichlorobenzenes, and TPH. No contaminants were detected.	**Current Status**: No further action required.	There is no evidence that this area was adversely affected by the spill. (No contaminants were detected.)
SS-13: Motor Gasoline (MOGAS) Spill, Building 394 (Motor Pool) In the mid-1970s, an unknown quantity of MOGAS was spilled. Fire hydrants were opened to dilute the spill. Attempts to excavate contaminated soils were hampered by frozen ground. The spill was never contained or removed.	**Soil**: In 1994, as part of a RI, surface and subsurface samples were analyzed for volatiles, PNAs, and metals. Lead (4.7–89.8 ppm) was detected in surface soils at concentrations exceeding health guidelines commonly used by ATSDR. **Groundwater**: In 1994, as part of a RI, groundwater samples from the POL Bulk Storage Area were analyzed for volatiles, BTEX, MTBE, and PNAs. (Note: Samples collected from the POL Bulk Storage Area are considered representative of conditions underlying SS-06, SS-13, and ST-40 because these sites are very close in proximity.) Several constituents exceeded ATSDR's drinking water CVs, including benzene (ND–1,200 ppb), ethylbenzene (ND–1,300 ppb), TCE (ND–13 ppb), and xylene (ND–4,600 ppb).	**Current Status**: No further action required.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Current and projected future use for this site is industrial/commercial. Exposures to detected lead concentrations are not expected to pose health hazards under this land use scenario. **Groundwater**: No on-base water supply wells are located in the vicinity of SS-13; therefore, no past or current exposures to groundwater in the POL Bulk Storage Area have occurred. Potential future exposures are not expected to cause a health hazard because (1) restrictions will ensure that the groundwater under SS-13 is not used until contaminants are reduced to safe levels and (2) the groundwater is not expected to migrate to off-site areas because it is being captured by the BPPTS and the ASPTS.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-14: JP-4 Spill, Southwest of Building 3029 Tank trucks were drained in this area in 1956 or 1957.	**Soil**: In 1987, subsurface samples were analyzed for BTEX, chlorobenzene, dichlorobenzenes, and TPH. No contaminants were detected. **Groundwater**: In 1987, groundwater samples were analyzed for BTEX, chlorobenzene, TPH, and dichlorobenzenes. No contaminants were detected.	**Current Status**: No further action required.	There is no evidence that this area was adversely affected by the spill. (No contaminants were detected.)
OT-16: Jet Engine Test Cell, Building 5098 Building 5098 was constructed in 1972 and was used to test engines until 1990s. Fuels and solvents that spilled to the floor were washed down a floor drain and passed through an OWS. Prior to 1988, discharge from the OWS was directed to a dry well. After that, it was directed to an AST. Records indicate that the OWS overflowed on several occasions.	**Soil**: In 1995, as part of a RI, several samples were analyzed for volatiles and metals. Benzo(a)pyrene (ND to 0.33 ppm in surface soil and ND to 3.0 ppm in subsurface soils) and arsenic (1.0 to 1.7 ppm in surface soil and 0.38–1.8 ppm in subsurface soils) were detected above ATSDR's soil CVs. (Note: Although site documents indicated that several other contaminants were above MDEQ's Generic Residential Criteria, their concentrations did not exceed ATSDR's CVs.) **Groundwater**: In 1991, several contaminants were detected in the groundwater. A sampling effort conducted in 1995 revealed that several constituents are present at concentrations above ATSDR's drinking water CVs, including benzene (ND–300 ppb), TCE (ND–16 ppb), toluene (ND–1,600 ppb), and xylene (ND–3,400 ppb). Additional samples will be collected during summer 2000 to fill in data gaps. **Surface Water/Sediment**: Contaminated groundwater has migrated to a wetland area. Data collected from the wetland are summarized in Tables 6 and 7.	**Corrective Activities**: • The drywell and surrounding soils were excavated in 1989. • The AST spill was cleaned using absorbent material. Soils were removed at a later date. • The AST was removed and the floor drain in the test bay was plugged in 1990. **Current Status**: A groundwater remedy will be chosen in 2000. (Base representatives propose natural attention; regulators will decide if this is an adequate solution after reviewing data from the summer 2000 sampling event.)	**Soil:** It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. This area will be used for recreational activity in the future. Based on available data and ATSDR's evaluation of potential current and future exposures, contaminants detected in the soil are not expected to pose health hazards. **Groundwater**: USAF's area-specific well AF25 is located near OT-16, but investigators have concluded that the well (which is located crossgradient) has not been impacted by the groundwater at OT-16. Groundwater conditions under OT-16 could worsen if groundwater under SS-51 migrates to the OT-16 area, but any potential future exposures are not expected to cause health hazards because (1) the groundwater under the site will be remediated and (2) restrictions will ensure that the groundwater under OT-16 is not used until contaminants are reduced to safe levels. **Wetland Area South of LF-27**: The wetland area south of LF-27 is used by people who hunt deer and turkey. As explained in the main body of the text, hunters are not expected to experience adverse health effects by coming into contact with the wetland's surface water and sediment. No tissue samples have been collected from game animals that might be exposed to the wetland's contaminants. Thus, ATSDR cannot make definitive conclusions about whether people could be eating contaminated game animals.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-17: Fuel Oil Spill, Near Building 25 In 1978, 100 gallons of heating oil was spilled from an AST. The oil was absorbed directly into the ground.	**Soil**: In 1991 and 1995, samples were analyzed for VOCs and PAHs. During both occasions, some PAHs (e.g., benzo[a]pyrene at 2.6 ppm in surface soil and 8.2 ppm in the subsurface) were detected above ATSDR's soil CVs. None of the contaminants exceeded MDEQ's Generic Industrial Criteria, however. **Groundwater**: SS-17 has been impacted by the Arrow Street Plume. In 1991, 1994, and 1996, groundwater samples were collected from the SS-17/SS-21 area. (The groundwater investigations at SS-17 are done is conjunction with SS-21 given the close proximity of the sites.) Several contaminants have been detected above ATSDR's drinking water CVs, including benzene, cis-1,2-dichloroethene, PCE, TCE, and toluene.	**Current Status**: • Remediation is ongoing (Groundwater is being treated by the ASPTS.)	**Soil:** It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soils in the past, but exposures were likely infrequent. Current and projected future use for this site is industrial/commercial. Based on available data and ATSDR's evaluation of potential current and future exposures, contaminant concentrations in the surface and subsurface are not expected to pose a health hazard. **Groundwater**: Groundwater under SS-17 has been impacted by the Arrow Street Plume (see Site SS-21). This plume impacted some of USAF's main water supply wells. (Potential past health hazards associated with exposures to these wells are discussed within the main body of the text.) No one is currently using the groundwater in the vicinity of SS-17. Potential future exposures are not expected to be associated with health hazards because (1) the groundwater under this site is being remediated by the ASPTS and (2) restrictions will ensure that the water under SS-17 is not used until contaminants are reduced to safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-19: JP-4 Spill, Building 393, Motor Pool About 400 to 500 gallons of JP-4 were spilled in Building 393 and flushed down the floor drain into an OWS in the mid-1970s. JP-4 was released to the sanitary sewer system in the process. SS-19 consists of the floor area where the spill occurred, the floor drain, and the sanitary lines leading to and from the OWS. (The OWS is addressed as ST-67.)	**Soil**: In 1991, one soil sample was collected beneath the floor slab of Building 393 and analyzed for VOCs and PNAs. No contaminants were detected above ATSDR's soil CVs. **Groundwater**: No groundwater samples were collected.	**Current Status**: No further action required.	**Soil**: Wastes were released to the subsurface. Therefore, past and current public exposures to impacted surface soils has not occurred. In the future, people could be exposed to soils if the area is excavated. Based on available data, however, soil contaminants are too low to pose health hazards. **Groundwater**: No on-base water supply wells are located in the vicinity of SS-19; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because (1) the groundwater under this site is being remediated by the BPPTS and (2) groundwater restrictions imposed under Site SS-06 will prevent people from using the water under SS-19 unless sampling data clearly show that the water is safe to drink.
SS-20: JP-4 Spill, Building 5001 In 1971, 250 gallons of JP-4 spilled inside Building 5001. The spill was contained within the building.	In 1985, a Phase I investigation was performed and investigators concluded that there was no evidence of contamination at this site. As a followup, subsurface soil samples were collected in 1991. No contaminants were detected above ATSDR's soil CVs.	**Current Status**: No further action required.	There is no evidence that this site contains contaminants at concentrations that are high enough to pose health hazards.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-21: TCE Spill (Arrow Street Plume), Northwest of Building 43 In 1962, a 500-gallon UST, containing waste oil and TCE, was installed. It was removed in 1977 when a leak was detected. It is unknown when the tank started leaking.	**Soil**: In 1991, one surface sample and several subsurface soil samples were analyzed for VOCs. No contaminants exceeded ATSDR's soil CVs. **Groundwater**: Site 21 is the source of the Arrow Street Plume, a plume that was identified in the late 1970s. The area under Site 21 has also been impacted by contaminants migrating from other sources (i.e., SS-06, SS-08, and SS-47). In 1991, 1994, and 1996, groundwater samples were collected. Several contaminants were above ATSDR's drinking water CVs, including benzene, cis-1,2-dichloroethene, PCE, TCE, and toluene.	**Corrective Activities**: The UST and about 245 yd^3 were removed in 1977. **Current Status**: Groundwater remediation is ongoing (The ASPTS became operational in 1981.) Efforts are underway to optimize the efficacy of the treatment system.	**Soil**: The original chemical release was to the subsurface, therefore, no exposures to surface soils were or are occurring. Remedial workers may have contacted subsurface soil in the past, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose a hazard because (1) contaminant concentrations are too low and (2) restrictions are in place to limit excavation activities. **Groundwater**: The Arrow Street Plume impacted some of USAF's main water supply wells. (Potential past health hazards associated with exposures to these wells are discussed within the main body of the text.) No one is currently using the groundwater in the vicinity of SS-21. Potential future exposures are not expected to cause health hazards because (1) the groundwater under this site is being remediated by the ASPTS and (2) restrictions will ensure that the water is not used until contaminant concentrations are reduced to safe levels.
SS-22: Pesticide Spill, Near Building 140 Between 1970 and 1989, tank trucks containing commercial pesticides, insecticides, and herbicides were washed east of Building 140.	In 1991, soil and groundwater was collected. No contaminants were detected above MDNR's Type B criteria.	**Current Status**: No further action required.	There is no evidence that this site was ever adversely impacted by site activities. Any contaminants that might have traveled to the groundwater aquifer will be remediated by the ASPTS. Also, groundwater restrictions will ensure that the water under SS-22 is not used in the future unless data clearly show that contaminants do not exceed safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
LF-23: Landfill, Southeast of POL Bulk Storage Wood debris, auto parts, small quantities of oil, and unknown solvents were reportedly disposed in LF-23 between 1951 and 1953. A geophysical investigation identified five areas where debris may have been buried.	**Soil**: In 1995, as part of a RI, several surface and subsurface samples were analyzed for VOCs, SVOCs, metals, pesticides, and polychlorinated biphenyls (PCBs). In surface soils, lead (229 ppm) was detected above soil CVs that are commonly used by ATSDR. In the subsurface, lead (455 ppm) and benzo(a)pyrene (6.0 ppm) exceeded these guidelines. (Note: Although site documents indicated that concentrations of several other contaminants exceeded MDEQ's guidelines, their concentrations did not exceed ATSDR's CVs.) **Groundwater**: In 1990, groundwater samples were analyzed for VOCs, but none exceeded ATSDR's drinking water CVs. In 1995, additional groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Methylene chloride (8 ppb) was detected above MDEQ's health guidelines, but investigators concluded that the detection was probably a laboratory contaminant.	**Current Status**: No further action required.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Current and projected future use for this site is industrial/commercial. Based on available data and ATSDR's exposure evaluation, exposures to the surface soil and subsurface soil will not be associated with current or future health hazards. **Groundwater**: No on-base water supply wells are located in the vicinity of LF-23; therefore, past and current exposures to groundwater have not occurred. Potential future exposures are not expected to pose health hazards because contaminant concentrations are currently low and are not expected to increase in the future. (Groundwater under LF-23 is being treated by the BPPTS. Also, soil contaminants are not leaching appreciably to the groundwater and contaminated water located upgradient of the site is being treated.)

