PUBLIC HEALTH ASSESSMENT

NAVAL CONSTRUCTION BATTALION CENTER GULFPORT
GULFPORT, MISSISSIPPI

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FOREWORD

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LIST OF ABBREVIATIONS

AFESC	Air Force Engineering and Services Center
AO	Administrative Order
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREG	cancer risk evaluation guide (ATSDR)
CV	comparison value
DOD	Department of Defense
ENSCO	Environmental Services Company
EPA	U.S. Environmental Protection Agency
HO	Herbicide Orange
IAS	Initial Assessment Study
IR	Installation Restoration
LOAEL	lowest observed adverse effect level
MCL	EPA's maximum contaminant level
MRL	minimal risk level (ATSDR)
MDEQ	Mississippi Department of Environmental Quality
NCBC	Naval Construction Battalion Center
NPL	national priorities list
NSCRF	National Study of Chemical Residues in Fish
PAS	Public Availability Session
OBAOC	off base area of concern
PHA	public health assessment
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
ppq	parts per quadrillion
RAB	Restoration Advisory Board
RBC	risk-based concentration (EPA)
RCRA	Resource Conservation and Recovery Act
RfD	reference dose (EPA)
RMEG	reference media evaluation guide (ATSDR)
TCDD	2,3,7,8 tetrachlorodibenzo-p-dioxin
TCE	trichloroethylene
TDI	tolerable daily intake
TEF	toxicity equivalent factor
TEQ	toxicity equivalent
USAF	U.S. Air Force
WHO	World Health organization

I SUMMARY

The Naval Construction Battalion Center (NCBC) is an active base covering approximately 1,100 acres in Gulfport Mississippi, approximately two miles north of the Gulf of Mexico. NCBC was officially established in June 1942. In 1952 all activities were consolidated into one unit referred to as NCBC. The primary mission of NCBC is to support the 20th Naval Construction Regiment, four Naval Mobile Construction Battalions, the Naval Construction Training Center, and other small tenant commands. Another primary role of the facility is to provide storage and shipping capabilities for the Navy and its fleet.

The nature of NCBC's mission has required the use, handling, storage, and disposal of hazardous materials. Additionally, as part of a cooperative agreement between the U.S. Air Force (USAF) and NCBC Gulfport, Herbicide Orange (HO), commonly referred to as Agent Orange, was stored at a 31-acre site (Site 8) at NCBC by the USAF between 1968 and 1977. HO was a defoliating agent and was used by the military during Vietnam to destroy covering vegetation denying cover and concealment to enemy troops in dense terrain. During the late 1960s and early 1970s published studies reported that toxicity associated with HO was caused by a specific contaminant identified as 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD or TCDD). TCDD is one of many dioxin compounds that are formed during the production of HO and is a byproduct of its use. Approximately 850,000 gallons of HO, contained in 55-gallon drums, was stored at Site 8. As a result of spills and leaks that occurred during HO storage, dioxin has migrated through the network of on-site ditches to off-site swampland, near Outfall 3, and to other off-site locations surrounding NCBC (e.g., Brickyard Basin).

In 1985, NCBC began identifying potential sources of contamination requiring evaluation and possible clean up under the Department of Defense's Installation Restoration Program. Although areas of contamination have been identified at NCBC, the Center has not been placed on the U.S. Environmental Protection Agency's (EPA's) National Priority List. An Administrative Order by the Mississippi Department of Environmental

Quality (MDEQ) was issued in 1996 requiring on- and off-site delineation of contamination and remediation of dioxin and dioxin-related constituents that potentially have been released to the environment by Site 8.

Acting on a request from a community member, the Agency for Toxic Substances and Disease Registry (ATSDR) visited NCBC in July 2003. During the site visit ATSDR met with NCBC representatives, toured the facility, reviewed site documents, and met with community members. In October 2003, ATSDR attended a Restoration Advisory Board (RAB) meeting. During this meeting ATSDR provided an update on its public health assessment activities related to NCBC. Immediately following the RAB meeting, ATSDR held a separate public availability session (PAS) to discuss community health concerns with residents and other interested parties.

ATSDR has been in contact with members of the Gulfport community who have expressed concerns about past dioxin exposure, specifically related to frequent recreational activities (e.g., fishing or swimming) associated with the drainage ditch system and off-site locations that may have received contaminated soil and sediments. ATSDR has worked with community members and NCBC representatives to identify locations where additional environmental sampling is needed. To prepare this PHA, ATSDR reviewed available environmental sampling data from investigations at NCBC. ATSDR also consulted with representatives from the Navy's Environmental Health Center (NEHC), NCBC personnel, and community members about environmental and public health issues and community concerns associated with NCBC. Based on this evaluation, ATSDR identified three exposure situations for further evaluation.

Exposure Situations Identified at NCBC

1. Coming into contact with dioxin-contaminated soil, sediment, and surface water migrating off-site from the former Herbicide Orange Storage Area.

2. Eating fish, other edible wildlife, and homegrown produce from of-site locations near NCBC

3. Potential for breathing in contaminated air from past incineration of dioxin-contaminated soils at the former Herbicide Orange Storage Area.

ATSDR's conclusions related to the three exposure situations follows and are also summarized in Table 1 at the end of Section III of this report.

- **Coming into contact with dioxin-contaminated soil, sediment and surface water**.

  Contact with Soil and Sediment: The average dioxin levels detected in off-site surface soils and sediments were well below ATSDR's established action level of 1 part per billion (ppb) for dioxin in soil. Extensive off-site sampling has been conducted in the drainage areas and surface water bodies near NCBC. It is possible that dioxin concentrations in off-site soil and sediment could have been higher when the HO-related contamination was initially transported off site through the drainage ditches. However, monitoring programs in place during the mid 1980s did not identify dioxin contamination off site at significantly higher levels than what was observed in more recent sampling efforts. The swampy area north of Canal # 3, referred to as the off-base area of concern (OBAOC), was the most contaminated off-site location and did not contain dioxins in soil and sediment at levels that have been demonstrated to cause illness or measurable adverse health effects.

  HO drums are no longer stored at NCBC and removal actions, both on site and off site, have occurred at locations where dioxins have been detected above state and federal regulatory cleanup levels for dioxin-contaminated soils. Since the source of dioxin exposure has been removed, ATSDR concludes that current and future exposures to dioxin-contaminated soil and sediment off-site at NCBC will not result in illness or harmful effects.

Coming into contact with dioxin-contaminated surface water: *ATSDR concludes that coming in contact with surface water off site near NCBC did not result in harmful exposures.* Most surface water samples collected off site at NCBC contained levels of dioxin that are below EPA's MCL of 30 ppt established for drinking water. Although past measurements of dioxins in surface water are not available, it is likely that residents were exposed only to very low concentrations since dioxins are not readily soluble in water.

ATSDR did not identify levels of dioxins in surface water that are a current health concern or would pose a concern in the future.

- **Eating fish, wildlife, and homegrown produce from areas near NCBC**

Consumption of Fish: ATSDR does not have sufficient information about past consumption rates and dioxin levels in fish to make a public health determination. Dioxin-related contamination did migrate off site, impacting the nearby drainage areas and fish and wildlife habitats adjacent to NCBC. ATSDR has not identified any off-site locations where dioxins in sediments were at levels of public health concern. It is unlikely that fish from the drainage ditches and nearby creeks accumulated dioxins at levels that would have caused harm for recreational consumption of fish. Recent environmental and biological sampling data indicate that common fishing locations such as Turkey and Brickyard Creek are not significantly impacted by dioxin contamination from NCBC. It is possible, however, that frequent consumption of fish (e.g., subsistence fishers consuming greater than 16 [8-ounce] fish meals per month) over several years from the most heavily dioxin-contaminated locations could have resulted in exposures that are higher than the general population. ATSDR has not identified any subsistence populations in the immediate NCBC Gulfport vicinity and historical investigations of the drainage ditches, both on-site and off-site ditches near NCBC Gulfport suggest that the availability of edible fish was not sufficient for a subsistence population.

Current and future consumption of fish in off-site drainage areas and surface waters near NCBC do not pose a hazard. HO is no longer stored at NCBC and remedial actions have significantly reduced dioxin contamination at Site 8 and in the drainage ditch system, thereby reducing the potential for bioaccumulation into small aquatic organisms and larger edible fish off site.

Consumption of Wildlife: Since exposure from this pathway may have occurred in the past and levels of contaminants in wildlife were not known, ATSDR does not have sufficient information about past consumption rates and dioxin levels in wildlife to make a public health determination. Samples of edible species of wildlife other than fish (e.g., turtles, frogs, ducks) near NCBC were not collected for analysis during recent site investigations. Some biological samples were collected during earlier monitoring programs, but most were not common edible species. Dioxins in the small number of biological samples collected off site were not detected at levels known to be of health concern and it is unlikely that people would have been exposed to levels in edible wildlife tissue in the past that would result in health effects. Although residents have reported eating wildlife near NCBC Gulfport in the past, there is some uncertainty about how frequently people harvested edible wildlife other than fish from the most contaminated off-site locations.

Current and future consumption of wildlife in off-site drainage areas and surface waters near NCBC do not pose a hazard. NCBC has removed most significant sources of dioxin contamination on site and has taken measures to prevent migration of residual dioxin-contaminated soil and sediment off site.

Consumption of Homegrown Produce*:* This exposure pathway did not result in past exposures that were harmful. Although fruits and vegetables were not collected for dioxin analysis at NCBC, dioxins do not readily accumulate in plant tissues and are detected infrequently in washed fruits or vegetables that are harvested above ground (e.g., tomatoes, corn, apples). Most dioxin-related exposure from garden vegetables is from the soil that adheres to root crops and leafy low growing vegetables (e.g., potatoes, spinach, strawberries). ATSDR believes that average dioxin concentrations detected in off-site surface soil, even in the OBAOC, were not sufficiently elevated to contaminate edible fruits and vegetables at levels that would cause adverse health effects in people.

- **Potential for breathing in contaminated air in the past from incineration of dioxin-contaminated soils.**

  From November 1987 to November 1988, NCBC incinerated approximately 26,000 tons of contaminated soils excavated from the former HO storage area (Site 8). Before this project took place, NCBC was first required to demonstrate to EPA that the incinerator could very efficiently destroy the organic contaminants in the waste, while not harming the public's health or the environment. After NCBC completed two demonstration tests, EPA issued the facility a permit to operate the incinerator. During selected time frames while the incinerator operated, NCBC collected samples of contaminants coming out of the stack and collected ambient air samples downwind of the excavation and incineration activities. None of the sampling results showed contamination at levels of public health concern. Based on this observation and the fact that the incinerator was designed to temporarily shutdown whenever critical operating conditions exceeded those specified in the permit issued by EPA, ATSDR concludes that contaminants released in 1987 and 1988 from the incinerator posed no harm to human health.

Recommendations

1. ATSDR supports NCBC Gulfport's ongoing investigations and remedial activities related to the Equipment Training Landfill (Site 5) and recommends continued monitoring of the soil cover. NCBC Gulfport should take appropriate actions to ensure that contaminants do not migrate to the Pinewood Housing Area or become accessible for contact.

2. The Navy's past searches and ongoing environmental investigations have not identified disposal locations for the empty HO containers. ATSDR recommends that the Navy continue its search for available information and document, as best possible, 1) the disposition of the empty HO drums from site 8 and; 2) the removal and transport of any soil and sediment from Canal # 1 to off-site disposal areas or other residential locations.

3. ATSDR recommends that the Mississippi Department of Health conduct a review of available registry data to determine if any unusual patterns of cancer incidence are observed in the areas near NCBC Gulfport.

II BACKGROUND

1. Site Description and Operational History

Naval Construction Battalion Center (NCBC) is located in the city of Gulfport, Harrison County, in the southeastern corner of Mississippi (Figure 1) (ABB-ES 1992). The center occupies 1,100 acres in western Gulfport, approximately two miles north of the Gulf of Mexico. The city of Long Beach borders the centers western boundary. The center is fenced and all entrances are secured to restrict unauthorized personnel from trespassing onto NCBC property (Harding Lawson 1999a; ABB-ES 1992).

Naval Construction Force personnel commonly referred to as “Seabees,” have been the military construction unit of the U.S. Navy since 1942. NCBC, originally Camp Hollyday, was officially established in June 1942 as an Advanced Base Depot. During the next several decades the facility continued to expand and in 1952 many of its activities were consolidated into one unit referred to as NCBC (ABB-ES 1992; NAVFAC 1998). The primary mission of NCBC is to support the 20th Naval Construction Regiment, four Naval Mobile Construction Battalions, the Naval Construction Training Center, and other small tenant commands. Another primary role of the facility is to provide storage and shipping capabilities for the Navy and its fleet. NCBC contains 37 acres of secured storage and 124 acres of open storage (NAVFAC 1998).

The nature of NCBC’s mission has required the use, handling, storage, and disposal of hazardous materials. Herbicide Orange (HO), a defoliating agent, was stored at a 31-acre site at NCBC by the U.S. Air Force (USAF) between 1968 and 1977. The site was used as a staging area for HO before its shipment to South Vietnam. Approximately 850,000 gallons of HO, contained in 55-gallon drums, was stored on the site (Harding Lawson 2001a). As a result of spills and leaks that occurred during HO storage, dioxin has migrated through the network of on-site ditches to off-site swampland, near Outfall 3, and portions of Brickyard Basin, south and east of NCBC (Tetra Tech 2002a).

2. Remedial and Regulatory History

In the past, there were few regulations governing the operations involving hazardous materials. In 1980, the Department of Defense (DOD) implemented a program to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, referred to as the Installation Restoration (IR) Program. The IR program was designed to identify past disposal sites and clean up any potential hazards in an environmentally responsible manner (NCBC 1994).

CERCLA, as amended, requires that the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) include a list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States. The National Priorities List (NPL) constitutes this list. The NPL is intended primarily to guide the U.S. Environmental Protection Agency (EPA) in determining which sites warrant further investigation. In 1985, NCBC began identifying potential hazardous waste sites requiring evaluation and possible clean up under the IR program. Although areas of contamination have been identified at NCBC, the Center has not been placed on EPA's National Priority List (NPL) as of this writing (NCBC 1994; Tetra Tech 2003a). The Mississippi Department of Environmental Quality (MDEQ) issued an administrative order (AO) in February 1996 requiring the on- and off-site delineation and remediation of dioxin and dioxin-related constituents that potentially have been released to the environment by Site 8 (ABB-ES 1997).

