Public Health Assessment for

PETITIONED PUBLIC HEALTH ASSESSMENT
EGLIN AIR FORCE BASE
(a/k/a USAF EGLIN AIR FORCE BASE ARMAMENT DIVISION)
EGLIN AIR FORCE BASE, OKALOOSA COUNTY, FLORIDA
EPA FACILITY ID: FL8570024366
APRIL 11, 2003

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Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment Branch
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

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FOREWORD

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

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

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

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

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

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

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

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

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

Letters should be addressed as follows:

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

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AFB	Air Force Base
AOC	area of concern
ARC	ambient reference concentration
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CEL	cancer effects level
CREG	cancer risk evaluation guide
CSF	cancer slope factor
2,4-D	2,4-dichlorophenoxyacetic acid
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DU	depleted uranium
EMEG	environmental media evaluation guide
EPA	US Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
HCH	hexachlorocyclohexane
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
µg/m^3	micrograms per cubic meter
µg/kg/day	micrograms per kilogram per day
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level
NAAQS	National Ambient Air Quality Standard
NPL	National Priorities List
OB/OD	open burning/open detonation
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene (perchloroethylene)
POI	point of interest
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RMEG	reference dose media evaluation guide
SSL	soil screening level
2,4,5-T	2,4,5-trichlorophenoxyacetic acid
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCE	trichloroethylene
TSP	total suspended particulates
UXO	unexploded ordnance
US	United States

SUMMARY

Eglin Air Force Base (AFB) is in the Florida Panhandle between Pensacola and Panama City. It is the largest forested military reservation in the United States, covering approximately 464,000 acres. Most of the Eglin Reservation is undeveloped, with small pockets of developed and semi-developed areas. Since 1935 it has been the Air Force's primary munitions testing and training facility.

Munitions training and testing, other standard defense missions and related activities, and waste handling practices have contaminated some areas on Eglin. In 1981, the Department of Defense initiated the Installation Restoration Program to identify, evaluate, and clean up contamination from past military activities. Throughout the history of the program, the Air Force has completed site investigations, interim measures, and removal/remedial actions at Eglin AFB, resulting in a "no further action"[1] status for many of these sites.

In February 1998, the Agency for Toxic Substances and Disease Registry (ATSDR) was petitioned to assess Eglin AFB for potential public health hazards. On April 6–8, 1998, and again on August 20–23, 2001, ATSDR visited Eglin AFB to evaluate the petitioner's concerns as well as other concerns identified during the public health evaluation process.

From talking with the petitioner and other community members, ATSDR identified five main issues of concern that are addressed in this public health assessment. To determine whether people are being exposed to levels of contamination that might cause health problems, ATSDR considers how people might come into contact with a chemical, what levels people might encounter, and for how long. If the environmental data show that people have or could come into contact with harmful chemicals at the site, ATSDR reviews the existing scientific information to determine if exposures are expected to result in harmful health effects. Based on a thorough review of the available information, data, modeling analyses, and calculated assumptions, ATSDR reached the following conclusions:

1. **Transport of contaminants via air to off-base areas:** *Would there be adverse health effects to off-base residents from harmful substances being transported through the air during herbicide spraying, open burning/open detonation (OB/OD) activities, wildfires, prescribed burns, and a past structural fire?*

ATSDR reviewed information characterizing the magnitude and duration of relevant chemical releases from Eglin AFB, including those from herbicide spraying, OB/OD activities, prescribed

[1]"No further action" indicates that sufficient data is available to determine the site poses no human or ecological health concern and that no additional remediation or sampling is necessary (personal communication with Eglin AFB personnel, July 2002).

burns, wildfires, and a past structural fire (C-6 Radar Facility). ATSDR determined that previous herbicide and pesticide spraying activities, current OB/OD operations, and a past structural fire do not pose a public health hazard. Contaminant levels in off-base residential areas would have been lower than levels expected to cause harmful health effects.

A prescribed burn is an intentional controlled fire. A wildfire is a fire caused by an accidental act of nature or man. To address whether on-base prescribed burns or wildfires pose a health hazard to off-base residents, ATSDR considered two different aspects of on-base fires. First, ATSDR evaluated whether fires in areas where soil contamination exist could cause contaminants to become airborne and transported to off-base residential areas. Then, exposure to chemicals released during the burning of plant material (trees, grasses, shrubs, etc.) was considered. Uncontrolled wildfires present much greater threat because their uncontrolled nature can cause them to burn longer and much greater area thus producing more hazardous substances into the air.

The findings indicate that the contaminants in soils (depleted uranium and herbicides, including Herbicide Orange[2]) would not reach off-base areas at levels associated with harmful health effects. Therefore, off-base residents would not come in contact with those contaminants.

However, the burning of plant material causes a release of particles and natural combustion products (smoke) that could cause some short-term adverse health effects (e.g., burning, itching or watery eyes; nausea; breathing difficulty; and asthma-like symptoms) in those people exposed. The frequency of such burns is low and the duration is very short (personal communication with Eglin AFB personnel, July 2002). Airborne emissions from prescribed burns and wildfires have not been measured. This evaluation is based on health effects seen from other wildfires. Individuals highly sensitive to the effects would be anyone with previous respiratory conditions such as asthma or emphysema, children, and the elderly. Health effects would likely be of short duration, i.e., developing within a few days of exposure and lasting no more than two or three weeks after exposure stopped.

Depleted uranium would not be an airborne contaminant from the burning of plant material since plants have a minimal uptake of uranium from soil.

During prescribed burns, Eglin takes several measures to minimize the impacts of fires on residential neighborhoods. ATSDR recommends that Eglin AFB continue notifying the entire

[2]Herbicide Orange: an herbicide used by the military until the 1970s for various purposes (e.g., used in Vietnam to remove leaves from trees). It is a 50:50 mixture of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2,4-dichlorophenoxyacetic acid (2,4-D). The 2,4,5-T was contaminated during the manufacturing process with dioxin (VA 2000). See Section III. Community Concerns for additional information about Herbicide Orange and exposure at Eglin AFB.

community (especially potentially impacted communities) when the prescribed burns are scheduled. This allows people to take measures to reduce potential exposures. If people are experiencing respiratory problems, they should seek the attention of their personal medical care provider.

2. **Transport of contaminants via surface waters:** *Are dangerous chemicals seeping into waterways on and off base, and would contact with those chemicals via swimming or eating fish be harmful to people's health?* (Water-bodies evaluated: Tom's Bayou; Weekly Pond; Pocosin Pond; Mullet, Trout, and Basin Creeks; and an unnamed pond near the North Gate of Eglin Main Base).

No. Based on ATSDR's review of available data, Air Force documents, and scientific literature, the chemicals detected in the surface water bodies, sediments, and fish are below levels of health concern. Contact with the water or eating fish from those water bodies presents no public health hazard.

Information on the unnamed pond near the North Gate could not confirm whether it might have contained Herbicide Orange. The presence of a sign in the pond indicating Herbicide Orange use is unsupported by the Air Force historical documents and herbicide testing information. Nevertheless, access to this area is limited and any potential exposure would be minimal.

3. **Transport of contamination to private drinking water wells via groundwater:** *Is groundwater contamination from the C-6 Radar Facility reaching off-base residential wells?*

No. The C-6 Radar Facility is located approximately 3 miles north of the town of Portland. The site is in an undeveloped section of Eglin AFB that is closed to the public. During a 2000 site investigation, the extent of the trichloroethylene (TCE) contamination was defined to be entirely on Eglin AFB property. To ensure that the contamination does not migrate to areas where people are using groundwater wells, long-term monitoring of the groundwater is conducted at the site on an annual basis. Therefore, this site poses no past, present, or future public health hazard.

4. **Contact with herbicide contamination:** *Could people be exposed to harmful levels of herbicide contamination at sites in the Herbicide Exposure Unit (SS-25/DP-09), C-52A Aerial Overspray Area (AOC-24), Upper Memorial Lake (LF-51), and Hardstand 7 (SS-26) (reported Herbicide Orange sites)?*

No. Human exposure to herbicide contamination on Eglin AFB is minimal. Access to the Herbicide Exposure Unit (DP-09 and SS-25), the C-52A Aerial Overspray Area (AOC-24), and Hardstand 7 (SS-26) has been, is, and will continue to be restricted by locked gates, fences, security personnel, and topography. Even though people have access to Upper Memorial Lake

(LF-51), the herbicide contamination was detected in the subsurface soil, and contact with subsurface soil would be minimal since Eglin AFB has implemented land use controls to minimize exposure. In addition, remedial activities have removed or contained, or both, the contamination formerly present at Mullet Creek Drum Disposal Site (DP-09) and Hardstand 7. Therefore, because contact with contamination is minimal, these sites pose no past, present, or future public health hazard.

5. **Contact with radioactive contamination:** *Could people be exposed to harmful levels of radioactive contamination from the Isotope Burial Area (AOC-63/-67), Test Area C-64 (RW-40), Test Area C-74L (RW-41), and the Low-Level Radioactive Waste Site (RW-42)?*

No. Access to the Isotope Burial Area (AOC-63/AOC-67), Test Area C-64 (RW-40), and Test Area C-74L (RW-41) is restricted by locked gates, fences, and security guards. Furthermore, because of the nature (chemical and physical forms) of the depleted uranium and other radioactive contamination, ATSDR does not expect that anyone would be exposed to radioactive contamination present at these sites. In addition, remedial activities have removed or reduced the contamination that was once present. Therefore, these sites pose no public health hazard. Still, although access is restricted, the Low-level Radioactive Waste Site (RW-42) is not fenced and trespassing by boat could occur. However, the measured radiation levels were at or near normal background levels. Thus, despite the fact exposure is possible, the frequency and duration would be minimal. Accordingly, this site poses no public health hazard.

Exposure Hazard Summary Table - *Eglin Air Force Base, FL*			
Community and ATSDR Questions on Possible Exposures	**Did Exposure Occur?**	**Hazard Category[1]**	**Comments**
Are air releases from herbicide spraying and open burning/open detonation (OB/OD) exposing off-base populations to unsafe chemical levels? (Herbicide Exposure Unit, Ranges C-62/C-52N)	In the past, present, and possibly in the future, people would be exposed.	The exposure presents no apparent public health hazard.	■ Available data for the most extensive herbicide spraying activities suggest that air concentrations did not reach unsafe levels at off-base locations. ■ All of the chemicals released to the air during OB/OD activities did not exceed EPA's regulatory standards.
Are air releases from prescribed burns and wildfires harmful to off-base populations?	In the past, present, and possibly in the future, people would be exposed.	The exposure presents a public health hazard, short-term effects.	■ Winds could occasionally blow plumes of potentially unhealthy smoke toward residential neighborhoods. If, however, harmful health effects occur, they are typically short-term, reversible, and subside after fires are extinguished.
Were air releases from a structural fire at C-6 Radar Facility in 1965 harmful to off-base residents?	People were possibly exposed in the past.	The exposure presents no apparent public health hazard.	■ The C-6 Radar Facility is 3 miles from Portland; therefore, contaminants that could have been in the smoke would have been significantly dispersed. The fire lasted only one day; therefore, inhalation exposures to contaminants were extremely short-lived.
Are chemicals from Eglin AFB seeping into Tom's Bayou and if so, would swimming, wading, or eating fish from the bayou be harmful to my family's health?	In the past, present, and possibly in the future, people would be exposed.	The exposure presents no apparent public health hazard	■ Even though contamination is present at sites on Eglin Main Base that are within the Tom's Bayou drainage basin, the levels detected are too low to be of health concern at these source areas.

Exposure Hazard Summary Table - *Eglin Air Force Base, FL*			
Community and ATSDR Questions on Possible Exposures	**Did Exposure Occur?**	**Hazard Category[1]**	**Comments**
Are people exposed to harmful contamination via swimming or fishing in Weekly Pond; Pocosin Pond; Mullet, Trout, and Basin Creeks; and a pond near the North Gate?	In the past, people were exposed. Currently and in the future, exposure is not likely.	The exposure presents no apparent public health hazard.	■ Even though pesticides were detected in the fish from Weekly Pond, the levels detected were too low to be of health concern for anyone eating the fish in the past. Currently, people are not allowed to eat fish from this pond. ■ People are not allowed to catch and eat fish from Pocosin Pond and no appreciable contamination exits. ■ Even though contamination is present in Mullet, Trout, and Basin Creeks, the levels detected are too low to be of health concern. ■ It is not expected that anyone could come in contact with Herbicide Orange at the unnamed pond near the North Gate often enough or in high enough doses to be a cause for health concern.
Is groundwater contamination from the C-6 Radar Facility reaching off-base residential wells?	No, not in the past or currently and not likely in the future would people be exposed.	No public health hazard	■ Although contamination is present in the groundwater at the C-6 Radar Facility, it is not affecting the nearest down-gradient wells. To ensure that the contamination does not migrate to areas where people are using groundwater wells and for restoration purposes, the Air Force is conducting long-term monitoring of the groundwater at the site on an annual basis.
Could people be exposed to harmful levels of herbicide contamination at the Herbicide Exposure Unit (SS-25/DP-09), C-52A Aerial Overspray Area (AOC-24), and Hardstand 7 (SS-26) (reported Herbicide Orange sites)?	No, not in the past or currently, and not likely in the future would people be exposed.	No public health hazard	■ Even though contamination is present at these sites, public access is restricted.

Exposure Hazard Summary Table - *Eglin Air Force Base, FL*			
Community and ATSDR Questions on Possible Exposures	**Did Exposure Occur?**	**Hazard Category[1]**	**Comments**
Could people be exposed to harmful levels of herbicide contamination at Upper Memorial Lake (LF-51), a reported Herbicide Orange site?	No, not in the past or currently, and not likely in the future would people be exposed.	The exposure presents no apparent public health hazard.	■ Even though contamination is present in the subsurface soil at this site, people who have access to the area would have minimal contact with subsurface soils, since Eglin AFB has implemented land use controls to minimize exposure.*Could people be exposed to harmful levels of herbicide contamination at Upper Memorial Lake (LF-51), a reported Herbicide Orange site?*
Could people be exposed to harmful levels of radioactive contamination from the Isotope Burial Area (AOC-63/-67), Test Area C-64 (RW-40), Test Area C-74L (RW-41)?	No, not in the past or currently, and not likely in the future would people be exposed.	No public health hazard	■ Even though contamination is present at these sites, public access is restricted and available information indicates that the contamination is localized within some of these areas.
Could people be exposed to harmful levels of radioactive contamination at the Low-Level Radioactive Waste Site (RW-42)?	Possibly in the past, present, and future people would be exposed.	The exposure presents no apparent public health hazard.	■ Although access is restricted, the Low-level Radioactive Waste Site is not fenced and trespassing by boat from the Gulf of Mexico or Santa Rosa Sound could occur. However, radiation levels are not at levels of health concern.

I. Background

A. Site Description and Operational History

Eglin Air Force Base (AFB) is an active military base located in Okaloosa, Walton, and Santa Rosa counties on the Florida Panhandle between Pensacola and Panama City (see Figure 1). The Eglin Reservation, as it is called, is the largest forested military reservation in the United States, covering approximately 464,000 acres (725 square miles) (EA Engineering, Science, and Technology 1997; Eglin AFB 2000c).

Eglin AFB was founded in 1935, as the headquarters for a bombing and gunnery base. In 1941, the Air Proving Ground Center was established at the base. During 1942, the Air Force began testing combat aircraft and equipment. Throughout and after World War II, Eglin AFB was the center for developing and testing new techniques and tactics in air armament. In 1968, the Air Proving Ground Center was renamed the Armament Development and Test Center, but Eglin AFB continued to research, develop, and test nonnuclear munitions. In 1989, the Armament Development and Test Center was renamed, to the Munitions Systems Division and, in 1990, to the Air Force Development Test Center. The Center tests and evaluates nonnuclear munitions, guided munitions, and electronic combat systems (Eglin AFB 2000c).

B. Remedial and Regulatory History

Standard defense missions or other related activities at Eglin AFB, such as storage, maintenance, and shipping of war material; research and development; and aircraft operations and maintenance, have contaminated some areas on Eglin AFB property. In 1981, the Department of Defense initiated the Installation Restoration Program (IRP) to identify, evaluate, and clean up contamination from past military activities. The Defense Environmental Restoration Account funds the IRP (EA Engineering, Science, and Technology 1997). As of March 2000, Eglin AFB identified 118 IRP and 17 compliance sites found to contain harmful materials (Eglin AFB 2000c). In addition, based on limited historical or circumstantial information, Eglin AFB has identified 236 areas of concern (AOCs) and 202 points of interest (POIs) which are pre-regulatory sites with the potential for contamination (Eglin AFB 2000c). Throughout the history of the IRP at Eglin AFB, the Air Force has completed numerous site investigations, interim measures, and removal/remedial actions that have resulted in a No Further Action status for many of these sites.

For detailed information on the Air Force's continued environmental investigation and remediation plans at Eglin AFB, refer to Eglin AFB's documents at the following three public repositories: the Learning Resource Center at Okaloosa-Walton Community College, Niceville Campus; Eglin Air Force Base AAC/EMR (207 N. Second Street, Bldg. 216); and at the Florida

Department of Environmental Protection (FDEP), Twin Towers Office Building (2600 Blair Stone Road) in Tallahassee, Florida.

C. ATSDR Involvement

In February 1998, a private citizen petitioned (see text box for definition), the Agency for Toxic Substances and Disease Registry (ATSDR) to assess contamination from Eglin AFB for potential public health hazards. ATSDR is responding to this petition in a document known as a public health assessment. Through the public health assessment process ATSDR examines what chemicals enter the environment, how they move through the environment, whether people are being exposed to these chemicals, and the levels of chemicals that people might encounter. ATSDR uses this information to determine whether people are exposed to levels of contamination that might cause health problems. ATSDR's evaluation focuses on public exposure and does not address exposure of base personnel who have access to the areas of concern.

A request from a concerned individual to evaluate a site is received through a written document known as a petition.

After receiving the petition letter and speaking with the petitioner, ATSDR on April 6–8, 1998, made a site visit to Eglin AFB. ATSDR staff scientists toured the multiple sites referred to by the petitioner and met with representatives from the base, Air Force, and the United States Environmental Protection Agency (EPA). On August 20-23, 2001, ATSDR toured the site for a second time to further evaluate the sites referred to by the petitioner as well as other sites ATSDR identified during the public health assessment process.

From talking with the petitioner and other community members, ATSDR identified five potential exposure pathways. They are listed below and addressed in detail in this public health assessment:

1. **Transport of contaminants via air to off-base areas:** *Would there be adverse health effects to off-base residents from harmful substances being transported through the air during herbicide spraying, open burning/open detonation (OB/OD) activities, wildfires, prescribed burns, and a past structural fire?*

2. **Transport of contaminants via surface waters:** *Are dangerous chemicals seeping into waterways on and off base, and would contact with those chemicals via swimming or eating fish be harmful to people's health?* (Water bodies include: Tom's Bayou; Weekly Pond; Pocosin Pond; Mullet, Trout, and Basin Creeks; and an unnamed pond near the North Gate of Eglin Main Base).

3. **Transport of contamination to private drinking water wells via groundwater:** *Is groundwater contamination from the C-6 Radar Facility reaching off-base residential wells?*

4. **Contact with herbicide contamination:** *Could people be exposed to harmful levels of herbicide contamination at the Herbicide Exposure Unit (SS-25/DP-09), the C-52A Aerial Overspray Area (AOC-24), Upper Memorial Lake (LF-51), and Hardstand 7 (SS-26) (reported Herbicide Orange sites)?*

5. **Contact with radioactive contamination:** *Could people be exposed to harmful levels of radioactive contamination from the Isotope Burial Area (AOC-63/-67), Test Area C-64 (RW-40), Test Area C-74L (RW-41), and the Low-Level Radioactive Waste Site (RW-42)?*

D. Demographics, Land Use, and Natural Resource Use

ATSDR examines demographic data (i.e., population information) to determine the number of people potentially exposed to environmental chemicals and to determine the presence of sensitive populations, such as women of childbearing age (age 15–44), children (age 6 and younger), and the elderly (age 65 and older), see Figure 4. Demographic data also provide details on population mobility which, in turn, helps ATSDR evaluate how long residents might have been exposed to environmental chemicals. ATSDR also examines land and natural resource use to determine what activities might put people at risk for exposure. Some of the general information used in that analysis is provided below.

Demographics

Okaloosa, Santa Rosa, and Walton Counties

Eglin AFB is located in portions of Okaloosa, Santa Rosa, and Walton counties. According to the 2000 United States (US) Census, Okaloosa County has the largest population (170,498 people), but is the smallest county in area (936 square miles); this results in the highest population density (182 people/square mile) of the three counties. Santa Rosa County is the next smallest county (1,016 square miles) with a population of 117,743 people; resulting in a population density of 116 people/square mile. Walton County has a considerably smaller population (40,601 people) and an area of 1,058 square miles; resulting in a much smaller population density (38 people/square mile) than the other two counties.

Demographics within one mile of Eglin AFB

A combination of commercial, residential, and undeveloped land surrounds Eglin AFB (EA Engineering, Science, and Technology 1997). According to the 2000 US Census, 101,792 people live within one mile of Eglin AFB—9,727 people are children aged 6 years and younger, 22,154 people are women of child-bearing age, and 11,014 people are adults aged 65 and older (see Figure 4). The total number of housing units within a one-mile buffer is 44,406.

Freeport and Portland

Freeport and Portland are small communities located within 2½ miles of the southeastern border of Eglin AFB. According to the 2000 US Census, nearly 1,100 people live in Freeport—106 people are children aged 6 and younger, 205 people are women of child-bearing age, and 159 people are adults aged 65 and older. Portland has a population of nearly 200 people—17 people are children aged 6 and younger, 31 people are women of child-bearing age, and 21 people are adults aged 65 and older.

Land Use

On-Base

Most of the Eglin Reservation is undeveloped (458,400 acres) with small pockets of developed (1,400 acres) and semi-developed areas (4,200 acres), see Figure 2 (EA Engineering, Science, and Technology 1997). Eglin Main Base is the largest developed complex on the reservation (see Figure 3). It is located in the south central portion of Eglin Reservation and employs about 15,000 military and civilian workers. Hurlburt Field is about 11 miles west of the Main Base and employs about 6,000 people. Duke Field and Camp Rudder are smaller areas that employ 50 and 300 workers, respectively.

About 65% (280,000 acres) of the Eglin's 464,000 acre reservation is open to the general public for outdoor recreation (Eglin AFB 2000d). Members of the public, as well as off-duty military members, can purchase recreational permits for a variety of activities from hunting to hiking. Approximately 12,000–14,000 people apply for permits to fish, hunt, camp, hike, or bike on the reservation every year (Daily News 2000a). In addition, every permit purchaser must watch an educational video and accept a brochure on the hazards of unexploded ordnance (UXO) and the proper procedure to take should they encounter one (Eglin AFB 2000d). Areas that have been determined to contain a known potential for UXO are closed to the public. To date, Eglin reservation has no recorded incidents involving a recreational user and UXO on the reservation (personal communication with Eglin AFB personnel, July 2002). The sections of the reservation that are restricted to all forms of public access are clearly posted with "Do Not Enter" signs and are marked in red on the Outdoor Recreation, Hunting, and Fresh Water Fishing Map (Eglin AFB

2000b). Those who purchase permits receive this map with an extensive list of regulations outlining permitted recreational activities on the Eglin Reservation.

With the appropriate permits, fishing is permitted in several lakes and ponds on the Eglin Reservation, as indicated below.

Lakes and Ponds on Eglin Reservation				
Anderson*	Atwell	Brandt	Brown	Buck
Bull	College	Crain	Duck†	Indigo‡
Jack§,¶	Jr. Walton	Kepner	Lost Boy‡	Lower Memorial§
Upper Memorial§,¶	Pocosin††	Speck	Roberts	Timberlake
Weekly§,¶	* Handicap accessible fishing pier and nature trail † Special Creel limits apply ‡ Currently closed for renovation § Restricted to DOD-affiliated personnel and their guests ¶ Catch-and -release fishing only ** The only pond open to fishing on Hurlburt Field †† Fishing is not allowed Source: Eglin AFB 2000b			
Hurlburt§,**				

Nearby Off-Base Areas

Tom's Bayou is in Valparaiso, Florida, and receives drainage from surface water bodies on Eglin Main Base. People reside around Tom's Bayou and engage in various recreational activities in the bayou (e.g., fishing, swimming, and boating). While fishing and crabbing occur in the bayou, harvesting shellfish is not approved by FDEP (personal communication with Florida Department of Health personnel, September 2002). Several IRP sites were identified within the Tom's Bayou drainage basin (see Figure 3).

Natural Resource Use

Three significant hydrogeologic units underlie Eglin Reservation: the surficial sand and gravel aquifer, the Pensacola Clay confining layer, and the Floridan aquifer (EA Engineering, Science, and Technology 1997). Groundwater flow in the sand and gravel aquifer is toward larger streams or the Choctawhatchee Bay. The Pensacola Clay is a thick confining layer that hydraulically isolates the sand and gravel aquifer from the Floridan aquifer. The Floridan aquifer is recharged to the north of Eglin AFB where the Pensacola Clay is thinner or absent. Groundwater flow in the Floridan aquifer is south toward the Gulf of Mexico (EA Engineering, Science, and Technology 1997).

Groundwater Use

On-Base

Eglin AFB receives its drinking water from deep groundwater wells (about 600 feet below mean sea level) that draw water from the Floridan aquifer, the primary source of public water in northwest Florida (EA Engineering, Science, and Technology 1997). As noted above, the Pensacola Clay forms a competent confining layer between the surficial aquifer and the Floridan aquifer. There are approximately 111 water supply wells on the Eglin Reservation. Twenty active wells are located on Eglin Main Base and another 20 wells have been capped, abandoned, or are inactive (EA Engineering, Science, and Technology 1997). The remaining 61 wells are assumed to be in areas other than the Main Base and active since they have not been categorized as capped, abandoned, or are inactive.

Off-Base

The majority of residents living near Eglin AFB are supplied with public water from Okaloosa County, Niceville, or Valparaiso water supplies. Some people use private groundwater wells and some communities or businesses have limited use commercial or community systems that require a permit from the Florida Department of Health (personal communication with Florida Department of Health personnel, September 2002).