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
OT-24: Three Pipes Drainage Ditch OT-24 consists of an underground network of storm sewers and the 3-pipes drainage ditch. Some of the water that is directed through this system is directed to an OWS retention pond before flowing into the 3-pipes drainage system. The ditch discharges to the Au Sable River.	**Groundwater**: The Mission Drive Plume extends under OT-24. Contaminants have been present in this area at concentrations exceeding ATSDR's CVs for several years. In the mid-1990s, an RI was performed. The results indicated that TCE and dichloroethene are the main constituents in the area, but that several others are also present at concentrations exceeding ATSDR's drinking water CVs, including: 1,1,1-trichloroethane, methylene chloride, PCE, 1,2-dichloroethane, benzene, and arsenic. **Surface Water/Sediment**: • *3-Pipes Drainage Ditch*. Surface water and sediment samples were analyzed for VOCs, SVOCs, PCBs, and metals in 1994. Arsenic (1–3 ppb), TCE (6.2–37 ppb), and PCE (0.6–1.2 ppb) were detected in the water samples above drinking water CVs and arsenic (0.57–1.4 ppm) was detected above ATSDR's soil CVs in sediments. • *OWS Retention Pond*. Surface water and sediment samples were analyzed for VOCs in 1994. No contaminants exceeded ATSDR's drinking water or soil CVs. • *Au Sable River*. Surface water and sediment samples were collected during the RI. Data are summarized in Tables 6 and 7. • *Duell Lake*. Surface water and sediment samples were collected during the RI. Data are summarized in Tables 6 and 7.	**Current Status**: Groundwater remediation is ongoing (The MDPTS became operational in the mid-1980s. Efforts are underway to optimize the efficacy of the treatment system. For example, new wells will be installed by mid-2000 to capture a portion of the Mission Drive Plume that has not been captured by the MDPTS.)	**Soil:** No soils are associated with OT-24. **Groundwater**: Groundwater in the vicinity of the OT-24 area has been impacted by the Mission Drive Plume. This plume impacted USAF's main water supply wells AF18 and AF19. (Potential past health hazards associated with exposures to these wells are summarized in the main body of the text.) No one is currently using the groundwater in the vicinity of OT-24. Potential future exposures are not expected to cause health hazards because (1) the groundwater under this site is being remediated by the MDPTS and (2) restrictions will ensure that the water is not used. Because the plume extends underneath on-base housing areas, ATSDR evaluated the potential for groundwater to volatilize into subsurface structures. As noted in the main body of the text, health hazards are not thought to be associated with this pathway. **Surface Water/Sediment**: • ***Three Pipes Drainage Ditch***. It is unlikely that people have been exposed to the ditch because the area is not easily accessible. (A fence blocks access.) Even if people trespass, infrequent exposures to such low contaminant concentrations would not pose health hazards. • ***OWS Retention Pond***: It is unlikely that people have contacted this area. (According to site representatives, this pond has always been surrounded by a locked fence.) Even if people trespass in the area, contaminant concentrations are too low to pose health hazards. • ***Au Sable River***: Humans may contact the Au Sable River while fishing, wading, and swimming. As described in the main body of the text, exposures to the Au Sable River are not associated with public health hazards. • ***Duell Lake***: Evidence indicates that the Mission Drive Plume has impacted Duell Lake. As discussed in the main body of the text, exposures to this lake will not pose health hazards to visiting duck hunters.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
LF-26: Landfill, East of SAC Alert Apron Between 1949 and 1951, LF-26 was reportedly used for the disposal of wood, coal, ash, broken concrete, and automobile parts. One report indicated that drums of solvents and other materials were buried in 15-foot deep trenches.	**Soil**: In 1994, as part of a RI, several surface and subsurface soil samples were collected. Arsenic (4.8 ppm in surface soil and 19.3 ppm in the subsurface) and lead (87.1 ppm in the surface and 405 ppm in the subsurface) were detected above CVs that are commonly used by ATSDR. (Note: Although site documents indicated that several other constituents exceeded MDEQ's health guidelines, their concentrations were below ATSDR's soil CVs.) **Groundwater**: In the early 1990s, samples were analyzed for VOCs, SVOCs, and metals. Lead (ND–660 ppb) was detected above guidelines that are commonly used by ATSDR. Between 1994 and 1996, as part of a RI, additional samples were analyzed for volatiles, PNAs, pesticides, PCBs, and metals. Contaminants detected above ATSDR's drinking water CVs included heptachlor epoxide (ND–0.04 ppb), antimony (ND–7.8 ppb), arsenic (ND–2.3 ppb), and manganese (ND–94.3 ppb).	**Current Status**: No further action required.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soils in the past, but past exposures were likely infrequent. This area will be used for recreational activity in the future. Based on available data and ATSDR's exposure evaluation, contaminants in the surface and subsurface soils are too low to pose current or future health hazards. **Groundwater**: No on-base water supply wells are located in the vicinity of LF-26; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because current contaminant concentrations are too low to pose a health hazard and the contaminant concentrations are not expected to increase in the future.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
LF-27: Landfill, South of the Center of SAC Instrument Runway LF-27 reportedly received coal ash and construction debris between 1950 and 1972.	**Soil**: In 1995, samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. In the surface soil, arsenic (0.68–13.1 ppm) and lead (2.8–166 ppm) exceeded soil CVs commonly used by ATSDR. These same metals were detected at elevated concentrations in the subsurface as well (arsenic at 0.44–12.8 ppm; and lead at ND–288 ppm). (Note: Although site documents indicated that several additional subsurface contaminants exceeded MDEQ's criteria, their concentrations did not exceed ATSDR's soil CVs.) **Groundwater**: In 1995 and 1996, groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Some constituents were detected above ATSDR's drinking water CVs. **Surface water/sediment**: Investigators suspect that landfill leachate is seeping into an adjacent wetland area. Data collected from the wetland are summarized in Tables 6 and 7.	**Corrective Activities**: In 1990, visible debris was removed from the surface. **Current Status**: • Groundwater is being treated with intrinsic bioremediation. • Groundwater and surface water monitoring will begin in the near future.	**Soil:** It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soils in the past, but exposures were likely infrequent. This area will be used for recreational activity in the future, but contaminant concentrations are not expected to pose health hazards given the frequency of exposure that is anticipated. **Groundwater**: No on-base water supply wells are located in the vicinity of LF-27; therefore, no past or current exposures to groundwater have occurred. Groundwater conditions under LF-27 could worsen in the future if groundwater under SS-51 migrates to the LF-27 area, but potential future exposures are not expected to pose a health hazard because (1) the groundwater is being remediated, and (2) restrictions will ensure that the groundwater is not used until contaminants are reduced to safe levels. **Wetland Area South of LF-27**: The wetland area south of LF-27 is used by people who hunt deer and turkey. As explained in the main body of the text, hunters are not expected to experience adverse health effects by coming into contact with the wetland's surface water and sediment. No tissue samples have been collected from game animals that might be exposed to the wetland's contaminants. Thus, ATSDR cannot make definitive conclusions about whether people could be eating contaminated game animals.
LF-28: Landfill, East of the Eastern SAC Overrun Some reports indicate that LF-28 was used for domestic and industrial waste disposal between 1953 and 1958.	In 1991, investigations were conducted to determine whether a landfill was actually located at this site. Ground-penetrating-radar and electromagnetic terrain conductivity surveys were conducted. Also, groundwater and soil data were analyzed. Investigators concluded that there is no evidence of a landfill in this area.	**Corrective Activities**: Materials in the landfill have been excavated and removed. **Current Status**: No further action required.	There is no evidence that this site was ever adversely impacted by site activities.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
LF-29: Domestic Waste Disposal, Northern portion of Alert Apron Reports indicate that domestic waste and some base cleanup refuse was disposed in this area between 1958 and 1959.	**Soil**: In 1995, subsurface samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. No contaminants exceeded ATSDR's soil CVs. **Groundwater**: In 1991, groundwater samples were analyzed for VOCs, PAHs, pesticides, PCBs, and metals. No contaminants exceeded ATSDR's drinking water CVs or state or federal criteria.	**Corrective Activities:** Materials in the landfill were excavated and removed in 1959. **Current Status**: No further action required.	**Soil***:* It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. No sampling data are available to indicate whether contaminants were present before the landfill was removed, but exposures to base employees were likely infrequent. Current and future exposures will not be associated with a health hazard because contaminant levels are too low. **Groundwater**: No on-base water supply wells are located near LF-29; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because there is no evidence that groundwater underlying the site has been impacted by site activities.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
LF-30 and LF-31: Northern Landfills Between 1960 and 1973, Landfill 30 received domestic and commercial waste. Between 1971 and 1979, two 6,000-gallon tanker trailers were used to store waste jet fuel, oils, solvents, thinners, and lubricants. Landfill 31 was opened in 1973 and accepted sanitary waste and hardfill until it was closed and capped in 1979. Some reports indicate that it received paint cans and metal as well.	**Soil**: In 1994, as part of a RI, surface and subsurface soil samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. In the surface soil, arsenic (0.4–1.4 ppm) was the only contaminant that exceeded ATSDR's soil CVs. In the subsurface, some PAHs (e.g., benzo[a]pyrene at ND–1.3 ppm), arsenic at 0.28–1.9 ppm, and lead 1.4–276 ppm exceeded these values. (Note: Although site documents indicated that other subsurface constituents exceeded MDEQ's criteria, their concentrations did not exceed ATSDR's soil CVs.) **Groundwater**: LF-30 and LF-31 are the sources of the Northern Landfill Plume, a plume that was discovered in 1979. Between 1979 and 1995, contaminant concentrations have been detected above ATSDR's drinking water CVs on numerous occasions. These contaminants include TCE, benzene, vinyl chloride, and 1,2-dichloroethene. **Surface Water/Sediment**: The Northern Landfill plume discharges to Van Etten Lake. Samples collected from the lake are summarized in Tables 6 and 7.	**Corrective Activities**: • Truck trailers were removed in 1979. • LF-30 and LF-31 have been covered with soil. In addition, an engineered cap rests on top of 11 acres. **Current Status**: • A pump-and-treat and air sparging system will be installed by mid 2001. • A monitoring plan is being developed.	**Soil**: It is unlikely that on-base residents or the general public were exposed to landfill soils before the landfill was capped because access to the area was restricted. No sampling data are available to indicate surface soil contaminant concentrations before capping, but exposures to base employees were likely infrequent. The cap eliminates the potential for people to be exposed to wastes in the future. Exposures to the subsurface are not expected to occur because restrictions are in place to prevent digging in this area. Additionally, contaminant concentrations detected in the surface and subsurface are not high enough to pose health hazards. **Groundwater**: The Northern Landfill Plume has migrated off base, impacting areas with private wells. Past and current potential health hazards associated with exposures to these wells are discussed in the main body of the text. Future health hazards are not expected to occur because (1) the groundwater under this site will be remediated, (2) most of the surrounding area now receives municipal water, and (3) advisories will be issued against drilling new wells into contaminated areas. Because the plume extends underneath off-base residences, ATSDR evaluated the potential for groundwater to volatilize into subsurface structures. As explained in the main body of the text, health hazards are not thought to be associated with this pathway. **Surface Water/Sediment**: Contaminants from the Pierce Point Plume discharge into Van Etten Lake. As explained in the main body of the text, swimmers, fishers, and people who consume fish are not expected to experience adverse health effects.
WP-32 and WP-33: Surface Impoundment Lagoons The sewage lagoon system consisted of three aerated lagoons and eight seepage lagoons.	According to site representatives, contaminants were not detected during site investigations.	**Corrective Activities**: Sludge and aeration equipment were removed in 1996 and 1997. **Current Status**: No further action required.	There is no evidence that this area was adversely affected by the site's activities.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
OT-35: Sludge Spreading Areas Between the 1960s and 1982, sludge from the waste treatment plant was spread along the runway and taxiway.	**Soil**: In 1991, subsurface samples were analyzed for VOCs, PAHs, and metals. Arsenic (0.076–0.45 ppm) exceeded ATSDR's soil CV. **Groundwater**: In 1991, groundwater samples were analyzed for volatiles and metals. PCE (ND–1.5 ppb) was detected above ATSDR's drinking water CV.	**Current Status**: No further action required.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted them in the past, but past exposures were likely infrequent. Past and current exposures to subsurface soils have not occurred, but these soils could be accessed in the future if the area is excavated. Contaminant concentrations are not high enough to pose health hazards, however. **Groundwater**: No potable water sources are in the immediate vicinity of OT-35; therefore past and current exposures to area groundwater have not occurred. Potential future exposures are not expected to cause health hazards because contaminant concentrations are currently too low and they will continue to decrease because the area is being remediated by the MDPTS.
ST-40: Leaking UST, Building 351 In May 1990, a leak was detected in a 2,000-gallon, underground, waste oil recovery tank.	**Soil**: In 1994, surface and subsurface soil samples were analyzed for volatiles, PNAs, and lead. No contaminants exceeded ATSDR's soil CVs. **Groundwater**: In 1994, groundwater samples from the POL Bulk Storage Area were analyzed for volatiles, BTEX, MTBE, and PNAs. (Note: Samples collected from the POL Bulk Storage Area are considered representative of conditions underlying SS-06, SS-13, and ST-40 because these sites are very close in proximity.) Several constituents exceeded ATSDR's drinking water CVs, including benzene (ND–1,200 ppb), ethylbenzene (ND–1,300 ppb), TCE (ND–13 ppb), and xylene (ND–4,600 ppb).	**Corrective Activities**: • The tank was removed in July 1990. **Current Status**: • Soil remediation is ongoing. (A bioventing system is operational.) • Groundwater remediation is ongoing by the BPPTS and the ASPTS.	**Soil**: Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. (Surface soil sampling confirmed that no contaminants are present at concentrations that would pose health hazards.) Remedial workers may have been exposed to subsurface soil when they removed the UST, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low. **Groundwater**: No base water supply wells are located in the vicinity of ST-40; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to be associated with a health hazard because (1) restrictions will ensure that groundwater is not used until contaminants are reduced to safe levels and (2) the groundwater is not expected to migrate to off-site areas in the future because it is being captured by the BPPTS and the ASPTS.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
OT-41: Leaking UST, Building 5011 USTs were located in this area in the past. At least one contained JP-4 jet fuel and another contained MOGAS. In May 1990, a gasoline leak was detected in one of the USTs.	**Soil**: In 1992 and 1995, subsurface samples were collected and analyzed for a variety of contaminants, but none exceeded ATSDR's soil CVs. **Groundwater**: Groundwater samples were collected between 1991 and 1996. Benzene, toluene, PCE, TCE, and naphthalene have been detected above ATSDR's drinking water CVs, but concentrations of some of these chemicals appear to be decreasing over time.	**Corrective Activities**: USTs were removed in 1991. **Current Status**: • Natural attenuation is ongoing. • Monitoring activities are ongoing.	**Soil**: Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. Remedial workers may have been exposed to subsurface soil when they removed the USTs, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low. **Groundwater**: No base water supply wells are located in the vicinity of OT-41; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to cause a health hazard because (1) the groundwater is being remediated and (2) restrictions will ensure that groundwater is not used until contaminants are reduced to safe levels.
SS-42: JP-4 Fuel Pump Spill, Aerospace Ground Equipment Shop (Building 5009) A fuel pump was used as an above ground tank without installing an antisiphoning device. About 1,500 gallons of JP-4 was spilled in November 1991.	**Soil**: In 1992 and 1995, samples were collected and analyzed for a variety of contaminants, but none exceeded ATSDR's soil CVs. **Groundwater**: In 1991, free product was identified floating on the groundwater. Groundwater samples were collected between 1991 and 1996. BTEX, TCE, PCE, and naphthalene have been detected above ATSDR's drinking CVs, but concentrations of some of these chemicals appear to be decreasing over time.	**Corrective Activities**: • In 1992, auto-skimming equipment was installed in a recovery well and about 750 gallons of product was recovered. • Natural attenuation is ongoing. • Monitoring activities are ongoing.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted them in the past, but past exposures were likely infrequent. Contaminant concentrations are not high enough to pose current or future health hazards. **Groundwater**: No on-base water supply wells are located in the vicinity of OT-42; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to be associated with a health hazard because (1) the groundwater is being remediated and (2) restrictions will ensure that groundwater is not used until contaminants are reduced to safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SD-43: Dry Well, Munitions Maintenance Squadron (Building 5044) In 1991, a dry well sump was discovered. The sump was connected to a floor drain in building 5044. The building was originally used as a battery shop. The well is thought to have been used for disposing of battery acid.	**Soil**: In 1992, subsurface soil samples were collected. Alpha-hexachlorocyclohexane (0.006 ppm) was detected above MDEQ's health guidelines, but below ATSDR's soil CV. **Groundwater**: In 1992, groundwater samples were collected. PCE (5.2 ppb) and manganese (270 ppb) were the only contaminants detected above MDEQ's health guidelines. (They also exceeded ATSDR's drinking water CVs.) PCE was not detected in a subsequent sampling round.	**Corrective Activities**: The drywell was removed in 1991. **Current Status**: No further action required.	**Soil**: Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. Remedial workers may have been exposed to subsurface soil when they removed the drywell, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low. **Groundwater**: No on-base water supply wells are located in the vicinity of SD-43; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to cause health hazards because (1) contaminants are currently too low to pose hazards and (2) groundwater conditions are not expected to worsen in the future. (Evidence indicates that soil contaminants are not leaching appreciably to the underlying groundwater.)
ST-44: Leaking UST, Alert Facility (Building 5350) In October 1991, a 20,000-gallon heating fuel tank failed a tightness test.	**Soil**: Three composite samples were collected when the tank was removed in 1992. No contaminants were detected above their detection limits. **Groundwater**: Two monitoring wells were installed at both ends of the tank in 1992. Samples were analyzed for BTEX, MTBE, and PAHs. No contaminants were detected above MDNR health guidelines.	**Corrective Activities**: • The tank was emptied when it failed the tightness test. • The tank and surrounding soils were removed in July 1992. **Current Status**: No further action required.	**Soil**: Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. Remedial workers may have been exposed to subsurface soil when they removed the UST, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low. **Groundwater**: No on-base supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because contaminant concentrations are too low.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
ST-45: Leaking UST, Defense Reutilization Management Office (DRMO) Area (Building 5608) In 1991, a heating oil UST failed a tightness test.	**Soil**: Soil samples were collected in 1992 and 1994, revealing that some contaminants were present above MDEQ's health guidelines. Additional soil samples were collected in 1996; no contaminants exceeded MDEQ's health guidelines or ATSDR's soil CVs. **Groundwater**: Groundwater samples were collected in 1992 and 1994, revealing that some contaminants were present above MDEQ's health guidelines. Additional samples were collected in 1995, 1996, and 1997. No contaminants were detected at levels that exceeded MDEQ's health guidelines during the latter two sampling events. (Note: Although the Remedial Action Plan for this site indicated that 1,2,4-trimethylbenzene [48 ppb] exceeded MDEQ's residential standards, the standard was raised to 1,000 ppb in June 1998.)	**Corrective Activities**: • The tank was pumped empty in 1991. • The tank was removed in May 1992. **Current Status**: No further action required.	**Soil**: Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. Remedial workers may have been exposed to subsurface soil when they removed the UST, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low. **Groundwater**: No on-base supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because (1) contaminant concentrations are too low and (2) groundwater conditions are not expected to worsen in the future because soil contaminants are not leaching appreciably into the underlying groundwater.
ST-46: Leaking UST (Building 7297) Three USTs were located at ST-46. In May 1990, a diesel fuel leak was detected in one of them.	**Soil**: No samples were collected prior to soil removal activities. Subsurface samples were collected, however, in 1990 and 1992. The results indicated that some low levels of contaminants remain and that some PAHs (e.g., benzo[a]pyrene at 1.6 ppm) exceed ATSDR's soil CVs. **Groundwater**: In 1990, free product was identified floating on the water table and light nonaqueous phase liquid (LNAPL) was detected in 1992. Investigators concluded that the LNAPL was migrating from SS-06.	**Corrective Activities**: • The tank was emptied upon discovery of the leak. • In October 1990, three USTs were removed, about 1,080 yd^3 of soil was excavated, and about ¼ inch of free product was removed. **Current Status**: Groundwater is being remediated by on-base PTS systems.	**Soil**: Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. Remedial workers may have been exposed to subsurface soil when they removed the UST, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low. **Groundwater**: No on-base supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Future exposure to groundwater under this site is not expected to cause health hazards because (1) the groundwater is being remediated by on-base PTS systems and (2) restrictions will prevent the groundwater from being used until contaminant levels are reduced to safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-47: Base Gas Station Three USTs were located at the Base Gas Station. In 1987, on-base employees documented a release from one that contained premium grade gasoline. (About 400 gallons leaked from a valve.)	**Soil**: In 1993, subsurface samples were collected. None of the detected contaminants exceeded MDEQ's health guidelines or ATSDR's soil CVs. **Groundwater**: In 1993 and 1994, groundwater samples were collected. Several constituents, including benzene (ND–2,600 ppb), 1,2-dichloroethane (ND–100 ppb) TCE (ND–510 ppb), toluene (ND–5,900 ppb), xylene (ND–3,000 ppb), and lead (ND–25 ppb) were detected at concentrations exceeding ATSDR's drinking water CVs and MDEQ's health guidelines. (The TCE and 1,2-dichloroethane are thought to have migrated from SS-21.)	**Corrective Activities**: • The USTs were emptied in 1993 and removed in 1996. • Soils underlying the USTs have been removed. **Current Status**: • Groundwater monitoring efforts are ongoing.	**Soil**: Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. Remedial workers may have been exposed to subsurface soil when they removed the USTs, but these workers used protective gear (at least level C) while performing their activities. Potential future subsurface exposures are not expected to pose health hazards because contaminant concentrations are too low. **Groundwater**: Contaminants from SS-47 that migrated to the groundwater are not associated with health hazards. By the time the contaminants were released, nearby water supply wells were not operating as potable sources. Potential future exposures to groundwater are not expected to cause health hazards because (1) the ASPTS is treating the water and (2) restrictions will ensure that the groundwater is not used until contaminant concentrations are reduced to safe levels.
SS-48: Locomotive Shop (Building 3020) In 1988, WAFB discovered that an AST was leaking.	A RI was conducted and no contaminants were detected above MDNR health guidelines in soil or groundwater samples.	**Corrective Activities**: Soils have been removed. **Current Status**: No Remedial Action required.	There is no evidence that this site contains contaminants at concentrations that are high enough to pose health hazards.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
OT-49: EOD Range, Northwest Section of the Base Starting in 1961, this area was used for the disposal and demolition of unused munitions and ordnance. (Materials were placed in a pit, covered with diesel fuel, and ignited.) The area was closed in 1991, but a few isolated disposal/detonation events were authorized after that time.	**Soil**: In 1994, subsurface soil samples were analyzed for PAHs, nitroamines, nitroaromatics, inorganics, BTEX, and MTBE. Arsenic (ND–4.4 ppm) was the only contaminant detected above ATSDR's soil CV. (Note: Although the Closure Certification Report indicated that concentrations of antimony and vanadium exceeded MDNR's guidelines, they were below ATSDR's soil CVs.) **Groundwater**: In 1994, samples were analyzed for VOCs, PAHs, nitroamines, nitroaromatics, and inorganics. Four constituents were detected above ATSDR's drinking water CVs: antimony (ND–5.8 ppb), arsenic (ND–2.9 ppb), manganese (ND–589 ppb), and thallium (ND–8.1 ppb).	**Corrective Activities**: Clearing activities were conducted in 1992 and 1993 to remove all unexploded munitions and ordnance. **Current Status**: MDNR approved WAFB's Closure Plan for this site in May 1994.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted contaminants in the surface soil in the past, but exposures were infrequent. Current and future exposures will not be associated with health hazards because contaminant concentrations are too low. **Groundwater**: No on-base water supply wells are located nearby; therefore past and current exposures to groundwater have not occurred. Any potential future exposures are not expected to be associated with health hazards because current contaminant concentrations are too low to pose a health hazard and the contaminant concentrations are not expected to increase in the future.
SS-51: KC-135 Crash Site, Midway on the Runway A KC-135 aircraft crashed in October 1988. About 3,000 gallons of JP-4 jet fuel were in the fuel tanks at the time of the crash.	**Soil**: In 1992 and 1993, as part of a RI, surface and subsurface soil samples were analyzed for VOCs and SVOCs. No constituents were detected above Target Method Detection Limits. **Groundwater**: Between 1989 and 1991, sampling results indicated that free-phase product was present. A groundwater plume (traveling in a south/southeasterly direction) was identified in 1992. Several contaminants detected in the plume exceeded ATSDR's drinking water CVs, including benzene (ND–280 ppb), ethylbenzene (ND–2,400 ppb), toluene (ND–3,700 ppb), and xylene (ND–9,700 ppb).	**Current Status**: • Groundwater monitoring is conducted on a regular basis. • Groundwater is being addressed with monitored natural attenuation.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted contaminants in the surface soil in the past, but exposures were infrequent. Current and future exposures will not be associated with a health hazard because contaminant concentrations are too low. **Groundwater**: No on-base water supply wells are in the immediate vicinity of SS-51; therefore past and current exposures to groundwater have not occurred. ATSDR does not expect health hazards to arise in the future because (1) the groundwater is being remediated and (2) restrictions will prohibit the use of groundwater until contaminant levels are reduced to safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-52: KC-135 Cockpit Trainer Spill, Northeast of the POL Bulk Storage Facilities In April 1991, a surface soil stain was discovered. The stain may have been from a heating oil spill.	**Soil**: An RI was performed. No contaminants of concern were detected above MDNR health guidelines. **Groundwater**: No samples were collected.	**Corrective Activities**: In 1991, seven drums of stained soil were removed. **Current Status**: No Further Remedial Action Planned.	There is no evidence that this site ever contained contaminants at concentrations that could pose health hazards. Due to the lack of groundwater data, it is impossible to state whether contaminants migrated to the aquifer. Even if they had, no past health hazards would have resulted because no on-base water supply wells were located nearby. Potential future exposures to groundwater are not expected to pose health hazards because there is no evidence that the groundwater was adversely affected by site activities.
SS-53: Parking Spot 19, Operational Apron In October 1988, a pressure check test on the fuel line revealed a leak.	This site is located within SS-08. Data pertaining to SS-53 are summarized under the SS-08 site.	See Site SS-08.	See Site SS-08.
SS-54: Aqueous Film Forming Foam (AFFF) Spill, Hangar 5063 In 1991, 80 gallons of AFFF spilled near a storm sewer inlet.	**Soil**: In 1994, surface and subsurface samples were collected during a Site Investigation. Results indicated that the soil has not been impacted by the AFFF spill. **Groundwater**: No samples were collected.	**Current Status**: No further action required.	There is no evidence that this site ever contained contaminants at concentrations that could pose health hazards. Due to the lack of groundwater data, it is impossible to state whether contaminants migrated to the aquifer. Even if they had, no past health hazards would have resulted because no on-base water supply wells were located nearby. Potential future exposures to groundwater are not expected to pose health hazards because (1) the groundwater is being remediated by an on-base PTS system and (2) restrictions will ensure that no one uses the groundwater unless contaminants are at safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-55: Small Arms Firing Range (SAFR), Northwestern part of base This area was used for small arms fire training between the 1960s and 1982. Lead slugs, lead shot, steel shot, and metal-jacketed bullets were fired into a sandy berm (80' by 200' at base and 17' high). Metal fragments, containing lead and copper, are embedded in the berm and surrounding area.	**Soil**: In 1995 (prior to soil removal activities), surface and subsurface samples were analyzed for lead, copper, and antimony. Lead (4.0–21,100 ppm) and antimony (ND–284 ppm) were detected above ATSDR's soil CVs, with the highest concentrations present in the top foot of soil. In 1998 (after soil removal activities), additional samples were analyzed for lead. Concentrations (up to 7,840 ppm) remained above health guidelines in the top foot of soil. **Groundwater**: In 1995, groundwater samples in the vicinity of SS-55 were analyzed for lead, but it was not detected above commonly used CVs (i.e., 15 ppb) in locations that were crossgradient or downgradient of SAFR. In August 1998, additional samples were analyzed for lead, copper, and antimony. All three contaminants exceeded drinking water CVs that are commonly used by ATSDR. A third sampling event took place during the summer of 2000. Preliminary results indicate that lead, copper, and antimony detections did not exceed CVs. MDEQ and USAF are currently talking about whether additional groundwater sampling rounds are necessary.	**Corrective Activities**: • In August 1998, Maectite® was applied to the berm and to a small area behind the berm. The chemical fixated the soil. About 175yd^3 of fixated soil was then removed and disposed off site. • Hotspots that were left behind will be removed in 2001. **Current Status**: Additional investigations are ongoing.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted contaminants in the surface soil in the past, but exposures were infrequent. Much of the contaminated top soil has already been removed from the site. Hot spots that remain will be removed in 2001. Confirmation samples will be collected after the removal activity to make sure that all areas with lead concentrations exceeding 400 ppm are removed. Once contaminants have been removed, the site will be considered acceptable for reuse. **Groundwater**: USAF's area-specific well AF16 is located crossgradient of SS-55. This well was used as a potable water source in the past, but available data indicate that the well was not impacted by site activities (See Table 4). No one is currently using the groundwater under SS-55. Future harmful exposures are not expected to occur. The most recent groundwater sampling results indicate that contaminants do not exceed CVs. MDEQ will review these results soon. If the agency determines that these results must be confirmed, USAF will be asked to perform additional sampling. If concentrations are detected at very elevated levels in subsequent sampling rounds, then a ban (prohibiting groundwater use) would be placed on the site and a remedial activity would be initiated. If the water proved to be only slightly contaminated, the base would forego the remedial activity, but would work with Township of Oscoda to get deed restrictions placed on the property. (The State of Michigan currently owns the property, but the property will be transferred to the Township of Oscoda soon.)