There are nine principle areas of investigation at NCBC

Six landfills:

Site 1 — Disaster Recovery Disposal Area
Site 2 — World War II Landfill
Site 3 — Northwest Landfill and Burn Pit
Site 4 — Golf Course Landfill
Site 5 — Heavy Equipment Training Area Landfill
Site 7 — Rubble Disposal Area

A former fire-fighting training area (Site 6);

A former HO storage site (Site 8): During the late 1960s through about 1977 the Air Force stored HO at NCBC; and

A PCB transformer oil spill area (Site 10).

NCBC is conducting environmental investigations of the former HO storage site (Site 8) under the AO. The AO establishes a comprehensive strategy to delineate and, when appropriate, clean up dioxin contamination resulting from the prior storage and handling of HO at NCBC. Appendix A provides a description of the former HO storage area (Site 8) as well as the other designated sites along with corresponding investigations, corrective activity, and ATSDR's public health hazard determination. Figure 2 shows the NCBC boundary and the location of each of the designated source areas (i.e., Sites 1-8 and 10).

3. ATSDR Involvement

In January 2003, ATSDR received a letter from a community member that expressed concerns about dioxin contamination that had migrated off the NCBC property boundaries. The community member asked that ATSDR evaluate the public health threats from dioxin contamination, and to determine if there was a possibility that exposure could be the cause of perceived increases in illness in the community.

ATSDR staff spoke with the concerned community member shortly after receiving the letter and representatives from ATSDR's Region 4 office met with the community member and toured areas of concern in the neighborhoods surrounding the base.

ATSDR conducted a site visit to NCBC between July 15 and July 17, 2003. During the site visit ATSDR met with NCBC representatives, toured the facility, and reviewed site documents. ATSDR also met with three community members who expressed concerns about the health of people who live near NCBC and wanted to know if site-related contaminants may be causing increased illness in their community.

On October 7, 2003, ATSDR attended a Restoration Advisory Board (RAB) meeting held at the Isiah Fredericks Community Center in Gulfport. During this meeting ATSDR provided an update on its public health assessment activities related to NCBC. Immediately following the RAB meeting, ATSDR held a separate public availability session (PAS) to discuss community health concerns with residents and other interested parties. During the PAS, ATSDR representatives were available to meet with people confidentially to discuss specific health concerns related to NCBC.

During the October visit, ATSDR representatives met concerned community members for a tour of areas in the community in close proximity to NCBC. The tour included several residential properties, portions of Turkey creek, canals and drainage ditches, and other areas of concern identified by community residents.

4. Demographics

ATSDR examines demographic information to identify the presence of sensitive populations, such as young children and the elderly, in the vicinity of a site. Demographics also provide details on residential history in a particular area, information that helps ATSDR assess time frames of potential human exposure to contaminants. Demographic information for the site and residential areas surrounding NCBC is presented in this section.

According to the 2000 U.S. Census, the population of Gulfport was approximately 71,000, an increase of nearly 10 percent from the 1990 census (Figure 3) (US Census Bureau 2000). There are approximately 3,700 active military personnel and 800 civilian personnel at NCBC. According to the Public Affairs Office, there are 900 resident family members living in on-base housing. In addition, approximately 1,500 drilling reservists use NCBC on an intermittent basis (U.S. Navy 1998; Jean Remley, Public Affairs Officer, Personal Communication, October 31, 2003).

There are no schools on NCBC property and one daycare facility is located in the south-central portion of NCBC. The daycare center serves up to 250 children through four years of age (Jean Remley, Public Affairs Officer, Personal Communication, October 31, 2003).

4. Land Use, Topography, and Natural Resources

Land use within one mile of NCBC consists primarily of residential and commercial use. The City of Gulfport supports a substantial tourism industry with a long stretch of coastline and a large port area (U.S. Navy 1998). Residential areas abut NCBC to the north, east, and southeast of the base.

The local topography of NCBC is relatively flat with the average elevation being about 23 feet above mean sea level. The terrain can be characterized as flat with localized swampy areas that extend along the gulf coast. Groundwater lies near the surface in this region and frequently pools in depressions during wet periods (Envirodyne 1985). Wetland areas, as defined by the EPA and US Army Corps of Engineers, have been identified on site and in off-site properties adjacent to NCBC. According to wetland delineation investigations conducted at NCBC, these areas are characterized as non-tidal, freshwater wetlands (Tetra Tech 2003b).

At NCBC, artificial lakes and surface impoundments are stocked with several varieties of fish for recreational fishing. Four ponds comprising a total area of 10 acres are recreationally fished. Three one-acre ponds, with an average depth of three feet, are stocked with channel catfish. A seven-acre pond, located at the golf course and approximately 5 feet deep, is stocked with largemouth bass, bluegill, redear sunfish, and channel catfish (Envirodyne 1985). There is one main recreational area on base, referred to as the CBC Lake and Recreational Area, used primarily for fishing and boating (Jean Remley, Public Affairs Officer NCBC, Personal Communication, October 31, 2003)

NCBC obtains drinking water from three supply wells on site. These supply wells are screened in the Miocene aquifer system. Most of the supply wells at NCBC withdraw water from a depth of 650 to 1,200 feet below the surface (Dames & Moore 1991; U.S. Navy 2004). Water from these wells is used for multiple purposes (e.g., drinking, cooking, fire fighting, and for industrial purposes). The City of Gulfport's municipal water system serves as a backup water supply to NCBC (EG&G 1990).

5. Hydrogeology

The Mississippi River and other smaller streams flowing into the Gulf of Mexico deposit large quantities of sand, gravel, and mud into the Mississippi delta plain. These sand and gravel deposits make up the principal aquifers in the Gulfport area (Dames & Moore 1991). Aquifers in the Gulfport area are at depths more than 500 feet below ground surface and the primary recharge areas are at least several miles north of the Gulfport area (Dames & Moore 1991).

Groundwater

Three aquifers are present in the Gulfport area: the Surficial Aquifer, the Citronelle Aquifer, and the Miocene Aquifer.

- The Surficial Aquifer is an unconfined aquifer near the surface consisting of sands and gravel that ranges between 13 and 45 feet in thickness (ABB-ES 1992). The water in this aquifer is considered to be of poor quality and is not used as a source of drinking water. Early groundwater investigations reported a southerly regional groundwater flow direction toward the Gulf of Mexico. However, recent investigations suggest that groundwater flow in the surficial aquifer primarily flows toward the north and northwest (ABB-ES 1992).

- The Citronelle Aquifer is primarily confined in the Gulfport area by a thick clay layer with varying amounts of quartz sand. It is generally found about 100 feet below land surface and ranges from zero to 300 feet thick.

Water that enters this aquifer either moves laterally and is discharged by seeps and springs or continues downward to the Miocene Aquifers (ABB-ES 1992).

- The Miocene Aquifer system is typically confined consisting of thick beds of clean quartz or gravel and is recharged through infiltration of precipitation and by mixing with the Citronelle Aquifer. Groundwater flow in this aquifer system is generally towards the Gulf of Mexico. The Miocene Aquifer is the primary groundwater source in the area and most potable water in the vicinity of NCBC is obtained from groundwater wells that are screened in the Miocene Aquifer (ABB-ES 1992).

Surface Water

Harrison County is located within the Coastal Streams basin, bounded on the west by the Pearl River basin and on the north and east by the Pascagoula River basin. NCBC is primarily located in the Bernard Bayou watershed. No natural drainage systems are present at NCBC. Turkey Creek is the closest natural drainage system, approximately 2,000 feet north of the NCBC property line (ABB-ES 1992).

NCBC contains six engineered drainage areas, each comprising a network of shallow ditches, storm sewers, and culverts that transport surface water and sediments to five outfalls surrounding the perimeter of NCBC (Figure 4) (Harding Lawson 1999a). The culverts and ditches are 2 to 5 feet lower than the land surface. The bottom of the surface water drainage system may intersect the shallow aquifer water system or may be just above it depending on precipitation patterns (Dames & Moore 1991).

Surface water runoff from Site 8A (Former HO Storage Area) is collected by a system of man-made shallow ditches that primarily drain into Canal No. 1. Canal No. 1 discharges north into Turkey Creek, eventually draining into the Gulf of Mexico (ABB-ES 1992). A large portion of the central and western portion of NCBC also drains into Canal No. 1. The eastern portion of NCBC drains to Brickyard Bayou, which drains east to Bernard Bayou. Some of the southern portions of NCBC drain south into the City of Gulfport storm sewer system, which ultimately discharges to the Gulf of Mexico (Envirodyne

1985). Surface water flow rates are typically very low or stagnant except in response to larger precipitation events (Harding Lawson 1987).

As mentioned previously, the drainage ditches and culverts on site transport water to a series of outfalls that discharge surface water off site. Some of the areas immediately off site of NCBC are considered wetlands, as defined by EPA and the U.S. Army Corps of Engineers (see Glossary-Appendix E). A wetland area, referred to as the off base area of concern [OBAOC] extends off site beginning at Outfall 3, which discharges from the NCBC drainage ditch network into a ditch on the north side of 28^{th} Street, and has been the focus of dioxin investigations and removal actions by NCBC. According to the Wetland Delineation Report for Off-base Areas, all of the wetlands north of Outfall 3 are non-tidal, freshwater wetlands (Tetra Tech 2003b).

6. Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the CERCLA program must meet standards for quality assurance and control measures for chain-of-custody, laboratory procedures, and data reporting. The environmental data presented in this PHA come from site characterization, remedial investigation, and groundwater monitoring reports prepared by NCBC under CERCLA and Resource Conservation and Recovery Act (RCRA). Based on our evaluation, ATSDR determined that the quality of environmental data available for NCBC is adequate for making public health decisions.

III ENVIRONMENTAL CONTAMINATION, HUMAN EXPOSURE PATHWAYS, AND PUBLIC HEALTH IMPLICATIONS

In this section, ATSDR evaluates whether community members have been (past), are (current), or will be (future) exposed to harmful levels of chemicals. Figure 5 describes the exposure evaluation process used by ATSDR. ATSDR screens the concentrations of contaminants in environmental media (e.g., groundwater or soil) against health-based comparison values (CVs) (Refer to text box below and Appendix B). Because CVs are not thresholds of toxicity, environmental levels that exceed CVs would not necessarily produce adverse health effects. If a chemical is found in the environment at levels exceeding its corresponding CV, ATSDR further evaluates site-specific exposures and likelihood of adverse health effects

What is meant by exposure?

ATSDR's PHAs are driven by evaluation of the potential for human exposure, or contact with environmental contaminants. Chemical contaminants released into the environment have the potential to cause adverse health effects. However, *a release does not always result in human exposure*. People can only be exposed to a contaminant if they come in contact with it—if they breathe, eat, drink, or come into skin contact with a substance containing the contaminant.

How does ATSDR determine which exposure situations to evaluate?

ATSDR scientists evaluate site conditions to determine if people could have been, are, or could be exposed (i.e., exposed in a past scenario, a current scenario, or a future scenario) to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, sediment, water, air, or biota) has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation.

If exposure was, is, or could be possible, ATSDR scientists consider whether contamination is present at levels that might affect public health.

About ATSDR's Comparison Values (CVs)

CVs are not thresholds for adverse health effects. ATSDR CVs represent contaminant concentrations many times lower than levels at which no effects were observed in experimental animals or human epidemiologic studies. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency of exposure), the toxicology of the contaminant, other epidemiology studies, and the weight of evidence for health effects. Some of the CVs used by ATSDR scientists include:

EMEGs — environmental media evaluation guides
RMEGs — reference dose media evaluation guides,
CREGs — cancer risk evaluation guides, and
MCLs — EPA's maximum contaminant levels (MCLs).

EMEGs, RMEGs, and CREGs are non-enforceable, health-based CVs developed by ATSDR for screening environmental contamination for further evaluation. MCLs are enforceable drinking water regulations developed to protect public health.

You can find out more about the ATSDR evaluation process by reading ATSDR's Public Health Assessment Guidance Manual at: http://www.atsdr.cdc.gov/HAC/HAGM/, or contacting ATSDR at 1-888-42ATSDR.

How does ATSDR decide which contaminants may be present at levels that are of concern?

ATSDR scientists select contaminants for further evaluation by comparing them against health-based CVs. These are developed by ATSDR from available scientific literature related to exposure and health effects. CVs are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed or an amount of air breathed) and body weight.

In the case of dioxin (specifically 2,3,7,8-TCDD) in soil, for example, ATSDR has developed a health-protective framework for evaluating potential exposure pathways. At sites where dioxin-contaminated soil is a potential hazard ATSDR initially screens all soil samples collected against ATSDR's health-protective child environmental media evaluation guide (EMEG) for dioxin, which is 50 parts per trillion (ppt). If one or more sampling values exceed the screening value for TCDD (or dioxin toxicity equivalency factor [TEF]) of 50 ppt, further site-specific evaluations are conducted (DeRosa 1999).

Where estimated levels of exposure in soil fall in the range of greater than 50 ppt to less than 1 ppb, a weight of evidence approach is used to evaluate the exposure and potential public health implications. ATSDR has established an action level of 1 ppb for dioxin (TCDD toxicity equivalents [TEQ]) in soil. Where a completed exposure pathway has been identified and concentrations in residential soils exceeding 1 ppb TEQs appear to be significant (i.e., multiple sampling locations showing dioxin levels greater than 1 ppb rather than one outlier sample exceeding 1 ppb), ATSDR designates the site a public health hazard and considers site-specific public health recommendations or actions to prevent or reduce any future exposures. These public health actions may include, but are not limited to, recommending health studies, community education, physician education, and exposure investigations (DeRosa 1999).

Following the strategy outlined above, ATSDR examined whether human exposure to harmful levels of contaminants from these pathways existed in the past, exists now, or could potentially exist in the future near NCBC Gulfport. To acquaint readers with terminology used in this report, a glossary is included in Appendix E.