ATSDR investigated a contaminated groundwater plume originating from the C-6 Radar Facility. The nearest downgradient drinking water wells from this site are located off base, 3 miles south, in the town of Portland, Florida. The extent of the trichloroethylene (TCE) contamination was defined to be entirely on Eglin AFB property. To ensure that the contamination does not migrate to Portland, the Air Force conducts long-term monitoring of the groundwater at the site on an annual basis (Earth Tech 2000a).

E. Quality Assurance and Quality Control

In preparing this public health assessment, ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the IRP program must meet specific standards for adequate quality assurance and control measures for chain-of-custody procedures, laboratory procedures, and data reporting. The environmental data presented in this public health assessment are from the referenced reports. The limitations of these data have been identified in the associated reports. After evaluating the data, ATSDR determined that the quality of environmental data available in site-related documents for Eglin AFB is adequate to make public health decisions.

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

ATSDR evaluated a number of areas identified by the petitioner and other community members to determine whether potential exposure to contaminated media would result in past, present, or future public health hazards. ATSDR identified five main ways people were concerned that they would be exposed to hazardous levels of contaminants. Table 1 provides a summary of the exposure pathways at Eglin AFB that were evaluated in this public health assessment. Figures 2 and 3 provide the locations of the sites evaluated. For reference, Appendix A defines some of the technical terms used in this public health assessment and a List of Acronyms is available after the Table of Contents.

OUTLINE OF IDENTIFIED EXPOSURE CONCERNS

1. ***Air Contamination***—ATSDR evaluated whether harmful levels of contaminants in the air would have reached people in off-base areas from (1) herbicide testing and spraying (2) OB/OD operations (3) smoke generated during wildfires and prescribed burns and (4) the 1965 fire at the C-6 Radar Facility.

2. ***Surface Water Contamination***—ATSDR evaluated whether harmful levels of contaminants (including Herbicide Orange) seeped into surface waters and whether contact with those chemicals via swimming or eating fish would be harmful to people's health at (1) Tom's Bayou (2) Weekly Pond (3) Pocosin Pond (4) Mullet, Trout, and Basin Creeks, and (5) in an unnamed pond near the North Gate of Eglin Main Base.

3. ***Groundwater Contamination***—ATSDR evaluated whether groundwater contamination from the C-6 Radar Facility is reaching off-base residential wells.

4. ***Herbicide Contamination***—ATSDR evaluated the potential for people to be exposed to herbicide contamination at the Herbicide Exposure Unit (SS-25/DP-09), the C-52A Aerial Overspray Area (AOC-24), Upper Memorial Lake (LF-51), and Hardstand 7 (SS-26).

5. ***Radioactive contamination***—ATSDR evaluated the potential for people to be exposed to radiation at a site where Zinc 65 was disposed (AOC-63 and AOC-67), at two areas with depleted uranium (DU) contamination (RW-40 and RW-41), and at one site where thorium from a BOMARC missile was disposed (RW-42).

A. Concern: Air Contamination

ATSDR obtained information characterizing the magnitude and duration of relevant chemical releases from Eglin AFB, including those from herbicide spraying, OB/OD activities, prescribed burns, wildfires, and a past structural fire (C-6 Radar Facility). Figure 2 shows the site locations.

ATSDR determined that previous herbicide spraying activities, current OB/OD operations, and a past structural fire did not pose public health hazards. Contaminant levels in off-base residential areas would have been much lower than levels shown to cause adverse health effects.

In order to address whether on-base prescribed burns or wildfires pose a health hazard to off-base residents ATSDR considered two different aspects of on-base fires. First, an evaluation of whether fires in areas where soil contamination exist could cause contaminants to become air-borne and be transported to off-base residential areas. Next, a consideration of exposure to contaminants released during the burning of plant material (trees, grasses, shrubs, etc.).

Findings indicate that the contaminants in soils (depleted uranium and herbicides, including Herbicide Orange[3]) would not reach off-base areas at levels associated with harmful health effects. Therefore, off-base residents would not come in contact with those contaminants.

Still, the burning of plant material causes a release of particles and natural combustion products (smoke) that could cause some short-term adverse health effects (e.g., burning, itching or watery eyes, nausea, breathing difficulty and asthma-like

Uranium: A radioactive metal, which is naturally present in rocks, soil, groundwater, surface water, air, plants, and animals in extremely small amounts. Because uranium is found in the environment in trace amounts, people can intake it into their bodies via air, food, soil, and water. Uranium contributes to a natural level of radiation in our environment, called background radiation (ATSDR 1999c).

Natural uranium, enriched uranium, and depleted uranium are mixtures of primarily three uranium isotopes (U-238, U-235, and U-234; chemically similar but with a different number of neutrons). All three isotopes are radioactive but have different specific activities (that is, radioactivity per gram of material). U-238 has the lowest specific activity and U-234 has the highest (ATSDR 1999c, 2002c). **Natural uranium** is, by weight, more than 99% U-238, 0.72% U-235, and 0.005% U-234. **Enriched uranium** is, by weight, greater than 0.72% U-235, usually ranging from 2 to more than 90 percent. **Depleted uranium (DU)** is, by weight, less than 0.72% U-235 and is also depleted in U-234. Therefore, DU is less radioactive (lower specific activity) than naturally occurring uranium. It is a heavy metal and is twice as dense as lead (Harley et al. 1999). This density provides its value for use in military applications such as armor and armor-piercing munitions.

[3]See Section III. Community Concerns for additional information about Herbicide Orange and exposure at Eglin AFB.

symptoms) in those people exposed. Airborne emissions from prescribed burns and wildfires have not been measured. This evaluation is based on health effects seen from other burns. Individuals highly sensitive to the effects would be anyone with previous respiratory conditions such as asthma or emphysema, children, and the elderly. Health effects would likely be of short duration, developing within a few days of exposure and lasting no more than 2 or 3 weeks after exposure stopped. The base takes several measures to minimize the impacts of fires on residential neighborhoods. Fires can, however, present a public health hazard to people who are sensitive to the effects of smoke.

- ***Herbicide Testing and Use***

Herbicides and pesticides have been sprayed at locations throughout Eglin AFB periodically for at least 40 years (Eglin AFB 2000c). Winds might have blown some of these chemicals to off-base locations. Measuring airborne levels of these chemicals is not a general practice and not required by regulation. Thus, airborne levels of herbicides or pesticides have never been measured in residential areas. To evaluate this concern, ATSDR estimated exposures based on what was sprayed, the distance to populated areas, and the wind speed and direction.

The base does not have comprehensive records that document exactly when, where, and the quantity of chemicals sprayed throughout the base. But it does have records that summarize spraying activities for the Herbicide Exposure Unit, where herbicides were sprayed from 1962 to 1970 (Eglin AFB 2000c) (for more details about this site see the Herbicide Exposure Unit discussion in the Herbicide Contamination concern). Though pesticides and herbicides have been, and continue to be, sprayed in other areas of the base, the amounts sprayed are notably lower when compared to those sprayed at the Herbicide Exposure Unit. Therefore, this evaluation is conservatively based on air exposures resulting from spraying activities at the Herbicide Exposure Unit—the area on Eglin AFB believed to be sprayed with the greatest quantities of potentially toxic chemicals.

ATSDR evaluated a simple and overestimated exposure situation: *What would have happened if the entire amount of chemicals used at the Herbicide Exposure Unit continuously blew directly toward the closest off-base location, instead of mostly depositing on the ground at the Herbicide Exposure Unit?* Though obviously unrealistic, this scenario provides an extreme upper bound estimate of what the actual ambient air concentrations might have been during relatively intense spraying activities.

ATSDR used an air dispersion model (the SCREEN3 Model; EPA 1995) together with Eglin AFB chemical use data to estimate off-base air concentrations at the nearest base boundary (about 2 miles). The model, agency assumptions, and the results are described in Appendix B. *Even with the extremely conservative assumptions in this analysis, the estimated average off-base concentrations were lower than levels expected to be harmful to humans.* In other words,

spraying activities at the Herbicide Exposure Unit did not cause concentrations of chemicals to reach levels of health concern at off-base locations. For example, the estimated average air concentration for arsenic at off-base locations (0.009 micrograms per cubic meter, or $\mu g/m^3$) is substantially lower than levels expected to be harmful to humans (0.7–613 $\mu g/m^3$; ATSDR 2000a). Further, this estimated arsenic concentration overstates the actual air concentration, that is ATSDR used the extremely conservative assumption that all of the arsenic that was sprayed at the Herbicide Exposure Unit blew directly to, and only to, off-base locations. See Appendix B for ATSDR's evaluation of additional chemicals sprayed at the Herbicide Exposure Unit.

Past herbicide spraying at the Herbicide Exposure Unit does not appear to have posed a past public health hazard. Therefore, current and future spraying activities, which use notably lower amounts and less toxic mixtures than past herbicide spraying, are not expected to pose current or future public health hazards to off-base residents.

- ***OB/OD Operations***

In October 1996, Eglin AFB obtained a permit to conduct OB/OD operations at Range C-62 and Range C-52N (EA Engineering, Science, and Technology 1999). These ranges are located in the northeast and east central sections of Eglin Reservation, respectively (see Figure 2). Range C-62 is about 14,500 feet from Eglin's east boundary and Range C-52N is about 25,000 feet from Eglin's north boundary. Range C-62 contains OB/OD units in the south-central portion of the range and Range C-52N contains an OD unit in the middle of the range.

OB/OD operations are a common practice at military installations that test and store ordnance. This procedure enables the Air Force to safely dispose of unexploded or "expired" ordnance under controlled conditions.

From October 1997 to October 1998, the Air Force monitored six OB/OD events at Range C-62 for total suspended particulates (TSP), barium, magnesium, and lead—all of which were previously identified during a human health risk assessment as the air quality compounds of concern. Ambient air sampling activities were pre-approved by EPA and FDEP (EA Engineering, Science, and Technology 1999).

The upwind and downwind ambient air samples showed that the chemical concentrations in the air did not exceed EPA's National Ambient Air Quality Standards (NAAQS) for TSP (75 $\mu g/m^3$) and the Florida ambient reference concentrations (ARCs) for barium (1.2 $\mu g/m^3$), magnesium (24 $\mu g/m^3$), and lead (0.09 $\mu g/m^3$); with the exception of one lead sample (0.15 $\mu g/m^3$) during one event (EA Engineering, Science, and Technology 1999). But, *average* lead results (0.03 $\mu g/m^3$) were below Florida's ARCs for lead.

The air quality monitoring was conducted within the range and the airborne contamination is expected to be substantially dispersed before reaching residential neighborhoods. The chemicals released during OB/OD operations are at levels too low to be of health concern on base and are not expected to be concentrated in off-base areas. Therefore, they pose no health hazard to off-base populations.

- ***Prescribed Burns and Wildfires***

Prescribed Burns

To reduce the likelihood and severity of wildfires, base personnel have since the 1900s conducted periodic prescribed (i.e., controlled) burns of vegetation (Eglin AFB 1999). Most open areas of Eglin AFB are burned at least once every 10 years through a series of prescribed burns. These burns normally are conducted in the spring, and sometimes in the fall. Each individual burn typically lasts less than 24 hours and spans an area of 1,500 acres or less (Eglin AFB 1997–98).

To prevent smoke plumes from reaching residential neighborhoods, the base approves prescribed burns only after detailed computer simulations show that potential impact of the fire on nearby residents is minimal (Eglin AFB 1999). Eglin AFB conducts prescribed burns under controlled conditions and follows procedures outlined in the US Forest Service's *A Guide for Prescribed Fires in Southern Forests*, which describes appropriate weather conditions, fire ignition methods, and other parameters for conducting successful prescribed burns and minimizing their adverse environmental effects. The Guide emphasizes the importance of managing smoke and avoiding risk to smoke-sensitive areas to the greatest extent possible (USFS 1989). According to EPA, prescribed burns are generally accepted as an "ecologically sound tool for forest, range, and wetland management," and prescribed burns are believed to release a "relatively smaller quantity" of air pollution than wildfires (EPA 1996).

Beginning in 2001, Eglin officials committed to improving the ways they inform the community when prescribed burns are scheduled (Daily News 2000b). Notifying potentially impacted community members, especially sensitive populations, through timely and informative press releases and radio announcements when the prescribed burns are scheduled affords these populations the opportunity to reduce potential exposures.

Wildfires

Wildfires occur in many parts of Florida, including Eglin AFB. Severe wildfires can spread over larger areas, and burn for durations much longer than those of typical prescribed burns. Therefore, wildfires are capable of producing a much greater volume of air pollution than prescribed burns. Furthermore, wildfires can have greater impacts on residential areas near Eglin

AFB than prescribed burns, primarily because wildfires can occur when winds are blowing in any direction. Given the base's policy of conducting regular prescribed burns to minimize the consequences of wildfires, however, the chance that a severe wildfire would occur at Eglin AFB is very low (especially in comparison to other parts of Florida where prescribed burns are not practiced).

Components of Air Releases from Fires

To determine the health impact of prescribed burns or wildfires on nearby residents and workers, ATSDR relied on information from other forest fires and wildfires across the country to determine possible components of the fire and smoke at Eglin AFB. Additional information about the fire components possibly released into the air were also ascertained from surface soil contaminants (e.g., herbicides and depleted uranium) found at Eglin AFB.

The main components of fire that could pose the greatest hazard by way of inhalation are carbon monoxide, carbon dioxide, aldehydes (i.e., formaldehyde and acrolein), ozone, and respirable particulates.

Carbon Monoxide: Carbon monoxide is a colorless, odorless gas released during incomplete combustion (i.e., fire) which primarily affects the nervous system. Exposure to carbon monoxide can cause headaches, dizziness, and lightheadedness. Exposure to low to moderate levels can affect concentration, cause memory and vision problems, loss of muscle coordination, temporary reduction in lung function, bronchitis, and asthma-like symptoms (New Jersey Hazardous Substance Fact Sheets; Ottmar and Reinhardt 1989; Reinhardt et al. 1999; Sharkey 1997).

Carbon Dioxide: Carbon dioxide is a colorless, odorless gas which, in addition to being a component released during fire, is released by our bodies when exhaled. Exposure to moderate amounts of carbon dioxide can cause lightheadedness, confusion, and loss of consciousness (New Jersey Hazardous Substance Fact Sheets).

Formaldehyde: Formaldehyde is a colorless, flammable gas with a strong, pungent odor. It can form explosive mixtures with air and oxygen. As an important industrial chemical of major commercial use, formaldehyde is found throughout the environment. It is also naturally produced in very small amounts in our bodies as part of our normal, everyday metabolism (ATSDR 1999a). In solution, it has a wide range of uses. Examples include the manufacture of resins and textiles, disinfectants, and laboratory fixatives or preservatives. Formaldehyde is formed during incomplete combustion of hydrocarbons (Reinhardt and Ottmar 2000). In outdoor air it can originate from many sources such as incinerators, photochemical smog, and engine exhaust. Atmospheric levels of formaldehyde have been reported to range from less than 0.005 ppm to 0.06 ppm near industrial outlets or in areas of heavy smog (Reinhardt et al. 2000). Workers who smoke are exposed to additional levels of formaldehyde, cigarette smoke contains as much as 40

ppm of formaldehyde by volume (Sharkey 1996). The first signs or symptoms noticed from exposure to formaldehyde at concentrations ranging from 0.1 to 5 ppm are burning of the eyes, tearing, and general irritation to the upper respiratory passages. Higher exposures (10 to 20 ppm) could produce coughing, tightening in the chest, a sense of pressure in the head, and palpitation of the heart (NIOSH 2000; New Jersey Hazardous Substance Fact Sheets; Reinhardt et al. 1994; USDA 1999).

Acrolein: Acrolein is a colorless to yellow liquid that produces vapors characterized by a foul choking odor. It is released from the burning of natural materials, such as plants. People can also breathe acrolein when near automobiles, because burning gasoline forms acrolein, which enters the air (New Jersey Hazardous Substance Fact Sheets; Reinhardt and Ottmar 2000; Reinhardt et al. 2000). Oil or coal power plants also release small amounts of acrolein. Acrolein is formed when fats are heated. Small amounts of acrolein can also be found in foods such as fried foods, cooking oils, and roasted coffee. In several large cities acrolein has been measured at levels of 0.009 ppm (Reinhardt et al. 1994). The levels in inside air can be much higher when tobacco is burning. For example, in a car with three people smoking and the windows closed, a person could breathe in 0.300 ppm. Acrolein can be smelled at levels above 0.160 ppm. Thus, a person smelling acrolein would probably notice eye, nose, and throat irritation before any lung damage occurred (Reinhardt et al. 1994).

Ozone: Ozone is a colorless gas with a sharp odor which can be smelled well below the permissible levels of exposure. At low exposure doses, an individual could experience irritation of the eyes, dryness of the nose and throat, and a cough. At moderate levels, headache, stomach ache and vomiting can occur. In addition, ozone is the main component in smog that can cause breathing problems, aggravate asthma, and increases the severity and incidence of respiratory infections (New Jersey Hazardous Substance Fact Sheets; Reinhardt et al. 1999).

Particulates: Particulates are small pieces of material released from combustion or from physical release. The effect particulates have when breathed in depends on the size of the particles. Larger particles (greater than 10 microns) get trapped by the nasal passages. Particles greater than 5 microns travel down the airway to the bronchioles and are removed by the cilia and by coughing. Respirable particles (0.5-5 microns) can travel deeper into the alveolar region of the lungs causing irritation, bronchitis and respiratory effects. Many particles smaller than 0.5 microns remain suspended in the air and are exhaled, however some are deposited in the alveolar region (Levy and Wegman 1988; Williams et al. 1985). These smaller particles are cleared by macrophages, lymphatics, and the bloodstream (Amdur et al. 1991). The legal airborne permissible exposure limit for workers is 50 ppm averaged over an 8-hour period (Reinhardt et al. 1994).

Other Chemical Considerations: If fires reach sufficiently high temperatures, they can also cause contaminants in soils, like metals and herbicides, to become airborne. Therefore, depending on

the location of a fire, smoke from the fires can also contain metals and other pollutants. As a hypothetical example[4], ATSDR evaluated whether a wildfire near the Herbicide Exposure Unit could release trace amounts of the chemicals that were tested in this area to the air, assuming that they are in the soil. To evaluate the public health implications of these emissions, ATSDR considered an extremely conservative exposure situation to determine whether smoke contains unhealthy levels of contaminants that were once in the soil[5]. From such analyses, ATSDR concluded that soil contaminants that might be released during wildfires are not expected to reach levels associated with adverse health effects at off-base locations. Appendix B contains more details about how this conclusion was reached.

Depleted Uranium: Depleted uranium (DU) describes a waste product from the production of nuclear fuel for energy production or weapons. Typically DU is approximately 50% less radioactive than naturally occurring uranium, yet it is just as dense. This density allows the waste material to be used in military applications such as armor and armor piercing munitions. During the use of DU munitions at Eglin, the areas where the DU were used was localized and studies suggest the majority of the DU remains in the areas (White 1981; Becker and Vanta 1995).

If the DU is in fine particles in the surface soils, it would have oxidized either by the original use of the munitions or by exposure to the environment. Uranium oxides do not vaporize (Moses 1978). Because DU particles are extremely dense, any particles in the soil that could get airborne would quickly settle to the ground in the area of use. Conceivably, very small particulates could disperse at greater distances from the source. However, deposition of these fine particles would be widely scattered, and consequently, measurable amounts of DU would not occur in localized areas distant from the source (ATSDR 1997). Also, if the DU is in large metal pieces, it would not get airborne during a prescribed burn or wildfire. Studies suggest that the munitions (large DU metal pieces) penetrated the ground surface to a depth of 6 inches (Earth Tech 2001b) which, if a prescribed burn or wildfire occurred, would not result in temperatures sufficient to affect the DU metal. Also, plants in the area would not be contaminated with uranium since uranium is minimally transferred from soil to vegetation (the uranium transfer factor from soil to vegetation is 0.0085); therefore, burning vegetation would not contribute to airborne DU (Baes et al. 1984).

Public Health Implications

The likelihood of becoming sick from chemical exposure increases as the amount of chemical exposure increases. This is determined by the length of time and the amount of chemicals to

[4]Eglin AFB does not conduct prescribed burning at the Herbicide Exposure Unit.

[5]ATSDR assumed that soils throughout a 5-acre area in the Herbicide Exposure Unit are contaminated at the maximum concentrations reported for a given chemical and assumed that a fire releases all chemicals found in the top 3 inches of the soil.

which someone is exposed. Short-term exposure typically refers to contact with a contaminant (e.g., by breathing it in, eating or drinking it, or touching it to the skin or eyes) for a short period of time, less than 1 year. Long-term exposure typically refers to contact with a contaminant for more than one year (New Jersey Hazardous Substance Fact Sheets; Reinhardt and Ottmar 2000; Sharkey 1996). Short-term health effects (also called acute health effects) are conditions, symptoms, or health changes that can occur immediately or shortly after exposure and last for less than 2 to 3 weeks (New Jersey Hazardous Substance Fact Sheets; Reinhardt and Ottmar 2000; Sharkey 1996). Long-term health effects (also called chronic health effects) are conditions, symptoms, or health changes that can occur at some time after exposure and can last for months or years. Short-term health effects can occur from exposure to high or low amounts of chemical contaminants and can also occur from short- or long-term exposures. Most long-term health effects, however, result from repeated exposures to a chemical (New Jersey Hazardous Substance Fact Sheets).

Health-related research shows that firefighters can experience both reversible, short-term health effects, such as eye and respiratory tract irritation, and long-term adverse health effects, such as decreased lung function and increased incidence of respiratory illness (Reinhardt 1991; Reinhardt et al. 1995; Reinhardt and Ottmar 1997). Long-term adverse health effects have been seen in a small portion of firefighters who were exposed to fire components on a daily basis for more than 1 year (Reinhardt 1991; Sandber 1999; Sharkey 1999). Data from studies show that between 1 and 10% of firefighters have exposures to fire and smoke components which exceed recommended Time Weighted Averages[6] for a normal 8-hour day/40 hour work week. Less than 5% of these smoke exposures exceed Occupational Safety and Health Administration (OSHA) permissible exposure limits, which are less stringent than the recommended limits, but which are legally applicable to federal agencies (Sharkey 1999). The exposures of firefighters to smoke and fire components have been identified by both the respired air from the lungs of firefighters and from actual air samples collected by monitors worn on the neck and chest of firefighters. Reports of studies conducted since 1988 show consistent results. In several studies, firefighters, who were given questionnaires after days of exposure, reported headaches, cough, shortness of breath, lightheadedness, and wheezing (Ottmar and Reinhardt 1989; Reinhardt et al. 1999; Reinhardt 1991; Sandber 1999).

Airborne emissions from prescribed burns and wildfires have not been measured in the counties surrounding Eglin AFB. Nevertheless, to provide perspective about health problems reported in the general population, ATSDR spoke with nurses from several counties where severe wildfires occurred during 2000. Most of the fire and smoke related cases reported eye, nose, and throat irritation that subsided within a few hours after exposures stopped. None of the county nurses

[6]Time weight averages are threshold limit values consisting of the average airborne concentration of the substance over a specified time limit.

reported adverse pregnancy or birth outcomes related to the fire and smoke. They noted that most phone calls were not related to health, but to how to get the smell of smoke out of the furniture and carpeting (ATSDR 2000c, 2000d, 2000e, 2000f, 2000g, 2000h).

That said, however, recent studies suggest that the incidence of certain acute respiratory health effects (e.g., asthma-like symptoms, acute bronchitis, and chest pain) among selected Florida residents is greater when large wildfires occur, as compared to when wildfires do not occur or are less severe (CDC 1999). The likelihood of observing these effects during a prescribed burn is believed to be much reduced because the base makes every effort to conduct prescribed burns only during meteorological conditions that favor rapid dispersion of smoke in directions away from residences. In addition, once emitted by fires, these pollutants gradually disperse as smoke plumes blow downwind.

Even though Eglin AFB takes several measures to minimize the impacts of fires on residential neighborhoods, components (chemical and physical) released from prescribed burns and wildfires could cause some short-term adverse health effects (such as burning, itching, or watery eyes and sinuses; headache; nausea; breathing difficulty; and asthma-like symptoms) in those people exposed, especially sensitive populations (such as anyone with previous respiratory conditions such as asthma or emphysema, children, and the elderly). Although, health effects would be of short duration, developing within a few days of exposure and lasting no more than 2 or 3 weeks after exposure stopped.

The Air Force should continue to notify community members when the prescribed burns are scheduled. This allows people to take measures to reduce potential exposures. If people are experiencing respiratory problems, they should seek the attention of their personal medical care provider.

- ***Structural Fire at the C-6 Radar Facility/Burial Site (SS-85) - 1965***

The C-6 Radar Facility was built in the mid-1960s to monitor the southeastern United States airspace (Earth Tech 2000a; Eglin AFB 2000c). It is located in the eastern portion of Eglin AFB, approximately 3 miles north of the town of Portland in an undeveloped section, see Figure 2 (Earth Tech 2000a). On January 5, 1965, during the final phases of its construction, the main building of the C-6 Radar Facility caught fire and was destroyed (Rust International 1996; Eglin AFB 1999, 2000). The main building was made of wood, but it housed high-voltage transformers and radar/surveillance equipment that contained polychlorinated biphenyls (PCBs) and other environmentally persistent materials (Earth Tech 2000a; Rust International 1996).

There are conflicting reports of the remedial activities following the fire. An Eglin employee in charge of operations reported that the entire facility and contents (e.g., transformers and radar/surveillance equipment) were buried in an unlined pit in the front of the remaining

foundation slab. A second employee claimed to be an eyewitness to the disposal activities, reported that most of the recyclable materials were removed from the site and only inert debris (e.g., concrete fragments and steel beams) were buried on site (Earth Tech 2000a; Rust International 1996).

Because the fire at the C-6 Radar Facility lasted only 1 day, inhalation exposures to contaminants from this fire, if any, were short term. No air sampling was conducted in the vicinity of the C-6 Radar Facility during or after the fire, and a detailed inventory of the original contents of the main building is not available.