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-56: Fuel Spill, Air Force Beach SS-56 is located on the Air Force Beach. The site consists of Building 1115 (a shed used for fuel container storage), fuel storage tanks, and fuel dispenser lines. The lines were fed by USTs until 1989 when the ASTs replaced them. Fuel from a ruptured dispensing line was released to Van Etten Lake during the winter of 1990 and identified by ice fishermen.	**Soil**: In 1992, surface and subsurface samples were analyzed for BTEX, PNAs, lead, and MTBE. Lead was the only contaminant detected, but at concentrations that are too low to pose health hazards. **Groundwater**: In 1992, three groundwater samples were analyzed for BTEX, PNAs, lead, and MTBE. Lead was detected, but at concentrations that are too low to pose health hazards. **Van Etten Lake**: In 1995, sediment samples were collected from Van Etten lake and analyzed for BTEX, PNAs, lead, and MTBE. Sampling locations were chosen after site investigators determined the location where the distribution line ruptured. Lead was the only contaminant detected, but it was detected at concentrations (0.9–2.0 ppm) that are too low to pose health hazards.	**Corrective Activities**: • Free-floating product removed. • The fuel distribution lines were removed in 1990. • Building 1115 was removed in 1993. **Current Status**: No further action required.	Based on available data, no contaminants were present in soil, groundwater, or sediment at high enough levels to pose health hazards.
SS-57: Base Operational Apron This site consists of a WWII refueling hydrant system which underlies the Base Operation Apron. Most of the system was abandoned in 1972.	**Soil**: In 1995, subsurface soil samples were collected along the hydrant's pipelines and from the sidewalls of UST excavations. The samples were analyzed for BTEX, MTBE, PNAs, and lead. Some PNAs (e.g., benzo[a]pyrene [ND–62 ppm]) were detected above ATSDR's soil CVs. In 1996, additional subsurface samples were collected and analyzed for VOCs, SVOCs, and metals. Arsenic (ND–0.69 ppm) was detected above ATSDR's soil CVs. Additional soil samples were collected during the summer of 1999; the results indicated that there are elevated contaminant concentrations in the soil. **Groundwater**: This site has been impacted by the Arrow Street plume (see Site 21). Therefore, several contaminants have been detected in the groundwater underlying the site.	**Corrective Activities**: In 1995, the hydrant piping system was abandoned in place and the associated USTs were removed. **Current Status**: A feasibility study has been drafted. Enhanced bioremediation of soil and groundwater has been identified as a proposed remedial action.	**Soil**: Contaminants at this site were released to the subsurface. Remedial workers may have been exposed to these soils when they removed the hydrant system. Available data indicate that contaminant concentrations were too low to pose health hazards to these workers. Construction workers could also be exposed to subsurface soils in the future if the area is excavated. Future exposures are not expected to pose health hazards because (1) workers will use protective gear and (2) the soil under the site will be remediated in the near future. **Groundwater**: Groundwater under SS-21 has been impacted by the Arrow Street Plume (see Site SS-21). This plume impacted some of USAF's main water supply wells. (Potential past health hazards associated with exposures to these wells are discussed within the main body of the text.) No one is currently using the groundwater in the vicinity of SS-57. Any future exposures are not expected to cause health hazards because (1) the groundwater under this site is being remediated by the ASPTS and (2) restrictions will ensure that the water under SS-57 is not used until contaminants are reduced to safe levels.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-58: USTs at Military Family Housing Units Eleven underground oil tanks, located in the vicinity of the on-base housing area, were abandoned in place in the early 1980s. Residual fuel or sludge may have leaked subsequent to abandonment. At least one tank—Unit 1752—had a confirmed release.	**Soil**: Subsurface soil samples were collected sometime before 1990 and in 1992. No contaminants exceeded ATSDR's soil CVs. **Groundwater:** Groundwater samples were collected in 1985, 1991, 1992, and 1993. Benzene (16 ppb) was the only contaminant detected above ATSDR's drinking water CVs. (The detection was reported in 1985 and was not repeated in subsequent sampling events.)	**Corrective Activities**: Unit 1752 and associated soils have been removed. **Current Status**: No further action required.	**Soil**: Contaminants at this site were released to the subsurface. Remedial workers may have been exposed to these soils when they removed the leaky line, tank, and soils. In addition, construction workers could be exposed to subsurface soils in the future if the area is excavated. All available data indicate that contaminant concentrations were and are too low to pose health hazards. **Groundwater**: No on-base water supply wells are located nearby; therefore, past and current exposures to groundwater did not occur. Based on available data, any potential future exposures would not be associated with a health hazard because contaminant concentrations are too low.
SS-59: AFFF Release (Building 5306) In January 1989, a tank containing AFFF cracked and released about 500 gallons of AFFF onto the soil adjacent to Building 5306.	**Soil/sediment**: In 1992, 1994, and 1995, samples were collected. Butyl Carbitol (ND–6.7 ppm) and diethylene glycol (ND–6 ppm) were detected in the subsurface during the 1994 event, but the detection was not repeated in the samples collected in the following year. **Groundwater**: In 1995, groundwater samples were analyzed for Butyl Carbitol, diethylene glycol, and butyl ether. No contaminants were detected.	**Current Status**: No further action required.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Current and future exposures to the surface and subsurface will not pose health hazards because contaminant concentrations are too low. **Groundwater**: No on-base water supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Based on available data, any potential future exposures will not pose health hazards because there is no evidence that the area has been impacted by the AFFF release.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-60: AFFF Release, Base Operational Apron For about 10 years, WAFB routinely emptied AFFF/water mixtures off the edge of the Base Operations Apron. This practice was stopped in 1992, when WAFB learned that AFFF contains a harmful substance.	**Soil**: In 1992, three soil samples were analyzed for Butyl Carbitol. The contaminant was not detected above detection limits.	**Current Status**: Originally, MDNR was reluctant to allow WAFB to close out this site because the Agency questioned the sensitivity of Butyl Carbitol's detection limit. This issue has been resolved and USAF is pursuing a "No Further Action" status.	There is no evidence that this site was adversely affected by site activities.
ST-61: JP-4 UST concrete vault, Building 5306 Four JP-4 USTs ruptured in December 1992, while being removed from a concrete containment vault. Although a small amount of fuel spilled, it was thought to be contained completely within the vault.	**Soil**: In 1996, surface and subsurface samples were analyzed for VOCs and SVOCs. No contaminants exceeded ATSDR's soil CVs. **Groundwater**: In 1996, groundwater samples were analyzed for VOCs and SVOCs. A few contaminants (i.e., phenol [ND–5.1 ppb], dichlorobromomethane [ND–1.3 ppb], and chloroform [ND–7.3 ppb]) were detected slightly above ATSDR's drinking water CVs.	**Current Status:** No Further Action required. (This decision is listed in a document that has been signed by the Air Force and the USEPA. MDEQ concurs with the decision.)	**Soil:** Surface soils are not likely to be impacted by site activities because contaminants were released to the subsurface. People could contact these soils if the area is excavated in the future. Potential exposures are not expected to pose future health hazards, however, because contaminant concentrations are too low. **Groundwater:** No on-base water supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because (1) contaminant concentrations are too low and (2) groundwater conditions are not expected to worsen in the future.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
LF-62: Potential Landfill Area, Northeast of Runway 24 Reports indicate that miscellaneous construction debris was deposited in this area in the 1950s.	**Soil**: In 1996, a geophysical survey was performed and investigators concluded that there was no indication of previous landfill operations. Soil samples were analyzed for SVOCs, pesticides, PCBs, and metals. Arsenic (0.75 ppm) was the only contaminant that exceeded ATSDR's soil CV. (It was detected in a composite sample.) **Groundwater**: No groundwater samples have been collected.	**Corrective Activities:** Area swept and cleared to a depth of 3 feet. **Current Status:** No Further Action required. (This decision is listed in a document that has been signed by the Air Force and the USEPA. MDEQ concurs with the decision.)	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Current and future exposures to the surface and subsurface will not pose health hazards because contaminant concentrations are too low. **Groundwater:** No on-base water supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because there is no evidence that the groundwater has been impacted by activities at LF-62.
LF-63: Potential Landfill Area, West of Weapons Storage Area Reports indicate that construction debris was deposited in this area in the 1940s and 1950s. Also, some reports indicate that the LF-63 area is located within a bombing range that was used during WWI. The area may, therefore, have been used for munition disposal. UXO could be buried in the area.	**Soil**: In 1996, a geophysical survey was performed and investigators concluded that there was no indication of previous landfill operations. Soil samples were analyzed for SVOCs, pesticides, PCBs, and metals. Arsenic (0.56 ppm) was detected above ATSDR's soil CV. Also, one sample contained some SVOCs at concentrations that exceeded ATSDR's soil CVs. These contaminants were recorded as nondetect, however, in a replicate sample. (Investigators explain the discrepancy between the original and the replicate composite sample by saying that the former probably contained foreign matter.) **Groundwater**: No groundwater samples have been collected.	**Corrective Activities:** Area swept and cleared to a depth of 3 feet. **Current Status:** No Further Action required. (This decision is listed in a document that has been signed by the Air Force and the USEPA. MDEQ concurs with the decision.)	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Future use of this area will be restricted to commercial/industrial usage. Current and future exposures to the surface and subsurface will not pose health hazards because contaminant concentrations are too low. **Groundwater:** No on-base water supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because there is no evidence that the groundwater has been impacted by activities at LF-63.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
ST-64: Storage tanks near Facility 5002 A 50-gallon fuel oil UST was located at ST-64. It was installed in the 1950s and removed and replaced by a 275-gallon diesel fuel AST in 1992. Investigators noticed stained soil underneath the AST in 1995.	**Soil**: Soil samples were collected in 1992 and 1996 and analyzed for BTEX and PNAs. PNAs were detected at concentrations exceeding ATSDR's soil CVs in surface and subsurface soils. In the surface soil, the maximum detections of these contaminants were benzo[a]pyrene (30 ppm), benzo[a]anthracene (40 ppm), benzo[b]fluoranthene (27 ppm), benzo(k)fluoranthene (12 ppm), chrysene (41 ppm), and indeno[1,2,3-c,d]pyrene (36 ppm). Concentrations of these contaminants in the subsurface were significantly lower, although a few did exceed ATSDR's soil CVs, reaching concentrations of 1.8 ppm. **Groundwater**: No groundwater samples have been collected.	**Corrective Activities**: Contaminated soil was removed from the site. **Current Status**: The site will officially be labeled as a "No Further Action" site in the near future.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Potential future exposures are not expected to pose a public health hazard because the contaminated soils have been removed from the site. **Groundwater:** No on-base water supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because there is no evidence that the groundwater has been impacted by activities at LF-64. Furthermore, any contaminants that may have reached the water will be captured by the MDPTS.
ST-65: ASTs near Facility 5013 Two different gasoline ASTs have serviced Facility 5013 throughout the base's history. The first AST was removed from service in 1992 when the second one was installed. (It is still operational.)	**Soil**: In 1992, soil samples were collected under the AST and analyzed for BTEX, PNAs, and lead. (Several PNAs were detected at concentrations ranging from 1.0 to 4.5 ppm.). Additional samples were collected in 1996 and analyzed for BTEX, PNAs, MTBE, and lead. Lead, the only contaminant detected, was present in the surface (ND–73 ppm) and subsurface (ND–6.1 ppm). **Groundwater**: No groundwater samples have been collected.	**Current Status**: The site will officially be labeled as a "No Further Action" site in the near future.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Current and future exposures to the surface and subsurface will not pose health hazards because contaminant concentrations are too low. **Groundwater:** No on-base water supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because there is no evidence that the groundwater has been impacted by activities at LF-65. Furthermore, any contaminants that may have reached the water will be captured by the MDPTS.