If someone is exposed, will they get sick?

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

In almost any situation, there is considerable uncertainty about the true level of exposure to environmental contamination. To account for this uncertainty and to be protective of public health, ATSDR scientists typically use worst-case exposure level estimates as the basis for determining whether adverse health effects are possible. These estimated exposure levels usually are much higher than the levels that people are actually exposed to. If the exposure levels indicate that adverse health effects are possible, ATSDR performs a more detailed review of exposure, also consulting the toxicologic and epidemiologic literature for scientific information about the health effects from exposure to hazardous substances.

What potential exposure situations were evaluated for NCBC?

ATSDR reviewed the environmental data generated from environmental investigations at NCBC to determine if there are any associated past, current, or future public health hazards. This included soil (surface and sub-surface), sediment, groundwater, surface water, and biological (e.g., fish tissue) sampling data. During this evaluation process ATSDR met with members of the community and recorded specific concerns that may have resulted in a past or current exposure pathway. In addition, ATSDR requested available health outcome data collected by the state of Mississippi to identify any unusual diseases or illnesses that are tracked by routine surveillance or disease registries maintained by the state. ATSDR identified *three* potential exposure situations at and near NCBC for further evaluation:

1. Coming into contact with dioxin-contaminated soil, sediment, and surface water migrating off-site from the former HO Storage Area (Site 8).
2. Eating fish, other edible wildlife, and homegrown produce from areas near NCBC.
3. Potential for breathing contaminated air from past incineration of dioxin-contaminated soils at the former HO Storage Area (Site 8).

On the basis of site visits, meetings with community members, and review of environmental monitoring and investigation results, ATSDR selected these three exposure situations for further evaluation. ATSDR also evaluated the potential exposures to other site-related contaminants (e.g., solvents and fuel spills) at NCBC. A description of the site (i.e., source areas), waste disposal history, results of investigations, remedial activities, and ATSDR's evaluation of public health hazards associated with the sites at NCBC are presented in Appendix A. Community members have expressed concern about other ways they might have previously been exposed to dioxin. For example, some residents asked if they might have been exposed to dioxin during NCBC's past use of HO for weed control along the fence line or if they might have been exposed to dioxin vapors that were released from leaking containers and spills. Readers should refer to Section IV of this PHA for ATSDR's responses to these specific community concerns.

ATSDR's evaluation at NCBC focuses on potential exposures resulting from the release and transport of HO and HO-related contaminants such as dioxins. Dioxins are a group of chemicals that have similar structures and chemical properties. Not all dioxins have the same toxicity. The most toxic chemical in the group is the 2,3,7,8-Tetrachlorodibenzo-para-dioxin (2,3,7,8-TCDD). Because it is the most toxic, 2,3,7,8-TCDD is the standard to which other dioxins are compared. When the other dioxins are measured in the environment, they are often converted to a 2,3,7,8-TCDD equivalent concentration. These converted dioxin values are added together to obtain a TEQ value. Appendix C contains additional information about calculating the 2,3,7,8-TCDD TEQ concentrations. The three potential exposure situations evaluated in this PHA are summarized in the Potential Exposure Pathways table (Table 1) and discussed in detail below.

Table 1: Exposure Situation Summary Table – NCBC Gulfport

Exposure Situation	Time Frame	Exposure:	Public Health Hazard	Actions Taken or Recommended	Comments
1. **Coming into contact with dioxin-contaminated soil, sediment, and surface water migrating off-site from the former Herbicide Orange storage area.**					
▪ Coming in frequent contact (e.g., playing or recreating) with contaminated soils near drainage outfalls near the NCBC property line. ▪ Transport of contaminated soil to locations where people could come in frequent contact with it (e.g., playing in the dump, dump digging, using soils for gardening, etc) ▪ Swimming and wading in creeks, ditches, and other surface water bodies near NCBC	Past Current Future	Possible Unlikely Unlikely	There was the potential for past exposure to dioxins in surface soil and sediments transported off site via drainage ditches and canals.	Actions taken include: On-Site: ❑ In November 1987, EPA Region IV provided final approval to incinerate dioxin-contaminated soil (> 1 ppb) on site at NCBC Gulfport. The remediation was completed in 1988. ❑ Sediment Recovery Traps (SRTs) were installed in April/May 1995 at 12 locations around the northern and southern perimeter of NCBC Gulfport. The SRTs are barriers that help slow the movement of sediment in ditches. Off-Site: ❑ Surface soil and sediment sampling has been conducted in drainage ditches and swampy areas north of NCBC. Off-site soil and sediment removal actions have occurred at locations along 28th Street (1995), along Perry Street (1996), at residential properties located within the OBAOC (2002), and locations adjacent to Canal Road culverts (2003).	***Past Exposure***: People may have come in contact with dioxin-contaminated soils and sediments in the past, especially if routine activities involved frequent contact with the off-site drainage ditches near NCBC. Off-site sampling of soil and sediment since the late 1970s showed that dioxin levels were below those levels that are known to cause health effects. However, the monitoring program was initiated in 1977 and data are not available for the time period when HO was actually stored at Site 8 (i.e., between 1968 and 1977). Sampling confirms that **surface water does not pose a public health hazard** in off-site locations. ***Current and future Exposure***: HO is no longer stored at NCBC Gulfport and contaminated soils and sediments have been removed. The incinerated ash was tested and confirmed to contain less than 1 ppb TCDD and, therefore, met the criterion for on-site backfill. **Current levels are below ATSDR's action level for dioxins in soil and do not pose a public health hazard.**

Table 1: Exposure Situation Summary Table – NCBC Gulfport					
Exposure Situation	**Time Frame**	**Exposure:**	**Public Health Hazard**	**Actions Taken or Recommended**	**Comments**
2. **Consuming fish, other edible wildlife, and homegrown produce from off-site locations potentially contaminated with dioxins.**					
▪ Eating contaminated fish from the drainage ditches and other surface water bodies near NCBC Gulfport ▪ Eating contaminated wildlife (e.g. frogs, crawfish, duck) from drainage ditch areas or other locations near NCB Gulfport. ▪ Consuming homegrown produce harvested in potentially contaminated soils near NCBC Gulfport.	Past Current & Future	Possible - fish - wildlife Unlikely - produce Unlikely - fish - wildlife - produce	There was the potential for past exposure to dioxins in fish and other edible wildlife that were collected from the drainage ditches near NCBC Gulfport. It is unlikely that washed fruits and vegetables contained site-related contaminants at levels that would be harmful. However, the ingestion of dioxin-contaminated soil from unwashed produce could result in some past exposure. No produce samples from local gardens have been collected and analyzed for dioxins.	Actions taken include: ❑ Limited biological sampling was conducted during environmental monitoring studies in the late 1970s and 1980s. ❑ A Creel Survey was conducted between January and April 1999 to determine fish consumption patterns (e.g., most common species collected and the frequency of consumption). ❑ A Human Health Risk Assessment report released in 2001 reports the results of dioxin analyses for fish samples collected during fall and spring 1999.	*Past Exposure:* ATSDR does not have sufficient information about past consumption rates and dioxin levels in fish and wildlife to make a public health determination and considers past consumption of fish and wildlife from drainage ditches, canals, and other surface waters near NCBC to be an **indeterminate public health hazard.** ATSDR concludes that consumption of homegrown produce did not result in past exposures that were harmful and classifies this exposure pathway as **no public health hazard.** *Current and Future Exposure:* ATSDR concludes that it is unlikely that current and future consumption of fish and edible wildlife near NCBC will result in harmful effects and, therefore, classifies these exposure pathways as **no apparent public health hazard.** Current or future exposures to dioxin contaminants in homegrown produce are very unlikely and do not pose a public health hazard.

Table 1: Exposure Situation Summary Table – NCBC Gulfport					
Exposure Situation	**Time Frame**	**Exposure:**	**Public Health Hazard**	**Actions Taken or Recommended**	**Comments**
3. Potential for breathing in contaminated air in the past from incineration of dioxin-contaminated soils.					
▪ Breathing in contaminated air from past incineration of dioxin contaminated soils at the former Herbicide Orange (HO) Storage Area (Site 8)	Past	Unlikely	ATSDR evaluated the potential for the on-site incinerator to emit contaminants in the air during its 12-month period of operation between 1987 and 1988.	Actions taken include: ❑ No actions have been taken or recommended for this exposure pathway	*Past Exposures*: While the incinerator released trace amounts of contamination to the air, the available emissions data and ambient air sampling data suggest that the contaminants were not released at levels that would harm local resident's health. Therefore, ATSDR concludes that the past incinerator operation from November 1987 to November 1988 did not result in harmful exposures and classifies this exposure pathway as **no apparent public health hazard.**

1. Coming into contact with dioxin-contaminated soil, sediment, and surface water off site (via surface water runoff and sediment migration from NCBC drainage system)

Issue:

Are people who come in contact (or who have come in contact in the past) with soil, sediments, and surface water exposed to harmful levels of dioxins originating at the Former HO Storage Area (Site 8)?

Characterization of Potential Exposure Pathway

The Herbicide Orange (HO) storage area has been a focus of environmental investigations since 1970 (USAF 1979). The Former HO Storage Area (Site 8) comprises approximately 30 acres in the north-central portion of NCBC. From 1968 through 1977, Site 8 was used as a storage area for approximately 850,000 gallons of the defoliant HO stored in 55-gallon drums (see text box below for more information about HO) (Tetra Tech 2003c).

According to site documents, the drums of HO were reported to have leaked onto the ground surface of the storage area in the late 1960s and early 1970s (ABB-ES 1992). As a result of the unintended release of HO into the environment at Site 8, the potential existed for dioxin-contaminated soil, surface water, and sediments to migrate towards on-site drainage ditches and subsequently to outfalls leading to off-site canals, swampy areas (i.e., wetlands), bayous, creeks, and streams. According to the Navy, in 1977, the HO was de-drummed and the HO and diesel rinse were transferred to the Dutch ship Volcanus for eventual incineration at sea. The empty drums were rinsed with diesel fuel and drained, crushed, and subsequently sold (or given to) a local smelter (U.S. Navy 2004; ABB-ES 1992).

What is Herbicide Orange (HO)?

HO was extensively used as a defoliant in Vietnam during the 1960s and also applied domestically for a period of time at some military bases (e.g. Eglin Air Force Base) and as a defoliant in forestry applications. HO primarily consists of two herbicide compounds, 2,4-dichlorophenoxyacetic- acid (Commonly known as 2,4-D) and; 2,4,5-trichlorophenoxyacetic acid (Commonly known as 2,4,5-T).

Around 1970 researchers studying the herbicide 2,4,5-T identified an unintended by-product referred to as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). TCDDs are a member of a family of 75 different compounds referred to as chlorinated dibenzo-p-dioxins (CDDs) (refer to Appendix F for more information about dioxins). CDDs may be formed during the manufacturing process of certain chlorinated organic chemicals including 2,4,5-T. These studies also showed that TCDD caused an increase in the rate of birth defects and cancer in animal studies. As a result of the findings of these studies, the Department of Defense (DOD) discontinued the use of HO in 1970. More information about health effects of dioxin exposure can be found on the ATSDR website at http://www.atsdr.cdc.gov/tfacts104.html or by calling the toll-free ATSDR information line at (888) 42-ATSDR.

Sources: ATSDR 1998; EG&G 1990

Numerous environmental investigations have been conducted to characterize the nature and extent of contamination associated with the Former HO Storage Area. Early in these investigations Site 8 was subdivided into three areas:

> Site 8A: Site 8A, the primary storage area consisting of approximately 13 acres, includes the upper reaches of the drainage areas for the eastern two-thirds of the base. Surface drainage from Site 8A flows to the northwest, exiting NCBC at Outfall 3 into a drainage system that feeds Canal No. 1. Prior to 1995, the surface water that exited through Outfall 3 discharged to a swampy area (i.e., OBAOC) that is a part of the Turkey Creek drainage basin (Tetra Tech 2003c). Canal No. 1 flows into Turkey Creek, which eventually drains into Bernard Bayou (Tetra Tech 2003c).

Site 8B — additional storage area: Site 8B consists of 18 acres located alongside and parallel to Site 8A. Surface water from Site 8B flows north and exits NCBC at Outfall 4, discharging to the Turkey Creek drainage basin (Tetra Tech 2003c).

Site 8C — additional storage area: Site 8C is a 1-acre parcel located alongside and parallel to Site 8B. Surface water from Site 8C predominately drains to the southeast, exiting NCBC at Outfall 2 into Brickyard Creek (Tetra Tech 2003c).

In 1984, the results of the initial HO monitoring program (1977-1984) were released. Soil samples were found to contain HO and HO byproducts such as TCDD. Between 1986 and 1988 the USAF excavated and incinerated (on site) soil at Site 8 that contained dioxins at concentrations of 1 ppb or greater (D&M 1991; Harding Lawson 2001a). Soil ash from the incineration of dioxin-contaminated soil was stored on Site 8A. The residual ash piles were reportedly exposed and in direct contact with soil on site. These ash piles, however, contained very low levels of dioxin (Tetra Tech 2003c). In response to finding detectable concentrations of HO in soil and sediments at the former HO storage area, NCBC conducted a "Comprehensive Soil Characterization Study" in 1987 and 1988 for Site 8A, 8B, and 8C (Envirodyne 1985; Dames & Moore 1991).

Base-wide sampling conducted in 1994 continued to identify detectable concentrations of HO and HO-byproducts (e.g., TCDD) in surface and subsurface soils at Site 8 and in sediments and surface waters in the drainage ditches on site (NCBC 1995a; Harding Lawson 1999a). NCBC subsequently conducted two rounds of off-site sampling; the first round was completed in March 1995 and the second round completed in April 1995, to characterize the magnitude and extent of dioxin migration off site (NCBC 1995b; NCBC 1995c).

In February 1996, MDEQ, issued an AO to both the Navy and Air Force requiring an on-site delineation study to identify the nature and extent of dioxin in sediment, surface water, soil, and groundwater within the boundaries of NCBC as well as in off-site locations (Harding Lawson 1999a). As a result of discussions with MDEQ, a series of delineation studies were initiated (post dioxin removal and incineration) at NCBC between 1995 through 1999. The sampling program was divided into two phases: Phase I activities were conducted during April and May 1997 and Phase II activities were initiated in the fall of 1997.