Some observations can help put potential exposures from this fire into perspective. For instance, meteorological data collected at a nearby air field on Eglin AFB indicate that wind blew predominantly from the east and northeast (or toward the west and southwest) on the date of the fire, thus suggesting that residents southwest of the site could have been briefly exposed to the smoke from the fire (NOAA 1965). Because the C-6 Radar Facility is 19,260 feet from the nearest boundary of the base (about 3 miles from Portland), contaminants in the smoke that reached residential neighborhoods were expected to be substantially dispersed and not concentrated. Though neither of these observations quantify actual exposures to smoke and fumes from the fire, they both suggest that the fire had little impact on residential neighborhoods near the C-6 Radar Facility.

B. Concern: Surface Water Contamination

To address this concern, ATSDR obtained information that characterizes the nature and extent of contamination and the potential for human exposure at the following surface water bodies: Tom's Bayou; Weekly Pond; Pocosin Pond; Mullet, Trout, and Basin Creeks; and an unnamed pond near North Gate; see Figures 2 and 3 for site locations.

ATSDR determined that although contamination from Eglin AFB is potentially migrating into Tom's Bayou, it would not cause a past, present, and future public health hazard for people living near, recreating in, or eating fish from Tom's Bayou.

ATSDR determined that eating fish from Weekly and Pocosin Ponds is not likely to present a past, current, and future public health hazard. As a precautionary measure, fishing is currently not allowed in Pocosin Pond and is designated as catch-and-release only in Weekly Pond. Based upon the available information, ATSDR determined that people who ate fish from Weekly Pond in the past were not exposed to unsafe levels of chemicals.

Recreating in Mullet, Trout, and Basin Creeks is also not likely to present a public health hazard because the chemicals detected in the surface water, sediment, and fish tissues were below levels of health concern.

One community member wanted information on whether Herbicide Orange was present in an unnamed pond near the North Gate of Eglin Main Base. The Air Force has no records of Herbicide Orange in this unnamed pond. Access to the unnamed pond near the North Gate is currently limited by the location of the pond and the presence of building rubble between an off-base stable and the pond; thus any potential exposures would have been minimal.

- ***Tom's Bayou***

Tom's Bayou is in Valparaiso, Florida, and is used for various recreational activities (e.g., fishing, swimming and boating) by those who reside near the bayou. There are several small ponds and streams located on Eglin Main Base to the south and west of Tom's Bayou, which drain into the bayou (e.g., small unnamed beaver ponds to the south and Tom's Creek to the west). Several IRP sites are at the headwaters or along these surface water bodies, potentially contributing to contamination in Tom's Bayou (see Figure 3). Table 2 provides site descriptions and remedial activities for these IRP sites. For the purposes of this evaluation, these sites were grouped into four areas according to location and flow into Tom's Bayou. These sites range from about 2,000–11,000 feet upstream of the bayou.

- The first set of sites (named Group 1 for the purposes of this document) is located near several beaver ponds to the south of Tom's Bayou and drains into a small unnamed stream, which flows into the southwest corner of the bayou. These sites include: LF-08 (Receiver Area Landfill), DP-07 (A-19 Drum Disposal Site), DP-96 (Taxiway 9e Disposal Area), ST-64 (Aero Club/Building 68), ST-112 (Base Operations Generator Tank, Building 60), POI-324 (First Baptist Church of Valparaiso/Napalm Site), and POI-390 (Transmission Building Site).

- The second group (named Group 2 for the purposes of this document) includes AOC-98 (Hardfill 01 End of Runway Disposal Area) and is located along the south shore of Tom's Creek, which flows directly into Tom's Bayou.

- The third set of sites (named Group 3 for the purposes of this document) is located near Hardstand Pond and Beaver Pond. Hardstand Pond is a marsh area with two surface water bodies flowing into a small stream, which in turn flows north for about 3,300 feet to Beaver Pond (Engineering & Services Laboratory 1987). Beaver Pond is dammed at Perimeter Road; only a small amount of surface water enters a culvert under the road and feeds into a wetland area near Tom's Creek, which flows into Tom's Bayou. Surface water within the ponds is reported to be essentially stagnant (Earth Tech 2001c). This third set of sites includes: SS-26 (Hardstand 7), DP-261 (Building 914 Disposal Area), AOC-88 (Hardstand 8 Alternate Loading Area), SS-32 (High Explosives Research & Development [HERD] PCE Spill), POI-412 (HERD Facility Building 1206), and POI-358 (Water Tower No. 1205).

- The fourth set of sites (named Group 4 for the purposes of this document) include OT-29 (Missile Maintenance Paint Stripper Pit) and POI-408 (SAC Munitions Maintenance/33rd Flight Munitions Area). These two sites are located to the south of Tom's Creek, upstream of AOC-98. Tom's Creek drains directly into Tom's Bayou.

ATSDR extensively investigated whether any sampling had been conducted in Tom's Bayou. The US Fish and Wildlife Service, as part of Eglin AFB's stream monitoring program, collected water quality data in Tom's Bayou, including dissolved oxygen levels, turbidity, and conductivity. They have also collected aquatic insects to determine taxa richness and diversity. Based on the information collected, Tom's Bayou is considered to be a healthy system (personal communication with US Fish and Wildlife Service personnel, April 2002).

In February 1997, FDEP sampled a site in Tom's Bayou during an environmental assessment of sediment quality in Boggy Bayou (Butts 1997). FDEP collected water quality data in Tom's Bayou and reported that the results indicate good water quality (with the exception of nitrate plus nitrite levels, however, according to ATSDR's evaluation the concentrations are below levels of health concern). FDEP also collected two sediment samples from Tom's Bayou and analyzed them for metals and volatile organic compounds. ATSDR reviewed the analytical data and determined that the chemical concentrations present in the sediment are not at levels of health concern for people using Tom's Bayou for recreational activities (i.e., all the concentrations were detected below levels known to cause harmful health effects, assuming that people were exposed to the chemicals present every day for 70 years, see Appendix C for more details about how ATSDR reached this conclusion). Finally, FDEP also evaluated the benthic macroinvertebrate community structure at the sample location in Tom's Bayou and reported a good assemblage of organisms present, especially in the more productive shallow zone (Butts 1997).

Because limited chemical data are available for Tom's Bayou, ATSDR evaluated the level of contamination present at the Eglin AFB sites located in the drainage basin that potentially contribute to contamination in Tom's Bayou. As a conservative approach, ATSDR assumed that the contaminant concentrations present at these sites are equivalent to the level of contamination that people are being exposed to in Tom's Bayou, even though these areas of Eglin Main Base are closed to all forms of recreation (Eglin AFB 2000b). ATSDR evaluated whether exposure to these contaminant concentrations could result in exposure levels high enough to cause harmful health effects, assuming people were being exposed every day for 70 years. Appendix C describes in greater detail the methods and assumptions ATSDR used to estimate human exposure doses and determine health effects.

The Air Force has conducted several investigations at many of the IRP sites within the Tom's Bayou drainage basin. ATSDR determined that the available information adequately defines the

extent of the contamination at the sites in the drainage basin and can be used to evaluate health concerns in the bayou.

- Group 1 sites are located to the south of Tom's Bayou in a drainage basin that does not receive additional contamination from Group 2, 3, or 4 sites. In 1994, 1995, 1996, and 2000, the Air Force collected surface water and sediment samples from the beaver ponds near the Group 1 sites and analyzed them for metals, volatile organic compounds, pesticides, herbicides, and PCBs (CH2MHILL 1996; Earth Tech 2001a; Eglin AFB 2000c; O'Brien & Gere Engineers 1996). ATSDR reviewed the available data and determined that the detected chemicals were not at levels of health concern for people using Tom's Bayou for recreational activities.

- The Group 2 site is located west of Tom's Bayou, along an area of Tom's Creek downstream of the Group 3 and 4 sites. In 1995 the Air Force conducted a site investigation at this site, and sampled groundwater and subsurface soil for metals, volatile organic compounds, pesticides, herbicides, and PCBs (Earth Tech 2001e). It should be noted that because surface water and sediment data were not available for this area, ATSDR assumed that the levels of chemicals present in the groundwater and subsurface soil were representative of contamination present at the surface. Using this conservative approach, ATSDR determined that the detected chemicals were not at levels of health concern for people using Tom's Bayou for recreational activities.

- The Group 3 sites are located to the south of Tom's Creek in a drainage basin that does not receive additional contamination from Group 1, 2, or 4 sites. From 1974 to 1980, the Air Force and the Florida Game and Freshwater Fish Commission collected soil, sediment, and biological samples from this area for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) analysis (Harrison et al. 1979; Harrison and Crews 1981). The results of the sediment sampling revealed that TCDD had migrated into the ponds. TCDD, however, was not detected in the one sample collected from Tom's Bayou. In addition, the Air Force sampled Hardstand Pond and Beaver Pond in 1994, 1999, and 2001 for metals, volatile organic compounds, pesticides, herbicides, and TCDD (Earth Tech 2001c; Eglin AFB 1994). ATSDR evaluated the data and determined that all detected concentrations were below levels of health concern. Moreover, because only a small amount of surface water and sediment flow into Tom's Creek from Hardstand Pond and Beaver Pond, very little contamination is expected to leave the ponds and flow into Tom's Creek (and eventually Tom's Bayou). Therefore, ATSDR determined that contamination from Group 3 sites would not cause harmful health effects in people using Tom's Bayou for recreational activities. As a note, Hardstand Pond, Beaver Pond, and the surrounding wooded areas are closed to all recreational activities—in 1985, the entire area was fenced to prevent trespassing and signs were posted to ban fishing (Eglin AFB 2000b, 2000c).

- The Group 4 sites are located west of Tom's Bayou, along an area of Tom's Creek that is farther upstream from the Group 2 site. In 1995, the Air Force collected surface water and sediment samples near these sites (EA Engineering, Science, and Technology 1997). The samples were analyzed for volatile organic compounds, pesticides, PCBs, and metals. ATSDR evaluated the data and determined that the chemicals that were detected are not at levels that would cause harmful health effects to people using Tom's Bayou for recreational activities.

In summary, ATSDR determined that all of the chemicals detected at the four areas that drain into Tom's Bayou are below levels of health concern and would not cause harmful health effects in people using Tom's Bayou for recreational activities in the past, present, and future. ATSDR's conclusions are based on calculated exposures that overstate actual exposures occurring in Tom's Bayou because (1) people are not expected to be exposed consistently to the maximum concentration on a daily basis and for an extended period of time. More realistically people would encounter a range of concentrations, including no concentrations, given that every chemical was not detected in every sample, (2) adults and children are not expected to be recreating in the bayou as often as 365 days of the year, and (3) the majority of the data are from sites that are located on Eglin Main Base and it is expected that the concentrations would be lower in the bayou than at the source areas.

It should be noted that ATSDR considered exposure to multiple chemicals during this evaluation. Several studies, including those conducted by the National Toxicology Program in the United States and the TNO Nutrition and Food Research Institute in the Netherlands, among others, generally support the conclusion that if each individual chemical is at a concentration not likely to produce harmful health effects (as is the case here), exposures to multiple chemicals are also not expected to be of health concern (for reviews, see Seed et al. 1995; Feron et al. 1993).

Fish from Tom's Bayou have not been sampled and analyzed for contamination. Without actual data, ATSDR can not definitively draw conclusions about whether eating fish from the bayou would be expected to cause harmful health effects. Still, based on the available information about the water and ecosystem quality in Tom's Bayou and the type of contamination present at the IRP sites within the drainage basin, ATSDR does not expect high levels of contamination to accumulate in fish in the bayou. FDEP and US Fish and Wildlife Service conducted water quality surveys in Tom's Bayou and concluded that the water quality is good and that the bayou is a healthy system, ecologically. The levels and types of contamination found at the sites on Eglin Main Base do not pose a health hazard to people, including those exposed directly to the contamination.

- ***Weekly Pond***

Weekly Pond is a small 6-acre pond located southeast of the runways on Eglin Main Base (see Figure 3). The pond is about 4,460 feet from the Lewis Junior High School, which is just outside Eglin AFB's East Gate (Eglin AFB 2001b). Fishing is limited to Air Force personnel and their guests, and Eglin AFB's Natural Resources Branch requires a permit to fish on base (Eglin AFB 2000b). While Weekly Pond was open to recreational fishing in the past, it currently has a catch-and-release policy with signs posted (Water and Air Research 1984). In 1996, the Natural Resource Department found trace amounts of dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenyldichloroethylene (DDE) in fish samples. Even though the levels were below health concern, Weekly Pond was posted catch-and-release as a precautionary measure. Also, Eglin AFB was concerned that new quantities of contaminants from a nearby landfill could increase levels in the future (personal communication with Eglin AFB personnel, July 2002).

ATSDR evaluated whether contaminant concentrations could result in exposure doses high enough to cause harmful health effects in people who in the past might have eaten fish from Weekly Pond. In the mid-1980s, Eglin AFB sampled fish tissue and detected pesticides (DDT, DDD, and DDE) (Eglin AFB 1989). Other contaminants have not been identified in Weekly Pond. To calculate exposures, ATSDR assumed that adults and children ate seven meals of fish from Weekly Pond each month (adults were estimated to eat 8 ounces of fish every meal and children were estimated to eat 4 ounces of fish every meal). The resulting exposure doses were well below levels of health concern when compared to values documented in the medical, toxicologic, and epidemiologic literature (ATSDR 2000b). Therefore, adverse health effects are not expected to have occurred from eating fish from Weekly Pond in the past. Thus, while exposure was possible, Weekly Pond poses no past public health hazard. Additionally, because people are not allowed to eat fish from Weekly Pond, people are not being exposed, and no current or future public health hazard is present. Appendix C describes in greater detail the methods and assumptions ATSDR used to estimate human exposure doses and determine health effects.

- ***Pocosin Pond (AOC-91)***

Pocosin Pond covers approximately 10–13 acres and is in the north-central section of the Eglin Reservation (see Figure 2), about 32,000 feet from the nearest base boundary (Earth Tech 2001b; Eglin AFB 2001b). In the past, the Air Force used this area for jungle-environment ballistic testing, air drops, and static detonation of conventional munitions (USACE August 1999 as cited in Earth Tech 2001b). Sometime between July 1969 and February 1970, during one exercise, approximately 500 rounds of DU ammunition were fired at a cloth target marker located in the middle of Pocosin Pond (Earth Tech 2001b).

Pocosin Pond is located in an area open to the public during designated hunting seasons but is restricted to the use of primitive weapons only; however, the thick brush surrounding the pond makes it unlikely that hunters would actually use the area near the pond (Earth Tech 2001b; Eglin AFB 2000b). Members of the Natural Resources Branch and US Fish and Wildlife Service sampled fish and amphibians in 1997. Pocosin Pond was found to be very acidic and no fish were present at that time (personal communication with Eglin AFB personnel, July 2002). Fishing is not allowed at Pocosin Pond and signs are posted to notify the public.

The Low-Level Radioactive Materials Partnering Team recommended No Further Action for the site with current land use controls in place. Even though DU fragments were not removed, the partnering team decided that further investigation would be impractical due to (1) the minimal number of rounds used, (2) the remoteness of the pond, (3) the thickness of the brush, and (4) the expense to remove the brush (Earth Tech 2001b).

Pocosin Pond receives surface water runoff from the area surrounding the Cattle Dipping Vat (OT-83; formerly AOC-113), which is located about 230 feet south of the pond. The cattle dipping vat was used from 1917 to 1944 during the National Cattle Tick Fever Eradication Program (Woodward-Clyde 1995 as cited in Eglin AFB 2000a). The cattle dip solutions commonly consisted of sodium carbonate, arsenic trioxide, pine tar, and water (Eglin AFB 2000c). Arsenic in soil is the primary contaminant detected at the Cattle Dipping Vat. In 1998, the Air Force excavated arsenic-contaminated soil and the concrete vat to remove the source of contamination. The Air Force recommended No Further Investigative Action with current land use controls for this site (Eglin AFB 2000a).

In general, the procedure used during a Preliminary Assessment in October 2000 to evaluate the levels of radioactivity associated with the Pocosin Pond area did not detect any radioactive material or radiation levels elevated above the investigation limit and, by definition, above natural background levels in site soils and dry sediments of Pocosin Pond (Earth Tech 2001b). In addition, documentation exists suggesting that the DU has not migrated from the area (Becker and Vanta 1995; White 1981). Furthermore, no visual evidence of depleted uranium fragments were found in or around a 50 to 100-foot perimeter of the pond. But because the penetrators could have been below the ground surface, this is not surprising. The surveyors also noted that the thick trees and brush surrounding Pocosin Pond make it unlikely that DU fragments would be found (Earth Tech 2001b).

Additionally, surface water and sediment samples were taken from Pocosin Pond as part of a Resource Conservation and Recovery Act (RCRA) Facility Investigation for the Cattle Dipping Vat. Contaminants were not detected above screening levels (Eglin AFB 2000a). Most importantly, Pocosin Pond is located in an area only open to licensed hunters during designated hunting seasons and fishing is *not* allowed (see the Community Concern section for a discussion about eating venison caught in the vicinity of the Eglin Reservation). Therefore, because people

are not allowed to catch and eat fish from Pocosin Pond and no appreciable contamination exits, Pocosin Pond poses no public health hazard.

- ***Mullet, Trout, and Basin Creeks***

Mullet, Trout, and Basin Creeks are in the southeastern section of the Eglin Reservation (see Figure 3) and receive surface water runoff from the Herbicide Exposure Unit (i.e., C-52A Herbicide Test Grid (SS-25) and the Mullet Creek Drum Disposal Site (DP-09)) and the C-52A Aerial Overspray Area (AOC-24). For more details about these sites see the Herbicide Contamination section of this document. The headwaters of all three creeks are located in areas closed to all forms of public access, but flow into areas that are open to seasonal recreational activities (with appropriate Eglin AFB permits). Mullet and Trout Creeks flow through the Fred Gannon Rocky Bayou State Recreational Area and all three creeks eventually drain into the Choctawhatchee Bay.

According to the Baseline Risk Assessment, none of the creeks are visited very often (EA Engineering, Science, and Technology 1997). The highest use was characterized as one or more persons visiting the area seasonally for Basin Creek (downstream of the Herbicide Exposure Unit) and lower Mullet Creek. The headwaters of Mullet Creek[7] and lower Trout Creek are visited even less (1 or more people annually) and the headwaters of Trout Creek are not expected to receive visitors (EA Engineering, Science, and Technology 1997).

The Air Force sampled surface water, sediment, and fish from Mullet, Trout, and Basin Creeks for organic compounds, pesticides and herbicides, dioxins and furans, PCBs, and inorganics (EA Engineering, Science, and Technology 1997; Engineering-Science 1993). Because contamination is present and people do have contact with the surface water, sediment, and fish in these creeks, ATSDR evaluated whether concentrations of chemicals were at levels that would be expected to cause harmful health effects in people who might swim, wade in, or eat fish from the creeks.

To determine if people were, are, or will be exposed to unsafe levels of the chemicals present, ATSDR calculated recreational exposure to the maximum concentrations detected in the surface water and sediment by conservatively assuming that adults and children visit the creeks 365 days/year, even though actual exposure is much lower (EA Engineering, Science, and Technology 1997). ATSDR also calculated exposure doses for catching and eating fish from the creeks by assuming that adults and children consume seven meals of fish from the creeks each month (adults were estimated to eat 8 ounces of fish every meal and children were estimated to

[7]The headwaters of Mullet Creek are not open to the public. During the Baseline Risk Assessment, however, there was evidence of infrequent use, probably by base employees (EA Engineering, Science, and Technology 1997).

eat 4 ounces of fish every meal). Appendix C describes in greater detail the methods and assumptions ATSDR used to estimate human exposure doses and determine health effects.

The resulting exposure doses were below levels of health concern when compared to values documented in the medical, toxicologic, and epidemiologic literature (ATSDR 2000a, 2002a; EPA 2002). For instance, the estimated dose from recreational exposure to the maximum concentration of arsenic in the surface water is 6.4×10^{-6} milligrams per kilogram per day (mg/kg/day) for adults and 2.8×10^{-5} mg/kg/day for children, *which are orders of magnitude below doses known to cause harmful cancer and noncancer health effects* (0.01 to 0.05 mg/kg/day; ATSDR 2000a). Further, the calculated exposures overstate the actual exposures occurring at Mullet, Trout, and Basin Creeks because (1) people are not expected to be exposed consistently to the maximum concentration on a daily basis and for an extended period of time. More realistically, people would encounter a range of concentrations, including none, because not every chemical was detected in every sample and (2) adults and children are not expected to be visiting the creeks as often as 365 days of the year.

Therefore, even though contamination was detected in Mullet, Trout, and Basin Creeks, adverse health effects are not expected from people engaging in recreational activities in the past, present, or future. For health evaluations concerning exposure at the Herbicide Exposure Unit in other environmental media, please see the Herbicide Contamination and Air Contamination Concerns.

- ***Pond Near North Gate***

An unnamed pond near the North Gate of Eglin Main Base is in a remote area with limited accessibility (e.g., access roads are not maintained), about 2,000 feet from the nearest non-base resident (Eglin AFB 2001b). A community member was concerned that Herbicide Orange was present in the pond. About 20 years ago, the community member would ride a horse from the stable to the pond and reported seeing a sign that warned of Herbicide Orange contamination. The Air Force has no records of ever placing a sign at this unnamed pond and the sign is no longer present. There are no historical Air Force documents that indicate Herbicide Orange was ever present at this pond (personal communication with Eglin AFB personnel, April 2002).

If Herbicide Orange was present, people would need to have contact with either the surface water or sediment in the pond to be exposed (e.g., either through touching the water or sediment or drinking water from the pond). If people are not being exposed, no harmful health effects can occur. Currently, there is no fence surrounding the pond or preventing access to the pond. A private off-base riding stable in Valparaiso, Florida is about 450 to 600 feet from the unnamed pond. The area between the stable and the pond is currently filled with building rubble, which severely limits access to the pond.

This unnamed pond is not an ideal location for recreational activities (e.g., swimming). Therefore, it is unlikely that anyone actually had contact with potential contamination in the pond, even in the past when people reportedly rode their horses to it. Because access to the pond is currently limited, there is a low chance that anyone is or will be exposed to high levels of contamination for a long time and on a regular basis. Consequently, harmful health effects are not expected to occur.

C. Concern: Groundwater Contamination at the C-6 Radar Facility

As stated previously, the C-6 Radar Facility was built in the mid-1960s and is located approximately 3 miles north of the town of Portland in an undeveloped section of Eglin AFB (Earth Tech 2000a; Eglin AFB 2000c). This area of Eglin Reservation is closed to the public and all recreational activities are prohibited (Eglin AFB 2000b). In addition, a barbed-wire fence and a locked gate restrict access to the site. The main facility is surrounded by a chain-link fence and is closely guarded (Earth Tech 2000a).

Monitoring wells were installed at the C-6 Radar Facility and the surficial aquifer was sampled several times between 1995 and 2000 (Earth Tech 2000a; Rust International 1996). While other volatile organic compounds and inorganics were detected, TCE is the primary contaminant of concern in the groundwater. During a 2000 site investigation (Earth Tech 2000a), the extent of the TCE contamination was defined to be entirely on Eglin AFB property. The nearest down-gradient drinking water wells are located off base, 3 miles south of the C-6 Radar Facility in the town of Portland, Florida. To ensure that the contamination does not migrate to areas where people are using groundwater wells, the Air Force is conducting annual long-term monitoring of the groundwater for chlorinated solvents (Earth Tech 2000a). Eglin will continue to sample at the C-6 Radar Facility until the Florida Maximum Contaminant Level for TCE (3 ppb) or lower is achieved. Eglin anticipates that long-term monitoring will continue for about five more years because current sampling results show TCE levels to be in the 4–5 ppb range (personal communication with Eglin AFB personnel, July 2002). Because access to the site is restricted and the groundwater contamination is closely monitored and does not extend into the nearest residential area, it is not expected that past, present, or future public health hazards occurred, are occurring, or will occur.

D. Concern: Herbicide Contamination

To address whether contact with herbicides is a health concern, ATSDR obtained information that characterizes the nature and extent of contamination and the potential for human exposure at areas with herbicide contamination. See Figure 2 for site locations. ATSDR evaluated the potential for the herbicides to move off-base via fires, spraying, and surface waters in previous sections. See also Section III. Community Concerns for additional information specific to Herbicide Orange and exposure at Eglin AFB.

In 1992, the Air Force conducted a base-wide investigation into all known and suspected Herbicide Orange locations at Eglin AFB (Engineering-Science 1993). Eleven sites were identified for further investigation: C-52A Test Grid (SS-25), Mullet Creek Drum Disposal Site (DP-09), C-52A Aerial Overspray Area (AOC-24), Hardstand 7 (SS-26), Receiver Landfill (LF-08), Upper Memorial Lake (LF-51), 3 sites at Lower Memorial Lake (AOC-81), Field No. 2 Drum Disposal (DP-11), and Field No. 2 Helicopter Loading Area (AOC-55). Of these, seven sites (Mullet Creek Drum Disposal Site, Receiver Landfill, 3 sites at Lower Memorial Lake, Field No. 2 Drum Disposal, and Field No. 2 Helicopter Loading Area) required No Further Action because herbicide contamination was not detected. Further investigation was recommended for three sites (C-52A Test Grid, C-52A Aerial Overspray Area, and Upper Memorial Lake), and remedial actions were recommended for Hardstand 7 (Engineering-Science 1993). See Figure 2 for site locations.

Access to the Herbicide Exposure Unit, the C-52A Aerial Overspray Area, and Hardstand 7 has been, is, and will continue to be restricted by locked gates, fences, security personnel, topography, or all these combined. Therefore, human exposure is unlikely to occur. In addition, in 1988, 1996, and 2001, Eglin AFB conducted remedial activities to remove, contain, or both, the contamination that was formerly present at the Mullet Creek Drum Disposal Site (included within the Herbicide Exposure Unit) and Hardstand 7. Thus, if people had been exposed, the levels would be very low. These sites pose no public health hazard.

Even though trace concentrations of TCDD were detected in the subsurface soil at Upper Memorial Lake, people who have access to the area would have minimal contact with subsurface soils, since Eglin AFB has implemented land use controls to minimize exposure. Therefore, this site also poses no public health hazard.