Site Name Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities and Current Status	ATSDR's Evaluation of Public Health Hazards
SS-66 Alert Apron The Alert Apron was constructed in 1959 or 1960. The area was used to stage aircrafts. Only minor maintenance and fueling/defueling activities took place. Other sites included within the Alert Apron's boundary are addressed under LF-29 and OT-44.	**Soil**: In 1996, 27 soil borings were drilled across the Alert Apron area. Several subsurface samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Several contaminants were detected, but only n-nitrosodi-n-propylamine (0.33 ppm) and arsenic (0.3–1.03 ppm) were detected above health guidelines that are commonly used by ATSDR. **Groundwater**: The groundwater under this site is discussed under SS-05.	**Current Status**: The site will officially be labeled as a "No Further Action" site in the near future.	**Soil**: It is unlikely that on-base residents or the general public were exposed to surface soils while the base was operational because access to the area was restricted. Base employees may have contacted surface soil in the past, but exposures were likely infrequent. Available data indicate that some subsurface contaminants are present at concentrations above ATSDR's soil CVs. If exposure occurs in the future via excavation, these concentrations are too low to pose health hazards. **Groundwater:** See SS-05
ST-67: OWS 393 According to site representatives, an OWS was installed around 1980. Water and products from Building 393 were washed down the floor drain and directed to the OWS. As indicated under the SS-19 description, JP-4 was flushed down the floor drain on at least one occasion.	**Soil**: In 1993, subsurface soil samples were collected from four borings. Some volatiles were detected above MDNR's standards, but the concentrations were well below ATSDR's CVs. Lead (130 ppm) was detected at elevated concentrations in a sample collected 5 feet deep, but other samples contained much lower concentrations. **Groundwater**: No samples were collected.	**Corrective Activities:** The OWS has been emptied, cleaned, and closed in place. **Current Status**: The site will officially be labeled as a "No Further Action" site in the near future.	**Soil**: Lead contamination at this site is present in the subsurface. Thus, it is unlikely that on-base residents or the general public were exposed to the site's soils. Workers could be exposed to lead contaminants for short durations if the area is excavated in the future. Concentrations are too low to pose a health hazard to this population, however. **Groundwater:** No on-base water supply wells are located nearby; therefore, no past or current exposures to groundwater have occurred. Potential future exposures are not expected to pose health hazards because there is no evidence that the groundwater has been impacted by activities at LF-67. Furthermore, any contaminants that may have reached the water will be captured by the BPPTS.
ST-68 This site consists of an OWS at Facility 5067. (The site is located within the boundaries of SS-06.)	**Soil:** According to site representatives, soil samples were collected and no contaminants exceeded health-based guidelines.	**Current Status**: USAF will pursue a "No Further Action" status for this site.	There is no evidence that this site was adversely impacted by site activities.

References: Air Force 1990, 1993, 1995; AFBCA 1993, 1997, 1998, 1999a, 1999b, 1999c, 1999d, 1999e, 1999f, 1999g, 1999h, 1999i, 1999j, 2000a, 2000b, 2000d, 2000e, 2001a; AFCEE 1994a, 1994b, 1994c, 1995a, 1995b, 1995c, 1995d, 1995e, 1995f, 1995g, 1995h, 1996a, 1996b, 1996c, 1996d, 1996e, 1996f, 1996g, 1996h, 1996i, 1996j, 1996k, 1997a, 1997b, 1997c, 1997d, 1997e, 1997f, 1998a, 1998b, 1998c, 1998d, 1998e, 1998f, 1998g, 1998h, 1998i, 1998j, 1998k, 1998l, 1998m, 1998n, 1998o, 1998p, 1998q, 1999, 2000; ATSDR 1998a; BRAC 1996; District 1999a, 2000e; USAF 2000, 2001; USEPA 2000a; USGS 1983, 1991; WWES 1993, 1994, 1995a, 1995b.

APPENDIX B: GLOSSARY

Absorption

How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure

Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Adverse Health Effect

A change in body function or the structures of cells that can lead to disease or health problems.

ATSDR

The Agency for Toxic Substances and Disease Registry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Background Level

An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.

Cancer

A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control.

Carcinogen

Any substance shown to cause tumors or cancer in experimental studies.

CERCLA

See Comprehensive Environmental Response, Compensation, and Liability Act.

Chronic Exposure

Contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

Completed Exposure Pathway

See Exposure Pathway.

Comparison Values (CVs)

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

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

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

Concern

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

Concentration

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

Contaminant

See Environmental Contaminant.

Dermal Contact

A chemical getting onto your skin. (see Route of Exposure).

Dose

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

Duration

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

Environmental Contaminant

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

Environmental Media

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

Environmental Protection Agency (EPA)

The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

EPA's cancer slope factors

The additional risk of cancer posed by the ingestion of 1 milligram of a substance, per kilogram of body weight, per day, over a lifetime.

EPA's chronic oral reference dose (RfD)

An estimate (uncertainty spanning perhaps an order of magnitude) of a daily exposure (milligram per kilogram per day [mg/kg/day]) to the general public (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime exposure or exposure during a limited time interval.

Exposure

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

Exposure Pathway

A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts:

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

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

Frequency:

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

Hazardous Waste

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

Health Effect

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

Ingestion

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

Inhalation

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

MRL

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

National Priorities List

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

Pesticides

Any organic or inorganic substance used to destroy or inhibit the action of plant or animal pests, including insecticides, herbicides, fungicides, rodenticides, miticides, fumigants, and repellants. All pesticides are toxic to humans to some degree. Pesticides vary in biodegradability.

PHA

Public Health Assessment. A report that evaluates chemicals at a hazardous waste site and indicates whether people could be harmed from coming into contact with those chemicals. The PHA also indicates whether further public health actions are needed.

Polychlorinated biphenyls (PCBs)

A group of synthetic organic chemicals that contain 209 individual chlorinated biphenyl compounds (known as congeners). There are no known natural sources of PCB in the environment. PCBs are either oily liquids or solids. Because they do not burn easily and are good insulating materials, PCBs have been used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in October 1977 as a result of evidence that they build up in the environment and cause harmful effects.

Plume

A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or

contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure

The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Examples include: (1) an area in a playground that has contaminated dirt, (2) a contaminated spring used for drinking water, (3) a location where fruits or vegetables are grown in contaminated soil, or (4) a backyard area where someone might breathe contaminated air.

Population

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

Public Health Assessment(s):

See PHA.

Public Health Hazard

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

Receptor Population

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

Reference Dose (RfD)

An estimate, with safety factors (see safety factor) built in, of the daily, life-time exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.

Route of Exposure

The way a chemical can get into a person's body. There are three exposure routes:

- breathing (also called inhalation),
- eating or drinking (also called ingestion), or
- getting something on the skin (also called dermal contact).

Safety Factor

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

Semivolatile Organic Compounds (SVOCs)

A class of organic (containing carbon) chemicals similar to VOCs, but that evaporate or volatilize less rapidly.

Source of Contamination

The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. (See Exposure Pathway.)

Toxic

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

Toxicology

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

Tumor

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

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 C: ATSDR'S COMPARISON VALUES

Comparison values (CVs) represent media-specific contaminant concentrations that are used to select contaminants for further evaluation. Site contaminants that are detected at or below ATSDR's CVs are not expected to cause any observable adverse health effect and are not evaluated further. If a contaminant is detected above these screening values, it does not necessarily follow that the contaminant will pose an adverse health effect. The contaminant's concentration and overall toxicity, as well as several site-specific environmental exposure factors (for example, duration and frequency of exposure) must be considered when determining whether a contaminant will pose a health hazard.

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 a 70-year life span. The Agency for Toxic Substances and Disease Registry's (ATSDR's) CREGs are calculated from the U. S. Environmental Protection Agency's (EPA's) cancer potency factors (CPFs). The CREG is the most conservative of ATSDR's CVs because it assumes that no threshold exists for the effects of chemical carcinogens (that is, it is assumed that no safe level of exposure occurs). As scientists learn more about the way different chemicals produce their effect, it is becoming apparent that this may not always be the case. CREGs, therefore, do not define levels of actual hazard (e.g., a 1-in-a-million "risk" level) and cannot be used to predict actual cancer incidence under specified conditions of exposure. As stated in EPA's 1986 Cancer Risk Assessment Guidelines, "the true risk is unknown and may be as low as zero."

Environmental Media Evaluation Guides (EMEGs)

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

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 people consuming 2 liters of water per day.

Reference Media Evaluation Guides (RMEGs)

ATSDR derives RMEGs from EPA's oral reference doses (RfDs). The RMEG represents the concentration in water or soil at which daily human exposure is not expected to result in adverse noncarcinogenic effects.

Risk-Based Concentration (RBC)

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

APPENDIX D: EVALUATION OF PAST EXPOSURES TO DRINKING WATER SUPPLIES

Overview of ATSDR's Methodology for Evaluating Potential Public Health Hazards

ATSDR evaluated past exposures to drinking water supplies at and near Wurtsmith Air Force Base (WAFB). ATSDR evaluated whether potential health hazards were associated with past exposures to water supplied by: (1) the U.S. Air Force's (USAF's) main water supply wells, (2) USAF's area-specific wells, and (3) off-base wells. To do so, ATSDR evaluated available data to determine whether contaminants were above ATSDR's drinking water comparison values (CVs). For those that were, ATSDR derived exposure doses and compared them against health-based guidelines. ATSDR also reviewed relevant toxicologic and epidemiologic data to obtain information about the toxicity of contaminants of interest.