In September 2002, dioxin-contaminated sediment and soil were removed from the drainage ditches and from portions of Site 8. Approximately 2,600 cubic yards of contaminated materials were excavated from approximately 3,800 feet of ditches at Site 8 (CCI 2003). The removal of sediment and soils was followed up with confirmatory sampling. Several other smaller scale removal actions on and off site have occurred since 1995 (NCBC 1995d; Tetra Tech 2002a; 2003d). The results of on- and off-site sampling efforts as well as the findings from confirmatory sampling from remedial activities are summarized in the nature and extent of contamination section below.

Units of Measurement

Certain units of measurement are used when reporting levels of pollutants in soil, sediment, water, and biological samples. The common units used throughout this PHA and a brief description of each are provided below:

- **Parts Per Million (PPM)**
One ppm is equivalent to 1 part in 1,000,000 or 10^6. About four drops of ink in a 55-gallon barrel of water would produce an "ink concentration" of 1 ppm

- **Parts Per Billion (PPB)**
One part per billion is equivalent to 1 part in 1,000,000,000 or 10^9

- **Parts Per Trillion (PPT)**
One ppt is 1 part in 1,000,000,000,000 or 10^{12}. To place this very small amount in perspective - One drop of ink distributed through the water contained in a 12-million-gallon reservoir would result in a final concentration of 1 ppt

- **Parts Per Quadrillion (PPQ)**
One ppq is equivalent to 1 part in 1,000,000,000,000,000 or 1 in 10^{15}

Nature and Extent of Contamination

<u>On-Site Soil</u>: Soon after the entire stock of HO at NCBC was transported off site and incinerated in 1977, the USAF instituted a storage site-monitoring program to determine the nature and extent of contamination. During the initial monitoring program soil samples were collected at different times at Site 8 (Former HO Storage Area) between August 1977 and April 1982. During the initial soil

sampling events, TCDD concentrations exceeded 1ppb in most of the samples collected in the HO storage area (Table 2) (D&M 1991).

In response to identifying widespread dioxin contamination at the HO storage area, a comprehensive soil characterization study was conducted. Between April 1984 and September 1986, approximately 1,300 soil samples were collected in a grid-like fashion across all of Site 8A and later as part of a follow-on study across Site 8B and 8C (in total nearly 2,500 samples were collected). TCDD was detected at a maximum concentration of 646 ppb and an average concentration of 14.5 ppb at Site 8A (Table 2) (Dames & Moore 1991; Tetra Tech 2002b). Sites 8B and 8C were also investigated and had far less contamination than Site 8A.

As described in Appendix A, other areas of on-site contamination do not pose a public health hazard because: 1) actions have been taken to limit or prevent exposure, such as removal of contaminated soil, installation of site access restrictions (e.g., fence restricting access and warning signs), and institutional controls that prevent workers from contacting contamination during any possible excavation activities; or 2) contamination is not part of a completed exposure pathway (e.g., soil contamination is below the surface or in restricted areas that are not accessible to people; shallow groundwater beneath NCBC is not being used as a drinking water source).

Off-Site Soil: There were only a small number of soil samples collected off site. Most surface soil samples were collected at on-site locations in close proximity to the source area (i.e., Site 8). Thirteen surface soil samples were collected either off-site or right along the NCBC fence line in April 1995 from areas where ditches overflow their banks along 28th Street. These samples were collected prior to a removal action that was initiated based on the findings of the December 1995 base-wide sampling efforts. The results of dioxin analyses showed that the highest concentrations (max = 28 ppt) were detected in surface soil adjacent to Outfall 3 on the south side of 28th Street (ABB-ES 1995b; ABB-ES 1995c).

Table 2: Results of Surface Soil Sampling at NCBC

Location	Number of Samples Collected	Dioxin (TEQ) Range or Max (ppt)	Sampling Time Frame
On Site			
Soil samples collected near the stored drums at the banks of the drainage system	Data requested, but not available	ND (1,000 ppb) Note: Tested herbicide not dioxin	July 1974
Soil samples near the rows of barrels on the HO storage site	2	ND (4) — 15 (TCDD)	December 1974
Initial HO Monitoring Program	Data requested, but not available	Data requested, but not available	August 1977 — Aug 1979
Initial HO Monitoring Program	Data requested, but not available	200 — 631,000	September 1980 — April 1982
Comprehensive Soil Characterization Study (Grid sampling - Site 8 HO Storage Area. Includes Sites 8A, 8B, and 8C)	1,300 [surface soil samples were analyzed for TCDD at a target detection limit of 0.1 ppb]	10 — 646,000 (TCDD) (Fifty-one percent of the 1,300 samples had TCDD concentrations < 1,000 ppt (i.e, 1 ppb).	April 1984 — May 1988
South end of Site 8A along the fence line	5	ND	1995
Site 8: Drainage Area 1 and Drainage Area 6	32	0 — 181	April/May 1997
On Base (Not at Site 8)	6	2 — 79	April 1997
On Base (Site 5)	2	67 — 720	June 2001
Site 8, Areas B&C Confirmation Samples	3	0.72 — 0.79	2002
Off Site			
28th Street Removal Action – Pre-removal sampling	13	0.6 — 28	April 1995

Sources:
Envirodyne 1985; EG&G Idaho 1990; Dames&Moore 1991; ABB-ES 1995b; ABB-ES 1996a; ABB-ES 1998; Tetra Tech 2003a.

EPA's Region III Risk-Based Concentration (RBC) for 2,3,7,8-TCDD in industrial soil is 19 ppt (screening value)
EPA's Region III RBC for 2,3,7,8-TCDD in residential soil is 4.3 ppt (screening value)
ND=Not Detected

On-Site Surface Water and Sediment: Surface water and sediments have been sampled from the drainage system near Site 8 as well as the entire NCBC drainage area and analyzed for HO and/or TCDD. ATSDR's document reviews identified surface water samples collected as far back as August 1974 and sediment samples as far back as June 1979. The earliest surface water samples collected were only analyzed for the active ingredients in HO (i.e., 2,4-D and 2,4,5-T). Surface water and sediment samples at NCBC have been collected as recently as March 2000 and September 2002 respectively.

In October 1976, TCDD was detected in one surface water sample collected from the HO storage area drainage ditches at a maximum concentration of 46 ppt (USAF 1979). However, TCDD was not detected in most other surface water samples collected from the drainage ditches.[1] TCDD was not detected in any of the surface water samples collected during the initial HO monitoring program conducted in March 1984 (Table 3). During this investigation surface water samples were collected and analyzed for TCDD along locations in the immediate vicinity of the Former HO Storage Area as well as other locations on and off site.

Low levels of dioxins were detected in surface water during Phase I of the surface water and sediment delineation study. Table 3 shows the range of dioxin levels detected in samples collected from 4 of the 6 drainage areas at NCBC. Surface water samples were not collected from Drainage Areas 4 and 6. The highest dioxin level (40 parts per quadrillion [ppq]) was detected in a surface water sample collected from Drainage Area 2, just northwest of Site 8B. The highest dioxin level detected in surface water from Drainage Area 1, which drains much of Site 8, was 3 ppt. Dioxin was also detected in surface water at Site 7 drainage areas at a concentration of 51.6 ppq.

[1] According to site reports, a total of 61 surface water samples were collected during the "history of the project." It is not clear what the time frame of this early sampling project was, but based on information from the document it appears as though the samples were either collected in October 1976 or during follow-up sampling conducted in 1979 (USAF 1979).

Table 3: Results of Surface Water Sampling at NCBC			
Location	**Number of Samples Collected**	**Dioxin (TEQ) Range or Max (ppq)**	**Sampling Time Frame**
Samples collected from the HO storage area drainage ditches	23[1]	46,000 (i.e., 46 ppt) Sampled near the storage area	October 1976
Initial HO monitoring program by ESL	DNA	ND (Range: 30 — 99) †	March 1984
Surface water & sediment investigation of major outfalls and on flows at NCBC	DNA	1.2	1994—1995
Drainage Area 1	6	ND — 3	April/May 1997
Drainage Area 2	2	36 — 42	April/May 1997
Drainage Area 3	3	0.2 — 13	April/May 1997
Drainage Area 4	NA	NA	April/May 1997
Drainage Area 5	4	2.6 — 3.6	April/May 1997
Drainage Area 6	NA	NA	April/May 1997

Sources: Envirodyne 1985; Dames&Moore 1991; ABB-ES 1998; Harding Lawson 1999a; Harding Lawson 2001b

[1] Only 1 of 23 samples contained detectable concentrations of TCDD (MDL = 0.01 ppb)
TEQ = Toxic Equivalents
EPA's Maximum Contaminant Level (MCL) for 2,3,7,8-TCDD in drinking water is 30 ppq
ppq= parts per quadrillion
DNA = Data requested, but not available
NA = Not analyzed
ND = The analyte was analyzed for, but was not detected above the reported sample quantitation limit
† Number in parentheses represents the method detection limit
Refer to Figure 4 for a map of the drainage areas at NCBC

In, June 1979, TCDD was detected in sediment samples collected in the immediate surface water drainage system of the Former HO Storage Area at a maximum concentration of 3.6 ppb (USAF 1979). Table 4 shows that the highest dioxin concentration detected in sediment (4 ppb) were collected from Drainage Area 2. The maximum concentration of all the samples collected from the other five drainage areas during the 1997 delineation study at NCBC was at or below 1 ppb (Harding Lawson 1999a). Even more recent sampling (2002) of drainage areas near Site 8 shows that remediation efforts have been successful in reducing dioxin contamination further.

Table 4: Results of Sediment Sampling (On-Site Locations)			
Location	**Number of Samples Collected**	**Dioxin (TEQ) Range or Max (ppt)**	**Sampling Time Frame**
Samples collected in the immediate surface drainage system of the HO storage area (Aquatic Sampling Site I)	2/8	2,700 — 3,600[1] (TCDD)	June 1979
Samples were collected from the drainage system that drains the former HO storage area.	DNA	DNA	1985
Samples were collected from storm drainage system and the portion of the drainage system that drains plats 6 through 23 of the former HO storage area.	DNA	DNA	April and June 1986
Outfall 1 Outfall 3 Outfall 4 Onflow 1 (Canal # 1)	1 1 1 1	0.2 150 0.8 74	1995 1995 1995 1995
On-Site Sediments (All samples collected during the Phase I & II Investigation)	114	0.02 — 3,990 (180)	April 1997—February 1999
Drainage Area 1 Drainage Area 2 Drainage Area 3 Drainage Area 4 Drainage Area 5 Drainage Area 6	14 9 8 3 17 6	1 — 1,002 5 — 4,000 2 — 120 3.3 — 33 7 — 31 0.8 — 20	April/May 1997 April/May 1997 April/May 1997 April/May 1997 April/May 1997 April/May 1997
On-site drainage ditches (BIO-1 and BIO-2)	2 (Multiple grab samples)	1.6 — 13	March 1999
Confirmatory sampling (Removal of Dioxin-contaminated sediment from Site 8, Areas B&C)	68	.03 — 10	Fall 2002

Source: USAF 1979; Dames & Moore 1991; ABB-ES 1996; ABB-ES 1998; Harding Lawson 1999a; Harding Lawson 2001a; Tetra Tech 2002; CH2MHILL 2003.

[1] Detection limits for non-detected samples were 2,000 ppt (5 samples) and 3,700 ppt (1 sample)
The value in parentheses represents the average of detected concentrations

Notes:
TEQ = Toxic Equivalents; ppt = parts per trillion (also expressed as ng/kg)
EPA's Region III Risk-Based Concentration (RBC) for 2,3,7,8-TCDD in industrial soil is 19 ppt.
ATSDR's CV for 2,3,7,8-TCDD or TCDD Toxicity Equivalents in soil = 50 ppt (Chronic EMEG-Child)
ATSDR' CV is used for purposes of screening chemical contaminants for further evaluation and do not represent levels at which health effects are likely to occur.
DNA = Data requested, but not available

Off-Site Surface Water and Sediment: Most of the off-site sampling efforts were focused on surface water and sediment in areas that are hydraulically connected to NCBC (i.e., locations where drainage ditches and canals transport and deposit surface water runoff originating from the base) (ABB-ES 1998). This sampling strategy allows investigators to concentrate on the residential areas that were likely to receive the most dioxin-contaminated sediment from the former HO storage area.

A small number of surface water samples have been collected off site near NCBC. Table 5 presents the results of all available off-site surface water analyses. The maximum dioxin concentration detected in surface water off site (39.4 ppq) was at Canal # 1, located southwest of NCBC (Harding Lawson 1999a). It is unlikely that the source of the dioxins at Canal #1 was from the HO Storage Area because very little 2,3,7,8-TCDD was detected, the Canal # 1 sampling station is not in close proximity (over 1 mile away) to Site 8 (HO Storage Area), and water runoff from Site 8 (Drainage Area 1) generally drains west and then north or northwest towards Outfalls 1, 3, and 4 on the northern NCBC boundary. The likely source of the dioxin at this sampling location has not been determined.

Table 5: Results of Surface Water Sampling Off-Site Near NCBC

Location	**Number of Samples Collected**	**Dioxin (TEQ) Range or Max (ppq)**	**Sampling Time Frame**
Phase I Investigation (Total) Canal # 1 Brickyard Creek Bernard Bayou Turkey Creek	20 1 1 1 1	0.02 — 39.4 39.4[1] 0.1 1.2 0.5	April/May 1997
Turkey Creek	1	11.3 (TC008)	June 1997

Source: Harding Lawson 1999a; Tetra Tech 2003
ppq = parts per quadrillion
[1] Most of the TEQ was from Octa- and hepta-chlorinated dioxins and not from 2,3,7,8-TCDD

Several rounds of off-site sediment sampling were conducted as part of NCBC's environmental investigations. The nature and extent of dioxin contamination in off–site sediments have been well characterized near drainage canals flowing off site and along the major surface water features flowing north and northeast of NCBC (i.e., Turkey Creek, Brickyard Creek, and Bernard Bayou). Dioxins were detected immediately north of NCBC on 28th Street and east of Canal Road, including two adjacent culverts and the swampy area northeast of Outfall 3 (OBAOC) (Tetra Tech 2003d). The highest dioxin concentration in off-site sediments (418 ppt) was detected in the OBAOC, located in the swampy area north of Outfall 3 (Harding Lawson 2001a). Most other off-site sampling locations contained low levels of dioxin ranging from 0.16 ppt to 61 ppt in sediments (Table 6).