- ***Herbicide Exposure Unit—C-52A Herbicide Test Grid (SS-25) and the Mullet Creek Drum Disposal Site (DP-09)***

Together, the C-52A Herbicide Test Grid and the Mullet Creek Drum Disposal Site are known as the Herbicide Exposure Unit. The sites are located in a rural area in the southeastern section of the Eglin Reservation, about 3 miles north of Choctawhatchee Bay and 8 miles east of Niceville, Florida, see Figure 2 (Eglin AFB 2001a). The C-52A Herbicide Test Grid is located about 10,930 feet from the nearest base boundary. The Mullet Creek Drum Disposal Site is located about ½ mile west of the C-52A Herbicide Test Grid (about 10,230 feet from the nearest [i.e., southern] base boundary).

- From 1962 to 1970 the Air Force used the C-52A Herbicide Test Grid area to evaluate the effectiveness of different aerial spray patterns and spray equipment (Eglin AFB 2000c). Herbicides Orange, Purple, Blue, and White; fuel oil; and Malathion were the main test chemicals at this 1.25 square mile test grid, which is

subdivided into four subgrids (Eglin AFB 2000c, 2001). The Air Force detected herbicides, fuel oil, Malathion, and arsenic in the soils, sediments, surface water, and groundwater at this site (Eglin AFB 2000c). The site is currently used for training activities that require security, isolation, or both (e.g., missions using live munition) (Eglin AFB 2001a).

- Between the late 1960s and early 1970s, hardfill (e.g., plastics, drums, concrete, etc.) was disposed of in the Mullet Creek Drum Disposal Site (Eglin AFB 2000c). Pesticides, dioxins, chlorides, petroleum hydrocarbons, and heavy metals are the primary contaminants in the soil, sediment, surface water, and groundwater. In 1988, the Air Force removed 663 drums and about 120 cubic yards of debris from the site (Eglin AFB 2000c, 2001).

Access to the Herbicide Exposure Unit is extremely limited due to steep topography, dense vegetation, and locked gates. In addition, the area is highly controlled by security personnel who patrol the area (Eglin AFB 2001a). Therefore, there is, has been, and will continue to be minimal contact with contamination at the Herbicide Exposure Unit. The Air Force recommended No Further Investigation Required with land use controls to restrict exposure to the area (e.g., signs are posted to not disturb the surface soil).

- ***C-52A Aerial Overspray Area (AOC-24)***

The C-52A Aerial Overspray Area is in the vicinity of the Herbicide Exposure Unit. According to witnesses, when climatic conditions were not appropriate for aerial spraying at the Herbicide Exposure Unit, aircraft would spray the already-loaded herbicides in this area (Hutto 1990; Ray 1990 as cited in Engineering-Science 1993). How often this occurred and what amount of herbicides were sprayed is not known (Eglin AFB 2000c). Based upon evaluations of the soil, sediment, biota, and groundwater, TCDD and arsenic in the soil are the primary contaminants (Engineering-Science 1993). Like the Herbicide Exposure Unit, access to this area is also controlled and well patrolled by security personnel (Engineering-Science 1993). Therefore, there is, has been, and will continue to be minimal contact with contamination at this site. In 1998 and 1999, No Further Action was approved by FDEP and EPA, respectively (Eglin AFB 2000c).

- ***Upper Memorial Lake (LF-51)***

Upper Memorial Lake is located on Eglin Main Base south of the east-west runway. A site north of the lake was identified as a former burial area used to dispose of herbicide drums, many of which were empty (Engineering-Science 1993). However, trace concentrations of TCDD were detected in the subsurface soil (Engineering-Science 1993). Recreational facilities are located nearby and base personnel and their families have easy access to the area (ES 1990b as cited in Engineering-Science 1993). However, herbicides were not detected in the surface soil and Eglin

AFB has implemented land use controls (e.g., signs are posted and a layer of clean soil was placed over the site) and erosion control measures to lessen any potential for exposure to herbicides (personal communication with Eglin AFB personnel, October 2002). Therefore, there is, has been, and will continue to be minimal contact with contamination at this site.

- ***Hardstand 7 (SS-26)***

Hardstand 7 is a concrete and asphalt aircraft parking and loading area located west of the north-south runway on Eglin Main Base, see Figure 2 (Eglin AFB 2000c; Engineering & Services Laboratory 1987). About 7,300 feet separate the site from the nearest non-base residence (on the southern side of Tom's Bayou). The site is about 130 feet in diameter with a 15-foot deep pit near the center of the concrete pad. Hardstand 7 was used to store herbicide drums and to transfer herbicides to the aircraft used to evaluate the effectiveness of different aerial spray patterns and spray equipment on the C-52A Herbicide Test Grid (Eglin AFB 2000c). Since 1970, the Air Force has conducted several site investigations to characterize the soil, water quality, and biota in the vicinity of Hardstand 7. Herbicides and dioxins in the soil, sediment, surface water, and groundwater are the primary contaminants at this site (Eglin AFB 2000c).

In 1985, the site was secured with a chain-link fence and locked gates, and signs were posted to prevent trespassing and fishing (Eglin AFB 2000c). In addition, because of its close proximity to active runways, the area is closely guarded (Earth Tech 2001c). In 1996, the Air Force conducted interim corrective measures at Hardstand 7, including embankment stabilization, drum excavation, and drain pit excavation. In 2001, the Air Force installed three erosion control structures to reduce erosion around the hardstand and to minimize storm water run-off into Hardstand Pond. In addition, an asphalt cap was installed over contaminated areas of Handstand 7 and the existing storm water pipe was checked for blockage and integrity (Eglin AFB 2002). Therefore, there was, is, and will continue to be minimal contact with contamination at Hardstand 7.

The current status of Hardstand 7 is that a Statement of Basis is in draft form. A Statement of Basis is the RCRA version of the Record Decision Document required in CERCLA clean ups. The Statement of Basis proposes that the site be maintained in its present condition with land use controls maintained permanently (personal communication with Eglin AFB personnel, July 2002).

E. Concern: Radioactive Contamination

To address this concern, ATSDR reviewed information characterizing the nature and extent of contamination and the potential for human exposure at four areas with past and/or present radioactive contamination: the Isotope Burial Area (AOC-63)/C-74 Sled Track Burial Area

(AOC-67), Test Area C-64 (RW-40), Test Area C-74L (RW-41), and the Low-level Radioactive Waste Site/Drum Burial (RW-42). See Figure 2 for site locations.

ATSDR determined that human exposure to radioactive contamination at levels of health concern is unlikely at the Isotope Burial Area/C-74 Sled Track Burial Area, Test Area C-64, and Test Area C-74L. This is because access to the sites is restricted by locked gates, fences or barbed wire, security guards, or all of these. Moreover, remedial activities have removed or lessened radiation that was once present. Therefore, no past, present, or future public health hazard exists.

ATSDR determined that the Low-level Radioactive Waste Site/Drum Burial site poses no public health hazard. There was no indication of radioactive contamination or levels of radiation in excess of local and regional background levels. Although access is restricted, the Low-level Radioactive Waste Site is not fenced and trespassing by boat from the Gulf of Mexico or Santa Rosa Sound could occur. However, trespassers would not be expected to be exposed to levels of radioactive contamination that would cause harmful health effects.

- ***Isotope Burial Area (AOC-63) and C-74 Sled Track Burial Area (AOC-67)***

AOC-63 and AOC-67 are considered one site. This inactive burial area is located north of the C-74 Complex, near a 2,000-foot sled track in an isolated area of the base where access was, is, and will continue to be restricted (see Figure 2). The site is fenced and locked with a sign posted to warn people that this is a controlled area. It is located about 15,200 feet (roughly 2¾ miles) from the nearest base boundary (Eglin AFB 2001b). Because this site is in a remote location and is not accessible to people, human exposure is minimal.

The burial area was created in 1960 to dispose of Zinc 65, which was used on bullets during a test project. Reportedly, a small quantity of Zinc 65 was buried at the site as late as the early 1970s (Eglin AFB 2000c). Zinc 65 has a half-life (see text box for definition) of 244 days and decays to a non-radioactive form of copper. Over 30 years has passed since Zinc 65 was disposed of in the burial area; therefore, Zinc 65 would have decayed through approximately 45 half-lives and would no longer be detectable in the burial site. Even if migration from the burial pit occurred, the Zinc 65 would no longer be present. An investigation in the early 1990s monitored for radiation and concluded that there was no radiation hazard (Eglin AFB 2000c). The AOC files are closed and a determination of No Further Action has been approved by the regulatory authorities.

> The amount of time required for ½ of the atoms of a radionuclide to decay is called its radioactive half-life.

Because there is minimal human exposure, no detectable radiation present above background levels, and the Zinc 65 has totally decayed, ATSDR does not expect that past, present, or future

public health hazards occurred, are occurring, or will occur from exposure to radiation at the Isotope Burial Area/C-74 Sled Track Burial Area.

- ***Depleted Uranium Site, Test Area C-64 (RW-40)—also known as the High Explosives Test Area***

Test Area C-64 is about 14 miles northeast of Eglin Main Base in the northeastern section of the Eglin Reservation, see Figure 2 (Earth Tech 2001d). The nearest base boundary is about 16,700 feet (roughly 3 miles) from the site (Eglin AFB 2001b). Since 1968 the site has been used for small-scale explosive tests, drop tests, bullet impact tests, and DU ammunition tests (Earth Tech 2001d; Eglin AFB 2000c). The site is currently fenced and locked to prevent access, with a sign posted to warn people that this is a controlled area. Therefore, people were not and are not expected to come in contact with radioactive contamination present at this site.

Test Area C-64 is part of an ongoing base-wide radiological survey with quarterly monitoring of the groundwater, soil, and runoff. This has been done since operations began (Eglin AFB 2000c). Uranium in soil and surface water has been the primary radiological material detected at this area (Eglin AFB 2000c). Several samples showed levels of uranium exceeding background levels; but, the overall trend in Test Area 64 has shown the uranium in soils to be below regulatory concern. The Air Force removed depleted uranium fragments in 1999, and 24 cubic feet of depleted uranium-contaminated soil in 2000 (Earth Tech 2001d; Eglin AFB 2000c). No Further Investigative Action is recommended for the site. Land use controls will, however, be implemented to limit the future use of Test Area C-64 to industrial activities (Earth Tech 2000b).

Public access is and has been restricted and remedial activities recently removed contamination. Therefore, it is not expected that past, present, or future public health hazards occurred, are occurring, or will occur from exposure to DU at Test Area C-64.

- ***Depleted Uranium Site, Test Area C-74L (RW-41)***

Test Area C-74L is in the northeastern section of Eglin AFB in an isolated area where access is restricted, see Figure 2. The test area is fenced and locked with a sign posted to warn people that this is a controlled area. The site is located about 18,000 feet (roughly 3½ miles) from the nearest base boundary (North to I-10 boundary). From the mid to late 1970s, a 3-acre area within Test Area C-74L was used to test penetrating munitions containing DU, resulting in contaminated soil and surface water (Eglin AFB 2000c).

Test Area C-74L is part of an ongoing base-wide radiological survey with regular radionuclide monitoring in the soil and runoff. The results of the analyses have been below regulatory concern (Eglin AFB 2000c). In 1980, the Air Force removed soil contaminated with DU and, in 1999,

removed and disposed of uranium penetrator fragments off site (Eglin AFB 2000c). Because some soils are still contaminated with DU, additional excavation has been recommended.

Because DU-contaminated soil remains at the site, public access has been and continues to be restricted; hence, people are not coming in contact with the remaining contamination. Therefore, it is not expected that past, present, or future public health hazards occurred, are occurring, or will occur from exposure to DU at Test Area C-74L.

- ***Low-level Radioactive Waste Site/Drum Burial (RW-42)***

The Low-level Radioactive Waste Site is located near the center of Santa Rosa Island, west of the A-15 compound, see Figure 2 (CH2MHILL 2000). The site is located about 7,000 feet (across the Santa Rosa Sound) from the nearest base boundary. The site was used to dispose of missile fragments, metallic wastes, 55-gallon drums, and batteries (Eglin AFB 2000c). Inorganic compounds and dieldrin are the primary contaminants detected at the site. In 1993, 1995, and 1999 surface and radioactive debris, missile fragments, drums, and petroleum-contaminated soils were removed from the site, and the site has been recommended for No Further Action (CH2MHILL 2000; Eglin AFB 2000c).

Access to the site is highly restricted—it is located on Santa Rosa Island about 12 miles west of the main access road where an armed guard and barbed wire prohibit entrance to unauthorized personnel (Eglin AFB 2000b). Nevertheless, although no trespassing signs are posted on the property, there are no fences to prevent people from entering the area by boat from the Gulf of Mexico or the Santa Rosa Sound (O'Brien & Gere Engineers 1997).

The site also contains wastes associated with a BOMARC missile which contained a magnesium-thorium alloy. Thorium is a naturally occurring radioactive element; but, the radiation levels associated with thorium are very low and the health threat is only from ingestion or inhalation of thorium. After an intensive search and retrieval program in 1993, the Air Force located many of the magnesium-thorium components, packaged them in approved shipping containers, and shipped them off site (Rust Remedial Services 1993). Although not all the components were found, radiological sampling indicates that migration of the radiological components did not occur, nor is it expected to occur in the future.

Even though this site is not fenced and people could trespass onto the property by boat from the Gulf of Mexico or the Santa Rosa Sound, trespassers would not be expected to be exposed to levels of contamination for a long time nor on a regular basis. Therefore, because exposure is possible, but the frequency and duration is minimal, exposure to radioactive contamination at the Low-level Radioactive Waste site poses no past, present, or future public health hazard.

III. Community Concerns

A. Community Concerns Regarding Herbicide Orange

What is Herbicide Orange?

Herbicide Orange (also known as Agent Orange) is a 50:50 mixture of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) (HSDB 2002a, 2002b). It is a reddish-brown to tan colored liquid, and was named after the orange stripe on the 55-gallon drum in which it was stored. Herbicide Orange was sprayed from airplanes, helicopters, trucks, and backpacks in Vietnam from 1965 to 1970 to kill unwanted plants and remove leaves from trees (VA 2001, 2002). Use of 2, 4, 5-T is currently restricted in the United States (ATSDR 1998).

During the manufacturing process of 2,4,5-T, a contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) was produced in small quantities (ATSDR 1998). Many of the health effects resulting from exposure to Herbicide Orange are attributed to the presence of this contaminant. Many effects have been observed in animals following exposure to TCDD, and this contaminant is considered more toxic than the pure components of the herbicides used in Vietnam (NAS 2000).

How are people exposed to Herbicide Orange?

Workers who were involved with the manufacture of Herbicide Orange were exposed through breathing contaminated air or through skin contact. To a lesser extent, workers who handled and applied Herbicide Orange were also exposed (ATSDR 1998). Vietnam veterans who were directly involved in the aerial spraying of Herbicide Orange as part of Operation Ranch Hand and veterans in the Army Chemical Corps (responsible for mixing, storing, and applying Herbicide Orange) are the two primary groups with increased Herbicide Orange exposure. However, despite many years of effort, researchers have been frustrated by a lack of useful exposure data (VA 2002). In other words, they do not know how much Herbicide Orange the veterans were exposed to and how long the exposure lasted.

What health effects could result from exposure to Herbicide Orange?

The National Academy of Science's Institute of Medicine concluded that there is sufficient evidence[8] of an association between the following health outcomes and exposure to *herbicides*

[8]Sufficient evidence means that the evidence is sufficient to conclude that there is a positive association (i.e., a positive association has been observed between herbicides and the outcome in studies in which chance, bias, and confounding could be ruled out with reasonable confidence).

(not specifically Herbicide Orange): chloracne, soft tissue sarcoma, non-Hodgkin's Lymphoma, and Hodgkin's Disease (NAS 2000 as cited in VA 2002). The Department of Veterans Affairs recognizes the following conditions as associated with (but not necessary caused by) Herbicide Orange exposure: chloracne, porphyria cutanea tarda, acute or subacute peripheral neuropathy, type 2 diabetes, and certain cancers (VA 2001).

How was Herbicide Orange used at Eglin AFB?

Several locations on Eglin AFB were used for the distribution, loading, storage, and disposal of herbicides; primarily to test different applications and the effectiveness of herbicides used as defoliants during the Vietnam Conflict (Engineering-Science 1993):

- Herbicide Orange was sprayed at the Herbicide Exposure Unit (SS-25/DP-09) from 1962 to 1970, to evaluate the effectiveness of different aerial spray patterns and spray equipment (Eglin AFB 2000c). Approximately 21,201 gallons of Herbicide Orange were sprayed during these activities (Hunter 1971 as cited in Engineering-Science 1990).

- When climatic conditions were not appropriate for aerial spraying at the Herbicide Exposure Unit from 1962 to 1970, aircraft would spray the already-loaded herbicides in the C-52A Aerial Overspray Area (AOC-24) (Hutto 1990; Ray 1990 as cited in Engineering-Science 1993).

- During one test project in the 1960s, the Army was evaluating the effectiveness of using helicopters to spray herbicides. The helicopters were loaded with herbicides at Field No. 2 (AOC-55) and then flown to the Herbicide Exposure Unit for testing (Engineering-Science 1993).

- Herbicide Orange was stored and transferred at Hardstand 7 from 1962 to 1970 (Eglin AFB 2000c).

- In 1980, dioxin-contaminated soil from Hardstand 7 (SS-26) was temporarily stored at the Receiver Area Landfill (LF-08) (Engineering-Science 1993). The soil was removed and spread out over the C-52A test grid (Hartman 1990 as cited in Engineering-Science 1993).

- Herbicides were buried in drums at Field No. 2 (DP-11) during the 1960's and 1970's (Eglin AFB 2000c; Engineering-Science 1993). Herbicides were also buried in drums in a clearing north of Upper Memorial Lake (LF-51)-time frame unknown. Prior to 1981, the drums were removed from Field No. 2 and disposed of at an unknown location (Eglin AFB 2000c; Engineering-Science 1993). In 1998, erosion control and habitat restoration were implemented at Upper Memorial Lake (Eglin AFB 2000c). In addition, the proposed

Statement of Basis recommended three years of sediment sampling and land use controls (Eglin AFB 2000c).

In 1992, the Air Force conducted a base-wide investigation into all known and suspected Herbicide Orange locations at Eglin AFB (Engineering-Science 1993). Eleven sites were identified for further investigation: C-52A Test Grid (SS-25), Mullet Creek Drum Disposal Site (DP-09), C-52A Aerial Overspray Area (AOC-24), Hardstand 7 (SS-26), Receiver Landfill (LF-08), Upper Memorial Lake (LF-51), 3 sites at Lower Memorial Lake (AOC-81), Field No. 2 Drum Disposal (DP-11), and Field No. 2 Helicopter Loading Area (AOC-55). At seven sites (Mullet Creek Drum Disposal Site, Receiver Area Landfill, 3 sites at Lower Memorial Lake, Field No. 2 Drum Disposal, and Field No. 2 Helicopter Loading Area) herbicide contamination was not detected. Further investigation was recommended for three sites (C-52A Test Grid, C-52A Aerial Overspray Area, and Upper Memorial Lake), and remedial actions were recommended for Hardstand 7 (Engineering-Science 1993). These four sites are described in more detail in the Herbicide Concern discussion, within Section II of the PHA.

Have community members been exposed to Herbicide Orange from Eglin AFB?

No, community members do not have access to areas on Eglin AFB where Herbicide Orange was tested or stored. Therefore, the only way for community members to be exposed to Herbicide Orange would be if it were transported through the air or through surface waters to places where people live or engage in recreational activities.

- Community members may have been exposed to Herbicide Orange when the Air Force tested the effectiveness of different aerial spray patterns and spray equipment at the Herbicide Exposure Unit. To evaluate this concern, ATSDR used a model to determine whether the community was exposed to harmful levels of Herbicide Orange (evaluated as its components—2,4-D, 2,4,5-T, and TCDD) in the air. The results indicate that any levels of Herbicide Orange the community might have been exposed to were too low to be of health concern. The upper-bound estimates of annual average air concentrations at the base boundary were 0.78 $\mu g/m^3$ for 2,4-D and 0.76 $\mu g/m^3$ for 2,4,5-T, both lower than EPA's health-based comparison value of 37 $\mu g/m^3$, lower than levels that cause adverse health effects (see Table B-1). The estimated inhalation doses for TCDD (6.6×10^{-9} µg/kg/day for adults and 1.4×10^{-8} µg/kg/day for children) were *thousands* of times lower than the most protective dose (1.2×10^{-4} µg/kg/day) in ATSDR's toxicological profile for chlorinated dibenzo-p-dioxins (ATSDR 1998). For more details about this pathway please see the Air Contamination discussion within Section II of the PHA and Appendix B.

- ATSDR also used a model to determine whether harmful levels of Herbicide Orange would be released to the air from the soil during a prescribed burn or wildfire. To

evaluate this exposure scenario, ATSDR considered whether wildfires near the Herbicide Exposure Unit could release trace amounts of soil contaminants (2,4-D, 2,4,5-T, and TCDD) to the air. 2,4-D was not detected in the soil at the Herbicide Exposure Unit (EA Engineering, Science, and Technology 1997). 2,4,5-T was only detected once at a concentration of 0.03 ppm. This would result in an estimated 24-hour average ambient air concentration of 0.03 $\mu g/m^3$ at off-site locations, well below EPA's health-based comparison value of 37 $\mu g/m^3$ and unlikely to cause adverse health effects (EA Engineering, Science, and Technology 1997; EPA 2002). The estimated inhalation doses for TCDD (5.3×10^{-6} µg/kg/day for adults and 1.1×10^{-5} µg/kg/day for children[9]) were below the most protective comparative dose (1.2×10^{-4} µg/kg/day) in ATSDR's toxicological profile for chlorinated dibenzo-p-dioxins (ATSDR 1998). Therefore, ATSDR concluded that soil contaminants that might be released are not expected to reach harmful levels at off-base locations. For more details about this pathway please see the Air Contamination discussion within Section II of the PHA and Appendix B.

- Herbicide Orange was tested, stored, or distributed at several sites located near surface water bodies at Eglin AFB. Mullet, Trout, and Basin Creeks receive surface water runoff from the Herbicide Exposure Unit and the C-52A Aerial Overspray Area. Tom's Bayou could potentially receive herbicide contamination from Hardstand 7. Community members could be exposed to components of Herbicide Orange in the areas of Mullet, Trout, and Basin Creeks that are open to seasonal recreational activities and when engaging in recreational activities in Tom's Bayou. However, ATSDR evaluated the available data for these surface water bodies and determined that community members were not exposed to harmful levels of Herbicide Orange (evaluated as its components—2,4-D, 2,4,5-T, and TCDD).

  - Concentrations of TCDD, 2,4-D, and 2,4,5-T in Mullet, Trout, and Basin Creeks were not detected above ATSDR's comparison values. In fact, most of the samples did not contain herbicides or TCDD (EA Engineering, Science, and Technology 1997; Engineering-Science 1993). As explained in Appendix C, concentrations detected at or below ATSDR's comparison values would not warrant health concern.

  - TCDD in surface water and 2,4-D and 2,4,5-T in surface water and sediment were not detected above ATSDR's comparison values in Tom's Bayou (Eglin AFB 1994; Harrison et al. 1979). The estimated doses (adult: 1.2×10^{-9} mg/kg/day and child: 1.0×10^{-8} mg/kg/day) resulting from exposure to the maximum

[9]The estimated exposure doses were calculated using the maximum soil concentration for the sum of all dioxin compounds using the formula D = [C x IR x EF]/[BW] (see Appendix B for more details).

concentration of TCDD in sediment near Hardstand 7, which potentially drains into Tom's Bayou, are lower than ATSDR's health effects level of 1.2×10^{-7} mg/kg/day. For more details about this pathway please see the Surface Water Contamination discussion within Section II of the PHA and Appendix C.

In conclusion, even though Herbicide Orange was, and still is, present at Eglin AFB, community members were not in the past, are not currently, and are not expected to be in the future exposed to levels of Herbicide Orange that would cause harmful health effects.

B. General Community Concerns

Could chemicals from Eglin AFB cause cancer in community members living near and using Tom's Bayou for recreational activities?

No. ATSDR did not find contaminant levels in the exposure situations evaluated that would be associated with high cancer rates or any other adverse health effect. To provide some perspective on the actual incidence rate for the county, ATSDR contacted the Florida Cancer Data System and requested cancer statistics (specifically, Hodgkin's Lymphoma) for the entire state of Florida and Okaloosa County, the county in which Tom's Bayou is located. The age-adjusted cancer incidence for Okaloosa County (2.1) was lower than that for the state of Florida (2.6).

Should I be concerned about exposure to radionuclides if I consume venison caught in the vicinity of the Eglin Reservation?

No. Although 65% of the base is open to the public for various recreational activities such as hunting, information about the levels of radionuclide contamination in deer or other game animals has not been collected in the area of Eglin. The DU used at the base is generally in the form of an oxide, which is not readily soluble in water nor easily absorbed by plants, animals, or humans. The DU could, however, adhere to soil particles and thus move through the environment. Nonetheless, plants do not readily absorb uranium. Studies suggest that the typical uptake is on the order of 1% or less (Eisenbud and Gesell 1997). If deer ate plants that contained DU, ATSDR estimates that the deer would absorb about 2% of the ingested uranium through their gastrointestinal system. The DU absorbed would be stored in the organs (kidney, liver, and bone) with little (based on laboratory animal studies) in the soft tissues a few days after intake. Similarly, if humans ingested venison that had previously ingested DU, the humans would only absorb 2% of the DU in the venison (less than 0.04% of the amount in the plants and less than 0.0004% of the concentration in soils). Therefore, ATSDR considers the venison caught in the vicinity of the Eglin Reservation safe to eat.

Could biological agents tested or researched at Eglin still be active given the treatment and disposal conditions and could a release of agents have occurred given the abrupt termination of that project?

ATSDR accompanied a biological agent expert from the Centers for Disease Control and Prevention to Eglin on December 17, 2002 to review documents classified and unclassified documents and to provide an opinion on some biological events that occurred intermittently from the 1950s through the 1960s on the airbase. This review was to determine the extent to which any purported release of biological agents would have impacted the surrounding community and if a health threat remained from early test activities. The review consisted of both classified and unclassified documents indicating that biological agents had, indeed, been evaluated on site in the mid-1950's and 1960's.