Comparing Data to ATSDR's CVs

Appendix C lists CVs that are commonly used by ATSDR. These values are derived using conservative exposure assumptions. CVs reflect concentrations that are much lower than those that have been observed to cause adverse health effects. Thus, CVs are protective of public health in essentially all exposure situations. As a result, concentrations detected at or below ATSDR's CVs are not considered to warrant health concern. While concentrations at or below the relevant CV may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. It cannot be emphasized strongly enough that CVs are not thresholds of toxicity. The likelihood that adverse health outcomes will actually occur depends on site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure, and not on environmental concentrations alone.

For this public health assessment, ATSDR evaluated data that were collected from wells and tap water to determine whether people were exposed to contaminant concentrations that exceeded ATSDR's drinking water CVs in the past. The vast majority of the detected contaminants fell at or below CVs and were not evaluated further. Contaminants that were above CVs were deemed worthy of further evaluation, prompting ATSDR to estimate exposure doses (i.e., the amount of chemical a person is exposed to over time) using site-specific exposure assumptions.

Deriving Exposures Doses

ATSDR derived exposure doses for those contaminants that were detected above ATSDR's drinking water CVs. These are presented in Table D-1. When estimating exposure doses, health assessors evaluate (1) contaminant concentrations to which people may have been exposed and (2) the length of time and the frequency of exposure. Together, these factors influence an individual's physiological response to chemical contaminant exposure and potential outcomes. Where possible, ATSDR used site-specific information about the frequency and duration of

exposures. In cases where site-specific information was not available, ATSDR applied several conservative exposure assumptions to estimate exposures for on-base residents, on-base employees, and off-base residents or recreational users. The following equation and assumptions were used to estimate exposures to contaminants that may have been ingested at or near WAFB:

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

where:

Conc. Maximum contaminant concentration detected in parts per million (ppm)

IR Ingestion rate. The value used differed depending on whether the water was supplied to residential areas or industrial/ commercial areas:
Residential: child=1 liter per day and adult=2 liters per day
Industrial/commercial: adult= 1 liter per day

EF Exposure frequency, or the number of exposure events. ATSDR used the following default values unless more specific exposure information was available:
Residential: 1 event x 7 days x 52 weeks or 365 days per year
Industrial/commercial: 1 event x 5 days x 52 weeks or 260 days per year

ED Exposure duration, or the duration over which exposure occurs. ATSDR assumed that adults were exposed for 30 years and children were exposed for 6 years unless more specific exposure information was available. (Note: As a preliminary screen, ATSDR assumed that adults were exposed to well water for 30 years because this is the upper-bound estimate for the amount of time that an individual remains at one residence.)

BW Body weight (kg): adult = 70 kg (154 pounds); child = 16 kg (35.2 pounds)

AT Averaging time, or the period over which cumulative exposures are averaged. To evaluate noncancer effects, ATSDR estimated exposure doses by using an averaging time of 6 years for children and 30 years for adults. Lifetime exposure doses were also calculated to evaluate potential cancer effects. The averaging time used to calculate the latter was 70 years.

The equation provided above estimates exposure doses that result from ingestion. At WAFB, the associated water supplies were also used for bathing, cooking, industrial processes, and other activities. As a result, people were also exposed to the water through dermal contact and inhalation of water vapors. Several complicated factors come into play when trying to estimate exposure doses for dermal and inhalation exposure routes. To be conservative, ATSDR assumed that each exposure route (i.e., ingestion, dermal, and inhalation) generates equivalent exposure doses. Therefore, to calculate the total potential exposure dose for all three routes, ATSDR multiplied the estimated exposure doses for ingestion by a factor of three (see Table D-1).

Using the Exposure Doses to Evaluate Potential Health Hazards

ATSDR performs a weight of evidence (WOE) analysis to determine whether exposures might be associated with adverse health effects (noncancer and cancer). As part of this process,

ATSDR examines relevant toxicologic, medical, and epidemiologic data to determine whether estimated doses are expected to result in adverse health effects. As a first step in evaluating *noncancer* effects, ATSDR compares estimated exposure doses to standard health guideline values, including ATSDR's minimal risk levels (MRLs) and the U.S. Environmental Protection Agency's (EPA's) reference doses (RfDs). The chronic MRLs and RfDs are estimates of daily human exposure to a substance that are not expected to result in noncancer effects over a specified duration. Estimated exposure doses that are less than these values are not considered to be of health concern. To be very protective of human health, MRLs and RfDs have built in "uncertainty" or "safety" factors that make them much lower than levels at which health effects have been observed. Therefore, if an exposure dose is much higher than the MRL or RfD, it does not necessarily follow that adverse health effects will occur.

If health guideline values are exceeded, ATSDR examines the effect levels seen in the literature and more fully reviews exposure potential to help predict the likelihood of adverse health outcomes. ATSDR looks at human studies, when available, as well as experimental animal studies. This information is used to (1) describe the disease-causing potential of a particular contaminant, and (2) compare site-specific dose estimates with doses shown to result in illness in applicable studies (known as the margin of exposure). For cancer effects, ATSDR also reviews genotoxicity studies to further understand the extent to which a contaminant might be associated with cancer outcomes. This process enables ATSDR to weigh the available evidence, in light of uncertainties, and offer perspective on the plausibility of adverse health outcomes under site-specific conditions.

Evaluation of Potential Past Health Hazards Associated With Exposures to USAF's Main Water Supply Wells

USAF's main water supply wells serviced on-base residential areas and many base facility buildings. For many years, water samples were collected from the faucets of these buildings and from the wells that supplied the water. ATSDR evaluated these data and identified the contaminants that exceeded ATSDR's drinking water CVs. (Note: The values detected in individual wells do not necessarily reflect the concentrations that were present at the faucet because water from several wells was mixed together before reaching the tap. Regardless, the well data were evaluated because samples were collected from them more regularly than they were from the tap and they were sampled for a wider variety of chemicals. Therefore, evaluating these data ensured that all potential contaminants were identified.) Eight contaminants were present in tap and/or well water samples at concentrations that exceeded ATSDR's drinking water CVs. The following summarizes what ATSDR concluded about each chemical:

Benzene. Water samples were analyzed for benzene on many occasions during the years that USAF's main water supply wells were operational. The contaminant was detected in tap water samples at concentrations ranging from nondetect to 1,510 ppb. A review of available data indicate that high concentrations were not typical, however. The maximum concentration (i.e., 1,510 ppb) was detected in the tap water of Building 5008, a location that was sampled on 154

occasions between February 1982 and October 1987. During these sampling events, benzene was recorded at nondetect levels 146 times, at trace levels twice, and as detected concentrations (i.e., 4.7 ppb, 6.4 ppb, 10.2 ppb, 10.9 ppb, 13.5 ppb, and 1,510 ppb) six times. ATSDR concluded that the reported spike of 1,510 ppb was anomalous because nondetects were reported in the 32 sampling events that preceded the spike and in the 17 events that followed it. Building 5008 was not the only location to report benzene concentrations above ATSDR's drinking water CVs in tap water. Elevated levels were also reported in samples collected from 9750B 8th Street, 10311 7th Street, the hospital, the Child Care Center, the Officer's Club, Building 5065, 10059 8th Street, and Building 1700. These detections, the highest of which was recorded at 38.6 ppb, were extremely rare, however (see Table 3 in the main body of the text). Data collected from the actual main water supply wells tell a similar story. That is, benzene *was* detected at concentrations that exceed ATSDR's drinking water standards, but detections, which never exceeded 37 ppb, were very infrequent (see Table 2 in the main body of the text).

As shown in Table D-1, ATSDR calculated ingestion exposure dose estimates and total exposure dose estimates (ingestion, dermal contact, and inhalation) for benzene using highly conservative assumptions. That is, ATSDR calculated the doses assuming that people were exposed to benzene concentrations of 38.6 ppb (the highest concentration detected in the tap, excluding the anomalous hit of 1,510 ppb) for extended periods of time. (As explained in the previous paragraph, ATSDR knows that this assumption grossly over exaggerates what actually happened at WAFB because benzene was not detected at high concentrations for extended periods.) Then, ATSDR performed a WOE analysis to determine whether the estimated doses could have posed health hazards. *ATSDR concluded that exposures to benzene were not expected to pose health hazards.*

Benzene has been classified as a known human carcinogen. Most of the studies that document adverse effects in humans evaluate the impact of inhalation exposures, primarily in occupational settings, where people would be exposed to doses that are much higher than those that were encountered via groundwater ingestion at WAFB. ATSDR did not find information on any human studies that specifically evaluated whether adverse effects result from ingesting low doses of benzene. However, oral exposure pathways have been studied more extensively in animal studies. A variety of studies have been performed on rats and mice; documented doses that caused increased cancer rates in these populations ranged from about 25 to 500 mg/kg/day [ATSDR, 1997d]. Lifetime exposure doses estimated as occurring at WAFB in the past [and, it should be remembered that these doses are probably overestimated] ranged from 0.0005 to 0.001, many thousands of times lower.

Chlorodibromomethane. Water samples were analyzed for chlorodibromomethane on many occasions during the years that USAF's main water supply wells were operational. As indicated in Table 3, the contaminant was detected above ATSDR's most conservative drinking water CV (i.e., 0.4 ppb) in tap water samples that were collected from the hospital; 9750A & B 8th Street; 10419 South Carolina Street; the Officer's Club; the Child Care Center; the Bioengineering building, the Civil Engineering building; and Buildings 291, 5006, 5008, 5067, and 1700. The

highest concentration of chlorodibromomethane detected in the tap water samples was 6.1 ppb. (Concentrations detected in the actual main water supply wells, which ranged from nondetect to 1.0 ppb, were even less than those detected at the tap.) As indicated in Table 3, chlorodibromomethane concentrations were not detected at 6.1 ppb consistently for extended periods of time. (During many sampling events, the contaminant was not detected. Also, many of the detections that registered above ATSDR's drinking water CVs were lower than 6.1 ppb.)

To be conservative, ATSDR used the highest concentration that was detected in tap water samples to estimate exposure doses. As shown in Table D-1, the estimated doses were lower than ATSDR's MRLs, which were used to screen for potential noncancer health hazards. ATSDR reviewed the scientific literature and learned that it is unclear whether chlorodibromomethane has the potential to cause cancer effects. While some epidemiologic studies do suggest a potential link between cancer effects and exposures to chlorinated drinking water, it is unclear what doses of chlorodibromomethane would cause this and whether the contaminant was truly responsible for the observed effects. Numerous other potential toxicants are known to exist in chlorinated drinking water, and these could have accounted for the effects that were recorded. Thus, data collected from human studies are too weak to draw conclusions about the carcinogenic potential of chlorodibromomethane in humans. EPA has classified this chemical as a possible carcinogen, however, because a study performed on mice indicated that exposure to chlorodibromomethane (at doses of 100 mg/kg/day) might cause an increased risk of developing liver tumors. It should be noted, however, that the carcinogenic response observed in the animal study was rather small, and that the weight of evidence for carcinogenicity was not considered to be clear and conclusive (ATSDR, 1990). Furthermore, the doses cited as causing adverse effects in the mice are about 500,000 to 1,250,000 higher than those estimated as occurring in the past at WAFB (see Table D-1). *After reviewing the available literature, ATSDR concluded that exposures to chlorodibromomethane from USAF's main water supply wells were not expected to pose health hazards.*

Chloroform. Water samples were analyzed for chloroform on many occasions during the years that USAF's main water supply wells were operational. As indicated in Table 3, the contaminant was detected above ATSDR's most conservative drinking water CV (i.e., 6.0 ppb) in tap water samples that were collected from on-base residents or other facilities that received their water from USAF's main water supply wells. For example, chloroform exceeded screening values in 1982 (detected in a sample collected from the hospital), in 1985 (detected in a sample collected from 8822A 3rd Street), in 1989 (detected in samples collected from Building 291 and the Procurement Building) and on several occasions between 1993 and 1997 (detected in samples collected from the hospital, the Child Care Center, 10419 South Carolina Street, Building 5067, Building 5006, Building 20, the Baker Engineering Building, and the Civil Engineering Building). The highest concentration of chloroform detected in the tap water samples was 34 ppb. (This concentration is similar to the highest concentration [i.e., 29.4 ppb] that was detected in the actual main water supply wells.) As indicated in Table 3, chloroform concentrations were not detected at 34 ppb in tap water samples for extended periods of time. (During many sampling

events, the contaminant was not detected. Also, many of the detections that registered above ATSDR's drinking water CVs were lower than 34 ppb.)

To be conservative, ATSDR used the highest concentration that was detected in tap water samples to estimate exposure doses. As shown in Table D-1, the estimated doses were lower than ATSDR's MRLs. Thus, it is unlikely that exposures to this chemical posed noncancer health effects. ATSDR reviewed the scientific literature and learned that it is unclear whether chloroform has the potential to cause cancer effects. While some epidemiologic studies do suggest a potential link between cancer effects and exposures to chlorinated drinking water, it is unclear what doses of chloroform could cause this and whether the contaminant was truly responsible for the observed effects. Numerous other potential toxicants are known to exist in chlorinated drinking water, and these could have accounted for the effects that were recorded. Thus, data collected from human studies are too weak to draw conclusions about the carcinogenic potential of chloroform in humans. However, based on studies that have been performed on animals, the EPA has classified this contaminant as a probable human carcinogen, the International Agency for Research on Cancer (IARC) has classified it as a possible human carcinogen, and the National Toxicology Program (NTP) regards it as a substance that may reasonably be anticipated to be carcinogenic in humans. These classifications have been assigned based on toxicologic studies performed on rats and mice. Evidence of cancerous effects were apparent in these populations at exposure doses ranging from 60 to 200 mg/kg/day (ATSDR, 1997e). These doses are about 60,000 to 500,000 times greater than those estimated as occurring in the past at WAFB (see Table D-1). *After reviewing these data, ATSDR concluded that exposures to chloroform from USAF's main water supply wells were not expected to pose health hazards.*

Dichlorobromomethane. Water samples were analyzed for dichlorobromomethane on many occasions during the years that USAF's main water supply wells were operational. As indicated in Table 3, the contaminant was detected above ATSDR's most conservative drinking water CV (i.e., 0.6 ppb) in tap water samples that were collected from the hospital; 9750A & B 8th Street; 10419 South Carolina Street; 8822A 3rd Street; the Officer's Club; the Procurement Office; the Child Care Center; the Bioengineering building, the Civil Engineering building; the Baker Engineering building, and Buildings 20, 291, 5006, 5008, 5067, and 1700. The highest concentration of dichlorobromomethane detected in the tap water samples was 7.4 ppb. (This concentration is similar to the highest concentration [i.e., 3.9 ppb] that was detected in the actual main water supply wells.) As indicated in Table 3, dichlorobromomethane concentrations were not detected at 7.4 ppb in tap water samples for extended periods of time. (During several sampling events, the contaminant was not detected. Also, many of the detections that registered above ATSDR's drinking water CVs were lower than 7.4 ppb.)