In response to public comments and community concerns, NCBC conducted additional community sampling in 2002 and as recently as March 2004. During the 2002 community sampling event 16 sediment samples were collected from several different off-site locations, both to the north of NCBC and to the southwest of the base. The areas sampled were identified from the examination of historical maps, aerial photographs, and interviews with local residents. The areas selected were biased toward where residents were concerned about, especially in locations prone to flooding during storm events and exhibiting visual sign of environmental stress (Tetra Tech 2003f).

Figure 6 shows the locations of sediment samples collected on-and off-site at NCBC Gulfport through 2003. The blue and red points represent sediment samples collected in response to specific comments or concerns from the community. The sediment samples collected during March 2004 were north of NCBC along Papania Lane and adjacent to Canal Road (Robert Fisher, Tetra Tech, Personal Communication, April 13, 2004). The results of most of the community sampling indicates very low concentrations of dioxins below levels of concern.

Table 6: Results of Sediment Sampling Analysis (Off Site Locations)				
Location	**Number of Samples Collected**	**Maximum Concentration (TEQ –ppt)**	**Maximum 2,3,7,8-TCDD Concentration (ppt)**	**Dates Samples Collected**
North of NCBC along Canal # 1 heading towards Turkey Creek	3	20*	NA	January 1976 — November 1979[1]
North of NCBC (28th Street)	Data requested, but not available	116	NA	February 1995 — April 1995[2]
Off-Site Sediments (All samples collected during the Phase I & II Investigation)	37	61 (13.6)	NA	April 1997 — February 1999[3]
Brickyard Creek Bernard Bayou	2 5	29.5 60.7	NA NA	October 1997[4] October 1997[4]
OBAOC (Swampy area north of Outfall 3)	86 samples (0—6'' bgs)	418 (77) Range: 0.3—418	NA	May 1997 and October 1997[4]
Turkey Creek (All) Turkey creek (Downstream) Brickyard Creek (Downstream) Bernard Bayou (BIO-6) Reference Location (Turkey Creek upstream)	10 2 2 1 1	11.3 (3.2) 6.7 10.5 2.6 3.9	1 ND ND ND ND	March 1999[5]
North of NCBC (28th Street)	10 Grab samples	35.5	ND	October 2002[6]
North of Turkey Creek/ Canal Road	2 Composite samples	3.9	0.3	October 2002[6]
Bear Creek	3 Grab samples	5.7	ND	October 2002[6]
Canal 1 Tributary	1 grab sample	0.01	ND	October 2002[6]
Gaston Point	1 grab sample	12.7	ND	October 2002[6]
Confirmatory samples for area adjacent to the Canal Road culverts	2 samples	5.5	0.65	April 2003[7]
Community Sample (Papania Lane)	1 sample	1.2	NA	March 2004[8]
Community Sample (Canal Road)	2 samples	Range: 1.9—23	NA	March 2004[8]

Sources:
[1] U.S. Air Force .1979. HO Site Treatment and Environmental Monitoring. November 1979.
[2] NCBC Fact Sheet 17: Removal Action, 28th Street Construction Project. October 1995.
[3] Harding Lawson. 2001. Human Health Risk Assessment and Screening Level Ecological Risk Assessment. March 2001.
[4] Harding Lawson. 1999. Surface Water and Sediment Dioxin Delineation Report. June 1999;
Tetra Tech NUS, Inc. 2003. Human Health risk Assessment of Groundwater Associated with Site 8. February 2003.
[5] Harding Lawson. 1999. Tier 1 Screening Level Fish/Sediment Sampling Results. November 1999.
[6] Tetra Tech NUS, Inc. 2003. Off-base Community Sampling Report. May 2003.
[7] Tetra Tech NUS, Inc. 2003. Letter Report for Sediment Removal Adjacent to Canal Road Culverts, NCBC. April 2003.
[8] Robert Fisher, Tetra Tech, Personal Communication, April 13, 2004.

Number in parentheses represents the average concentration
The state of Mississippi clean up goals for dioxin in residential areas is 4.26 ppt
ATSDR's CV for 2,3,7,8-TCDD or TCDD Toxicity Equivalents in soil = 50 ppt (Chronic EMEG-Child)
EPA's Region III RBC for 2,3,7,8-TCDD in residential soil is 4.3 ppt (screening value)

TEQ = Toxic Equivalents; ppt = parts per trillion (also expressed as ng/kg); SID = Sample Identification number
ND = The analyte was analyzed for, but was not detected above the reported sample quantitation limit
NA – ATSDR requested the information, however, the Navy was unable to find or obtain a copy of the report
OBAOC = Off-base Area of Concern

* The maximum concentration was reported as TCDD with a detection limit of 10 ppt

Evaluation of Potential Public Health Hazards

ATSDR evaluated the potential for residents living near NCBC to come in contact with dioxin-contaminated soil and sediment migrating off site from the HO storage area (through surface water runoff and sediment migration from the NCBC drainage system). For purposes of this discussion, soils and sediments have been evaluated together and surface water is evaluated separately. Typically surface water and sediments are evaluated together because sediments are usually found at the bottom of surface water features (e.g., streams, ponds, etc). However, given the topography of the Gulfport area (e.g., large areas covered by seasonal wetlands), people could come into contact with sediments near creeks and swampy areas in a frequency similar to that of surface soil.

How are people exposed to dioxins in the environment?

Ninety-five percent of exposure to the general population occurs through dietary consumption of foods that contain fat or fatty tissues such as meats, dairy products, and fish (ATSDR 1998). Other possible, but usually much less significant, exposure pathways may include coming into contact with and/or ingesting contaminated soil/sediment, water, and breathing in dioxin from the air.

Most dioxins taken in by animals, including humans, are stored in fatty body tissues where dioxins may persist for months or years. The half-life for dioxins (i.e., the time needed for the body to rid itself of half the contaminants) in humans is 6 to 10 years (Pirkle 1989).

People who live near sites where dioxins have been released into the environment may have additional dioxin exposures beyond what's found in a typical diet. Table 7 presents dioxin levels detected in soil at other hazardous waste sites across the country compared to what has been detected in dioxin-contaminated soil at NCBC in the past.

Evaluation of Dioxins in Soil and Sediment

Past Exposure

Between 1968 and 1977, HO-containing drums were stored at NCBC (Site 8). During this time some of the drums leaked liquid herbicide onto the ground surface of the storage area. Monitoring of dioxin contamination began shortly after the drums were removed and the HO incinerated off site. According to a report published in the late 1970s, limited off-site sampling conducted between 1977 and 1979 indicated that off-site migration of dioxin-contaminated sediments was occurring. However, the report did not identify off-site dioxin contamination in sediments at levels demonstrated to be of health concern (USAF 1979). More extensive off-site monitoring did not begin until the early 1990s after dioxin-contaminated soils were incinerated at NCBC.

The highest TCDD-TEQ concentration detected in sediment samples collected off-site at NCBC was 418 ppt at the OBAOC (swampy area north of Outfall 3). The maximum concentration detected in sediment off-site at NCBC is below ATSDR's action level of 1 ppb for dioxin in soil. The OBAOC area was the most contaminated off-site location identified in the residential areas around NCBC. Most other sediment samples collected in the residential areas off site contained, on average, much lower levels of dioxin than the 418 ppt detected at the OBAOC. For example, Table 6 shows that the maximum concentrations of dioxin detected in sediments at other locations where dioxin was identified off site (e.g., North of NCBC – 28th Street) were more than three times lower than the maximum concentration detected at the OBAOC.

Although dioxin levels in soil and sediment vary considerably depending on land use, there is some limited data available in the literature on what "average background" concentrations of dioxins are across the United States. To place the levels detected near residential areas at NCBC in perspective, Table 7 compares some typical background dioxin levels in soil and sediment across the United States to average levels found in off-site sediments at NCBC. Although there is considerable variability in the data, the average dioxin concentrations for rural and urban areas are in the 1-21 ppt range. The average dioxin concentration in sediments detected at the most contaminated off site location (OBAOC), before any removal actions were completed, was 77 ppt. Sediment samples collected at most other off-site locations near NCBC were within the background range observed in other parts of the country.

Table 7: Typical Background Dioxin Levels in Soil and Sediment in Selected locations Across the United States Compared to Average Levels Found in Off-Site Sediments at NCBC

Location	Average Dioxin Concentration (ppt-TEQ)	Time Period
North America (Soil)	8	1994[1]
North America (Sediments)	4	1994[1]
Connecticut (Background - soil)	6 (34)	1992[2]
Minnesota (Semi-rural background - soil)	4(4)	1990[2]
Washington (Urban - soil)	4 (14)	1999[2]
Maine (Background - soil)	3 (8)	1997[2]
Ohio (Urban – soil)	21 (18)	1996[2]
Ohio (Rural - soil)	1 (3)	1996[2]
NCBC—Off Site 28th Street— along and north of NCBC boundary (Surface Soil)	4.2 (13)	1995[3]
NCBC—Off Site OBAOC (Sediment)	77 (86)	1997 — 1999[4]
Turkey Creek (Sediment)	3.2 (10)	1999
Off-base Community Sampling	4.7 (17)	2002
NCBC—Off Site (soil only)	4.2 (13)	1995

1. U.S. Environmental Protection Agency. 1994. Estimating Exposure to Dioxin-Like Compounds: Volume II: Properties, Sources, Occurrence and Background Exposures. Washington, DC: U.S. Environmental Protection Agency. EPA/600/6-88/005Cb. June 1994.

2. U.S. EPA Region VIII. 2001. Denver Front Range Study Dioxins in Surface Soil: Study 1: Characterization of Dioxins, Furans and PCBs in Soil Samples Collected from the Denver Front Range Area. July 2001

3. ABB –ES 1995b.

4. Harding Lawson. 2001.

Numbers in parentheses represent the number of samples collected

Since most of the off-site sediment samples have been collected in the last ten years, a complete history of the nature and extent of dioxin contamination near NCBC is not available. The lack of extensive off-site soil and sediment characterization during the actual storage and removal of HO at NCBC adds a level of uncertainty to our evaluation. However, the OBAOC has not been excavated, nor is it subject to significant erosion. Therefore, the results of recent dioxin tests likely accurately reflect the highest concentrations that would have been detected historically at the OBAOC and elsewhere.

The off-site data collected to date is reassuring because maximum levels detected in sediments in the most contaminated area (i.e., OBAOC) *did not* exceed ATSDR's action level of 1 ppb for dioxin. The established action level is based on a review and evaluation of animal and epidemiological studies, the range of health guidance values developed by ATSDR (e.g., EMEG and MRL), and the limitations and uncertainties of the scientific data these values are based on. ATSDR's health guidance values represent "safe" levels where health effects have not been observed in peer reviewed animal and human studies.

In addition, as a health-protective measure ATSDR assumes that the entire amount of chemical detected in the soil or sediment is available to impact the health of humans. To more accurately estimate oral exposure to dioxins in contaminated soil, several elements that can affect the assessment need to be considered. First, an accurate estimate of soil ingestion is needed, typically ranging from 50-200 mg/day (Calabrese et al, 1997; Van Wijnen et al., 1990, Davis et al., 1990). Secondly, site-specific factors need to be weighed that may affect the degree of dioxin mobilization from soil. The oral bioavailability of dioxins in soil varies with soil type, age, and chlorination level of the compound, with bioavailability decreasing with aging in the soil and with greater levels of chlorination (NEPI, 2000). Chlorinated compounds in soils with higher organic content appear to be less bioavailable (Fries 1985).

Dioxins are very stable chemicals and typically have a long half-life in soil and sediment.[2] Given what is known about the half-life of dioxins in soils, it is unlikely that dioxin concentrations would have been much higher when the HO-related contamination was initially transported off site primarily through the drainage ditch system. Additionally, monitoring programs in place during the mid 1980s did not identify dioxin contamination off site at significantly higher levels than what was observed in more recent sampling efforts. It is, therefore, unlikely that people who came into contact with

[2] The half-life is defined as the time required for half the amount of an agent (e.g., chemical) to be eliminated from the media that is being studied (i.e., soil or sediment). Estimates of the half-life of dioxin-contaminated soil range from 9 to 15 years, whereas the half-life of dioxin in subsurface soil may range from 25 to 100 years (Paustenbach 1992).

soils and sediments (e.g., through playing in ditches, wading in creeks, digging in yards, gardening, etc.) in the past would have been exposed at levels that are known to cause health effects. On the basis of the available information, ATSDR does not consider past exposures to dioxin-contaminated soil and sediment at NCBC to be of health significance.

Current and Future Exposure

In 1977, the entire inventory of HO stored at NCBC was removed from Site 8 and transported to an at-sea incinerator. In 1988, dioxin-contaminated soil at Site 8 was incinerated under a RCRA approved permit. Other removal actions, both on site and off site, have occurred at locations where dioxins have been detected above MDEQ and federal regulatory clean up levels for dioxin-contaminated soils. MDEQ requires dioxin-contaminated soil and sediment be cleaned up to a level of 4.26 ppt for unrestricted residential use and 38 ppt for industrial use. The off-site clean up actions have resulted in dioxin levels in soil and sediments that are similar to background levels across the United State. Since the source of dioxin exposure has been removed and current levels of dioxins in soil and sediment, both on and off site, are generally below state and federal regulatory standards, current and future exposures to dioxin-contaminated soil and sediment off site at NCBC are not a health hazard.

<u>Evaluation of Dioxins in Surface Water</u>

Past Exposure

Some residents living near NCBC have expressed concerns about whether it was safe to come in contact (e.g., swim) with surface water from creeks and ponds that may have been impacted by dioxin contamination. Chlorinated chemicals such as dioxins are not typically found in harmful concentrations in surface or ground water. This is because dioxins are not readily soluble in water and they tend to bind to the non-dissolved particulate matter that floats in the water or the sediments associated with surface water features.