The classified documents reviewed showed that biological agents tested or researched at Eglin were not released and were destroyed after use so the potential for adverse health impacts on any surrounding communities resulting from the biological work at Eglin is negligible. Agents present at Eglin during this period were not developed or manufactured on base, nor did manipulation or research into whether the biological agents could cause disease take place. Any tests using human biological agents were done in sealed containers and those containers were adequately disinfected and sterilized to destroy all agents. Any tests using non-human biological agents were conducted in a localized area on base that was thoroughly disinfected at the end of the tests.

Biological agent - "Living organisms, or the materials derived from them, that cause disease in, or harm, humans, animals, or plants, or cause deterioration of material."

Simulant - "A chemical that appears and acts like an agent."

C. Public Comments Received During the Public Comment Period

Comment 1

Such vocabulary as "might, should, assumptions, and not expected" leads the reader to question the validity of the conclusions. It makes the reader feel that the degree of confidence with regard to the study's conclusions is rather low.

ATSDR has used the most recent up-to-date body of scientific evidence on which to make conclusions about the contaminants found at Eglin and the off-base vicinity. This information is used to discuss the public health implications of coming in contact with those chemical at the levels detected.

Our knowledge about how hazardous substances interact with the human body is science-based, and it has been obtained from a variety of sources. Such sources include (a) studies of populations who have been exposed to a substance or substances to define and understand short- and long-term health effects and (b) drawing conclusions, on the basis of animal studies and other research, about the possible effects of human exposure to hazardous substances. The medical and scientific communities use this information to identify the general levels of exposure at which a health effect might be seen.

It is important, however, to keep in mind that a number of factors are involved in human health. For example, each individual has a unique genetic makeup, a different overall health status, and different levels and lengths of exposure to the substance over a lifetime. Therefore, we cannot be 100% certain that a given person exposed to a certain substance will have a specific health outcome. Consequently, we must qualify our language to account for the unique characteristics of each human being and the unknown factors associated with exposures.

Also, our scientific judgments are influenced by the number of human and animal studies available on any specific toxicant, which varies, as well as by the quality of such studies, which also varies. We are more definitive when we have many studies that are well designed. We are more tentative when we have fewer and/or poorer quality studies.

With regards to Agent Orange - or Herbicide Orange, there have been many studies on the health effects since the Vietnam war. Human exposure to levels much greater than was possible at Eglin have not been shown to cause lymphomas (Hodgkin's or non-Hodgkin's).

Comment 2

The age-adjusted cancer incidence for Okaloosa County (2.1) was lower than that for the state of Florida (2.6). The question is not about the incidence of cancer for Okaloosa County, but rather, the incidence of cancer for Tom's Bayou residents.

A review of the cancer incidence for any given area is an epidemiological evaluation involving statistics. Because of this limitation, conclusions are more definitive when there are larger numbers of people included. The state of Florida maintains the cancer registry information. Because of the low population of the area around Eglin, the people living in Tom's Bayou are included in the cancer information for the whole county. The information is not available for the street or even the block level at this time. Therefore, we are limited by the information that is available. In this case, the information is based on people living near Eglin who may be exposed mixed with information of people who do not live near Eglin and are not exposed.

After our review of the areas that are contaminated on and off the Eglin AFB, and the ways in which people could come in contact with possible contaminants, ATSDR determined that levels of contaminants from Eglin that could have impacted the Tom's Bayou residents are not at levels that have been shown in scientific studies to cause adverse health effects.

Communities that are interested in collecting their own epidemiological information based on acceptable scientific protocol can use a survey designed for such a purpose. In this way, citizens can go door to door to survey all the residents in a particular area of concern. Information collected can then be evaluated. ATSDR will provide information about such an approach to the person who made this comment.

Comment 3

Herbicide Orange is extremely dangerous. The wording [below] sounds as if the author is dismissing the eye witness account of the community member in favor of the lack of Air Force documentation.

Not at all. The comments made by community members help ATSDR investigate areas often times not included in the military's environmental program, as is the case with this pond. However, the lack of documentation and inclusion in the environmental program limits the ability of ATSDR to evaluate laboratory data on contaminants and levels detected. Therefore, ATSDR must pull scientific information of environmental and human health impacts based on other areas that have been studied. Because this pond is not an area where people would have easy access and constant contact with possible contaminants present, any exposure to adults and children would be intermittent and infrequent. Thus, infrequent contact would mean that exposure would be less than people who worked with the chemicals on a daily basis. ATSDR used information based on worker exposures and accidental exposures to the highly concentrated

chemical mixture. We determined that exposures to the off-base residents who visited this pond would be much lower and infrequent than exposures of workers and thus not expected cause adverse health effects.

From the body of the public health assessment: "An unnamed pond near the North Gate of Eglin Main Base is in a remote area with limited accessibility (e.g., access roads are not maintained), about 2,000 feet from the nearest non-base resident (Eglin AFB 2001b). A community member was concerned that Herbicide Orange was present in the pond. About 20 years ago, the community member would ride a horse from the stable to the pond and reported seeing a sign that warned of Herbicide Orange contamination. The Air Force has no records of ever placing a sign at this unnamed pond and the sign is no longer present. There are no historical Air Force documents that indicate Herbicide Orange was ever present at this pond (personal communication with Eglin AFB personnel, April 2002).

If Herbicide Orange was present, people would need to have contact with either the surface water or sediment in the pond to be exposed (e.g., either through touching the water or sediment or drinking water from the pond). If people are not being exposed, no harmful health effects can occur. Currently, there is no fence surrounding the pond or preventing access to the pond. A private off-base riding stable in Valparaiso, Florida is about 450 to 600 feet from the unnamed pond. The area between the stable and the pond is currently filled with building rubble, which severely limits access to the pond.

This unnamed pond is not an ideal location for recreational activities (e.g., swimming). Therefore, it is unlikely that anyone actually had contact with potential contamination in the pond, even in the past when people reportedly rode their horses to it. Because access to the pond is currently limited, there is a low chance that anyone is or will be exposed to high levels of contamination for a long time and on a regular basis. Consequently, harmful health effects are not expected to occur."

IV. Children's Health Considerations

ATSDR recognizes that infants and children can be more sensitive to environmental exposure than adults in communities faced with contamination of their water, soil, air, or food. This sensitivity is a result of the following factors: 1) children are more likely to be exposed to certain media (e.g., soil or surface water) because they play and eat outdoors; 2) children are shorter than adults, which means that they can breathe dust, soil, and vapors close to the ground; and 3) children are smaller; therefore, childhood exposure results in higher doses of chemical exposure per body weight. Children can sustain permanent damage if these factors lead to toxic exposure during critical growth stages. As part of the ATSDR Child Health Initiative, ATSDR is committed to evaluating the special interests of children at sites such as Eglin AFB.

ATSDR evaluated the likelihood that children living near Eglin AFB could have been or could be exposed to contaminants at levels of health concern. *ATSDR did not identify long-term situations in which children were expected to be or have been exposed to chemical contaminants at levels that pose a health concern.* Short-term health effects are possible on rare occasions when winds blow smoke plumes from prescribed burns and wildfires directly toward residential neighborhoods. If, however, harmful health effects occur, they are typically reversible and subside after the fires are extinguished.

V. Conclusions

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

1. **Air Contamination Concern:** *It is not expected that in the past, present, or future, off-base residents could be exposed to air contaminants emitted from Eglin AFB often enough or in high enough doses to be of health concern from previous herbicide and pesticide spraying activities, current OB/OD operations, and a past structural fire at the C-6 Radar Facility.* These exposures pose no apparent public health hazard. ATSDR's category of no apparent public health hazard means that people could be or were exposed, but the level of exposure would not likely result in adverse health effects (see Appendix A for ATSDR's Conclusion Categories).

   Prescribed burning and wildfires could pose a past, present, and future public health hazard. Our findings indicate that the contaminants in soils (herbicides, including Herbicide Orange) would not reach off-base areas at levels associated with harmful health effects. Therefore, off-base residents would not come in contact with those contaminants. However, the burning of plant material causes a release of particles and natural chemicals (smoke) that could cause some short-term adverse health effects in those people exposed. Health effects could include burning, itching or watery eyes and sinuses, headache, nausea, breathing difficulty and asthma-like symptoms. Individuals highly sensitive to the effects would be anyone with previous respiratory conditions such as asthma or emphysema, children, and the elderly. But any health effects would only be of short duration, developing within a few days of exposure and lasting no more than 2 or 3 weeks after exposure stopped.

   ATSDR does not consider the presence of depleted uranium in soils to be a concern during either wildfires or prescribed burning in the area. Depleted uranium would not be an airborne contaminant from the burning of plant material since plants have a minimal uptake of uranium from soil.

2. **Surface Water Contamination Concern:** *It is not expected that in the past, present, or future, people could be exposed to contamination in surface water, sediment, or fish in Tom's Bayou; Weekly Pond; Pocosin Pond; Mullet, Trout, and Basin Creeks; and an unnamed pond near the North Gate of Eglin Main Base often enough or at high enough doses to be of health concern.* These surface water bodies pose no apparent public health hazard. Information on the unnamed pond near the North Gate could not confirm whether it might have contained Herbicide Orange.

3. **Groundwater Contamination Concern:** *It is not expected that in the past, present, or future, people could be exposed to groundwater contamination originating from the C-6 Radar Facility on Eglin AFB.* To ensure that the contamination from the C-6 Radar Facility does not migrate to areas where people are using groundwater wells, the Air Force conducts long-term monitoring of the groundwater at the site on an annual basis. This site poses no public health hazard.

4. **Herbicide Contamination Concern:** *It is not expected that in the past, present, or future, people could be exposed to herbicide contamination on Eglin AFB often enough or in high enough doses to be of health concern.* Human exposure is minimal because access to the Herbicide Exposure Unit (DP-09 and SS-25), the C-52A Aerial Overspray Area (AOC-24), and Hardstand 7 (SS-26) is restricted by locked gates, fences, security personnel, and topography. Therefore, there is a low chance that anyone would be exposed to herbicide contamination present at these sites. In addition, remedial activities have removed or contained, or both, the contamination that was formerly at Mullet Creek Drum Disposal Site (DP-09) and Hardstand 7. Therefore, these sites pose no past, present, or future public health hazards.

   Even though people have access to Upper Memorial Lake (LF-51), the nearby herbicide contamination was detected in the subsurface soil, and contact with subsurface soil would be minimal since Eglin AFB has implemented land use controls to minimize exposure. Therefore, this site poses no apparent public health hazard.

5. **Radioactive contamination Concern:** *It is not expected that in the past, present, or future, people could be exposed to radioactive contamination on Eglin AFB often enough or in high enough doses to be of health concern.* Human exposure is minimal because access to the Isotope Burial Area (AOC-63/AOC-67), Test Area C-64 (RW-40), and Test Area C-74L (RW-41) is restricted by locked gates, fences, and/or security guards. Therefore, it is not expected that community members would be exposed to radioactive contamination present at these sites. In addition, remedial activities have removed or reduced radioactive contamination that was once present. Thus, these sites pose no public health hazard.

   Although trespassing can occur at the Low-level Radioactive Waste Site (RW-42), the levels of radioactive contamination present are too low to be of health concern for this type of exposure (i.e., of short duration). Thus, this site poses no apparent public health hazard.

VI. Public Health Action Plan

The public health action plan for Eglin AFB contains a description of actions taken at the base and those to be taken at the base subsequent to the completion of this public health assessment. The purpose of the public health action plan is to ensure that this public health assessment not only identifies potential and ongoing public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to harmful substances in the environment. The following public health actions at Eglin AFB are completed, ongoing, planned, or recommended:

Completed Actions

- Eglin AFB has conducted remedial activities at Test Area C-64 (RW-40), Test Area C-74L (RW-41), the Low-level Radioactive Waste Site (RW-42), the Mullet Creek Drum Disposal Site (DP-09), Hardstand 7 (SS-26), Taxiway 9e Disposal Area (DP-96), Building 914 Disposal Area (DP-261), Aero Club/Building 68 (ST-64), Base Operations Generator Tank, Building 60 (ST-112), Hardstand 8 Alternate Loading Area (AOC-88), and Pocosin Pond (AOC-91).

Ongoing Actions

- Eglin AFB is conducting long-term groundwater monitoring at the C-6 Radar Facility (SS-85).

- Eglin AFB is working to identify on-base sites with low-level radioactive contamination.

Planned Actions

- Additional excavation is planned for Test Area C-74L (RW-41).

Recommended Actions

1. Despite the low risk of long-term health effects from exposure to smoke from prescribed burns, Eglin AFB should continue to notify residents, especially sensitive populations, when the prescribed burns are scheduled, so these individuals can take measures to reduce their short-term exposure.

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TABLES

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Range C-62 and Range C-52N	Open burning and open detonation operations	Air	Downwind residents ■ Inhalation	Off-base residents	Past, present, and future	These ranges are active and are not currently being investigated under the Installation Restoration Program (IRP).	All of the chemicals released to the air were below air quality standards; therefore, even though exposure is possible, there is no public health hazard.
Prescribed Burns	Prescribed burns on Eglin Reservation	Air	Downwind residents ■ Inhalation	Off-base residents	Past, present, and future	Prescribed burns are not currently being investigated under the IRP.	Even though Eglin AFB schedules its prescribed burns to minimize human impacts, unpredictable changes in wind patterns could blow plumes of potentially unhealthy smoke to residential areas on some occasions, which could result in short-term health effects. Therefore, there is a public health hazard for short-term effects.
Wildfires	Wildfires on Eglin Reservation	Air	Downwind residents ■ Inhalation	Off-base residents	Past, present, and future	Wildfires are not currently being investigated under the IRP.	Winds could occasionally blow plumes of potentially unhealthy smoke toward residential neighborhoods, which could result in short-term health effects. Therefore, there is a public health hazard for short-term effects.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
C-6 Radar Facility (SS-85)	In 1965, a fire destroyed the main building of the C-6 Radar Facility. The burned debris, including high voltage transformers and radar/surveillance equipment, might have been buried at the site.	Air	Downwind residents ■ Inhalation	Off-base residents	Past (1/5/65)	One person reported that the entire facility and contents were buried. A second person reported that only minimal inert debris were buried at the site.	The fire lasted only one day; therefore, inhalation exposures to contaminants were extremely short-lived and probably did not result in chronic health effects. Therefore, while exposure was possible, there is no public health hazard.
		Groundwater	None	None	None	The Air Force is conducting long-term groundwater monitoring.	Although contamination is present in the groundwater, it is not affecting the nearest downgradient wells. In addition, long-term groundwater monitoring will help ensure that the contamination does not migrate off base. Therefore, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Tom's Bayou	Surface water drainage from: DP-07, LF-08, SS-26, OT-29, SS-32, ST-64, DP-96, ST-112, DP-261, AOC-88, AOC-98, POI-324, POI-358, POI-390, POI-408, and POI-412	Surface water, sediment, and fish	People using Tom's Bayou	Residents who live around the bayou	Past, present, and future	Tom's Bayou is not currently being investigated under the IRP.	Even though contamination is present at sites on Eglin Main Base that are within the Tom's Bayou drainage basin, the levels detected are too low to be of health concern at these source areas. Therefore, even though exposure is possible, Tom's Bayou poses no public health hazard.
Weekly Pond	The source is most likely surface runoff from adjacent areas where pesticides and herbicides were applied (personal communication with Eglin AFB personnel, August 2002).	Fish	People who fished in Weekly Pond ■ Ingestion Since 1996 only catch-and-release fishing has been allowed in the pond.	People catching and eating fish in the past	Past (Prior to 1996)	Weekly Pond is not currently being investigated under the IRP.	Even though pesticides were detected in the fish, the levels detected were too low to be of health concern for anyone eating the fish; therefore, there is no past public health hazard. There is also no present or future public health hazards because people are not allowed to eat fish from Weekly Pond (i.e., no exposure).

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Pocosin Pond (AOC-91)	Depleted uranium (DU) ammunition were fired at a target located in the middle of the pond. In addition, Pocosin Pond receives surface water runoff from the area of the Cattle Dipping Vat (OT-83; formerly AOC-113).	Fish	None Fishing is not allowed in the pond.	None	None	No Further Action with current land use controls In 1998, the Air Force removed arsenic-contaminated soil and the concrete cattle dipping vat from OT-83.	People are not allowed to catch and eat fish from Pocosin Pond; therefore, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Pond near the North Gate of Eglin Main Base	Unknown; Herbicide Orange suspected	Surface water and sediment	People using the unnamed pond ■ Ingestion ■ Dermal contact The pond is located in a remote area with limited accessibility.	People who rode their horses to the pond	Past	This pond is not currently being investigated under the IRP.	Information on the unnamed pond could not confirm whether it might have contained Herbicide Orange. However, it is not expected that anyone could come in contact with Herbicide Orange often enough or in high enough doses to be a cause for health concern. Therefore, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Herbicide Exposure Unit—C-52A Herbicide Test Grid (SS-25) and the Mullet Creek Drum Disposal Site (DP-09)	Herbicides, Malathion, and fuel oil were used at SS-25 to evaluate the effectiveness of aerial spray patterns and spray equipment. DP-09 was used for hardfill (e.g., plastics, drums, concrete, etc) disposal.	Soil and groundwater	None The site has locked gates and security personnel who patrol the area.	None	None	No Further Action with land use controls In 1988, the Air Force removed drums and debris from DP-09.	Even though contamination is present at the site, public access is restricted; therefore, there is no public health hazard.
		Air	Downwind residents ■ Inhalation	Off-base residents	Past, present, and future	Same as above	Available data for the most extensive activities suggest that air concentrations did not reach unsafe levels at off-base locations; therefore, while exposure is possible, there is no public health hazard.
		Surface water, sediment, and fish	People using Mullet, Trout, and Basin Creeks ■ Ingestion ■ Dermal contact	Recreational users	Past, present, and future	Same as above	Even though contamination is present in the surface water, sediment, and fish, the levels detected are too low to be of health concern; therefore, while exposure is possible, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
C-52A Aerial Overspray Area (AOC-24)	Herbicides were sprayed at AOC-24 when climatic conditions were not appropriate for testing at the Herbicide Exposure Unit.	Soil and groundwater	None Access is restricted.	None	None	No Further Action/ AOC file closed	Even though contamination is present at the site, public access is restricted; therefore, there is no public health hazard.
		Air	Downwind residents ■ Inhalation	Off-base residents	Past, present, and future	Same as above	Available data for the most extensive spraying activities (conducted at the Herbicide Exposure Unit) suggest that air concentrations did not reach unsafe levels at off-base locations; therefore, while exposure is possible, there is no public health hazard.
		Surface water, sediment, and fish	People using Mullet, Trout, and Basin Creeks ■ Ingestion ■ Dermal contact	Recreational users	Past, present, and future	Same as above	Even though contamination is present in the surface water, sediment, and fish, the levels detected are too low to be of health concern; therefore, while exposare is possible, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Upper Memorial Lake (LF-51)	Herbicide drums were buried at a site north of Upper Memorial Lake.	Soil	People using Upper Memorial Lake ■ Ingestion ■ Dermal contact	On-base personnel and their families	Past, present, and future	Sediment sampling and land use controls The Air Force posted signs, placed a layer of clean soil over the site, implemented erosion control measures, prevents residential development, annually monitors sediment quality, and quarterly inspects the site.	Even though contamination is present in the subsurface soil at this site, people who have access to the area would have minimal contact with subsurface soils, since Eglin AFB has implemented land use controls to minimize exposure. Therefore, there is no public health hazard.
		Fish	None Only catch-and-release fishing is allowed.	None	None	Same as above	People are not allowed to catch and eat fish from Upper Memorial Lake; therefore, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Hardstand 7 (SS-26)	The site was used to store herbicide drums and to transfer herbicides to aircrafts.	Soil, surface water, sediment, and groundwater	None The site is fenced, locked, has signs posted, and is closely guarded.	None	None	A draft Statement of Basis proposes that the site be maintained in its current condition with land use controls. In 1996, the Air Force stabilized the embankment and excavated drums and the drain pit. In 2001, the Air Force installed erosion control structures and an asphalt cap.	Remedial activities limited contaminant exposure/migration and public access is restricted; therefore, there is no public health hazard.
Isotope Burial Area (AOC-63) and C-74 Sled Track Burial Area (AOC-67)	Zinc 65 on bullets was buried at the site from 1960 to the early 1970s.	Soil	None The site is fenced and locked with signs posted.	None	None	No Further Action/ AOC files closed	No Zinc 65 remains at the site and public access is restricted; therefore, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Test Area C-64 (RW-40)	DU from small-scale explosive tests, drop tests, bullet impact tests, and DU ammunition tests	Soil and surface water	None The site is fenced and locked with signs posted.	None	None	No Further Investigative Action with land use controls In 1999, the Air Force removed DU fragments. In 2000, the Air Force removed soil contaminated with DU.	Remedial activities removed DU fragments and soil contaminated with DU. In addition, public access is restricted; therefore, there is no public health hazard.
Test Area C-74L (RW-41)	Testing of DU munitions	Soil and surface water	None The site is fenced and locked with signs posted.	None	None	Additional excavation is recommended. In 1980, the Air Force removed soil contaminated with DU and in 1999, they removed uranium penetrator fragments.	Although remedial activities removed uranium penetrator fragments and some soil contaminated with DU, additional radioactive contamination still exists. Because, however, public access is restricted, there is no public health hazard.

Table 1
Evaluation of Potential Exposure Pathways at Eglin AFB (continued)

Site Name/ Event	Exposure Pathway Elements					Status/Remedial Activities	Comments
	Source of Contamination	Environmental Media	Point of Exposure/ Route of Exposure	Exposed Population	Time of Exposure		
Low-level Radioactive Waste Site (RW-42)	The site was used to dispose of missile fragments, metallic wastes, 55-gallon drums, and batteries.	Soil and groundwater	Access to the site is highly restricted at the main access road where an armed guard and barbed wire prohibit entrance. Because, however, there are no fences surrounding the site, people can trespass onto the island by boat. ■ Ingestion ■ Dermal contact	People who trespass	Past, present, and future	No Further Action In 1993, the Air Force removed surface debris. In 1995, they removed stained soil and in 1999, they removed additional soil.	Public access is restricted at this site. Although trespassing can occur, the levels of radioactive contamination present are too low to be of health concern for this type of exposure (low probability, frequency, and duration). Therefore, there is no public health hazard.

Table 2
IRP Sites Evaluated for Potentially Contributing Contamination to Tom's Bayou

Site Name	Description	Nature of Contaminants	Status/Remedial Activities
		Group 1 Sites	
LF-08 Receiver Area Landfill	This site was an active landfill from the late 1960s to the late 1970s. The landfill was closed by covering it with several feet of soil. Debris known and suspected of being dumped include tires, wire, spools, mattresses, concrete, asbestos insulation, polychlorinated biphenyl (PCB) transformers, electrical components, paint shop residues, aqueous film-forming foam, waste fuel and oils, solvents, septic tank pumpings, federal prison garbage, pesticides, and pesticide containers. The landfill also serves as a storage and venting area for petroleum-contaminated soil, which is placed on three cured 10,000-ft^2 concrete pads.	Inorganics were identified as the primary contaminants in surface water, groundwater, and sediments; and volatile organics were identified as the primary contaminants in sediments.	The Air Force concluded that this site has had no significant effect on human health or the environment. A re-evaluation of analytical sediment results concluded that the sediment contaminants were not emanating from the former landfill. The sediment issue was referred to the Environmental Compliance Division for management under Eglin's Storm Water Management Program.
DP-07 A-19 Drum Disposal Site	The site was used during the 1960s and 1970s to dispose of hardfill and demolition debris (e.g., concrete rubble, scrap metal, asphalt, wood scraps, 55-gallon drums, empty fuel oil drums, and drums potentially containing waste fuels and solvents).	Pesticides and petroleum hydrocarbons were identified as the primary contaminants in soils; and dichlorodiphenyltrichloroethane (DDT), total lead, and cyanide were identified as the primary contaminants in surface water.	No Further Action was approved for the site.
DP-96 Taxiway 9e Disposal Area	This site was used as an unauthorized dumping area.	Inorganics, synthetic organic compounds, and pesticides were identified as the primary contaminants in soil, sediment, and surface water.	In 1998, the Air Force removed metallic and large surface debris (e.g., concrete rubble, empty 55-gallon drums, scrap metal) from the site.

Table 2
IRP Sites Evaluated for Potentially Contributing Contamination to Tom's Bayou (continued)

Site Name	Description	Nature of Contaminants	Status/Remedial Activities
ST-64 Aero Club/Building 68	The site consists of an aircraft fueling area and parking apron. Petroleum products were discovered in the soil when a former 6,000-gallon steel underground storage tank (UST) was excavated in 1991.	Petroleum products were identified as the primary contaminants in soil.	The Air Force excavated the excessively contaminated soil. The site was approved for No Further Action by the Florida Department of Environmental Protection (FDEP).
ST-112 Base Operations Generator Tank, Building 60	A 500-gallon UST was discovered in 1997 to be leaking diesel fuel.	Volatile organic compounds and other petroleum by-products were identified as the primary contaminants in soil.	The Air Force removed the UST and excessively contaminated soil. The site was approved for No Further Action by FDEP.
POI-324 First Baptist Church of Valparaiso/Napalm Site	In 1967, a napalm bomb was accidentally released near the First Baptist Church. While the bomb did not explode, some napalm leaked from the bomb.	None	The bomb and napalm were immediately removed, thus any remaining contamination would have quickly biodegraded. The US Environmental Protection Agency (EPA) and FDEP concur with No Further Action.
POI-390 Transmission Building Site	Steam was reported to rise from an area of stressed vegetation behind the building. An investigation of personnel and building and utility drawings found no past disposal practices or underground structures.	None	EPA and FDEP approved No Further Action.