To be conservative, ATSDR used the highest concentration that was detected in tap water samples to estimate exposure doses. As shown in Table D-1, the estimated doses were lower than ATSDR's MRLs. Thus, it is unlikely that exposures to this chemical posed noncancer health effects. ATSDR reviewed the scientific literature and learned that no studies have been

performed to determine whether dichlorobromomethane poses a carcinogenic risk to human populations. EPA does classify it as a probable human carcinogen, but this classification has been made based on toxicologic studies that have been performed on rats and mice. These studies showed that cancerous effects were apparent at exposure doses of about 50 to 150 mg/kg/day (ATSDR, 1989). These levels are between 100,000 and 1,700,000 times greater than those estimated as occurring in the past at WAFB (see Table D-1). *After reviewing available literature, ATSDR concluded that exposures to dichlorobromomethane from USAF's main water supply wells were not expected to pose health hazards.*

1,2-Dichloroethane. Many tap water samples were collected in the 1980s, but only a limited number were analyzed for 1,2-dichloroethane. Samples collected from Building 1700 were analyzed for this chemical between May 1983 and April 1986. Results indicated that 1,2-dichloroethane was present at concentrations of 0.5 ppb in May 1983 and June 1983. This concentration is in slight excess of ATSDR's drinking water CV (i.e., 0.4 ppb). (Similar concentrations were detected in AF2—one of the main water supply wells—during this time period.) It appears that 1,2-dichloroethane was only present at these elevated concentrations for a short period of time. (The contaminant was not detected in a tap water sample that was collected from Building 1700 in April of 1986. Nor was it detected above ATSDR's drinking water CVs in any of the main water supply wells that were sampled between the mid-1980s and 1997. Between 1993 and 1997, tap water samples were collected from a number of locations [i.e., the hospital; 10419 South Carolina Street; the Child Care Center; the Bioengineering building, the Civil Engineering building; the Baker Engineering building, and Buildings 20, 5006, and 5067] and analyzed for 1,2-dichloroethane. The contaminant was not detected in any of these samples.)

To be conservative, ATSDR used the highest concentration that was detected in tap water samples to estimate exposure doses. As shown in Table D-1, the estimated doses were significantly lower than ATSDR's health guidelines. Thus, it is unlikely that exposures to this chemical posed noncancer health effects. ATSDR reviewed the scientific literature and learned that EPA classifies 1,2-dichloroethane as a probable human carcinogen. Animal studies suggest that exposure to the chemical might cause an increased risk of developing cancer, and some data suggest that 1,2-dichloroethane and its metabolites could be mutagenic. ATSDR found no studies that shed light on the exposure doses that could cause increased cancer risks in humans. Doses associated with cancer effects in mice and rats have been reported between 50 and 150 mg/kg/day (ATSDR, 1999). These levels are between 2,500,000 and 25,000,000 times greater than those estimated as occurring in the past at WAFB (see Table D-1). *After reviewing the available literature, ATSDR concluded that exposures to 1,2-dichloroethane from USAF's main water supply wells were not expected to pose health hazards.*

1,2-Dichloroethene. Many tap water samples were analyzed for 1,2-dichloroethene throughout the 1980s and 1990s, but none contained the contaminant at concentrations that exceeded ATSDR's most conservative drinking water CV (i.e., 200 ppb). The chemical was detected slightly above these standards in one main water supply well, however, in December 1985. The

detection, which registered at 207 ppb, was recorded in well AF5. As indicated in Table D-1, if people had been exposed to this concentration over an extended period of time, this would have resulted in exposure doses that exceed ATSDR's health guidelines. However, ATSDR is confident that this did not occur. In fact, it is unlikely that people were ever exposed to concentrations as high as 207 ppb because the concentrations detected in AF5 do not reflect what people were exposed to at the tap. (The detection of 207 ppb was recorded during a time when AF5 was only being used on a supplemental basis on the rare occasions that the base's water demands could not be met by wells AF30, AF31, and AF32. Site records do not indicate whether AF5 was being used in December 1985 [i.e., the time period when the high detection was recorded]. If it was, water from AF5 would have been mixed with water provided by AF 30, AF31, and AF32 before being shuttled to on-base residential buildings and other facilities. Samples were collected from wells AF30, AF31, and AF32 on three occasion in December 1985 and analyzed for 1,2-dichloroethene; the contaminant was not detected in any of them. Thus, any 1,2-dichloroethene that would have been contributed from AF5 would have been greatly diluted before reaching the tap.) Furthermore, a more thorough analysis of available data sets indicates that the maximum concentration recorded in AF5 was probably an anomaly and does not represent the conditions of the well water over time. (About 165 samples were collected from AF5 and analyzed for this contaminant between December 1979 and June 1993. In the overwhelming majority of the sampling events, 1,2-dichloroethene was not detected at all. On the rare occasions that it was, concentrations were below 10 ppb, except for the 207 ppb detection that was recorded in December 1985. One half month before this detection, the contaminant was detected at trace levels. One-half month later, it was listed as nondetect.) *ATSDR concluded that exposures to 1,2-dichloroethene were not expected to pose health hazards.*

1,1,2,2-tetrachloroethane. USAF started analyzing well and tap water samples for 1,1,2,2-tetrachloroethane in 1982. The contaminant was detected at concentrations that exceeded ATSDR's most conservative drinking water CV (i.e., 0.2 ppb) in all of the samples that were collected during that year. (The contaminant was detected, at concentrations ranging between 0.8 and 3.5 ppb, in tap water samples that were collected from the hospital, 9750A& B 8th Street, the Officer's Club, Building 5008, and Building 1700. Similar concentrations, ranging from 2.5 to 4.3 ppb, were also detected in one of the main water supply wells in 1982.) Tap water samples were analyzed for this contaminant again in 1986 and several times between 1993 and 1997. The contaminant was not detected above ATSDR's drinking water CVs during these sampling events. Nor was it detected at elevated concentrations in any of the samples that were collected from the main water supply wells after May 1983.

Because all of the initial sampling results indicated that 1,1,2,2-tetrachloroethane was present, ATSDR cannot rule out the possibility that the contaminant was present for several years before 1982. Thus, to be conservative, ATSDR assumed that people could have been exposed to the maximum concentrations that were detected in tap water samples for an extended period of time. As shown in Table D-1, the doses that would have been associated with such exposures were significantly lower than ATSDR's health guidelines. Thus, it is unlikely that exposures to this chemical posed noncancer health effects. ATSDR reviewed the scientific literature and learned

that it is unclear whether 1,1,2,2-tetrachloroethane has the potential to cause cancer effects in humans. A weak correlation between increased cancer rates and exposures to 1,1,2,2-tetrachloroethane was documented in one epidemiologic study. However, the study, which focused on exposures that occurred via inhalation and dermal contact, was confounded by many uncontrolled factors. No studies have been performed to evaluate the potential for carcinogenic effects in humans who ingest the chemical. Based on data provided in animal studies, EPA has classified the contaminant as a possible human carcinogen. These studies showed that mice experienced an increased incidence of hepatocellular carcinomas when they were exposed to doses of about 140 mg/kg/day (ATSDR, 1996b). These doses are about 1,000,000 to 4,000,000 times greater than those estimated as occurring in the past at WAFB (see Table D-1). *After reviewing the literature, ATSDR concluded that exposures to 1,1,2,2-tetrachloroethane from USAF's main water supply wells were not expected to pose health hazards.*

Trichloroethylene (TCE). USAF started sampling tap water samples and the main water supply wells for TCE in 1977. They were prompted to do so after an on-base resident complained that peculiar tastes and odors were present in the drinking water. In October 1977, a tap water sample was collected from one base housing area; TCE was detected at concentrations of 1,100 ppb. In November 1977, samples were collected from USAF's main water supply wells to determine which were contaminated with TCE. The contaminant was recorded as nondetect in some of the wells, but reached concentrations of 895 ppb and 5,173 ppb in AF1 and AF3, respectively. These wells were immediately removed from service.

Following the initial sampling events, USAF collected tap water and well samples regularly and analyzed them for TCE. ATSDR reviewed data that were collected between 1977 and 1997. The agency found that the TCE concentrations that people were exposed to varied greatly over time. Thus, when evaluating exposures, ATSDR looked at two different populations:

People Who Used Water From the Main Water Supply Wells Between 1962 and 1979

As noted above, TCE was detected at 1,100 ppb in a tap water sample that was collected in October 1977. ATSDR does not know how long TCE concentrations had been at this level prior to October 1977 because no samples were collected before that date. To be extremely conservative, ATSDR assumed that concentrations could have been that high since 1962. (This year was chosen because this is when Site 21's underground storage tank [UST] was installed. This UST is the suspected source of the Arrow Street Plume, which has been blamed for the contamination of USAF's main water supply wells.) Such high concentrations were not sustained in the tap water samples after 1977, however. In fact, concentrations dropped very rapidly. By November 1977, samples collected from the tap contained TCE at concentrations of 150 ppb. Between November 1977 and December 1979, concentrations detected in tap water samples bounced between nondetect and 150 ppb, with many detections registering between 20 ppb and 80 ppb.

To be conservative, ATSDR used the highest concentration that was detected in tap water samples (i.e., 1,100 ppb) to estimate the TCE dose for people potentially exposed between 1962 and December 1979. As shown in Table D-1, the estimated doses did not exceed ATSDR's acute MRL. A chronic MRL health guideline has not been developed, but ATSDR evaluated possible cancer effects associated with chronic exposures. ATSDR reviewed the scientific literature to evaluate the carcinogenicity of TCE. *Given the high concentrations that were encountered prior to 1980, ATSDR concluded that it is possible, that exposures to TCE could have been associated with an increased risk of developing cancer. It must be strongly emphasized however, that the link between TCE and the incidence of cancer in humans is controversial.* While some studies that evaluated human exposures to TCE in drinking water showed that exposures might cause a possible increase in the incidence of certain cancers, these studies are inconclusive either because (1) they lacked information on exposure level or dose, (2) study subjects were exposed to multiple substances rather than just TCE, and/or (3) the study included only a small number of participants (ATSDR, 1997a). TCE has been shown to cause cancer in laboratory animals under experimental conditions where high doses were administered. Animal studies (e.g., mice and rats) are helpful in predicting possible human health effects, but TCE appears to be metabolized differently in these animals, particularly at low doses. This suggests that the same outcomes might not be expected in animals and humans. Because possible effects resulting from lower level exposures are difficult to study, scientists are uncertain about the effects of such exposures, especially in humans. That is why screening values (e.g., ATSDR's Cancer Risk Evaluation Guide) are set very low to help ensure that people are not exposed to contaminant levels even remotely close to effect levels seen in experimental studies. It is important to note, however, that even if a 150 pound (70 kg) person had been exposed to the maximum TCE concentration of 1,100 ppb detected in on-base water supplies (drinking 2 liters per day for 18 years [i.e., between 1962 and December 1979]), estimated doses (see Table D-1) would have been significantly lower than levels resulting in cancer in laboratory studies (1,000 mg/kg/day) (NTP, 1990).

The relevance of laboratory animal data and available human data are being closely examined by scientists and government agencies. EPA, for example, is currently reviewing the scientific literature pertaining to the carcinogenicity of TCE to determine how it should be classified (e.g., as a probable or possible human carcinogen). Considering the ongoing controversy about the relevance of cancers induced in animals under extreme conditions of exposure (lifetime gavage administration of very high doses), and the recent evidence of the different manner in which TCE may be metabolized in humans as compared to rodents, the only thing that can be said is that TCE may be carcinogenic in humans.

People Who Used Water From the Main Water Supply Wells After 1979

As noted above, TCE concentrations detected in tap water samples decreased rapidly after 1977, but it did take a couple of years for contaminant concentrations to stabilize. Between 1980 and 1997, several hundred tap water samples were analyzed for TCE. During this time period, the contaminant was rarely detected above ATSDR's drinking water CVs, and only reached as high

as 25 ppb once during the 17 year period. *Since detections were infrequent and low, ATSDR concluded that TCE was not expected to pose a health hazard to people who consumed water from the main water supply wells after 1979.*

Evaluation of Potential Past Health Hazards Associated With Exposures to USAF's Area-Specific Wells

USAF's area-specific wells differed from the main water supply wells in that they only serviced one particular area or building. The water that was pumped from the area-specific wells was not mixed with other water streams on its way to building faucets. As a result, samples collected from the wells reflect the conditions that were present at the tap and vice versa. ATSDR evaluated available well and tap water data to determine whether any of the area-specific wells contained contaminants at concentrations that exceeded ATSDR's drinking water CVs. Wells AF16 and AF25 did not, but TCE, chloroform, and/or methylene chloride were detected at concentrations that exceeded ATSDR's CVs in the other area-specific wells. ATSDR calculated ingestion exposure doses and total exposure doses (see Table D-1) for these contaminants and compared them to available health guidelines. In addition, ATSDR performed a WOE analysis to determine whether the estimated doses were expected to result in adverse effects. (Information on toxicologic studies and the overall toxicity of TCE and chloroform is summarized under Appendix D's "Evaluation of Potential Past Health Hazards Associated With Exposures to USAF's Main Water Supply Wells" section. Thus, this information will not be repeated here. Information about toxicologic studies that have been performed on methylene chloride, however, are presented below.) ATSDR concluded the following about each of USAF's area-specific wells that contained contaminants above ATSDR's drinking water CVs:

Well AF7. This well, which serviced the North Cottage, contained TCE (nondetect to 17.6 ppb) at concentrations above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures to TCE because the estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 1,000,000 and 5,000,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that well AF7 was used or what population it serviced. Even though the maximum concentration was used to estimate exposure doses, it is unlikely that people were exposed to 17.6 ppb over an extended period of time. Samples were collected from AF7 and analyzed for TCE 38 times between December 1977 and January 1980. The contaminant was only detected above 10 ppb during four of the sampling events.)

Well AF8. This well, which serviced the South Cottage, contained TCE (nondetect to 27 ppb) at concentrations above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE would not pose a health*

hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern. No noncancer effects are likely associated with past exposures to TCE because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 1,000,000 and 3,500,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that well AF8 was used or what population it serviced. Even though the maximum concentration was used to estimate exposure doses, it is unlikely that people were exposed to 27 ppb over an extended period of time. Samples were collected from AF8 and analyzed for TCE about 40 times between October 1978 and September 1980. Concentrations were listed at nondetect levels on 22 occasions and at trace levels on five occasions.)

Well AF14. Tap water, collected from the building that AF14 serviced, contained TCE (12.1 to 12.7 ppb) at concentrations above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 2,000,000 and 5,000,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that well AF14 was used or what population it serviced.)

Well AF15. This well, which serviced the procurement building, contained TCE (2.9 to 296 ppb) at concentrations above ATSDR's drinking water CV. ATSDR calculated exposure doses for adult populations who may have been exposed to the water while at work. Exposure doses were not calculated for children because it is unlikely that they frequented the procurement building. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that the maximum detected concentrations of TCE were too low to pose health hazards to those who were exposed to the water during their working hours.* No noncancer effects are likely associated with past exposures because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 250,000 and 1,000,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that the assumptions that were used to estimate exposure doses may overestimate the length of time that people were exposed to well water. [Base representatives did not know how long the well had been in service.] The assumptions also probably overestimate the concentrations that people were exposed to. [More than 100 samples were analyzed for TCE between 1977 and 1985. Concentrations averaged around 50 ppb.])

Well AF22. This well, which serviced the Burkhart Lodge for many years, contained TCE (trace to 30.4 ppb) at concentrations above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures would not pose a*

health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern. No noncancer effects are likely associated with past exposures because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 1,000,000 and 2,500,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that the assumptions that were used to estimate exposure doses overestimate the length of time that people were exposed. [The lodge was used to house visiting pilots.] The assumptions also overestimate the concentrations that people were exposed to. [More than 100 samples were analyzed for TCE between 1977 and 1981. Concentrations averaged around 12 ppb.])

Well AF23. This well, which serviced the Air Force Beach in the past, contained TCE (1.1 to 14.7 ppb) at concentrations above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE would not pose a health hazard even if people were exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 2,000,000 and 5,000,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that the well was used or what population it serviced.)