The analytical results of most of the samples collected from surface water off site at NCBC are below EPA's MCL of 30 ppt for dioxin established for drinking water. One exception was a sample collected along Canal # 1 which contained a TEQ dioxin concentration slightly above (39 ppt) EPA's MCL. The data support the belief that the transport of dioxins along the drainage ditch systems to off-site locations is primarily a result of the migration of sediments and not surface water. ATSDR believes that the samples collected are representative of most of the surface water features near NCBC and the quality and quantity of samples is adequate to make a public health determination. ATSDR concludes that coming in contact with surface water off site near NCBC did not result in harmful exposures.

Current and Future Exposure

On the basis of the available data, ATSDR did not identify levels of dioxins in surface water that are a current health concern or would pose a concern in the future. ATSDR concludes that coming in contact with off-site surface water is not a health hazard. Due to the potential for illness due to bacteria or parasites, ATSDR recommends that swimmers avoid swallowing creek and pond water.

2. Eating fish, other edible wildlife, and homegrown produce from off-site locations near NCBC

Issue:

Are or were people who consumed fish, other edible wildlife species, or homegrown produce exposed to harmful levels of dioxins?

Characterization of Potential Exposure Pathway

A number of on- and off-site surface water bodies are used for fishing and harvesting other edible wildlife (e.g., crawfish, frogs, and turtles). Some of the on-site drainage ditches are stocked with fish and can be used by NCBC personnel. Although some of the on-site drainage ditches contain fish, access to NCBC is restricted and residents (both on- and off-site) are not permitted to fish in these locations. Turkey Creek is the principle surface water body that drains NCBC and is used by residents for recreational fishing and harvesting edible wildlife. The focus of this section is to evaluate the potential for residents to be exposed to dioxin through consuming fish, wildlife, and homegrown produce in off-site locations.

A Creel study was conducted at NCBC between January and April 1999 to determine the fish species most likely consumed by people in the vicinity of NCBC. The study findings also helped guide the selection of fish sampling locations. The Creel study confirmed a previous community survey indicating that humans are eating fish collected from the ditch system around NCBC (Harding Lawson 1999b; Harding Lawson 2001a). According to the findings of the Creel study, there is no evidence of crayfish being consumed from the ditch system at NCBC. Therefore, crayfish were not collected for dioxin analysis (Harding Lawson 1999b).

Samples collected from the on-site drainage ditches, canals, and outfalls that transport storm water and sediments off site contained detectable concentrations of dioxins. Since NCBC personnel and local residents reportedly use some of the surface waters for fishing, a potential past and current exposure pathway exists from eating contaminated fish and other wildlife. In addition, dioxin-contaminated sediments and soils from Site 8 may have migrated off site during heavy flood events and contaminated residential properties in close proximity to NCBC. ATSDR will evaluate whether this off-site migration of contaminants has resulted in a likely past or current exposure pathway for people eating locally obtained produce.

Nature and Extent of Contamination

In 1974, the USAF conducted environmental sampling as part of a survey and ecological monitoring assessment. Although several biological samples (i.e., fish, snails, tadpoles, frogs, and insects) were collected for dioxin analysis during the 1974 environmental monitoring effort, the samples were not analyzed. According to site documents, biological samples were not analyzed for dioxins because water and sediment sample analyses did not indicate that the drainage system was contaminated (USAF 1979).

In January 1976, the USAF conducted biological sampling in close proximity to the HO storage area and the surface drainage system (USAF 1979). Samples analyzed for dioxin during the 1970s and 1980s were generally reported as total TCDD and not as TEQ dioxin values (i.e., sum of all the 2,3,7,8-TCDD-weighted individual dioxin congeners (See Appendix C). Table 8 presents the analytical results of biological samples collected between 1976 and 1986. In 1979, TCDD was detected in a biological sample collected from the HO storage area drainage ditch at a maximum concentration of 7.2 ppb (USAF 1979). A crayfish sample collected in 1976 from the Site 8 drainage ditch contained TCDD at a maximum concentration of 3.2 ppb. A single crayfish sample collected off site near the NCBC boundary contained TCDD at a concentration of 0.02 ppb.

On the basis of the creel survey conducted in 1999 and the environmental sampling that showed detectable levels of dioxins in the soil and sediments near the HO storage area, NCBC conducted fish sampling on and off site. Fish tissue samples were collected during two rounds of sampling conducted in March and August 1999. A total of 56 fish samples were collected from eight locations (Refer to Table 9 for the location of sampling stations) and analyzed for dioxin and furans (Harding Lawson 2001a). Fish were collected and analyzed either as whole body samples or fish fillet tissue. The total TEQ dioxin concentrations of the fish fillets were mostly non-detect. A TEQ concentration of 2.3 ppt was detected in one catfish fillet sample collected off site from Brickyard Creek). The maximum dioxin concentration detected was 10.5 ppt in a non-edible species of fish at Outfall 3 (Table 9). The U.S. Food and Drug Administration (FDA) sets “tolerances” for allowable levels of contaminants in specific food items and enforces these levels by monitoring the food supply. The highest dioxin concentration (10.5 ppt TEQ) detected during the 1999 sampling effort at NCBC Gulfport was well below FDA’s established tolerance level of 25 ppt for dioxins in fish.

Table 8: Results of Biological Sampling Analysis (On and Off Site Locations)

Species	Frequency of Detection	Range of Values (TCDD)	Location of sample with maximum concentration	Sample Collection Date
Crayfish and various other invertebrates (e.g., insects, snails, leaches, tadpoles, mosquito fish)	Not Reported	0.14 — 3.5 (ppb) [Note; 3.5 ppb value was reported in one crayfish]	HO Storage Area (On Site Drainage Ditch)	January 1976
Not specified	Not Reported	1.6 — 7.2 (ppb)	HO Storage Area (On Site Drainage Ditch)	January 1979
Not specified	Not Reported	0.2 — 2.2 (ppb)	Approximately 3,000 feet downstream from the former HO storage area (On Site Drainage Ditch)	Between 1977 and 1979
Crayfish	2/2	0.02 — 0.045 (ppb)	Between 7,000 (On Site) and 9,000 (Off Site) feet down- stream from the former HO storage area (Drainage Ditch)	February 1979
Mosquito fish (composite sample)	0/1	ND (MDL = 10 ppt)	Approximately 12,000 feet (Off Site) from the former HO Storage Area	February 1979
Data requested, but not available	Not Reported	Not Reported	Not Reported	April 1986 Sampling Event
Data requested, but not available	Not Reported	Not Reported	Not Reported	June 1986 Sampling Event

Source: USAF 1979

The Region III EPA RBC for 2,3,7,8-TCDD in fish tissue is 0.02 ppt [0.00002 ppb] (screening value)
FDA’s tolerance level for dioxin in fish is 25 ppt
MDL = method detection limit; PPB = parts per billion; PPT = parts per trillion

Table 9: Results of 1999 Fish Sampling (On and Off Site Locations)				
Species	**Frequency of Detection**	**Range of Values (TEQ– ppt)**	**Location of sample with maximum concentration**	**Sample ID**
Catfish	4/17	ND — 2.3	Brickyard Creek (Off Site)	BIO-8-WF-CF
Large Mouth Bass	4/18	ND — 5	Outfall 3 (On Site)	BIO-1-FF-LB
Bluegill	1/8	3.2	Canal 1 (On Site)	BIO-2-WF-BG
Redear Sunfish	1/1	2.6	Outfall 3 (On Site)	BIO-1-FF-RE
Striped Mullet	1/3	2.2	Brickyard Creek (Off Site)	BIO-8-SW-SW
Other Non-Edible Fish Species	5/8	ND — 10.5	Outfall 3 (Off Site)	BIO-9-WF-AM

Source: H&L 2001

All samples were collected in March or August 1999
ND = Not Detected; PPT = parts per trillion

Note: The state of Mississippi recommends limiting the consumption of fish from fishing areas containing greater than 5 ppt TEQ dioxin and avoiding consuming fish containing 25 ppt or greater TEQ dioxin (Henry Folmer, Lab Director, Department of Environmental Quality, Office of Pollution Control. Personal Communications. February 9 and 10, 2004).

FDA's tolerance level for dioxin in fish is 25 ppt

Sampling Station Locations:
BIO-1: This sampling station is a small pool in a drainage ditch located on-site, south of 28th Street and upstream of a sediment recovery trap.

BIO-2: This sampling station is located on-site in Canal 1.

BIO-3: This sampling station is located in the upper section of Turkey Creek (off-site and up-gradient from NCBC)

BIO-4: This sampling station is located on Turkey Creek (off-site) just downstream from NCBC.

BIO-5: This sampling station is located on Turkey creek downstream of the airport and about half a mile upstream of the confluence with Bernard Bayou.

BIO-6: This sampling station is located in the eastern side of Bernard Bayou

BIO-7: This sampling station is the downstream-most location on Brickyard Creek and is downstream of the airport.

BIO-8: This sampling station is the upstream-most location on Brickyard Creek, immediately downstream of NCBC.

BIO-9: This sampling station is located 1500 feet north of NCBC on the east side of Canal Road, where the Outfall 3 meets Canal Road.

NCBC has not collected any samples of fruits, vegetables, or other biota near NCBC. According to NCBC representatives, there are no plans to sample any food items from residential vegetable gardens for dioxin contamination.

ATSDR evaluated the potential for residents living near NCBC to be exposed in the past as well as evaluating current and future exposure to harmful levels of dioxins through the consumption of locally obtained fish, other edible wildlife (e.g., crawfish, frogs, and turtles), and locally grown produce. The Community Survey and Exposure Assessment conducted by the Navy in 1997 documented fishing activity in the ditch systems and creeks around NCBC (U.S. Navy 1997). In 1999, a Creel Study was conducted to confirm fishing activity around NCBC and identify the most common type of species consumed by local anglers. The general frequency of occurrence of other exposure-related activities in the immediate NCBC area, such as gardening and playing in the ditches, was also documented (U.S. Navy 1997) during the 1997 community survey and anecdotal information (e.g., discussions with community members).

Every person has some amount of dioxin in his or her body. This is because dioxin does not readily break down in the environment. ATSDR's evaluations of dioxin-contaminated sites generally focus on whether people's exposures have exceeded what would normally be considered typical background levels and, if so, whether those higher exposures are likely to result in health effects. As mentioned previously, people are exposed to dioxins mainly through their diet. Fish often contribute a large proportion of a person's dietary exposure to dioxins because many common species of game fish accumulate these compounds through the food chain. ATSDR reviewed studies investigating dioxin levels in fish to assess whether fish collected at NCBC may exceed typical background dioxin levels.

Between 1986 and 1989, the EPA conducted the National Study of Chemical Residues in Fish (NSCRF). The purpose of NSCRF was to assess the concentration of toxic pollutants in the tissues of fish across 388 sites surveyed nationwide. The mean TEQ dioxin value for the entire data set was 11.1 ppt and the median value was 2.8 ppt. This study also looked at source areas and found that the average concentration of 2,3,7,8-TCDD at background sites (i.e., areas with no known sources of dioxin contamination) was 0.5 ppt (ATSDR 1998).

Evaluation of Dioxins in Fish

Past Exposure

In evaluating past exposure to dioxins in fish caught near NCBC, ATSDR reviewed the available site-specific data, calculated exposure doses based on average concentrations detected in commonly consumed fish species, and used the available body of literature about dioxin toxicity to place past exposures in perspective. Edible fish species were not collected and analyzed for dioxins during the 1970s and 1980s, when dioxin contamination may have been most extensive throughout the on and off-site drainage system. However, aquatic monitoring in the late 1970s and early 1980s, which included the collection of sediment, surface water, and limited biological samples (e.g., crayfish, tadpoles, snails, and mosquito fish), did not identify dioxin contamination off-site at levels known to be harmful.

Biological sampling data are not available for the time period Gulfport residents have expressed the most concerns about, specifically from 1968 through the 1980s. The earliest biological sampling was conducted in 1979 in crayfish, mosquito fish, and frogs. ATSDR relied primarily on the more recent (i.e., 1999) fish sampling data because earlier biological samples did not include common edible fish species (e.g., catfish and bass) and older methods for analyzing dioxins were not as sensitive (i.e., the method detection limits were higher) as current methods. The average levels detected in fish in the off-site drainage ditches and surface water bodies during the sampling conducted in 1999 were close to background levels reported by EPA. The average 2,3,7,8-TCDD concentrations off-site at NCBC (0.6 ppt) were nearly identical to the background levels reported by EPA's NSCRF (0.5 ppt). The maximum TEQ concentration detected in edible species of fish at NCBC was 5 ppt. The state of Mississippi recommends limiting the consumption of fish caught in waters where average dioxin concentrations exceed 5 ppt TEQ and recommends avoiding consuming fish from areas where average dioxin concentrations exceed 25 ppt TEQ.

Only limited biological data characterizing past dioxin contamination in the drainage ditch system are available. It has been documented that dioxin-related contamination did migrate off site, impacting the nearby drainage areas and fish and wildlife habitats. However, ATSDR has not identified any off-site locations where dioxins in sediments were at levels of public health concern. In fact, on the basis of recent sampling data, the more common fishing locations such as Turkey and Brickyard Creek do not appear to have been significantly impacted by dioxin contamination from NCBC. If dioxins were present at dangerous levels in the past in the off-site creeks near NCBC, current sampling data should at least reflect some elevated dioxin levels in the sediments. This is not the case and it is unlikely that fish from the nearby creeks accumulated dioxins at levels that would cause harm if eaten.

Nevertheless, some higher dioxin concentrations were detected in sediments in the immediate drainage areas, canals, and outfalls leading off site, although still below ATSDR's action level of 1 ppb. It is possible that frequent consumption of fish (e.g., subsistence fishers consuming greater than 16 [8-ounce] fish meals per month) over several years from the most heavily dioxin-contaminated locations could have resulted in significant and perhaps even harmful exposures. However, ATSDR has not identified any subsistence populations in the immediate NCBC Gulfport vicinity and historical investigations of the drainage ditches, both on-site and off-site ditches near NCBC Gulfport suggest that the availability of edible fish was not adequate for a subsistence population. Although some degree of exposure occurred in the past, ATSDR does not have sufficient information to determine the magnitude of this exposure and to make a determination regarding the degree of public health impact. ATSDR considers past exposures to dioxins from consuming fish collected from drainage ditches, canals, and other surface water bodies near NCBC to pose an indeterminate public health hazard.