Table 2
IRP Sites Evaluated for Potentially Contributing Contamination to Tom's Bayou (continued)

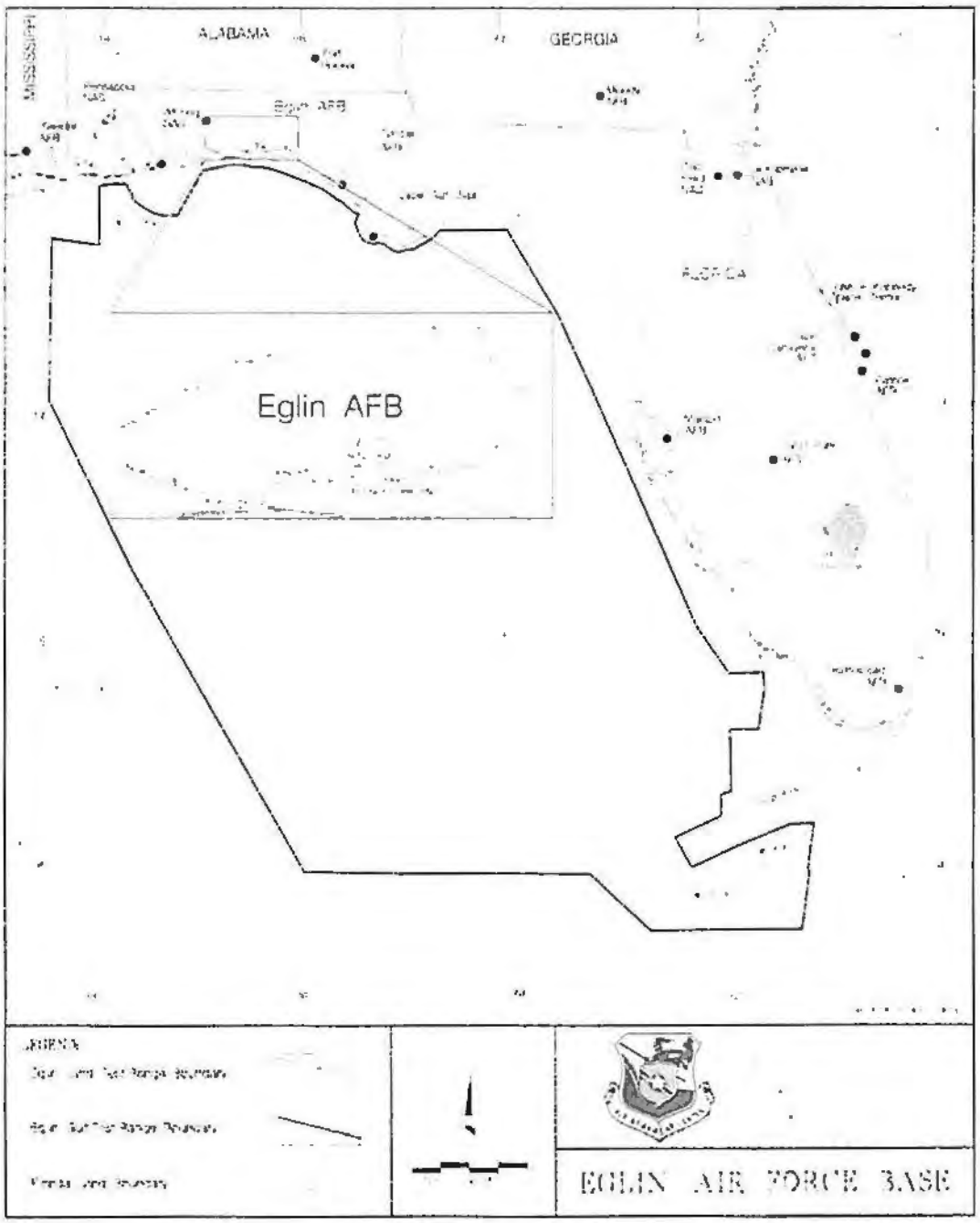
Site Name	Description	Nature of Contaminants	Status/Remedial Activities
		Group 2 Site	
AOC-98 Hardfill 01 End of Runway Disposal Area	This area was used during the 1970s for subsurface disposal of hardfill material (e.g., scrap metal, asphalt, and construction debris). Reportedly, in 1981, about 260 cubic yards of soil potentially contaminated with Herbicide Orange was briefly stored at this site.	Dieldrin, arsenic, and beryllium were identified as the primary contaminants in subsurface soil.	No Further Action with land use controls was approved by EPA and FDEP.
		Group 3 Sites	
SS-26 Hardstand 7	The site was used to store herbicide drums and transfer herbicides to aircrafts.	Herbicides and dioxins were identified as the primary contaminants in soil, sediment, surface water, and groundwater.	In 1996, the Air Force stabilized the embankment and excavated drums and the drain pit. In 2001, the Air Force installed erosion control structures and an asphalt cap.
DP-261 Building 914 Disposal Area	The site was used to dispose of hardfill (e.g., plastics, metal debris, concrete, and drums) from the late 1960s to early 1970s.	Pesticides and daughter products of DDT were identified as the primary contaminants in soil.	In 2001, the Air Force excavated soil to remove the source of contamination to the sediment and a 2-foot sand cover was installed over the entire bottom of upper Hardstand Pond.
AOC-88 Hardstand 8 Alternate Loading Area	The site is a concrete and asphalt pad at Hardstand 8. It was used as an alternate herbicide loading area between 1962 and 1970.	Arsenic and lead were identified as the primary contaminants in soil.	No Further Investigative Action with land use controls has been accepted by EPA and FDEP. In 2001, the Air Force removed lead-contaminated soil to a safe level (i.e., removed soils with lead concentrations above 400 ppm).

Table 2
IRP Sites Evaluated for Potentially Contributing Contamination to Tom's Bayou (continued)

Site Name	Description	Nature of Contaminants	Status/Remedial Activities
POI-412 HERD (High Explosives Research & Development) Facility Building 1206	Building 1206 was used to partially assemble six warheads in the early 1990s (i.e., the hollow portions of the warheads were filled with inert material and painted to prevent contamination of the facility).	None	EPA and the Florida Department of Health concur with No Further Action.
POI-358 Water Tower No. 1205	The water tower was constructed in 1986 with paint that is not lead-based. A site investigation in 1998 showed no soil impacts.	None	No Further Action is approved by EPA and FDEP.
Group 4 Sites			
OT-29 Missile Maintenance Paint Stripper Pit	The site was in operation from 1976 to 1981, to capture residues generated from paint stripping of large missile components.	Aluminum and antimony were identified as the primary contaminants in groundwater; chromium was identified as the primary contaminant in soil; and arsenic was identified as the primary contaminant in sediment.	A concrete cap was placed over the pit in 1984. A Decision Document is pending, stating No Further Remedial Action is required for this site.
POI-408 SAC Munitions Maintenance/ 33rd Flight Munitions Area	The site might contain buried unknown material.	This site is still under investigation.	This site is still under investigation.

FIGURES

Figure 1
Location of Eglin AFB



Source: Eglin AFB 2000d

Figure 2
Eglin Reservation

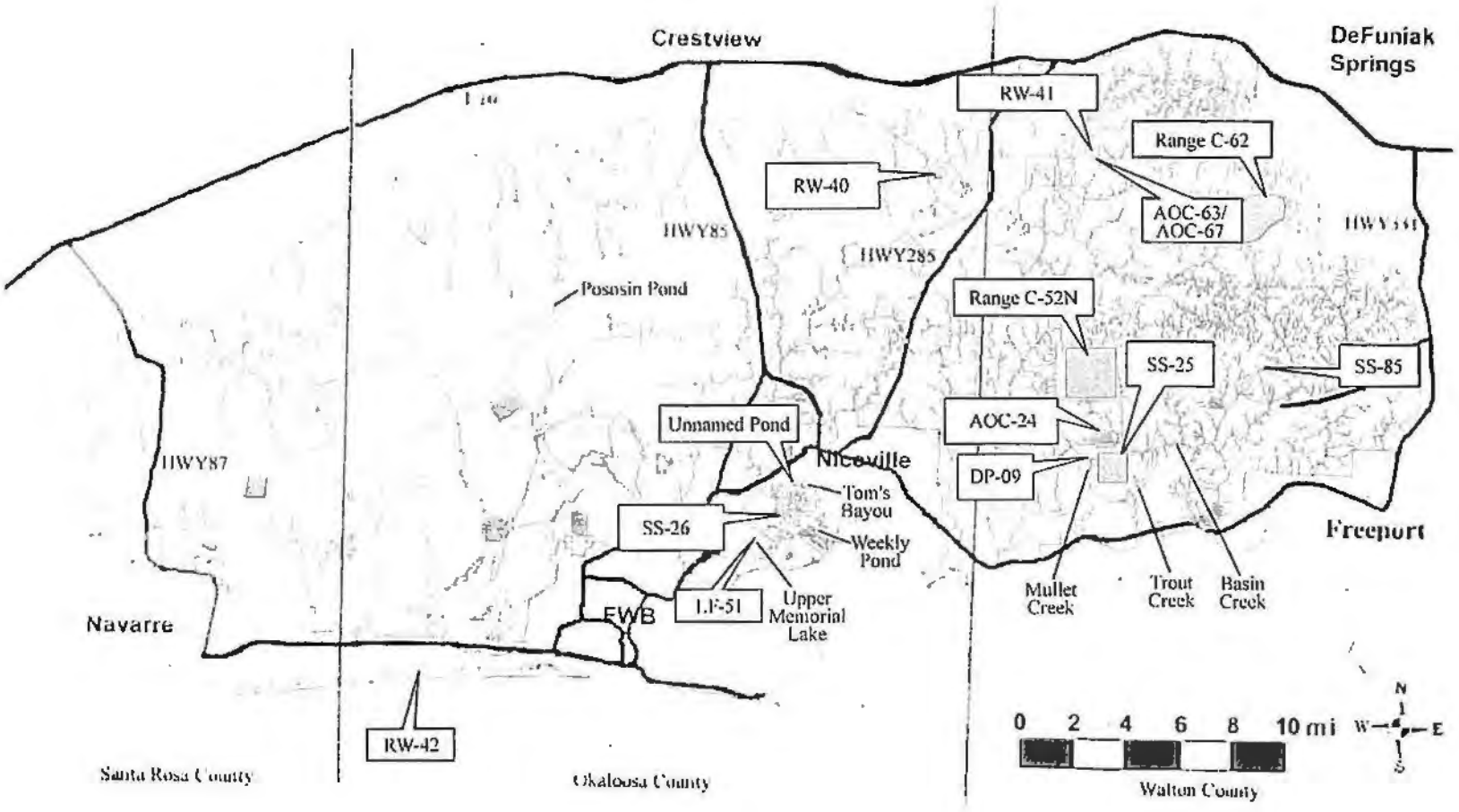
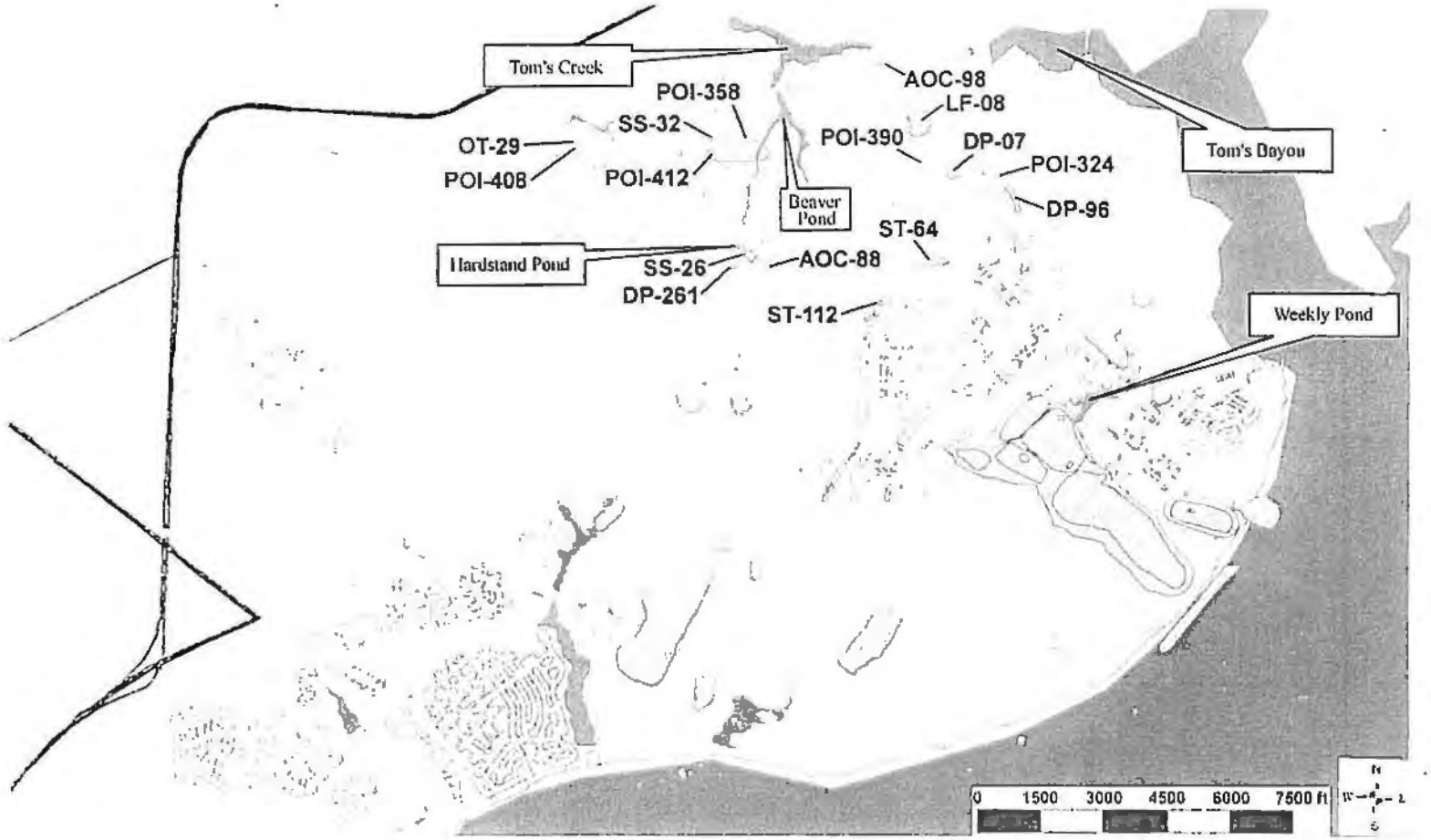


Figure 3
Eglin Main Base

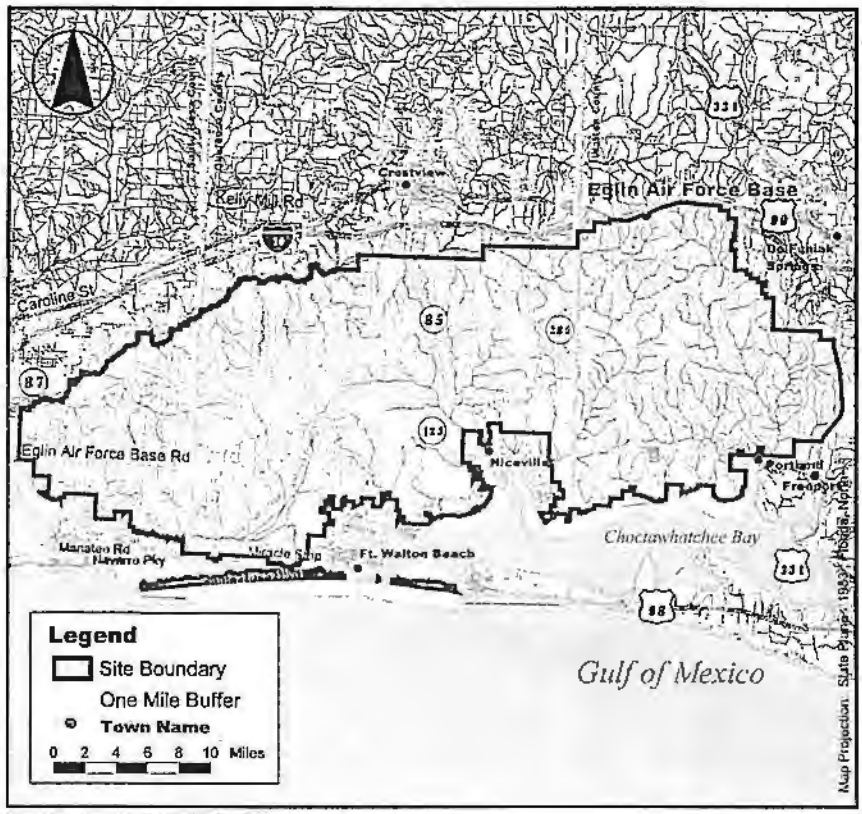


Eglin Air Force Base

INTRO MAP

Eglin AFB, Florida

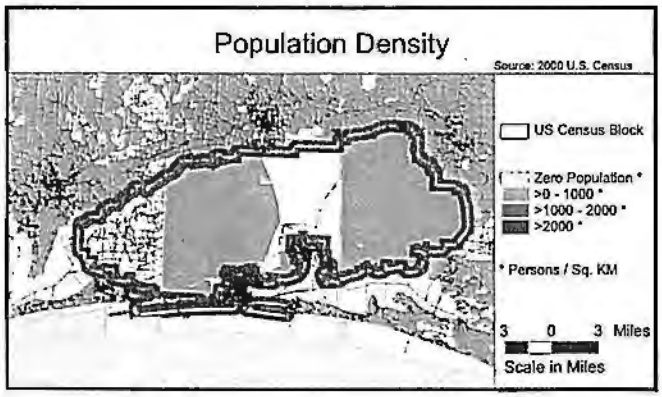
EPA Facility ID FL8570024366

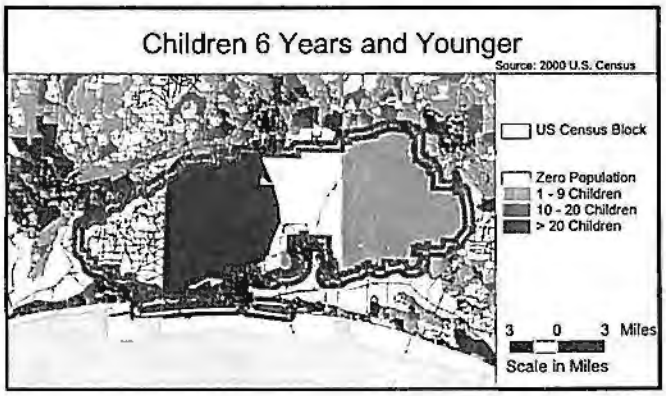


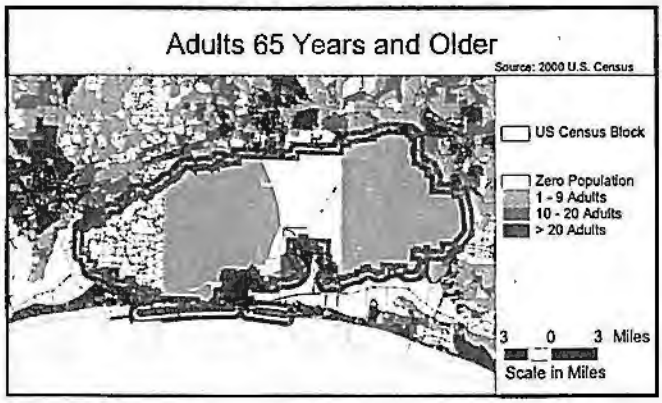
Base Map Source: 1995 TIGER/Line Files

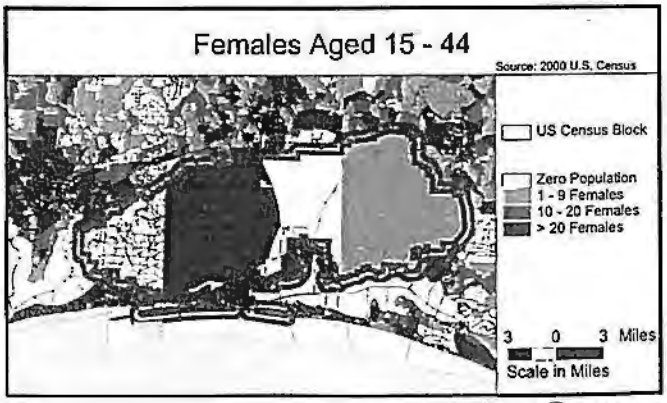
Demographic Statistics Within Area of Concern*	
Total Population	101789
White alone	83804
Black alone	9291
Am. Indian and Alaska Native alone	601
Asian alone	2825
Native Hawaiian and Other Pacific Islander alone	168
Some other race alone	1681
Two or More races	3417
Hispanic or Latino	5258
Children Aged 6 and Younger	9727
Adults Aged 65 and Older	11012
Females Aged 15 - 44	22154
Total Housing Units	44406

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









ATSDR SAIDS

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APPENDICES

Appendix A
ATSDR Plain Language Glossary of Environmental Health Terms

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.

Ambient: Environmental or surrounding conditions.

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.

Biota: Used in public health, things that humans would eat – including animals, fish and plants.

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

Chronic Exposure: A 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 Value (CV): 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 enacted in 1980. It is also known as **The Superfund Act**. This act concerns releases of hazardous substances into the environment, the cleanup of these substances and hazardous waste sites. This act created ATSDR, which 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 could 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**.

U.S. Environmental Protection Agency (EPA): The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Epidemiology: The study of the different factors that determine how often, in how many people, and in which people will disease occur.

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

Exposure Assessment: The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

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).

Hydrogeology: Dealing with the nature and distribution of aquifers and aquitards in a geologic system.

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

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**).

Isotope: Any of the forms of an element having the same number of protons (atomic number) but a different number of neutrons (atomic mass).

NPL: The National Priorities List. (Which is part of **Superfund**.) 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 investigated to see if people can be exposed to chemicals from the site.

No Apparent Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals might have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Further Action: No further action indicates that sufficient data is available to determine the site poses no human or ecological health concern and that no additional remediation or sampling is necessary.

No Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

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). For examples: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the 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): A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

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.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:

- Urgent Public Health Hazard
- Public Health Hazard
- Indeterminate Public Health Hazard
- No Apparent Public Health Hazard
- No Public Health Hazard

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**).

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), and
- or getting something on the skin (also called dermal contact).

Semivolatile Organic Compound: A class of organic (carbon-containing) chemicals similar to **Volatile Organic Compounds**, but that evaporate, or release less readily.

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who could be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics: A branch of the math process of collecting, looking at, and summarizing data or information.

Superfund Site: See **NPL**.

Time Weighted Average: The threshold limit value consisting of the average airborne concentration of the substance over a specified time limit, usually a normal 8-hour workday and a 40-hour workweek.

Topography: The surface features of a place or region.

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.

Upper Bound Estimate: Estimate not likely to be lower than the true risk.

Urgent Public Health Hazard: This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

Volatile Organic Compounds: A class of organic (carbon-containing) chemicals which reality evaporate, or release. They are frequently used as solvents, degreasing agents, and in other industrial applications.

APPENDIX B

AIR MODELING ASSUMPTIONS AND RESULTS

I. Herbicide Air Modeling

Because Eglin Air Force Base (AFB) does not have comprehensive records that document exactly when, where, and the quantity of chemicals sprayed throughout the base, ATSDR modeled potential air exposures resulting from spraying activities at the Herbicide Exposure Unit—the area on Eglin AFB believed to be sprayed with the greatest quantities of potentially toxic chemicals. From 1962 to 1970, varying mixtures of chemicals were sprayed at the Herbicide Exposure Unit to test the effectiveness of defoliants for use in the Vietnam Conflict (Engineering-Science 1993). Modeling was conducted for the six chemicals sprayed at the Herbicide Exposure Unit (see Table B-1).

Modeling Approach

Rather than simulating the many complex factors that affect how toxic chemicals disperse in air, ATSDR evaluated a simple and overestimated exposure situation: *What would have happened if the entire amount of chemicals used at the Herbicide Exposure Unit remained airborne and blew toward off-base locations, rather than mostly depositing on the ground and vegetation at the Herbicide Exposure Unit?* Though obviously unrealistic, this scenario provides an extreme upper bound estimate of what the actual ambient air concentrations might have been during relatively intense spraying activities. ATSDR used the SCREEN3 air dispersion model (EPA 1995) and Eglin AFB chemical use data to estimate air concentrations at the nearest base property line—roughly 3,000 meters (or nearly 2 miles) from the center of the Herbicide Exposure Unit. The SCREEN3 air dispersion model is one of many Gaussian air dispersion models that has been designed to evaluate atmospheric dispersion for stationary sources.

Several assumptions need to be made when modeling atmospheric dispersion of contaminants from any source. Examples of assumptions ATSDR made to model dispersion of herbicides sprayed at Eglin AFB are listed here. Table B-2 outlines the model inputs used during this analysis.

- First, ATSDR focused on the time frame 1962 to 1970, or the period when the greatest quantities of herbicides were sprayed.

- Second, ATSDR simulated the release of contaminants as a continuous emissions source. Although aerial spraying at Eglin AFB did not occur continuously, this assumption is not expected to bias predictions of annual average concentrations, because spraying

reportedly occurred during all seasons of the year, during various times of day, and during a wide range of meteorological conditions.

- Finally, and perhaps most notably, ATSDR assumed in its initial evaluations that the entire amount of herbicides sprayed remained airborne, rather than depositing on the target. This assumption was made to assess the worst-case scenario. ATSDR notes, however, that recent studies involving US Environmental Protection Agency (EPA) researchers on aerial spraying of many different pesticides and herbicide formulations in agricultural settings has found that less than 1% of the active ingredients sprayed remain aloft just 300 meters from the source (Teske et al. 2001)[10]. This low rate of chemicals remaining airborne reflects the intent of spray application of pesticides and herbicides—spray application technologies are designed to transfer as much chemicals as possible to the intended target because chemicals that remain airborne and drift downwind are essentially wasted.

When running the model, ATSDR simulated emissions from a ground-level volume source. The source was considered to be square at the base (with lateral dimensions of 610 meters). The height of the source was 100 meters, based on data provided by the base indicating that herbicides were typically released at heights ranging from 45 to 150 meters (personal communication with Eglin AFB personnel, May 1999). By using a volume source, ATSDR essentially assumed that herbicides were continuously released from a "box" of air above the Herbicide Exposure Unit. Additionally, ATSDR considered rural atmospheric dispersion coefficients and simple terrain in this assessment. Finally, to estimate annual-average ambient air concentrations from the maximum hourly concentrations calculated by SCREEN3, ATSDR multiplied the output concentrations by 0.1—a factor commonly used to estimate annual average levels from SCREEN3 outputs (EPA 1992).