Unlabeled well that serviced the Defense Reutilization Management Office (DRMO). This well, which serviced the DRMO area in the past, contained chloroform (nondetect to 75 ppb) and methylene chloride (nondetect to 13 ppb) at concentrations above ATSDR's drinking water CVs. ATSDR calculated exposure doses for adult populations who may have been exposed to the water while at work. Exposure doses were not calculated for children because it is unlikely that they frequented the DRMO on a regular basis. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that the maximum detected concentrations of chloroform and methylene chloride were too low to pose health hazards to individuals who were exposed to the water during their working hours.* The following provides justifications for this conclusion:

> *Exposures to chloroform.* No noncancer effects are likely associated with past exposures to chloroform because the estimated exposure doses [see Table D-1] are much lower than ATSDR's acute and chronic MRLs. Also, the doses are between 60,000 and 700,000 times lower than those that have been shown to cause cancer effects in animals.
>
> *Exposures to methylene chloride.* No noncancer effects are likely associated with past exposures to methylene chloride because the estimated exposure doses are much lower than ATSDR's acute and chronic MRLs. Information about the cancer causing potential of methylene chloride has not yet been presented in this appendix. Thus, the chemical is discussed here. EPA has classified the chemical as a probable human carcinogen, IARC has classified it as a possible carcinogen in humans, and NTP regards it as a substance that may reasonably be anticipated to be carcinogenic in humans. It should be noted however, that

no studies have been performed showing that the chemical does actually cause cancer in humans. In fact, epidemiologic studies, which have been performed to study occupational exposures, failed to show a causal relationship between deaths due to cancer and exposures to methylene chloride. Exposures were shown to cause increased cancer effects in one animal study, where animals inhaled high concentrations of methylene chloride. No apparent increased cancer risks were observed, however, when mice and rats were exposed to drinking water that contained methylene chloride at doses ranging from 50 to 250 mg/kg/day, which are between 250,000 and 4,200,000 times higher than estimated doses associated with past exposures to the DRMO well (ATSDR, 1998b).

Unlabeled well that serviced the dog kennels. This well, which serviced the dog kennels in the past, contained chloroform (nondetect to 49 ppb) and methylene chloride (nondetect to 15 ppb) at concentrations above ATSDR's drinking water CVs. ATSDR calculated exposure doses for adult populations who may have been exposed to the water while at work. Exposure doses were not calculated for children because it is unlikely that they frequented the dog kennels. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that the maximum detected concentrations of methylene chloride and chloroform were too low to pose health hazards to individuals who were exposed to the water during their working hours.* No noncancer effects are likely associated with past exposures to chloroform or methylene chloride because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute and chronic MRLs. Also, the doses estimated for chloroform were thousands of time lower than those that have been shown to cause cancer in animal studies. As noted above, exposures to drinking water that was contaminated with methylene chloride failed to induce an increased risk of developing cancer effects in animals that were exposed to doses of 50 to 250 mg/kg/day. These doses are thousands of times higher than those associated with past exposures to the well that serviced the dog kennel.

Evaluation of Potential Past Health Hazards Associated With Exposures to Off-Base Wells

Some of WAFB's groundwater plumes have migrated off base towards wells that service residences, campgrounds, and other recreational buildings. As indicated in the main body of the text and summarized in Table 5, water samples have been collected from 61 properties located along West Shore Drive and F-41 County Road. TCE, chloroform, 1,1-dichloroethene, and/or methylene chloride were detected above ATSDR's drinking water CVs at nine of these properties (see Table 5). ATSDR calculated ingestion exposure doses and total exposure doses (see Table D-1) for these contaminants and compared them to available health guidelines. In addition, ATSDR performed a WOE analysis to determine whether the estimated doses were expected to result in adverse effects. (Information on toxicologic studies and the overall toxicity of TCE, chloroform, and methylene chloride are summarized in previous sections of this appendix. Thus, this information will not be repeated here. Information about toxicologic studies that have been performed on 1,1-dichloroethene, however, are presented below.) ATSDR concluded the following about each off-base well that contained contaminants above ATSDR's drinking water CVs:

5944 West Shore Drive. This well, which serviced a residential property, contained TCE (19 to 25 ppb) at concentrations above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures to TCE because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 1,000,000 and 3,500,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that the well was used or what population it serviced.)

6376 West Shore Drive. This well, which serviced a residential property, contained benzene (3 ppb) at a concentration above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to benzene would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures to benzene because estimated exposure doses are between 250,000 and 12,500,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that the well was used or what population it serviced. Even though the maximum concentration was used to estimate doses, it is unlikely that people were exposed to 3.0 ppb over an extended period of time. Samples were collected from this well and analyzed for benzene in May 1980, November 1983, December 1986, January 1987, and May 1990. The contaminant was only detected once, during the December 1986 sampling event.)

6504 West Shore Drive. This well, which serviced a residential property, was used as a drinking water source until the late 1970s. In May and June 1979, several water samples were analyzed for TCE; results indicated that the contaminant was present at concentrations ranging from 500 to 837 ppb. Immediately upon discovering the contamination, USAF started supplying bottled water to the residence. The well continued to be used, however, for nonpotable purposes until a municipal hookup was established in the 1990s. Samples continued to be collected during this time of nonpotable usage and TCE concentrations ranged from nondetect to 1,281 ppb.

Site documents do not reveal when the well at 6504 West Shore Drive was installed and no sampling data exist to indicate whether TCE contamination was present in the well before 1979. The suspected source of contamination, SS-05, became operational in 1956. To be conservative, ATSDR assumed that the well at 6504 West Shore Drive had been drilled by 1956 and that TCE was present at a concentration of 837 ppb (the maximum concentration detected in 1979) between 1956 and 1979. Using these assumptions, ATSDR estimated exposure doses (see Table D-1). The estimated doses were lower than ATSDR's acute MRL, which is used to screen for potential noncancer health hazards. Thus, ATSDR concluded that concentrations detected while the well was being used as a potable source, were not high enough to pose health hazards.

ATSDR also concluded that the maximum concentration detected during the years of nonpotable use would not have been high enough to pose hazards in the absence of the ingestion exposure route. As shown in Table D-1, estimated lifetime exposures, which are typically used to evaluate potential cancer effects, ranged from 0.008 to 0.02 mg/kg/day. These doses are virtually the same as those that were estimated for populations that were exposed to USAF's main water supply wells before 1980. As was described under Appendix D's "Evaluation of Potential Past Health Hazards Associated With Exposures to USAF's Main Water Supply Wells" section, ATSDR cannot conclusively state that exposures of this sort would not pose a potential for an increased risk of developing cancer effects. *Thus, ATSDR concludes that it is possible, that past exposures to the well that is located at 6504 West Shore Drive could have been associated with an increased risk of developing cancer. It must be strongly emphasized however, that the link between TCE and the incidence of cancer in humans is controversial.* Furthermore, ATSDR probably overestimated the amount of time that people were exposed to the more elevated concentrations. In actuality, it is highly improbable that the maximum concentration was present at 837 ppb since 1956 because contaminants from SS-05 probably did not migrate off base immediately. On average, people were probably exposed to much lower concentrations.

6559 West Shore Drive. This well, which serviced a residential property, contained chloroform (33 ppb) at a concentration above ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to chloroform would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures to chloroform because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute or chronic MRL. Also, the doses are between 60,000 and 500,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that the well was used or what population it serviced. It should be noted that the assumptions used to estimate exposure doses were probably overly conservative; available data indicate that chloroform was not present consistently in the well.)

Knights of Columbus Lodge. This well, which serviced the Knights of Columbus lodge, contained TCE at concentrations above ATSDR's drinking water CV. According to site representatives, the Arrow Street Plume is suspected to be the source that contaminated the lodge's well. It is unclear when the contaminant reached the well, but it could not have been before 1962—the year that the UST at Site 21 was installed. The lodge stopped using the well as a drinking water source in 1986, when it received municipal water. Assuming a worse case scenario, lodge members may have been exposed to TCE for 24 years (i.e., 1962 to 1986). Sample collection, which began in 1980 and continued through 1986, revealed that TCE was present at concentrations ranging from nondetect to 36 ppb. This information was used to calculate exposure doses. *The results indicated that TCE concentrations were too low to warrant concern in the populations that would have visited the lodge (i.e., lodge members and people attending events).* No noncancer effects are likely associated with past exposures to TCE

because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 2,500,000 and 10,000,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR overestimated exposure doses. The maximum detected TCE concentration was used to estimate doses even though people were not exposed to 36 ppb over an extended period of time. In fact, TCE concentrations only exceeded ATSDR's CVs four times out of more than 100 sampling events.)

6056 F-41 County Road. This well contained TCE (45 ppb) at a concentration that exceeded ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures to TCE because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute MRL. Also, the doses are between 500,000 and 1,700,000 times lower than those that have been shown to cause cancer effects in animals. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that the well was used or what population it serviced.)

6082 F-41 County Road. This well contained methylene chloride (98 ppb) at a concentration that exceeded ATSDR's drinking water CV. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to methylene chloride would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* No noncancer effects are likely associated with past exposures to methylene chloride because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute or chronic MRL. Also, as noted above, no apparent increased cancer risks were observed when animals were exposed to drinking water that contained methylene chloride at doses ranging from 50 to 250 mg/kg/day, which are between 12,500 and 250,000 times higher than the exposure doses that were estimated for the well at 6082 F-41 County Road.
(It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that the well was used or what population it serviced.)

6146 F-41 County Road. This well, which serviced a residential property contained TCE (13 ppb) and 1,1-dichloroethene (0.6 ppb) at concentrations above ATSDR's drinking water CVs. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE and 1,1,-dichloroethene would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern.* The following provides justifications for this conclusion:

Exposures to TCE. No noncancer effects are likely associated with past exposures to TCE because estimated exposure doses [see Table D-1] are much lower than ATSDR's acute

MRL. Also, the doses are between 2,000,000 and 5,000,000 times lower than those that have been shown to cause cancer effects in animals.

Exposures to 1,1-dichloroethene. No noncancer effects are likely associated with past exposures to 1,1-dichloroethene because the estimated exposure doses are lower than ATSDR's intermediate MRL. Information about the cancer causing potential of 1,1-dichloroethene has not yet been presented in this appendix. Thus, the chemical is discussed here. EPA has classified the chemical as a possible human carcinogen, a category that is used to describe chemicals for which there is limited evidence of carcinogenicity in animals and inadequate evidence in humans. The effects of this chemical in human populations was evaluated in one occupational exposure study, but the study used too small a sample size and was run for too short a duration to make meaningful conclusions about the chemical's potential to cause cancer effects. Several studies have been performed to evaluate whether exposures pose carcinogenic risks when mice ingest, inhale, or contact the chemical. Only one of these studies, which involved the inhalation pathway, showed that there was a relationship between exposures and cancer effects (ATSDR, 1994). ATSDR concluded that it is unlikely that past exposures to 1,1-dichloroethene caused increased cancer effects because: (1) the evidence that links cancer effects to 1,1-dichloroethene exposures is weak, and (2) concentrations detected in the well were not much higher than ATSDR's CV. (It should be noted that the CV that was developed for 1,1-dichloroethene is extremely conservative.)

6182 F-41 County Road. This well, which serviced a residential property, contained TCE (13-15 ppb) and 1,1-dichloroethene (0.5 ppb) at concentrations above ATSDR's drinking water CVs. *After estimating exposure doses and performing a WOE analysis, ATSDR concluded that exposures to TCE and 1,1,-dichloroethene would not pose a health hazard even if people had been exposed to the maximum detected concentration for a 30-year period under a residential usage pattern*. No noncancer effects are likely associated with past exposures to TCE or 1,1-dichloroethene because estimated exposure doses [see Table D-1] are much lower than ATSDR's health guidelines. Also, based on information that is available in the literature, it is unlikely that the exposure doses estimated for either chemical are high enough to pose health hazards. (It should be noted that ATSDR used highly conservative assumptions when estimating exposure doses because no information was available on the length of time that the well was used or what population it serviced.)

TABLE D-1. Estimated Exposure Doses

Contaminant	Area of Evaluation	Maximum Contaminant Concentration (ppm)	Exposure Doses (6 to 30 Years)[a] Estimated Exposure Dose (mg/kg/day)[b] Adult	Exposure Doses (6 to 30 Years)[a] Estimated Exposure Dose (mg/kg/day)[b] Child	Exposure Doses (6 to 30 Years)[a] Total Estimated Exposure Dose (mg/kg/day)[c] Adult	Exposure Doses (6 to 30 Years)[a] Total Estimated Exposure Dose (mg/kg/day)[c] Child	Health Guideline Oral (mg/kg/day)	Exposure Doses (Lifetime)[a] Estimated Exposure Dose (mg/kg/day)[b]	Exposure Doses (Lifetime)[a] Total Estimated Exposure Dose (mg/kg/day)[c]
Benzene	Tap (from MWSW)[d,e] OBW (6376 WSD)[f]	0.039 0.003	0.001 0.00009	0.002 0.0002	0.003 0.0003	0.007 0.0006	Not available	0.0005 0.00004	0.001 0.0001
Chlorodi-bromomethane	Tap (from MSWS)[d]	0.0061	0.0002	0.0004	0.0005	0.001	0.04[o] 0.03[p]	0.00008	0.0002
Chloroform	Tap (from MWSW)[d] ASW (DRMO)[g] ASW (Kennel)[g] OBW (6559 WSD)[f]	0.034 0.075 0.049 0.033	0.0010 0.0008 0.0005 0.0009	0.002 — — 0.002	0.003 0.002 0.002 0.003	0.006 — — 0.006	0.3[o] 0.01[p]	0.0004 0.0003 0.0002 0.0004	0.001 0.001 0.0006 0.001
Dichloro-bromomethane	Tap (from MWSW)[d]	0.0074	0.0002	0.0005	0.0006	0.001	0.04[o] 0.02[p]	0.00009	0.0003
1,2-Dichloroethane	Tap (from MWSW)[d]	0.0005	0.00001	0.00003	0.00004	0.00009	0.2[q]	0.000006	0.00002
1,1-Dichloroethene	OBW (6146 F-41)[f] OBW (6182 F-41)[f]	0.0006 0.0005	0.00002 0.00001	0.00004 0.00003	0.00005 0.00004	0.0001 0.00009	0.009[p]	0.000007 0.000006	0.00002 0.00002
1,2-Dichloroethene	AF5 (a MWSW)[m]	0.207	0.006	0.01	0.02	0.04	0.02[r]	0.003	0.008
Methylene chloride	ASW (DRMO)[g] ASW (Kennel)[g] OBW (6082 F-41)[f]	0.013 0.015 0.098	0.0001 0.0002 0.003	— — 0.006	0.0004 0.0005 0.008	— — 0.02	0.5[o] 0.2[p]	0.00006 0.00007 0.001	0.0002 0.0002 0.004
1,1,2,2-Tetra-chloroethane	Tap (from MWSW)[d]	0.0035	0.0001	0.0002	0.0003	0.0007	0.04[p]	0.00004	0.0001