Current and Future Exposure

People who eat fish from dioxin-contaminated water bodies may take in more dioxin than the average person. The World Health Organization (WHO) has recommended a tolerable daily intake (TDI) for total dioxins at a range of 1 to 4 x 10^{-9} mg/kg/day. This range is based on the examination of adverse health effects seen in animal and human studies (WHO 1998; 1999). ATSDR has set a protective *MRL* of 1 x 10^{-9} mg/kg/day (this is equivalent to 1 picogram [pg] /kg/day). Using health-protective assumptions (see Appendix D for an explanation of ATSDR's assumptions), the average estimated exposure dose for an adult consuming channel catfish[3] from off-site drainage ditches and surface water bodies (e.g., Turkey Creek) near NCBC is 2.3 x 10^{-10} mg/kg/day. These values are well within the WHO's TDI range and below ATSDR's MRL.

ATSDR's Minimal Risk Levels (MRLs)

The MRL is derived from the lowest observed adverse effect level (LOAEL) identified in the scientific literature. The LOAEL is the lowest dose at which an adverse health effect has been observed. It is divided by a safety factor to protect sensitive groups and to account for the differences between humans and animals in response to exposure. MRLs are protective by design and represent doses below which non-cancer adverse health effects are not expected to occur, even from daily exposure over a lifetime. *MRL's are not thresholds for harmful health effects. A dose that exceeds the MRL indicates only the increasing potential for toxicity and that further toxicological evaluation is needed*

NCBC has taken numerous measures to clean up dioxin contamination at Site 8 (i.e., soil removals and on-site incineration) and in on-and-off site drainage areas. In an effort to minimize additional off-site migration sediment recovery traps (SRTs) have been installed over the last 10 years in ditches connected to Site 8. These efforts have

[3] Channel Catfish represent the most common edible species likely to accumulate higher levels of dioxins and other contaminants because they are omnivorous and feed off of the bottom sediments. ATSDR also evaluated largemouth bass, a commonly consumed species of fish, and estimated the dose for an adult to be 5 x 10^{-10} mg/kg/day.

significantly reduced dioxin contamination from Site 8 into the drainage ditch system, thereby reducing the potential for bioaccumulation into small aquatic organisms and larger edible fish off site. Recent off-site community samples have mostly indicated very low concentrations of dioxins in sediments. One sampling location adjacent to Canal Road did indicate slightly higher dioxin concentrations in excavation mounds near a small unnamed pond. Community members have indicated that people fish in this pond. To ATSDR's knowledge, no sediment or biota sampling has been conducted at this location. Because data are currently unavailable, ATSDR is unable to make any determination about health hazards from fishing in this pond, however results from other recent off-site biota sampling have not detected significant contaminant concentrations, so it is unlikely that contamination in biota and pond sediment would be at levels posing a health hazard.

On the basis of current dioxin levels in fish samples collected off site and very low concentrations of dioxin detected in off-site sediments, it is unlikely that people are being exposed to dioxins at harmful levels. ATSDR concludes that current and future consumption of fish in off-site drainage areas and surface waters near NCBC does not pose a health hazard.

<u>Evaluation of Dioxins in Edible Wildlife and Locally Grown Produce</u>

Past Exposure

Samples of edible species of wildlife (e.g., turtles, frogs, ducks) near NCBC were not collected for analysis and, therefore, no site-specific data for this pathway can be evaluated. It is possible that some edible wildlife species (e.g., ducks, turtles, frogs) that fed almost exclusively on organisms found in the contaminated drainage ditches could have contained dioxin levels that were not safe for frequent human consumption. However, since off-site sampling of dioxins in fish did not identify levels that are higher than background levels across the United States, it is unlikely that people would have been exposed to dioxin levels in edible wildlife tissue in the past that would result in health effects. Although there exists some uncertainty about how frequently people harvested edible wildlife from the most contaminated off-site locations, we believe that this exposure pathway did not pose a past health hazard.

Fruit and vegetable samples from gardens or in off-site locations near NCBC were not collected during site investigations. Dioxins do not readily accumulate in plant tissues and are detected infrequently in washed fruits or vegetables that are harvested above ground (e.g., tomatoes, corn, apples). Most dioxin-related exposure from garden vegetables is from the soil that adheres to root crops and leafy low growing vegetables (e.g., potatoes, spinach, strawberries). We believe that average dioxin concentrations detected in surface soil off site, even in the OBAOC, were not sufficiently elevated to contaminate edible fruits and vegetables at levels that would cause health effects in people. Because the dioxin contamination would be limited to the dirt sticking to the exterior, washing fruits, garden vegetables, and any other edible plants obtained locally would reduce or eliminate any potential dioxin exposures resulting from the consumption of produce. ATSDR concludes that this exposure pathway would not produce a public health hazard.

Current and Future Exposure

The measures NCBC has taken to clean up dioxin contamination at Site 8 and in on-and-off site drainage areas should be adequate to prevent any current or future health hazards. ATSDR concludes that current and future consumption of edible wildlife and locally grown produce that are harvested near off-site drainage areas and surface waters do not pose a current or future health hazard.

3. Potential for breathing contaminated air from past incineration of dioxin-contaminated soils at the Former HO Storage Area (Site 8)

Issue:

Did the incineration of contaminated soils at NCBC in 1987 and 1988 cause people to be exposed to harmful levels of air contamination?

Characterization of Potential Exposure Pathway

As noted many times in this PHA, soils at the HO storage area were contaminated in the late 1960s and 1970s due to leaking drums and spills. After extensive research on how to address this issue, NCBC decided to treat the contaminated soils using a mobile incinerator. The incinerator operated on site for 12 months, between 1987 and 1988, and treated approximately 26,000 tons of contaminated soils. Refer to the text box at the end of this section for a chronology of key events relevant to the incinerator.

Although the incinerator was shown to be highly efficient at destroying TCDD and other organic contaminants in the soils (EG&G 1990, 1991a; 1991b), not all of the contamination was destroyed and trace amounts of selected contaminants were released to the air. The remainder of this section provides background information on the incinerator, reviews sampling data relevant to the air exposure pathway, and comments on the public health implications of past exposures. This section focuses entirely on inhalation exposures that might have occurred in 1987 and 1988 as a result of the incineration activity. All analyses in this section are based on documents prepared by contractors to NCBC (EG&G 1990, 1991a; 1991b; 1991c); these documents not only include original work conducted by NCBC's contractors, but also include relevant articles, reports, comments, and permits issued by EPA, MDEQ, and the local media.

Background Information on the Incineration Operation at NCBC

NCBC used a mobile incinerator to treat contaminated soils from the former HO storage area. TCDD was the primary contaminant of concern, but the soils also contained 2,4-D, 2,4,5-T, and other constituents. The goal of the incineration operation was to destroy the organic contaminants in the soil, without creating hazardous residuals (e.g., wastewater and ash). This section describes the technology used to incinerate the contaminated soils.

Soils that were excavated from the HO storage area were fed into the incinerator, which included two combustion chambers. The primary combustion chamber was a rotary kiln, which consistently operated at temperatures greater than 1,450 ^{o}F. This temperature was sufficient to separate organic contaminants from the soil; it was also sufficient to destroy some of these contaminants. Contaminated soil remained in the rotary kiln for 30 to 60 minutes, and any residuals at the end of the kiln (i.e., the ash) were collected and stored on site. Gases from the rotary kiln then passed into a secondary combustion chamber, in which temperatures typically ranged from 2,150 to 2,200 ^{o}F. This range of temperatures was selected to destroy any gaseous organic contaminants, such as TCDD, that entered the secondary combustion chamber, where gases typically remained for at least 2 seconds.

In the primary and secondary combustion chambers, nearly all of the organic material was reduced to simple, relatively benign molecules, such as carbon monoxide, carbon dioxide, water, and oxides of nitrogen and sulfur. However, the gases leaving the secondary combustion chamber did contain airborne particles, some products of incomplete combustion, trace levels of soil contaminants that were not destroyed, and other pollutants. These contaminants were not vented directly to the atmosphere; rather, to reduce potential air quality impacts from this source, the gases passed through a series of air pollution controls, which included a cyclone, a scrubber, a packed tower, and a demister. These controls removed many of the contaminants from the process stream before the final exhaust was vented through a stack to the atmosphere.

The incinerator was equipped with extensive process monitoring equipment and process controls to ensure that operations complied with the EPA permit and did not harm the environment. Examples of the process monitoring equipment included devices that continuously measured the following: temperatures in the combustion chambers; concentrations of oxygen, carbon dioxide, and carbon monoxide in the stack exhaust; and waste residence time in the combustion chambers. If these indicators (or several others that were routinely measured) ever fell outside acceptable bounds, the incinerator would automatically stop processing waste and temporarily shut down until the process could be better controlled. Thus, the incinerator was equipped with controls designed to prevent operations from reaching levels that might lead to harmful emissions.

Timeline of Events Relevant to the Incinerator

Late 1960s to 1977:
NCBC maintained a large stockpile of HO. During this time, leaking drums and spills contaminated soils in the HO storage area (Site 8). In 1970, the U.S. government suspended most uses of an ingredient in HO, and in 1977 850,000 gallons of HO that were being stored on site were shipped out to sea for incineration.

1977 to 1987:
US Air Force and NCBC conduct multiple soil sampling studies to determine levels of soil contamination in the HO storage area and to delineate areas where TCDD concentrations do not meet acceptable levels. More than 2,600 soil samples were collected during this time.

Late 1986:
Components of the mobile incinerator arrive at NCBC, and the incinerator is assembled on site.

December 1986:
NCBC conducts a verification burn, which demonstrates that the incinerator is capable of destroying TCDD in soil, such that the treated soils have TCDD concentrations lower than 1 ppb.

May 1987:
NCBC conducts a trial burn, which demonstrates that the incinerator is capable of removing and destroying organic constituents in waste at an efficiency greater than 99.9999%.

November 23, 1987:
EPA issues NCBC a final research, development, and demonstration (RD&D) permit, thus allowing NCBC to proceed with incinerating TCDD-contaminated soils.

November 25, 1987 to November 19, 1988:
NCBC incinerates approximately 26,000 tons of contaminated soils that were excavated from the former HO storage area.

February 1989:
The incinerator was decontaminated, dismantled, and shipped off site.

As noted previously, full-scale operation of the incinerator occurred for a 12-month period. Though incineration at times occurred up to 24 hours a day, the incinerator did not operate continuously, due to interruptions for scheduled maintenance, unscheduled maintenance, and other unexpected shut downs. Overall, the incinerator operated approximately two-thirds of the time between November 1997 and November 1998.

Emissions and Efficiency Data for the Incineration at NCBC

Before EPA would issue a permit for the incinerator, NCBC had to demonstrate that the incinerator was an acceptable technology for treating the contaminated soil, but without harming human health or the environment. Consequently, NCBC conducted two rounds of tests to evaluate the incinerator performance. These tests—a verification burn and a trial burn—generated much of the sampling data available to ATSDR on the incinerator operations. The following paragraphs review the sampling results from these two tests, after which ATSDR comments on the significance of their findings.

- *December 1986 verification burn.* The purpose of the verification burn was to determine whether the incinerator was capable of treating the contaminated soil, without generating hazardous residuals. During this 2-week test, approximately 100 tons of contaminated soils were first excavated from areas believed to have some of the highest TCDD concentrations (up to 390 ppb). NCBC then fed these contaminated soils to the incinerator during five specific test periods that simulated the anticipated conditions to occur during full-scale operations. In each of these tests, samples were collected to determine the amounts of TCDD and other contaminants that remained with the soil (i.e., in the ash) and that flowed out of the stack into the air. The verification test was conducted using standard methods and included appropriate quality control checks and quality assurance measures, such as analyzing blank samples, conducting an independent data review, and adhering to applicable Contract Laboratory Procedures.

  Several key findings were observed during the verification burn. Of particular importance, TCDD was not detected in any of the stack samples collected during the five test periods. Based on the detection limits used in the study, which ranged from 0.22 to 0.32 $\mu g/m^3$, NCBC concluded that the incinerator was destroying or removing at least 99.9968% of the TCDD that was in the contaminated soil. The actual destruction and removal efficiency was higher than this level, but it could not be measured precisely due to the amount of TCDD in the contaminated soil and the sensitivity of the sampling and analytical methods at the time. While factors beyond NCBC's control prevented it from demonstrating the 99.9999%

efficiency that EPA required at the time, the follow-up trial burn would adequately address this issue. The next bulleted item discusses this issue further.

Other key findings included the following: none of the ash sampled tested positive for TCDD, with detection limits for the individual samples ranging from 0.0001 to 0.0054 ppb; chloride emissions from the stack were found to be considerably lower than 1.8 kg/hour, which was the emissions limit that EPA enforced at the time; particulate matter concentrations were more than three times lower than the concentration limit that EPA enforced at the time; and 2,4-D and 2,4,5-T (the main constituents of HO) were not detected in the stack samples.

The verification burn also included stack testing for a group of combustion by-products known as polycyclic aromatic hydrocarbons (PAHs). No permit limits or emissions standards were available at the time to examine the measured amounts of PAHs that the incinerator released. However, based on a screening modeling analysis of the emissions data, ATSDR believes the exposure concentrations that likely occurred at off-site locations were below levels of health concern, especially considering that the exposure duration was limited to just 1 year.

- *May 1987 trial burn.* The purpose of the trial burn was for NCBC to demonstrate to EPA that the incinerator was capable of meeting several requirements outlined in federal incineration regulations. Specifically, the incinerator had to destroy or remove 99.9999% of organic compounds similar to TCDD, while not releasing chloride or particulate matter at levels greater than established emissions limits. Before conducting the trial burn, NCBC first prepared a detailed trial burn plan that was submitted to, and approved by, EPA. The trial burn plan not only specified exactly how the incinerator would operate during the test, but it also included a thorough quality assurance project plan. ATSDR's review of the trial burn plan found that NCBC used appropriate sampling and analytical methods and adequate quality control checks and quality assurance measures.