Modeling Results

Table B-1 lists the upper-bound ambient air concentrations that ATSDR estimated for the chemicals considered in this analysis. ATSDR emphasizes that these are *upper-bound estimates* because the initial modeling application assumed that the entire amount of material sprayed at the site remained airborne.

[10]It should be noted that release heights for cropdusting applications (<3 meters) are considerably lower than those for aerial application of chemicals at Eglin AFB (45 to 150 meters). However, the amount of chemical that deposits on the ground is a function of several factors—tree height, the chemical, and efficiency of the spray equipment—in addition to the release height. Therefore, it is unclear whether a higher release height would significantly affect the amount of chemical deposited on the ground at Eglin AFB.

Even when considering the extremely conservative assumptions in this analysis, the estimated average off-base concentrations for four of the chemicals— 2,4-dichlorophenoxyacetic acid (2,4-D); 2,4,5-trichlorophenoxyacetic acid (2,4,5-T); cacodylic acid; and picloram—were at least two times lower than current or previously published health-based comparison values (see Table B-1). In other words, the chemical usage data indicate that spraying activities at the Herbicide Exposure Unit did not cause concentrations of these four chemicals to reach "unsafe" or "unhealthy" levels at off-base locations. ATSDR notes again that actual ambient air concentrations of these chemicals were probably considerably lower than the upper-bound estimates shown in Table B-1, because a large portion of the chemicals undoubtedly deposited on the ground surface before reaching locations beyond the Eglin AFB property line.

While concentrations at or below comparison values are considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. It cannot be emphasized strongly enough that comparison values are not thresholds of toxicity.

Potential arsenic exposures. As Table B-1 shows, the upper-bound estimate of the annual average concentration of arsenic (0.009 micrograms per cubic meter, or $\mu g/m^3$) was higher than the lowest health-based comparison value (cancer risk evaluation guide: 0.0002 $\mu g/m^3$). As a result, a more detailed review of the environmental and toxicologic data for arsenic was necessary. Following are key observations from ATSDR's review:

- The upper-bound estimate average concentration of arsenic (0.009 $\mu g/m^3$) falls within the range of arsenic concentrations that have been documented for rural and urban areas (ATSDR 2000a).

- The actual exposure concentrations at Eglin AFB were likely considerably lower than the upper-bound estimate. If 99% of the herbicides applied landed either on the intended target or on areas adjacent to the Herbicide Exposure Unit (as is consistent with data published in the "cropdusting" literature [Teske et al. 2001]), then the estimated annual average concentration of arsenic would be 0.0001 $\mu g/m^3$—lower than ATSDR's health-based comparison value.

- The literature on occupational and animal studies involving arsenic exposure indicates that even the upper-bound estimated concentration (0.009 $\mu g/m^3$) is considerably lower than the range of exposure concentrations that have caused harmful effects in humans (0.7–613 $\mu g/m^3$; ATSDR 2000a).

For the reasons listed above, ATSDR concludes that ambient air concentrations of arsenic at the facility boundary of Eglin AFB did not reach unhealthy levels as a result of the herbicide spraying applications.

Potential 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) exposures. Table B-1 indicates that the upper-bound estimate of annual average TCDD concentrations (2.8×10^{-5} µg/m^3) is higher than the most conservative health-based comparison value that ATSDR located (4.2×10^{-8} µg/m^3). Because both the modeling analysis and the health-based comparison value include several layers of conservatism, or "margins of safety," ATSDR conducted a more detailed review of TCDD releases and exposures to determine whether unhealthy inhalation exposures could have occurred. Key observations follow:

- The estimated intake rate is based on the unrealistic assumption that community members breathed air at Eglin AFB's boundary continuously 24 hours a day, 365 days a year and that the winds blew directly toward the community members. Because of this, ATSDR expects that actual exposures were lower.

- As stated before, the upper-bound estimates of ambient air concentrations in Table B-1 assume that all of the herbicides applied at Eglin AFB remained airborne and transported downwind. If ATSDR assumes that 99% of these formulations landed on the target or in its immediate vicinity (a reasonable assumption based on current literature [Teske et al. 2001]), then a more reasonable estimate of annual average ambient air concentrations of TCDD is 2.8×10^{-7} µg/m^3. ATSDR notes that the detections of TCDD in soils at the Herbicide Exposure Unit is consistent with our assertion that the majority of the chemicals did not remain aloft.

- Based on the average concentration assuming 99% deposition (or 2.8×10^{-7} µg/m^3), the average daily intake of TCDD for an individual continuously exposed at the property boundary of Eglin AFB would be 5.6×10^{-6} µg/day. Although this intake is higher than the estimated average daily inhalation intake for the general United States population (1×10^{-6} µg/day), it is substantially lower than the overall average daily intake from all media (4.7×10^{-5} µg/day), which is dominated by TCDD in food products (Travis and Hattemer-Frey 1989 as cited in ATSDR 1998).

- No human or animal toxicity data have been identified that specifically study adverse health effects associated with TCDD inhalation exposures (ATSDR 1998). Studies that have examined potential inhalation exposures examine populations known to reside or work in environments with above-background concentrations of chlorinated dibenzo-p-dioxins. Analyzing these studies is complicated by incomplete exposure data, exposure to other chemicals, and a small number of people in some of the studies. Therefore, the extent to which estimated doses can be compared to the toxicologic literature is limited, and any comparisons must be done with caution.

Some perspective can be gained by reviewing toxicity data from studies where *animals* were exposed to TCDD *orally*[11]. Limited data in rats suggest that inhalation absorption of TCDD may be at least as efficient as oral absorption. Among the studies reviewed by ATSDR, a reproductive study in Rhesus monkeys was the study at which an effect (altered social behavior) was seen at the lowest dose—1.2×10^{-4} micrograms per kilogram per day (µg/kg/day) (Schantz et al. 1992 as cited in ATSDR 1998). Using this as the most protective comparative dose, the estimated inhalation doses at Eglin AFB (6.6×10^{-9} µg/kg/day for adults and 1.4×10^{-8} µg/kg/day for children) are several orders of magnitude lower[12]. Cancer effects have been observed in animal studies at oral doses ranging from approximately 0.007–0.4 µg/kg/day (ATSDR 1998), these doses are also much higher, *more than a million times higher*, than those believed to have been encountered from herbicide testing at Eglin AFB.

Based on these observations, ATSDR concludes that people who lived along the perimeter of Eglin AFB in the 1960s might have been exposed to trace amounts of TCDD. However, to put this exposure into perspective—the inhalation exposures that might have occurred are *far lower* than estimates of dietary exposures that residents likely experienced at the same time. Thus, inhalation exposures to TCDD from past aerial application of herbicides did not substantially increase exposure to TCDD above normal background levels. In addition, when doses are estimated and compared, with caution, to the limited toxicologic data, the exposures at Eglin AFB are *much* lower. Therefore, potential exposure to TCDD from herbicide testing did not appear to be a public health hazard.

Summary of ATSDR's Findings

ATSDR analyzed available herbicide and pesticide spraying data for the Herbicide Exposure Unit—the area on Eglin AFB believed to be sprayed with the greatest quantities of potentially toxic chemicals. This analysis found that the toxic chemicals sprayed in this area probably never reached concentrations at off-base locations at levels thought to be associated with adverse health effects, even when considering extremely conservative exposure assumptions. Because the period of most intense spraying activity does not appear to pose a public health hazard, ongoing

[11]In the absence of human data, animal data can be used to study possible human effects as long as the inherent uncertainties of doing so are kept in mind.

[12]The following equation was used to estimate inhalation doses: D = [C x IR x EF]/[BW] where

D = average daily inhalation dose (µg/kg/day)
C = contaminant concentration in inhaled air: maximum concentration = 2.8×10^{-7} µg/m^3
IR = inhalation rate: adult = 15 m^3/day; child = 4.5 m^3/day (EPA 1997)
EF = exposure factor (unitless): 0.11
BW = body weight: adult = 70 kg; child = 10 kg

spraying activities, which use notably lower amounts and less toxic mixtures, also are not expected to pose past, present, or future public health hazards to off-base residents.

II. Modeling of Soil Contaminants Released During Fires

The text in the PHA presents ATSDR's analyses of exposures to smoke during fires. In these analyses, ATSDR not only considered the general components of smoke from such fires (e.g., particulate matter, carbon monoxide, and other chemical by-products of combustion), but also considered the possibility that additional contaminants could be released. Specifically, if fires reach sufficiently high temperatures, they could also cause contaminants in soils, like metals and herbicides, to become airborne. Therefore, depending on the location of a fire, smoke from the fires could also contain metals and other pollutants.

To evaluate this exposure scenario, ATSDR considered whether wildfires near the Herbicide Exposure Unit could release trace amounts of soil contaminants to the air[13]. ATSDR selected the Herbicide Exposure Unit for several reasons: (1) community members have expressed concern about past herbicide applications, (2) the Herbicide Exposure Unit is relatively close to the base property line, and (3) it is more reasonable to assume that wildfires might affect this part of the base, as compared to waste sites adjacent to buildings.

Modeling Approach

Because no air sampling has been conducted during fires at Eglin AFB, ATSDR developed a scenario to model and evaluate the public health implications of soil contaminants that might be released to the air. To estimate emissions, ATSDR assumed that a 5-acre section of the Herbicide Exposure Unit was contaminated at the maximum soil concentrations found in this area. ATSDR further assumed that the temperatures would cause the entire amount of soil contaminants in the top inch of soil in this 5-acre section to become airborne. This is an extremely conservative assumption. ATSDR already knows that contaminants remain in the surface soil at Eglin AFB, even in areas where fires have occurred in the past. ATSDR also assumed that the emissions from the soil would occur during a 24-hour period. The analyses, therefore, provide an upper-bound estimate of actual emissions from soils during fires. Modeling was conducted for eight chemicals identified as contaminants of concern in the Herbicide Exposure Unit (see Table B-3).

ATSDR again used the SCREEN3 air dispersion model (EPA 1995) to estimate the potential air quality impacts for the scenario being evaluated. This modeling assumes that winds continuously blow from the source (the fire) directly to the receptor (the nearest off base property). ATSDR modeled the emissions from fires as ground-level area sources, with dimensions of 142 meters (a

[13]Eglin AFB does not conduct prescribed burning at the Herbicide Exposure Unit.

5-acre square), and rural dispersion coefficients. This model can also be a useful tool for assessing atmospheric dispersion for sources that move small distances, especially when the distances that the source moves is small when compared to the distance from the source to the receptor (as is the case for the Herbicide Exposure Unit at Eglin AFB). Table B-4 outlines the model inputs used during this analysis.

Modeling Results

Table B-3 lists the modeling results for the eight contaminants considered. Specifically, the table indicates: the maximum soil concentration used as an input to the modeling analysis, the estimated highest 24-hour average ambient air concentration that would result at the nearest offsite location, and the lowest ambient air concentration found to be associated with adverse health effects following acute exposures. More detail on each of these data fields follows:

- The maximum soil concentration in the Herbicide Exposure Unit was taken directly from values reported in site documents and reviewed elsewhere in this PHA. As stated previously, for purposes of the modeling ATSDR assumed that the top inch of surface soil in an entire 5-acre area of the Herbicide Exposure Unit was contaminated at this maximum level. ATSDR also assumed that the entire amount of contamination in this area was released to the air in a 24-hour period.

- The highest 24-hour average ambient air concentration is an output from the dispersion model. The model generated this value by assuming that winds consistently blew from the source toward the receptor for the entire 24-hour period, and during the least favorable meteorological conditions (e.g., very light winds, highly stable atmospheric conditions). The modeling results should be viewed as a worst-case scenario. Finally, ATSDR notes that the concentrations listed in Table B-3 would only occur for a 24-hour period.

- The final column in Table B-3 lists, for the eight chemicals considered, the lowest ambient air concentration found to be associated with adverse health effects following acute exposures. These data points are based entirely on compilations of toxicologic and epidemiologic studies reviewed in ATSDR's corresponding toxicological profiles. It should be noted that adverse health effects following acute exposures to lower air concentrations can occur, because the available toxicologic studies have not considered the entire range of exposure concentrations. Nonetheless, the data currently available show that the highest estimated 24-hour average ambient air concentration (even with the conservative assumptions) are all at least 40 times lower than the exposure concentrations found to cause adverse health effects.

Summary of ATSDR's Findings

ATSDR used a modeling analysis to assess the likelihood of fires causing unhealthy amounts of soil contaminants to be released to the air. Even when evaluating one of the most contaminated areas at Eglin AFB and assuming that all contaminants in the top inch of surface soil are released to the air in a fire, ATSDR found that exposures that could result are not at levels of health concern. In other words, previously existing *soil* contamination in areas that are burned do not cause harmful health effects because these contaminants would not reach off-base areas at levels associated with adverse health effects. As noted in the main part of this PHA, *smoke* that is released from burning vegetation can cause health problems for people who are exposed to it.

Table B-1

Upper-Bound Estimates of Annual Average Air Concentrations for Chemicals Applied at the Eglin AFB Herbicide Exposure Unit Between 1962 and 1970

(assumes all herbicides sprayed remained airborne)

Chemical	Upper-Bound Estimate of Annual Average Air Concentration at Base Boundary ($\mu g/m^3$)	Health-Based Comparison Value ($\mu g/m^3$)	Type of Comparison Value
2,4-D	0.78	37	RBC
2,4,5-T	0.76	37	RBC
Picloram	0.01	(See notes)	(See notes)
Arsenic	0.009	0.0002	CREG
Cacodylic Acid	0.06	(See notes)	(See notes)
TCDD	2.8×10^{-5}	4.2×10^{-8}	RBC

Notes: The upper-bound concentration estimates of 2,4-D and 2,4,5-T are both considerably lower than the listed health-based comparison values, which are EPA Region 3's risk-based concentrations for non-carcinogenic health effects. Thus, exposures to these levels of chemicals are not believed to result in adverse health effects.

The upper-bound concentration estimates for picloram and cacodylic acid are 0.01 $\mu g/m^3$ and 0.06 $\mu g/m^3$, respectively. These are both considerably lower than the RBCs EPA Region 3 had previously published for these chemicals, which were 260 $\mu g/m^3$ for picloram and 11 $\mu g/m^3$ for cacodylic acid. Both chemicals, however, no longer appear on EPA's list of RBCs.

Refer to the Herbicide Air Modeling section for further interpretation of exposures to arsenic and TCDD.

Abbreviations: CREG - cancer risk evaluation guide
RBC - risk-based concentration
$\mu g/m^3$ - micrograms per cubic meter

Table B-2
Inputs for the Herbicide Air Modeling Evaluation

Parameter	Selected Value	Rationale
Source to consider	Aerial spraying of chemicals at the Herbicide Exposure Unit	Because no air sampling was ever conducted to characterize drift from the aerial spraying, modeling was the only tool available to evaluate past exposures.
Type of source	Volume	No source type in the SCREEN3 model has been developed to specifically represent emissions from aerial application of chemicals. Using a volume source assumes that chemicals throughout a volume (i.e., the air space beneath the aircraft and the ground) can potentially blow downwind.
Vertical dimension of volume source	46 meters	The initial vertical dimension of a volume source is calculated by dividing the actual dimension by 2.15. This value was selected by taking the midpoint of the range of spray heights identified by base personnel (45 to 150 meters) and dividing by 2.15.
Horizontal dimension of volume source	142 meters	ATSDR assumed the spray targets for individual applications spanned an area of 610 meters by 610 meters. No detailed information was provided by the base to help select this input parameter.
Urban vs. Rural	Rural	Based on the absence of significant terrain features and urban development, rural dispersion coefficients were used in this evaluation. Ambient air concentrations predicted with rural dispersion coefficients are higher than those predicted with urban dispersion coefficients.
Terrain	Simple	Topographic maps indicate that no significant terrain features are in the area that would warrant complex terrain modeling.
Emission Rates	Vary by chemical	ATSDR calculated chemical emission rates by assuming that the amount of chemicals that were reportedly used between 1962 and 1970 were released continuously. This is essentially an exercise of division (total mass used by the time frame) and unit conversions. Specific data for these chemicals follows:

Chemical	Total Usage (1962–1970)[14]	Emission Rate (g/s)
2,4-D	169,200 pounds	0.270
2,4,5-T	166,300 pounds	0.266
Picloram	2,250 pounds	0.00359
Arsenic	2,050 pounds	0.00328
Cacodylic acid	13,600 pounds	0.0218
TCDD	6.1 pounds	0.00000987

[14]Source: EA Engineering, Science, and Technology 1997

Table B-3
Upper-Bound Estimates of 24-Hour Average Ambient Air Concentrations at Offsite Locations That Might Result from Soil Contaminants Being Emitted During a Fire

Chemical	Maximum Soil Concentration at Herbicide Exposure Unit (ppm)	Estimated 24-Hour Average Ambient Air Concentration at Offsite Locations ($\mu g/m^3$)	Lowest Ambient Air Concentration Found to be Associated with Adverse Health Effects Following Acute Exposures ($\mu g/m^3$)
Arsenic	10	10.4	627,000
Cadmium	1	1.2	170
Chromium	13	13.6	900
Nickel	5	4.79	220
Dioxins	2.15×10^{-4}	2.24×10^{-4}	NA
DDT	0.46	0.48	NA
alpha-Chlordane	0.021	0.022	154,000
Benzo(a)pyrene	0.66	0.69	NA

Notes: "Dioxins" refers to the sum of all dioxin compounds. The soil and air concentrations for dioxins are expressed on a toxic equivalent (TEQ) basis.

The final column lists the lowest ambient air concentration found to be associated with adverse health effects following acute exposure. This number is based on the lowest air concentration documented in ATSDR's toxicological profiles found to cause adverse health effects, regardless of the severity, and regardless of whether in laboratory animals or humans. Some additional notes on these values follow: the entry for nickel is based on an exposure study involving nickel subsulfide; ATSDR's toxicological profiles have not identified levels of significant exposure for acute inhalation to dioxins, DDT, and benzo(a)pyrene.

Refer to the Modeling of Soil Contaminants Released during Prescribed Burns and Wildfires section for more information on ATSDR's modeling analysis of this exposure scenario and interpretations of the data in this table.

Abbreviations: $\mu g/m^3$ - micrograms per cubic meter
ppm -parts per million

Table B-4
Model Inputs for the Analysis of Soil Contaminants Released During Fires

<table>
<tr><th>Parameter</th><th>Selected Value</th><th>Rationale</th></tr>
<tr><td>Source to consider</td><td>Prescribed burns occurring at the Herbicide Exposure Unit</td><td>This site was considered due to its proximity to the petitioner and the documented presence of soil contamination.</td></tr>
<tr><td>Type of source</td><td>Area</td><td>No source type in the SCREEN3 model has been developed to specifically represent emissions from a high-temperature source that covers an area. The area source option enables predictions of air quality impacts from chemicals released over a broad planar surface, like the soils of the Herbicide Exposure Unit, but buoyancy cannot be considered. A point source allows for representation of buoyancy effects, which may be important in fires, but does not consider the lateral movement of the fire. Simulations comparing point to area source predictions found that concentrations predicted by the area source model were 2.5 times greater than those predicted by the point source model.</td></tr>
<tr><td>Area considered</td><td>5 acres</td><td>Assumed dimension over which maximum soil concentrations occur.</td></tr>
<tr><td>Urban vs. Rural</td><td>Rural</td><td>Based on the absence of significant terrain features and urban development, rural dispersion coefficients were used in this evaluation. Ambient air concentrations predicted with rural dispersion coefficients are higher than those predicted with urban dispersion coefficients.</td></tr>
<tr><td>Terrain</td><td>Simple</td><td>Topographic maps indicate that no significant terrain features are in the area that would warrant complex terrain modeling.</td></tr>
<tr><td>Emission rates</td><td>Vary by chemical</td><td>No information was available on the amount of soil contaminants that might be released to the air during a fire. To evaluate this scenario, ATSDR first calculated an upper-bound estimate of the amounts of chemicals found in the top inch of soil, by assuming that the highest concentration detected existed over the entire 5 acre area of concern. ATSDR then assumed that the emissions of soil contaminants during a fire would likely not be greater than this amount of chemical in the surface soil. Based on this approach, the emission rates were computed as follows.
<table>
<tr><th>Contaminant</th><th>Emission Rate (g/s/m^2)</th></tr>
<tr><td>Arsenic</td><td>4.41E-06</td></tr>
<tr><td>Cadmium</td><td>5.29E-07</td></tr>
<tr><td>Chromium</td><td>5.78E-06</td></tr>
<tr><td>Nickel</td><td>2.03E-06</td></tr>
<tr><td>Dioxin (sum of TEQs)</td><td>9.49E-11</td></tr>
<tr><td>DDT</td><td>2.03E-07</td></tr>
<tr><td>alpha-Chlordane</td><td>9.26E-09</td></tr>
<tr><td>Benzo(a)pyrene</td><td>2.91E-07</td></tr>
</table>
</td></tr>
</table>

APPENDIX C

INFORMATION ON HOW ATSDR ASSESSES EXPOSURE

I. Estimates of Human Exposure Doses and Determination of Health Effects

What is meant by exposure?

ATSDR's public health assessments are driven by exposure or contact. Chemicals released into the environment have the potential to cause harmful health effects. Nevertheless, *a release does not always result in exposure*. People can only be exposed to a chemical if they come in contact with that chemical. If no one comes into contact with a chemical, then no exposure occurs, thus no health effects could occur. Often the general public does not have access to the source area of the environmental release; this lack of access becomes important in determining whether the chemicals are moving through the environment to locations where people could come into contact with them.

The five elements of an exposure pathway are: (1) source of contamination, (2) environmental media, (3) point of exposure, (4) route of human exposure, and (5) receptor population. The source of contamination is where the chemical was released. The environmental media (i.e., groundwater, soil, surface water, air, etc.) transport the chemical. The point of exposure is where people come in contact with the contaminated media. The route of exposure (i.e., ingestion, inhalation, dermal contact, etc.) is how the chemical enters the body. The people actually exposed are the receptor population.

The route of a chemical's movement is the *pathway*. ATSDR identifies and evaluates exposure pathways by considering how people might come into contact with a chemical. An exposure pathway could involve air, surface water, groundwater, soil, dust, or even plants and animals. Exposure can occur by breathing, eating, drinking, or by skin contact with a substance containing the chemical.

How does ATSDR determine which exposure situations to evaluate?

ATSDR scientists evaluate site-specific conditions to determine whether people are being exposed to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, water, air, waste, or biota) is occurring through ingestion, dermal (skin) contact, or inhalation.

If exposure is possible, ATSDR scientists then consider whether contamination is present at levels that might affect public health. ATSDR selects chemicals for further evaluation by comparing them against health-based comparison values. Comparison values are developed by ATSDR from available scientific literature concerning exposure and health effects. Comparison values are derived for each of the media and reflect an estimated chemical concentration that is

not expected to cause harmful health effects for a given chemical, assuming a standard daily contact rate (e.g., amount of water or soil consumed or amount of air breathed) and standard body weight.

Comparison values are not thresholds for harmful health effects. ATSDR comparison values represent chemical concentrations many times lower than levels at which no effects were observed in experimental animals or human epidemiologic studies. If chemical concentrations are above comparison values, ATSDR further analyzes exposure variables (e.g., duration and frequency) for health effects, including the toxicology of the chemical, other epidemiology studies, and the weight of evidence.

Some comparison values used by ATSDR scientists include ATSDR's environmental media evaluation guides (EMEG), reference dose media evaluation guides (RMEG), and cancer risk evaluation guides (CREG). EMEGs, RMEGs, and CREGs are non-enforceable, health-based comparison values developed by ATSDR for screening environmental contamination for further evaluation. Risk-based concentrations (RBCs) and soil screening levels (SSLs) are health-based comparison values developed by EPA Region III to screen sites not yet on the National Priorities List (NPL), respond rapidly to citizens inquiries, and spot-check formal baseline risk assessments.

More information about the ATSDR evaluation process can be found in ATSDR's Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/HAGM/ or by contacting ATSDR at 1-888-42-ATSDR.

If someone is exposed, will they get sick?

Exposure does not always result in harmful health effects. The type and severity of health effects that occur in an individual as the result of contact with a chemical depend on the exposure concentration (how much), the frequency and duration of exposure (how long), the route or pathway of exposure (breathing, eating, drinking, or skin contact), and the multiplicity of exposure (combination of chemicals). Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status of the exposed individual influence how that individual absorbs, distributes, metabolizes, and excretes the chemical. Taken together, these factors and characteristics determine the health effects that can occur as a result of exposure to a chemical in the environment.

Considerable uncertainty exists regarding the true level of exposure to environmental contamination. To account for that uncertainty and to protect public health, ATSDR scientists typically use high-end, worst-case exposure level estimates to determine whether harmful health effects are possible. These estimated exposure levels are usually much higher than the levels to which people are really exposed. If the exposure levels indicate harmful health effects are

possible, a more detailed review of exposure, combined with scientific information from the medical, toxicologic, and epidemiologic literature about the health effects from exposure to harmful substances, is performed.

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

To evaluate exposures on Eglin Air Force Base (AFB), ATSDR evaluated available data to determine whether contaminants were above ATSDR's comparison values. For those that were, ATSDR derived exposure doses (see text box for definition) 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. It is important to remember that exposure to a certain chemical does not always result in harmful health effects. The type and severity of health effects expected to occur depend on the exposure concentration, the toxicity of the chemical, the frequency and duration of exposure, and the multiplicity of exposures.

An exposure dose is the amount of chemical a person is exposed to over time.

Comparing Data to ATSDR's Comparison Values

Comparison values are derived using conservative exposure assumptions. Comparison values reflect concentrations much lower than those that have been observed to cause adverse health effects. Thus comparison values are protective of public health in essentially all exposure situations. As a result, *concentrations detected at or below ATSDR's comparison values are not considered to warrant health concern.* While concentrations at or below the relevant comparison value can reasonably be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. It cannot be emphasized strongly enough that comparison values 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 an environmental concentration alone.