Contaminant	Area of Evaluation	Maximum Contaminant Concentration (ppm)	Exposure Doses (6 to 30 Years)[a] Estimated Exposure Dose (mg/kg/day)[b] Adult	Exposure Doses (6 to 30 Years)[a] Estimated Exposure Dose (mg/kg/day)[b] Child	Exposure Doses (6 to 30 Years)[a] Total Estimated Exposure Dose (mg/kg/day)[c] Adult	Exposure Doses (6 to 30 Years)[a] Total Estimated Exposure Dose (mg/kg/day)[c] Child	Health Guideline Oral (mg/kg/day)	Exposure Doses (Lifetime)[a] Estimated Exposure Dose (mg/kg/day)[b]	Exposure Doses (Lifetime)[a] Total Estimated Exposure Dose (mg/kg/day)[c]
TCE	Tap (from MSWS)[d,j]	1.1	0.03	0.07	0.09	0.20	0.20[o]	0.009	0.02
	Tap (from MWSW)[d,j]	0.025	0.0007	0.002	0.002	0.005		0.0002	0.0005
	ASW (AF7)[h]	0.0176	0.0005	0.001	0.002	0.003		0.0002	0.0007
	ASW (AF8)[h]	0.027	0.0008	0.002	0.002	0.005		0.0003	0.001
	ASW (AF14)[h]	0.0127	0.0004	0.0008	0.001	0.002		0.0002	0.0005
	ASW (AF15)[g]	0.296	0.003	--	0.009	--		0.001	0.004
	ASW (AF22)[h]	0.0304	0.0009	0.002	0.003	0.006		0.0004	0.001
	ASW (AF23)[h]	0.0147	0.0004	0.0009	0.001	0.003		0.0002	0.0005
	OBW (5944 WSD)[f]	0.025	0.0007	0.002	0.002	0.005		0.0003	0.0009
	OBW (6504 WSD)[f,k]	0.837	0.02	0.05	0.07	0.16		0.008	0.02
	OBW (KOC)[l]	0.036	0.0004	0.002	0.001	0.005		0.0001	0.0004
	OBW (6056 F-41)[f]	0.045	0.001	0.003	0.004	0.008		0.0006	0.002
	OBW (6146 F-41)[f]	0.013	0.0004	0.0008	0.001	0.002		0.0002	0.0005
	OBW (6182 F-41)[f]	0.015	0.0004	0.0009	0.001	0.003		0.0002	0.0006

Key:

ASW: Area-specific well
KOC: Knights of Columbus
mg/kg/day: milligrams contaminant per kilogram body weight per day
MWSW= Main water supply well
ppm: parts per million
OBW: Off-base well
WSD: West Shore Drive

Notes:

a ATSDR calculated two types of exposure doses: Exposure Doses (6 to 30 years) and Exposure Doses (Lifetime). While the former is used to evaluate noncancer effects, the latter is used to evaluate potential cancer effects. The same equations are used to generate both of the doses, but different averaging times are used. See page D-2 for additional details.

b The calculations that are used to estimate exposure doses are presented on page D-2.

c Total Estimated Exposure Dose = estimated exposure dose x 3 (to account for ingestion, dermal, and inhalation exposure routes)

c Total Estimated Exposure Dose = estimated exposure dose x 3 (to account for ingestion, dermal, and inhalation exposure routes)

d Unless otherwise specified, concentrations represent the maximum that was ever detected in tap water samples that were collected from on-base housing areas or base facilities that received water from the main water supply wells. ATSDR estimated exposure doses based on a residential scenario because on-base residents were exposed to this water.

e ATSDR did not use the highest benzene concentration (i.e., 1,510 ppb) that was ever detected in tap water samples because ATSDR considers this detection to be anomalous (see page D-4). Thus, 39 ppb, the next highest value detected in tap water samples, was used in this analysis.

f Concentrations represent the maximum that was detected in a specific off-base well. ATSDR estimated exposure doses based on residential scenarios.

g The water provided by these wells did not service residential populations. ATSDR did not calculate exposure doses for children because it is unlikely that children would have accessed these areas with any regular frequency. The adults that used the water at these facilities were not likely to drink as much or to be exposed as often as someone who was using the water for residential purposes. Therefore, ATSDR estimated exposure doses based on industrial/commercial scenarios (see page D-2).

h ATSDR could not find detailed information about how long the wells were used and the exact population that they serviced. To be conservative, ATSDR estimated exposure doses based on a residential scenario (see page D-2).

j ATSDR calculated two exposure doses for TCE to determine whether health hazards were associated with exposures to USAF's main water supply wells over two different time periods. The first dose was calculated assuming that people were exposed to 1,100 ppb of TCE for 18 years (i.e., 1962 to December 1979). The second was calculated assuming that people were exposed to 25 ppb of TCE for 17 years (i.e., 1980 to 1997).

k ATSDR calculated exposure doses using the maximum concentration (837 ppb) detected while the well at 6504 West Shore Drive was being used as a potable water source. ATSDR assumed that exposures lasted for 23 years (i.e., 1956 to 1979).

l ATSDR assumed that people who were exposed to water at the Knights of Columbus Lodge drank quantities that were equivalent to the industrial/commercial exposures. Also, ATSDR assumed that exposures occurred over 24 years (i.e., 1962 to 1986).

m AF5 is one of USAF's main water supply wells. (The maximum concentration detected in AF5 does not necessarily reflect the concentrations that people would have been exposed to at their faucets. Water supplied by AF5 was mixed with water provided by other wells before being shuttled to the tap.)

o ATSDR's acute oral minimal risk level (ATSDR, 2000).

p ATSDR's chronic oral minimal risk level (ATSDR, 2000).

q ATSDR's intermediate oral minimal risk level (ATSDR, 2000).

r EPA's Chronic reference doses for trans-1,2-dichlorothene (ATSDR, 2000).

APPENDIX E:
RESPONSES TO PUBLIC COMMENTS

The Agency for Toxic Substances and Disease Registry (ATSDR) released the Wurtsmith Air Force Base (WAFB) Public Health Assessment (PHA) on October 4, 2000, for public review and comments. The public comment period ended on November 22, 2000. In this appendix, ATSDR responds to the comments and questions that were submitted during the comment period. For comments that questioned the validity of statements made in the PHA, ATSDR verified or corrected such statements. The list of comments does not include editorial comments concerning such things as word spelling or sentence syntax.

1. **Comment**: One of the sentences included under the "Quality Assurance and Quality Control" section is misleading. The sentence reads: "Based on our evaluation, ATSDR determined that the quality of environmental data available in most site-related documents for WAFB is adequate to make public health decisions." This contradicts other sections of the PHA which clearly indicate that data gaps exist and that these gaps prevent ATSDR from making definitive conclusions about public health hazards.

   Response: ATSDR agreed that this statement could be misleading. Thus, ATSDR deleted the sentence.

2. **Comment**: There is no longer an occupant at facility 5098. The building is now being used to store equipment for FT-02's new remedial system. The United States Air Force (USAF) plans to sample AF25, the well that services Building 5098.

   Response: ATSDR contacted a WAFB site representative to confirm the occupancy status of Building 5098 and to determine when well AF25 will be sampled. ATSDR learned that the building is indeed vacant and that AF25 will be sampled in spring 2001; ATSDR modified the "Evaluation of Environmental Contamination and Potential Exposure Pathways" to reflect this new information. In addition, ATSDR deleted its recommendation that samples be collected from the well at AF25 since USAF is already planning to do this. A sentence was added to the "Public Health Action Plan,"describing the sampling event that is planned at well AF25.

3. **Comment**: ATSDR needs to expand upon its recommendation to collect fish samples from Au Sable River and Van Etten Lake. It is difficult to see what public health issue(s) are being addressed with this recommendation. Obviously, ATSDR must feel that there is a community concern about contaminated fish and that collecting samples will address the concern. However, without a clear statement of compounds to test for and their possible sources, it is unclear if ATSDR is recommending this sampling to address contaminants related to WAFB or general water quality issues. Is there a contaminant that ATSDR predicts will be found in the fish and must be tested for? Could ATSDR state clearly their proposed sampling plan, specific compounds or classes of contaminant, and a general idea of where they think these fish contaminants might come from? Could ATSDR indicate

whether the recommendation for fish tissue sampling will be forwarded to the Michigan Department of Natural Resources (MDNR)?

Response: Community members have expressed concern about eating fish from Van Etten Lake and the Au Sable River, both of which have been impacted by WAFB's contaminants. In this PHA, ATSDR used surface water and sediment data to determine how contaminants might be affecting fish that live in Van Etten Lake and the Au Sable River. Based on available information, ATSDR does not expect that fish residing in the lake or river would pose a health hazard to those who eat them. However, contaminants, specifically arsenic, have been detected that might be emanating from WAFB. And, because there are currently no data on arsenic in fish, ATSDR would prefer to have additional data to verify that the fish are safe to eat. Conclusive assurances can only be obtained by collecting and analyzing tissues directly from fish. ATSDR recommends that WAFB and MDNR coordinate to determine the most effective means of collecting and analyzing fish tissue from these water bodies.

4. **Comment**: Installation of the Northern Landfill Plume remediation system will not be completed until June 1, 2001.

   Response: ATSDR modified the PHA to reflect this information.

5. **Comment**: USAF plans to sample the private off-base well that is located at 6092 F-41 County Road.

   Response: ATSDR contacted a WAFB site representative to determine whether the sampling event had occurred. ATSDR learned that it had and obtained a copy of the analytical results. The results indicated that no volatile organic compounds were present. ATSDR incorporated this information into Table 5 and the "Evaluation of Environmental Contamination and Potential Exposure Pathways." In addition, ATSDR removed the recommendation that samples be collected from the well at 6092 F-41 County Road.

6. **Comment**: There is little evidence that ATSDR actively gathered information or comments from citizens, community groups, or area health professionals. ATSDR made no effort to publicize the PHA. Very few area residents were aware that a public health assessment was being conducted, thus limiting public input and reducing the credibility of the PHA document."

   Response: ATSDR visited WAFB in 1995 and 1998. During both visits, ATSDR did actively gather information and comments from citizens, community groups, and area health professionals. More detail about these interactions has been added to the PHA's "Background" section to describe the interactions that the agency had with the community. (See the subsection entitled "The Agency For Toxic Substances and Disease Registry [ATSDR]'s Involvement.")

In addition, it should be noted that ATSDR followed a set of standard procedures to ensure that local news media were notified of the PHA's availability. First, ATSDR perused a media database to locate the names, addresses, and telephone numbers of media outlets in Oscoda, Michigan. Then, ATSDR faxed a note to local news media alerting them that a draft version of the PHA was being released for public comment. In addition, ATSDR sent copies of the PHA to local repositories, to WAFB representatives, and to regulators and community members that were included on a designated mailing list.

7. **Comment**: The Citizens' Advisory Committee on Wurtsmith AFB Contamination sent ATSDR a petition letter in December 1993 asking the agency to evaluate health effects associated with WAFB. The time lapse between the petition letter and the final PHA is a "negative factor."

Response: ATSDR recognizes that much time has passed since the community submitted its petition letter. When performing PHAs the Agency follows a prescribed and detailed process. For the WAFB PHA, ATSDR evaluated past, current, and future health hazards that might be associated with all 58 of WAFB's areas of concern. In addition, the Agency spent much time tracking down information and data that would shed light on how WAFB's contamination impacted off-site areas. While following a methodical assessment process does take a significant amount of time, using such an approach yields a thorough product. The following paragraph indicates why a significant amount of time was required to complete this PHA.

In December 1993, the Citizen's Advisory Committee on Wurtsmith AFB Contamination, Inc., petitioned ATSDR to perform a PHA. One month later, the site was placed on the proposed National Priorities List. Once on the list, ATSDR was mandated to perform a PHA for the site. Throughout 1994, ATSDR collected data on WAFB and made plans for a site visit. This visit was conducted in June 1995; one of the visit's goals was to collect enough information to rank the site according to its potential for imminent public health hazard. After reviewing available data and collecting information from Air Force personnel and community members, ATSDR concluded that the site posed no current public health issues. Thus, the site was not placed as high on ATSDR's priority list as other sites that required immediate investigation and attention. The agency did acknowledge, however, that there was a need to evaluate past exposures to contaminated environmental media in a detailed PHA. This effort was initiated in earnest in 1998. In July of that year, ATSDR revisited WAFB, collected data, interviewed Air Force personnel, met with community members, and talked with representatives from Camp Nissokone. Since that site visit, ATSDR has reviewed data that have been collected over the last three decades from WAFB and nearby off-site areas. These data were provided by the Air Force and numerous health and environmental agencies. ATSDR invested much time identifying appropriate contacts from each agency and obtaining data. Over the last two years, ATSDR has talked extensively with local agencies to obtain the information that was required for this PHA. ATSDR took care to ensure that the concerns expressed were addressed sufficiently and that the information presented in the document was accurate. Thus, a preliminary draft of the report was released for review to environmental and health organizations prior to its

release to the public. ATSDR received constructive comments on this draft and ATSDR was alerted that new information and data were available. After obtaining these data and revising the preliminary draft, the PHA was released for public comment in October 2000.

8. **Comment**: The PHA would have been more useful if ATSDR had conducted or commissioned independent studies to fully research health effects encountered by those who worked or resided at or near Wurtsmith AFB. Failure to conduct studies of this sort, make many of the PHA's conclusions seem presumptuous.

Response: ATSDR's mandate and primary goals when conducting health assessments include evaluating community concerns, reviewing available health outcome data (e.g., cancer registry data, community-based health study data), and recommending further health study as warranted.

When community members express a concern about a specific health outcome (e.g., cancer), ATSDR's first step is to study the degree of exposure and determine whether the outcomes of interest could be plausibly linked to detected contaminant levels. This involves performing an exposure and health effects evaluation: that is, studying site-specific exposures and determining how detected chemicals might have impacted community members. At Wurtsmith, ATSDR determined that only a limited population (those consuming water from the main water supply wells and one off-base private well before 1980), if any, *might* have been exposed to potentially harmful levels of trichloroethylene (TCE), a possible human carcinogen. It should be noted, however, that harm would only have occurred if the populations were exposed to the water for extended durations of time. ATSDR suspects that it is unlikely that such extended exposures actually occurred. Also, it is imperative to note that there is much controversy in the scientific community regarding TCE's ability to pose adverse health effects in humans. EPA is currently reviewing the scientific literature to determine the chemical's potential to cause cancer in humans. In light of uncertainties regarding TCE carcinogenicity in humans and the transient nature of on-base water use, it is unlikely that exposures were long enough to increase individual cancer risks in those who worked or resided at or near the site.

Nonetheless, ATSDR attempted to identify health outcome studies to further evaluate community concerns regarding cancer rates. Ideally, ATSDR would want to study specific cancers possibly associated with TCE (e.g., leukemia) in only those individuals who were known to be exposed to elevated contaminant levels in their drinking water. Unfortunately, according to representatives from the Michigan Department of Community Health and the District Health Department, no health outcome studies have been performed to evaluate cancer statistics in the community that surrounds WAFB.

When exposures appear to be high AND some elevated disease rates are observed or suspected, ATSDR may recommend additional study (e.g., disease surveillance, health study). However, based on its exposure and health effects evaluation, ATSDR did not feel further study was warranted. Should additional information become available to indicate site-related exposures (e.g., additional monitoring data) and outcomes of concern might be

a problem in the site community, ATSDR will re-evaluate the conclusions and recommendations presented in this PHA.

9. **Comment**: Phrases such as "no sampling data were available" and "no definitive conclusions can be drawn" appear throughout the PHA. Due to the lack of sampling data, it is difficult, if not impossible, to make any definitive conclusions about long-term impacts to the health of affected citizens.

   Response: ATSDR acknowledges the commenter's frustrations regarding data gaps. ATSDR agrees that the lack of extensive environmental sampling makes it impossible for the Agency to make definitive conclusions about the long-term impacts to the health of affected citizens. For this reason, ATSDR has not used definitive language in its conclusions. For example, ATSDR states that "past exposures to groundwater *may have* posed an increased risk of developing adverse health effects" and "past, present, and future exposures to surface water and sediment are *not expected* to pose a public health hazard." While ATSDR would like to make more definitive statements about the impact of past exposures, it is not possible to do so because data for a wide variety of chemicals were not collected from environmental media on a consistent basis prior to 1984. The aim of this PHA is to provide insight to the community so that community members can put their health concerns in perspective. Obviously, there is no way to go back in time and collect environmental samples to determine the levels that past populations were exposed to. Absent this information, ATSDR uses the best data available, identifies where data gaps exist, and provides perspective on the *likelihood* of exposure to a particular chemical causing harm.