For this public health assessment, ATSDR evaluated data collected from sites within the Tom's Bayou drainage basin (surface water and sediment samples); from Weekly Pond (fish samples); and from Mullet, Trout, and Basin Creeks (surface water, sediment, and fish samples) to determine whether people were exposed to contaminant concentrations that exceeded ATSDR's comparison values. The majority of detected contaminants fell at or below comparison values and were not evaluated further. Contaminants that were above comparison values were deemed worthy of further evaluation, prompting ATSDR to estimate exposure doses using site-specific exposure assumptions.

Deriving exposure doses

ATSDR derived exposure doses for those contaminants that were detected above ATSDR's comparison values or did not have comparison values. Exposure doses are expressed in milligrams per kilogram per day (mg/kg/day). When estimating exposure doses, health assessors evaluate chemical concentrations to which people could be exposed, together with the length of time and the frequency of exposure. Collectively, these factors influence an individual's physiological response to chemical 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 and off-base residents, and those who use the area for recreational purposes.

The following equation was used to estimate recreational exposure to contaminants in surface water:

$$\text{Estimated exposure dose} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

- C: Maximum concentration in parts per million (ppm)
- IR: Ingestion rate: 0.15 liters per day[§]
- EF: Exposure frequency, or number of exposure events per year of exposure: 365 days/year
- ED: Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
- BW: Body weight: adult = 70 kg; child = 16 kg*
- AT: Averaging time, or the period over which cumulative exposures are averaged (6 years or 30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects)

[§] The ingestion rate is based on swimming for 3 hours per event (EPA 1997).

* ATSDR assumes that older children (i.e., toddlers) would be more likely to play in the creeks and Tom's Bayou.

The following equation was used to estimate recreational exposure to contaminants in sediments:

$$\text{Estimated exposure dose} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

- C: Maximum concentration (ppm)
- IR: Ingestion rate: adult = 100 mg per day (0.0001 kg/day)[§]; child = 200 mg per day (0.0002 kg/day)[§]
- EF: Exposure frequency, or number of exposure events per year of exposure: 365 days/year
- ED: Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
- BW: Body weight: adult = 70 kg; child = 16 kg*
- AT: Averaging time, or the period over which cumulative exposures are averaged (6 years or 30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects)

[§] The ingestion rate is a standard assumption for soil (ATSDR 2002b).

* ATSDR assumes that older children (i.e., toddlers) would be more likely to play in the creeks and Tom's Bayou.

The following equation was used to estimate exposure to contaminants in fish:

$$\text{Estimated exposure dose} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

- C: Maximum concentration (ppm)
- IR: Ingestion rate: adult = 54 grams per day (0.054 kg/day)[§]; child = 27 grams per day (0.027 kg/day)[§]
- EF: Exposure frequency, or number of exposure events per year of exposure: 365 days/year
- ED: Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
- BW: Body weight: adult = 70 kg; child = 16 kg*
- AT: Averaging time, or the period over which cumulative exposures are averaged (6 years or 30 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects)

[§] The ingestion rate represents daily intake averaged over a year for a person eating seven meals of fish a month (EPA 1991b).

* ATSDR assumes that older children (i.e., toddlers) are eating fish.

Using exposure doses to evaluate potential health hazards

ATSDR analyzes the weight of evidence of available toxicologic, medical, and epidemiologic data to determine whether exposures might be associated with harmful health effects (noncancer and cancer). As part of this process, ATSDR examines relevant health effects data to determine whether estimated doses are likely to result in harmful health effects. As a first step in evaluating noncancer effects, ATSDR compares estimated exposure doses to conservative health guideline values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs). The MRLs and RfDs are estimates of daily human exposure to a substance that are unlikely 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 maximize human health protection, MRLs and RfDs have built-in uncertainty or safety factors, making these values considerably lower than levels at which health effects have been observed. The result is that even if an exposure dose is higher than the MRL or RfD, it does not necessarily follow that harmful health effects will occur.

For carcinogens, ATSDR also calculates a theoretical increase of cancer cases in a population (for example, 1 in 1,000,000 or 10^{-6}) using EPA's cancer slope factors (CSFs), which represent the relative potency of carcinogens. This is accomplished by multiplying the calculated exposure dose by a chemical-specific CSF. Because they are derived using mathematical models which apply a number of uncertainties and conservative assumptions, risk estimates generated by using CSFs tend to be overestimated.

If health guideline values are exceeded, ATSDR examines the health effects levels discussed in the scientific literature and more fully reviews exposure potential. ATSDR reviews available human studies as well as experimental animal studies. This information is used to describe the disease-causing potential of a particular chemical and to compare site-specific dose estimates with doses shown in applicable studies to result in illness (known as the margin of exposure). For cancer effects, ATSDR compares an estimated lifetime exposure dose to available cancer effects levels (CELs), which are doses that produce significant increases in the incidence of cancer or tumors, and reviews genotoxicity studies to understand further the extent to which a chemical 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 harmful health outcomes under site-specific conditions.

Using other methods to evaluate potential health hazards

When dealing with exposure to lead, ATSDR uses a second approach in addition to the traditional methodologies described above. A substantial part of human health effects data for lead are expressed in terms of blood lead level rather than exposure dose. Thus, ATSDR developed a secondary approach to utilize regression analysis with media-specific uptake parameters to estimate what cumulative blood lead level might result from exposure to a given

level of contamination. This is accomplished by multiplying the detected concentration by a media-specific slope factor (which is 0.0068 micrograms per deciliter (µg/dl) per ppm of lead ingested; ATSDR 1999b). The Centers for Disease Control and Prevention (CDC) has determined that health effects are more likely to be observed if blood lead levels are at or above 10 µg/dl.

Essential nutrients (e.g., calcium, magnesium, potassium, and sodium) are important minerals that maintain basic life functions; therefore, certain doses are recommended on a daily basis. Because these chemicals are necessary for life, MRLs and RfDs do not exist for them. They are found in many foods, such as milk, bananas, and table salt. Ingestion of these essential nutrients at the concentrations found at Eglin AFB will not result in harmful health effects.

Sources for health-based guidelines

By Congressional mandate, ATSDR prepares toxicological profiles for hazardous substances found at contaminated sites. These toxicological profiles were used to evaluate potential health effects from contamination at Eglin AFB. ATSDR's toxicological profiles are available on the Internet at http://www.atsdr.cdc.gov/toxpro2.html or by contacting the National Technical Information Service at 1-800-553-6847. EPA also develops health effects guidelines, and in some cases, ATSDR relied on EPA's guidelines to evaluate potential health effects. These guidelines are found in EPA's Integrated Risk Information System (IRIS)—a database of human health effects that could result from exposure to various substances found in the environment. IRIS is available on the Internet at http://www.epa.gov/iris. For more information about IRIS, please call EPA's IRIS hotline at 1-301-345-2870 or e-mail at Hotline.IRIS@epamail.epa.gov.

III. Evaluation of Health Hazards Associated with Contamination at Eglin AFB

ATSDR evaluated data that were collected from sites within the Tom's Bayou drainage basin (surface water and sediment samples); from Weekly Pond (fish samples); and from Mullet, Trout, and Basin Creeks (surface water, sediment, and fish samples). For each of these areas, contaminant concentrations were compared to comparison values. Many of the contaminants were detected below their corresponding comparison values. For each pathway in which chemicals were detected above comparison values or did not have comparison values, exposure doses were calculated. For most of the chemicals, the calculated exposure doses were less than their respective health guidelines (i.e., MRLs and RfDs) and were not expected to cause an increase in cancer outcomes. After evaluating the available toxicologic data for those chemicals where the exposure doses exceeded health guidelines, ATSDR concludes that ***none of the chemicals were detected at levels of health concern in any of the evaluated areas***. More details about each of the exposure pathways follow.

Tom's Bayou

Tom's Bayou is located in Valparaiso, Florida, and is used for various recreational activities by those people who reside around the bayou. Several small ponds and streams are located on Eglin Main Base, which drain into the bayou. Several Installation Restoration Program (IRP) sites are located at the headwaters or along these surface water bodies, potentially contributing to contamination in Tom's Bayou. The US Fish and Wildlife Service (FWS) and Florida Department of Environmental Protection (FDEP) sampled Tom's Bayou for overall system quality during environmental surveys. In addition, Eglin AFB has conducted several investigations at many of the IRP sites within the Tom's Bayou drainage basin. Surface water and sediment samples from the surface water bodies that drain into the bayou have been analyzed for metals, volatile organic compounds, pesticides, herbicides, dioxins, and PCBs (CH2MHILL 1996; EA Engineering, Science, and Technology 1997; Earth Tech 2001a, 2001c, 2001e; Eglin AFB 1994, 2000c; Harrison et al. 1979; Harrison and Crews 1981; O'Brien & Gere Engineers 1996). The majority of the chemicals were either not detected or were detected below comparison values. Table C-1 lists the chemicals that were detected above comparison values. Arsenic, antimony, thallium, trichloroethene, dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), dieldrin, heptachlor, and aroclor-1254 were detected above comparison values in the surface water; and arsenic, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), DDD, DDE, DDT, dieldrin, and aroclor-1260 were detected above comparison values in the sediment.

Exposure doses were calculated for each of the chemicals listed in Table C-1 using the formulas and assumptions described previously. Most of the exposure doses were below their respective MRLs and RfDs and; therefore, were not at a level of health concern (see Table C-2). These calculated exposures overstate the actual exposures occurring in Tom's Bayou because (1) people are not expected to consistently be exposed to the maximum concentration on a daily basis and for an extended period of time, more realistically people would encounter a range of concentrations, including none, since not every chemical was detected in every sample, (2) adults and children are not expected to be recreating in the bayou as often as 365 days of the year, and (3) the majority of the data are from sites that are located on Eglin Main Base and it is expected that the concentrations would be lower in the bayou than at the source areas. Only arsenic, TCDD, and DDT in the sediment were above health guidelines and are evaluated further:

- *Arsenic.* Although elemental arsenic sometimes occurs naturally, arsenic is usually found in the environment in two forms—inorganic (arsenic combined with oxygen, chlorine, and sulfur) and organic (arsenic combined with carbon and hydrogen). The inorganic forms of arsenic are usually more toxic than the organic forms (ATSDR 2000a). Once in the body, the liver changes some of the inorganic arsenic into the less harmful organic

form (i.e., by methylation). This process is effective as long as the dose of inorganic arsenic remains below 0.05 mg/kg/day (ATSDR 2000a).

Being exposed to the maximum concentration of arsenic found in the sediment at any of the IRP sites within the Tom's Bayou drainage basin would result in exposure doses of 0.000081 mg/kg/day for adults and 0.00071 mg/kg/day for children (see Table C-2). As noted above, the metabolism (i.e., how it is broken down in the body) of inorganic arsenic has been extensively studied in humans and animals. ATSDR's estimated doses are well below those that inhibit the body's ability to detoxify or change it to non-harmful forms (doses greater than 0.05 mg/kg/day inhibit detoxification). Therefore, the amount of arsenic that a person might be exposed to in the sediment of Tom's Bayou should be controlled by normal metabolic processes in the body. In addition, several studies reported CELs ranging from 0.01–0.05 mg/kg/day, which are also much higher than the estimated doses (ATSDR 2000a). Considering the use of the conservative assumptions noted previously, ATSDR concludes that the arsenic levels are too low to be of health concern for both children and adults who might use Tom's Bayou for recreational activities.

- *TCDD* is one of 75 different compounds commonly referred to as polychlorinated dioxins. A lot of research has been conducted evaluating exposures to TCDD, which is one of the most toxic dioxins to mammals (ATSDR 1998). The oral health guideline (ATSDR's MRL) is based on a study in which adverse health effects were reported in animals exposed to 1.2×10^{-7} mg/kg/day of TCDD in their food (Schantz et al. 1992 as cited in ATSDR 1998). The estimated exposure doses resulting from exposure to the sediment (adult: 1.2×10^{-9} mg/kg/day and child: 1.0×10^{-8} mg/kg/day) are lower than this level (see Table C-2). In addition, several studies reported CELs ranging from 7.1×10^{-6} –3.6×10^{-4} mg/kg/day, which are also higher than the estimated doses (ATSDR 1998). Considering the use of the conservative assumptions noted previously, ATSDR concludes that the TCDD levels are too low to be of health concern for both children and adults who might use Tom's Bayou for recreational activities.

- *DDT* is a pesticide that was commonly used in the past to control insects on agricultural crops. In 1972, the use of DDT was banned in the United States, however, it continues to be used in other countries (ATSDR 2000). The oral health guideline (EPA's RfD) is based on a study in which no adverse health effects were reported in animals exposed to 0.05 mg/kg/day of DDT in their food (Laug et al. 1950 as cited in EPA 1991a). The calculated doses resulting from exposure to the sediment (adult: 0.0001 mg/kg/day and child: 0.00088 mg/kg/day) are much lower than this level. In addition, several studies reported cancer effects (i.e., CELs) at doses ranging from 0.33–116 mg/kg/day, which are also much higher than the estimated doses (ATSDR 2000). Considering the use of the conservative assumptions noted previously, ATSDR concludes that the DDT levels are

too low to be of health concern for both children and adults who can use Tom's Bayou for recreational activities.

Weekly Pond

Weekly Pond is a small, catch-and -release pond that the Air Force had opened to fishing for base personnel and their guests (Water and Air Research 1984). In the mid-1980s, Eglin AFB sampled fish tissue (catfish, bluegill, and bass) and detected pesticides (DDD, DDE, and DDT) (Eglin AFB 1989). Other contaminants have not been identified in Weekly Pond. The results were reported as a sum of DDD, DDE, and DDT concentrations (i.e., no individual concentrations were provided). The maximum concentration was 2.53 ppm, higher than each individual pesticide's comparison value (EPA's RBCs are DDD: 0.013 ppm, DDE: 0.0093 ppm, DDT: 0.0093 ppm). Therefore, exposure doses were calculated using the formulas described previously. Because concentrations were not reported for each pesticide, ATSDR conservatively assumed that each pesticide was detected at the maximum sum concentration (2.53 ppm). The resulting doses were above EPA's chronic RfD of 0.0005 mg/kg/day (adult: 0.002 mg/kg/day and child: 0.004 mg/kg/day). Therefore, ATSDR further examined the effects levels seen in the literature and more fully reviewed exposure potential to help predict the likelihood of adverse health outcomes.

- *DDD, DDE, and DDT* are pesticides that were commonly used in the past to control insects on agricultural crops. Both DDD and DDE are breakdown products of DDT, which was used to a great extent. The oral health guideline (EPA's RfD of 0.0005 mg/kg/day) is based on a study in which no adverse health effects were reported in animals exposed to 0.05 mg/kg/day of DDT in their food (Laug et al. 1950 as cited in EPA 1991a). The calculated doses resulting from eating fish from Weekly Pond (adult: 0.002 mg/kg/day and child: 0.004 mg/kg/day) are lower than this level. In addition, several studies reported cancer effects (i.e., CELs) at doses ranging from 0.33–116 mg/kg/day, also much higher than the estimated doses (ATSDR 2000). Considering that the maximum concentration used in the exposure equation was a sum of all three pesticides, ATSDR concludes that the pesticide levels are too low to be of health concern for either children or adults who in the past might have eaten fish from Weekly Pond.

Mullet, Trout, and Basin Creeks

Mullet, Trout, and Basin Creeks receive surface water runoff from the Herbicide Exposure Unit. The headwaters of all three creeks are located in areas closed to all forms of public access. Still, they flow into areas that are open to seasonal recreational activities (with appropriate Eglin AFB permits). According to the Baseline Risk Assessment, none of the creeks are visited very often (EA Engineering, Science, and Technology 1997). In 1995, the Air Force sampled surface water, sediment, and fish from Mullet, Trout, and Basin Creeks for organic compounds, pesticides and

herbicides, dioxins and furans, PCBs, and inorganics (EA Engineering, Science, and Technology 1997). The majority of the chemicals were either not detected or were detected below comparison values. Table C-3 lists the chemicals that were detected above comparison values in Mullet, Trout, and Basin Creeks. Only arsenic, aldrin, heptachlor, and delta-hexachlorocyclohexane (delta-HCH) were detected above comparison values in the surface water. Arsenic and benzo(a)pyrene were detected above comparison values in the sediment, and arsenic, benzo(a)pyrene, aldrin, heptachlor, and delta-HCH were above comparison values in fish.

Using the formulas and assumptions described previously, exposure doses were calculated for each of the chemicals listed in Table C-3. All but one (arsenic in fish) of the exposure doses were below their respective MRLs and RfDs and, therefore, were not at a level of health concern (see Table C-4). These calculated exposures overstate the actual exposures occurring at Mullet, Trout, and Basin Creeks because people are not expected to be exposed consistently to the maximum concentration on a daily basis and for an extended period of time. More realistically, people would encounter a range of concentrations, including none, because not every chemical was detected in every sample and adults and children are not expected to be visiting the creeks as often as 365 days of the year. And further evaluation of arsenic in fish from the creeks showed the following:

- *Arsenic.* As noted previously, arsenic is usually found in the environment in two forms—inorganic and organic, with the inorganic forms of arsenic being more toxic than the organic forms (ATSDR 2000a). In fish and shellfish, generally only about 1–20% of the total arsenic is in the more harmful inorganic form (ATSDR 2000a; Francesconi and Edmonds 1997; NAS 2001; FDA 1993). Arsenic can be found in most foods, but seafood, particularly shellfish, contains the highest concentrations (FDA 1993). Once in the body, the liver changes some of the inorganic arsenic into the less harmful organic form (i.e., by methylation). This process is effective as long as the dose of inorganic arsenic remains below 0.05 mg/kg/day (ATSDR 2000a).

  Consuming the maximum concentration of arsenic from Mullet, Trout, or Basin Creek up to 7 times a month would result in exposure doses of 0.0004 mg/kg/day for adults and 0.0008 mg/kg/day for children (see Table C-4). As noted above, the metabolism of inorganic arsenic has been extensively studied in humans and animals. ATSDR's estimated doses are well below those that inhibit the body's ability to detoxify or change it to non-harmful forms (doses greater than 0.05 mg/kg/day inhibit detoxification). Therefore, the amount of arsenic that a person might consume in fish from the creeks should be controlled by normal metabolic processes in the body. In addition, several studies reported CELs ranging from 0.01–0.05 mg/kg/day, which are also much higher than the estimated doses (ATSDR 2000a). Considering the use of the conservative assumptions noted previously and that ATSDR did not account for only 1–20% of the

total arsenic was the more harmful inorganic form, ATSDR concludes that the arsenic levels are too low to be of health concern for either children or adults who could have eaten fish from Mullet, Trout, and Basin Creeks.

Table C-1
Chemicals Detected Above Comparison Values at IRP Sites within the Tom's Bayou Drainage Basin

Chemical	Maximum Concentration	Comparison Value	Type
Surface Water (ppb)			
Arsenic	1.6	0.02	CREG
Antimony	5.3	4	child RMEG
Thallium	2.5	0.5	MCLG/LTHA
Trichloroethene	1.6	0.09	CREG
Dichlorodiphenyldichloroethane (DDD)	0.3	0.1	CREG
Dichlorodiphenyldichloroethylene (DDE)	0.29	0.1	CREG
Dichlorodiphenyltrichloroethane (DDT)	2.9	0.1	CREG
Dieldrin	0.019	0.002	CREG
Heptachlor	0.049	0.008	CREG
Aroclor-1254	0.5	0.2	child RMEG
Sediment (ppm)			
Arsenic	57	0.5	CREG
Benzo(a)pyrene	4.9	0.1	CREG
Benzo(a)anthracene	6.8	0.87	RBC
Benzo(b)fluoranthene	5.6	0.87	RBC
Dibenz(a,h)anthracene	1.2	0.087	RBC
Indeno(1,2,3-cd)pyrene	3	0.87	RBC
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.00082	0.00005	chronic child EMEG
DDD	4	3	CREG
DDE	2.2	2	CREG
DDT	70	2	CREG

Table C-1
Chemicals Detected Above Comparison Values at IRP Sites within the Tom's Bayou Drainage Basin (continued)

Chemical	Maximum Concentration	Comparison Value	Type
Dieldrin	0.21	0.04	CREG
Aroclor-1260	4	0.32	RBC

Notes: The concentrations listed are the maximums from the available data for all sites within the drainage basin.
Lead was evaluated by calculating a cumulative blood lead level. The resulting blood lead level from the maximum concentration (1,100 ppm) was below CDC's effects level of 10 µg/dl (7.5 µg/dl).

Abbreviations: CREG - cancer risk evaluation guide
EMEG - environmental media evaluation guide
LTHA - lifetime health advisory for drinking water
MCLG - maximum contaminant level goal
RBC - risk-based concentration
ppb - parts per billion
ppm - parts per million

Table C-2
Exposure Doses for Chemicals Above Comparison Values at IRP Sites within the Tom's Bayou Drainage Basin

Chemical	Maximum Detected Concentration (ppm)	Estimated Exposure Dose (mg/kg/day)		Oral Health Guideline (mg/kg/day)	Basis for Health Guideline
		Adult	Child		
Surface Water					
Arsenic	0.0016	8.1×10^{-6}	3.6×10^{-5}	0.0003	chronic MRL
Antimony	0.0053	1.1×10^{-5}	5.0×10^{-5}	0.0004	chronic RfD
Thallium	0.0025	5.4×10^{-6}	2.3×10^{-5}	0.00007	chronic RfD
Trichloroethene	0.0016	3.4×10^{-6}	1.5×10^{-5}	0.006	chronic RfD
DDT	0.0029	6.2×10^{-6}	2.7×10^{-5}	0.0005	chronic RfD
Dieldrin	0.000019	4.1×10^{-8}	1.8×10^{-7}	0.00005	chronic MRL
Heptachlor	0.000049	1.1×10^{-7}	4.6×10^{-7}	0.0005	chronic RfD
Aroclor-1254	0.0005	1.1×10^{-6}	4.7×10^{-6}	0.00002	chronic RFD
Sediment					
Arsenic	57	8.1×10^{-5}	**7.1×10^{-4}**	0.0003	chronic MRL
TCDD	0.00082	**1.2×10^{-9}**	**1.0×10^{-8}**	1.0×10^{-9}	chronic MRL
DDT	70	1.0×10^{-4}	**8.8×10^{-4}**	0.0005	chronic RfD
Dieldrin	0.21	3.0×10^{-7}	2.6×10^{-6}	0.00005	chronic MRL

Notes: **Bolded** text indicates that the calculated exposure dose is above the health guideline.

DDD and DDE in surface water were evaluated for cancer health effects using an EPA cancer slope factor only because a noncancer health guideline is not available. The resulting risks were within acceptable ranges (DDD: 6.6×10^{-8} and DDE: 9.1×10^{-8}).

Benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, DDD, DDE, and aroclor-1260 in sediment were evaluated for cancer health effects using an EPA cancer slope factor only because a noncancer health guideline is not available. The resulting risks were within acceptable ranges (benzo(a)pyrene: 2.2×10^{-5}, benzo(a)anthracene: 3.0×10^{-6}, benzo(b)fluoranthene: 2.5×10^{-6}, dibenz(a,h)anthracene: 5.4×10^{-6}, indeno(1,2,3-cd)pyrene: 1.3×10^{-6}, DDD: 5.9×10^{-7}, DDE: 4.5×10^{-7}, and aroclor-1260: 4.9×10^{-6}).

Abbreviations: MRL - minimal risk level
RfD - reference dose
mg/kg/day - milligrams per kilogram per day
ppm - parts per million

Table C-3
Chemicals Detected Above Comparison Values in Mullet, Trout, and Basin Creeks

Chemical	Maximum Concentration	Comparison Value	Type
Surface Water (ppb)			
Arsenic	3.0	0.02	CREG
Aldrin	0.013	0.002	CREG
Heptachlor	0.01	0.008	CREG
delta-Hexachlorocyclohexane- (HCH)	0.007	0.006	CREG
Sediment (ppm)			
Arsenic	4	0.5	CREG
Benzo(a)pyrene	0.34	0.1	CREG
Fish (ppm)			
Arsenic	0.48	0.0021	RBC
Benzo(a)pyrene	0.0025	0.00043	RBC
Aldrin	0.00085	0.00019	RBC
Heptachlor	0.00085	0.0007	RBC
delta-HCH	0.00085	0.0005	RBC

Abbreviations: CREG - cancer risk evaluation guide
RBC - risk-based concentration
ppb - parts per billion
ppm - parts per million

Table C-4
Exposure Doses for Chemicals Above Comparison Values in Mullet, Trout, and Basin Creeks

Chemical	Maximum Detected Concentration (ppm)	Estimated Exposure Dose (mg/kg/day)		Oral Health Guideline (mg/kg/day)	Basis for Health Guideline
		Adult	Child		
Surface Water					
Arsenic	0.003	6.4×10^{-6}	2.8×10^{-5}	0.0003	chronic MRL
Aldrin	0.000013	2.8×10^{-8}	1.2×10^{-7}	0.00003	chronic MRL
Heptachlor	0.00001	2.1×10^{-8}	9.4×10^{-8}	0.0005	chronic RfD
delta-HCH	0.000039	8.4×10^{-8}	3.7×10^{-7}	0.0003	chronic RfD (gamma-HCH)
Sediment					
Arsenic	4	5.7×10^{-6}	5.0×10^{-5}	0.0003	chronic MRL
Fish					
Arsenic	0.48	**3.7×10^{-4}**	**8.1×10^{-4}**	0.0003	chronic MRL
Aldrin	0.00085	6.6×10^{-7}	1.4×10^{-6}	0.00003	chronic MRL
Heptachlor	0.00085	6.6×10^{-7}	1.4×10^{-6}	0.0005	chronic RfD
delta-HCH	0.00085	6.6×10^{-7}	1.4×10^{-6}	0.0003	chronic RfD (gamma-HCH)

Notes: Only arsenic in fish was detected above the health guideline **(bolded)**.
Benzo(a)pyrene was evaluated for cancer health effects using an EPA cancer slope factor only because a noncancer health guideline is not available. The resulting risks were within acceptable ranges (sediment: 1.5×10^{-6} and fish: 6.0×10^{-6}).

Abbreviations: MRL - minimal risk level
RfD - reference dose
mg/kg/day - milligrams per kilogram per day
ppm - parts per million

1.See Appendix A for ATSDR's Conclusion Categories.