  The trial burn was conducted in May 1987 and reported three main findings. First, the study found that the incinerator destroyed and removed two surrogate compounds for TCDD (hexachloroethane and trichlorobenzene) with efficiencies greater than 99.9999%. Even though these surrogates were added to the input stream in considerable quantities, one was never detected in the stack emissions and the other was detected at a trace level in just one sample. Because these two compounds are more resistant to incineration than is TCDD, NCBC concluded that the incinerator's destruction and removal efficiency for TCDD is also greater than 99.9999%. The second major finding was that chloride emissions from the incinerator were more than 10 times lower than the maximum amount that EPA permitted at the time, and the third finding was that concentrations of particulate matter in the stack gases also were within limits specified in EPA regulations.

Taken together, the verification burn and the trial burn offer important insights into the incinerator operations at NCBC. Both tests clearly showed that air emissions of chloride and particulate matter—contaminants known to be released by incinerators—for a wide range of testing conditions were well within limits EPA established as being protective of health and the environment. Further, the TCDD and surrogate stack sampling data during both tests strongly suggests that the incinerator was capable of destroying nearly all organic compounds in the contaminated soils, provided that the incinerator was operated under the same conditions used during the two burns. Recognizing this, EPA used the results from the verification burn and trial burn to set appropriate permit conditions for the incinerator at NCBC.

Ambient Air Sampling Data for the Incineration at NCBC

Even though permit conditions were established to be protective of human health and the environment, ambient air sampling was conducted to verify that releases from the incinerator and associated excavation activities were indeed not causing air contamination to reach potentially unhealthy levels. ATSDR identified the following two ambient air-sampling studies, or studies that measured contamination levels in air that people might actually have breathed:

- *Air sampling during the 1986 verification burn.* During the verification burn, NCBC collected ambient air samples on 10 days. Samples were collected while three different operations occurred: excavation, incineration, and both excavation and incineration. During each sampling event, NCBC collected air samples at three locations. One sampling station was near the incineration or excavation site of interest, and the other two were upwind and downwind from the site.

  Two different sampling methods were used. One method collected samples to be analyzed for concentrations of total suspended particulates (TSP). TSP is a mixture of airborne particles and droplets that people might inhale. The highest 24-hour average measured TSP concentration was 109 $\mu g/m^3$, which is much lower than EPA's health-based air quality standard for TSP at the time (260 $\mu g/m^3$). The other method collected samples that were analyzed for 2,4-D and 2,4,5-T. The highest concentration of 2,4-D was 0.006 $\mu g/m^3$, and the highest level of 2,4,5-T was 0.030 $\mu g/m^3$. Both of these peak concentrations are considerably lower than corresponding Risk-Based Concentrations (RBCs) that ATSDR typically uses to identify contaminants of potential concern. For reference, the RBCs for 2,4-D and 2,4,5-T are both 37 μg/m^3. Therefore, the measured concentrations of these contaminants were both more than 1,000 times lower than levels that would trigger a more detailed evaluation. In short, the limited air sampling data collected during the verification burn showed no evidence of air quality impacts of health concern, whether from excavation or incineration activities.

- *Air sampling during the full-scale operation.* When EPA issued the incineration permit, the agency required NCBC to monitor ambient air for particulate matter and TCDD for at least the first 30 days of the incinerator's operation. Consistent with these requirements, NCBC developed an ambient air monitoring plan, which EPA reviewed and approved. This required monitoring characterized airborne levels of contaminants near the excavation areas, but also reflected contributions from the incinerator's stack exhaust.

  Initially, NCBC's monitoring program was relatively intense. On every day of excavation, two air samples were collected for particulate matter and five air samples were collected for TCDD. Monitoring equipment was placed both upwind and downwind of excavation areas and the incinerator. After the first 30 days of monitoring were completed, NCBC reviewed the sampling data and reported to EPA that TCDD had not been detected in any of the air samples collected at the downwind monitoring location of greatest interest (EG&G 1990, 1991a; 1991b). The TCDD detection limit for this program was 2.5 pg/m^3 (or 0.0025 ng/m^3). Based on these results, NCBC concluded that the dust suppression techniques used in the excavation were adequate and that air samples could be collected less frequently. EPA concurred and allowed NCBC to continue with the excavation and incineration project with far less intense ambient air monitoring requirements. Overall, airborne levels of TCDD were measured at multiple locations at NCBC when incineration began, but the contaminant was never detected.

Public Health Evaluation of the Incineration Operation at NCBC

ATSDR identified extensive documentation of the past incinerator operations at NCBC. According to these records, NCBC conducted two emissions tests that demonstrated the incinerator could destroy TCDD (and other organic chemicals) in soils, without creating air emissions or residuals that pose health hazards to off-site residents. Moreover, ATSDR found that the incinerator was designed and operated in a manner that provides further protection to health and the environment: the incinerator automatically shut down when critical processing parameters reached levels beyond those specified in the operating permit. In other words, several contingencies were in place to prevent unsafe operating conditions from occurring. The available ambient air sampling data provide further support that incinerator operations did not harm nearby residents. Specifically, the sampling results show that particulate matter and key ingredients of HO did not reach potentially unhealthy levels on the days that measurements were collected.

Overall, the incinerator at NCBC treated extremely large volumes of soil between November 1987 and November 1988. While the incinerator efficiently destroyed the organic contaminants of greatest concern, the device released some contaminants and combustion by-products to the air. However, the best available information suggests that the amounts released were too small and occurred over too short a time frame to present a public health hazard. In short, exposures may have occurred, but not at amounts expected to harm area residents' health.

IV COMMUNITY HEALTH CONCERNS

ATSDR identified community health concerns through meetings and correspondence with community members, state and local officials, and NCBC personnel, and through review of site documents. During the PAS held in October 2003, ATSDR representatives were provided an opportunity to meet with residents in a confidential setting to discuss their individual or family's health concerns. These concerns are presented below along with ATSDR's responses.

Concern about airborne exposure to dioxin from the use of HO for weed control along the fence line.

Some residents informed ATSDR that NCBC personnel previously used HO to control weeds growing along the base fence line and have expressed concerns that breathing in HO-related contaminants might have resulted in exposure and health problems. To research this issue, ATSDR first tried to gather information on the extent to which HO was used to control weeds. ATSDR asked the concerned residents, NCBC, and Navy contractors to provide detailed insights on past HO uses.

Specifically, ATSDR asked for information on how much HO was used for weed control, how often HO was used for this purpose, and where HO was most likely sprayed. Unfortunately, site representatives and Navy contractors informed ATSDR that no recorded information is available on this issue. However, anecdotal information provided to ATSDR indicates that HO spraying may have occurred on occasion, but there is no evidence that suggests that frequent or periodic spraying occurred (Bob Fisher, Tetra Tech NUS, Personal Communication, December 9, 2003). In short, there is no detailed or quantitative information on the nature and extent of past HO spraying for weed control.

Without such quantitative information, ATSDR can only conduct a qualitative analysis resulting from the apparently limited past use of HO for weed control. This qualitative analysis is based on several general observations about the issue. First, the best available information suggests that HO was only sporadically used for weed control, and these uses were likely limited to the time when HO inventory was kept on site (i.e., more than 25 years ago). Second, ATSDR found no accounts or concerns that HO was sprayed directly on residents' properties. Third, the weed control applications apparently were made with direct application of HO, rather than by spraying from aircraft; this distinction is important because direct application would be expected to cause far less drift of the herbicide than would aerial spraying.

Finally, and perhaps most importantly, dioxin levels measured in surface soils along parts of the NCBC fence line are not unusually elevated. Specifically dioxin levels in 13 surface soil samples collected in April 1995 along, and just north of the NCBC fence line ranged between 0.6 ppt and 28 ppt TEQ, with an average dioxin concentration of 4.2 ppt TEQ. The samples were collected prior to any removal actions. This average concentration is roughly one-half the average dioxin level in soil samples collected across North America (8 ppt TEQ, see Table 7). Although it is not known if any of the samples were collected in areas where HO was used for weed control, these sampling results certainly suggest that widespread soil contamination does not remain along the property line from past HO applications in the area.

Additionally, the compound 2,3,7,8-TCDD was only detected in 3 out of the 13 surface soil samples collected near the NCBC boundary. This is the dioxin congener with the highest toxicity and one that is known to be a by-product in the HO formulation. If HO was routinely used to control weeds along the fence line we would expect to see higher and more frequent detections of 2,3,7,8-TCDD.

While none of the individual observations mentioned above provide a definitive account of the exposures that residents might have experienced from past weed control activities, the observations collectively suggest that HO applications were limited and did not leave contamination levels in soil that were detected in more recent sampling efforts. For these reasons, ATSDR does not believe the limited past HO spraying for weed control was a significant exposure pathway at NCBC. ATSDR will revisit this issue if more detailed insights on past weed control uses are brought to our attention during the Public Comment Period for this PHA.

Concern about past exposures to vapors that emanated from leaking HO drums, spills, and de-drumming activities at the former HO storage area (Site 8).

Some people living near NCBC have expressed concern about dioxin exposure from leaking containers at the HO Storage Area. Concerns also were expressed regarding potential exposures during de-drumming activities. The information provided below is based on ATSDR's review of records and documents at NCBC and from discussions with NCBC personnel. ATSDR's assessment of the potential exposure hazard associated with HO vapors from leaking drums takes into consideration, both, available site-specific information and ATSDR's experience evaluating similar concerns at other sites.

ATSDR researched site documents to find detailed information on this concern. The HO storage-related activities occurred more than 25 years ago and on-site monitoring programs were not established until after the HO drums were removed from the site. During the storage of HO at Site 8 the HO reportedly often saturated the soil by drums leaking or spillage during re-drumming or other routine maintenance. Most of the leaks were initially attributed to breakdown of the bung seals used in the drum closure or an occasional seam leak. However, leaks were also reported in the drum surfaces as well (Air Force 1979).

Discussions with NCBC personnel and records of communication with former NCBC employees confirmed the reports of leaking containers. However, according to a former NCBC employee who worked at the open storage areas, including the Site 8—HO Storage Area, the drums were not transported to any off-site locations (Gordon Crane, NCBC, Record of Communication, April 12, 2003). ATSDR could not identify any supporting documentation that the drums remained on site. Additionally, some Gulfport residents have claimed that excavated soil from contaminated areas on site was transported to an off-site disposal location on Canal Road.

The most direct measure of exposure would be ambient air sampling results for TCDD collected while NCBC stored drums containing HO. Unfortunately, no such studies were conducted between the late 1960s and 1977. However, ATSDR was provided two reports from NCBC archives that contain limited measurements and estimates of the amounts of 2,4-D and 2,4,5-T that might have become airborne in this time frame:

- The first study appears in a trip report, which documents the results of limited industrial hygiene sampling and ambient air sampling conducted in 1974 (Jackson 1974). The sampling reportedly detected trace amounts of 2,4-D and 2,4,5-T at various on-site locations, apparently during HO de-drumming activities. The highest concentrations recorded were 11 $\mu g/m^3$ of 2,4-D and 7 $\mu g/m^3$ of 2,4,5-T, both of which are considerably lower than their corresponding health-based comparison value (which is 37 $\mu g/m^3$ for both contaminants). Though the measurements do not reveal exposures at levels of health concern, ATSDR notes that the trip report provides virtually no information on laboratory analytical methods, quality assurance measures, or quality control checks. As a result, the data are of questionable quality and did not factor into the overall conclusions on this community concern.

- The second study appears to be an internal draft document that presents engineering estimates of 2,4-D and 2,4,5-T concentrations at locations downwind from de-drumming activities (Jackson and Normington 1974). Though no environmental sampling results are documented in this study, the estimated concentrations of 2,4-D and 2,4,5-T for off-site locations are reasonably consistent with the measurements documented in the previous bulleted item. ATSDR has reservations about using this study to formulate conclusions, because the report provided appears to be in draft form. This raises questions to ATSDR about whether the data presented in the report are final findings, or perhaps initial results that were later revised. Consequently, this study also does not factor into ATSDR's overall evaluation of this community concern.

For the reasons stated above, neither study provides definitive insights on whether residents experienced elevated TCDD exposures while NCBC stored HO on site. Furthermore, without detailed information on the number of drums that leaked or the extent of spilling that occurred, ATSDR cannot make quantitative estimates of how much TCDD was released to the air between the late 1960s and 1977 from the HO storage area.

ATSDR can qualitatively assess the environmental fate and transport of TCDD, by considering the physical properties of this contaminant. When compared to other organic contaminants, TCDD has an extremely low vapor pressure, a low solubility in water, a strong sorption potential for soils, and a very long half-life for various degradation mechanisms. Taken together, these observations suggest that TCDD released to the environment, such as during a spill, will have a high affinity for soils and will tend to remain in soils for relatively long periods of time, while experiencing little evaporation. These general observations clearly do not quantify the magnitude of past exposures for this concern. Nonetheless, TCDD's physical properties at least suggest that the majority of the chemical released during spills and de-drumming activities probably remained with the soil, rather than being largely released to the air.

Overall, the actual exposures residents experienced to TCDD vapors from the former HO storage area are not known, because the information from past sampling studies is insufficient to quantify exposure levels. What can be said definitively is that only those residents who lived near NCBC more than 25 years ago might have been exposed to the vapors from the drums. Based on TCDD's physical properties, however, spills of HO likely resulted in TCDD being released to the soils, where the contaminant would be expected to remain for long time periods, with limited TCDD releases to the air and, consequently, limited TCDD inhalation exposures experienced by off-site residents.

Concern about harmful dioxin exposures in the past from unauthorized disposal of HO storage drums and from contaminated soil and sediment transported to the dump on Canal Road [Specific activities potentially contributing to dioxin exposure included children playing in the dump and people participating in a traditional practice referred to as "dump digging."]

ATSDR has not located any records that document the disposal of empty drums containing HO stored at Site 8. According to NCBC personnel and site documents released by the US Air Force's Occupational and Environmental Health Laboratory, the HO-containing drums were drained using a suction wand, inverted, and allowed to drain again for a minimum of two minutes, and then rinsed with diesel fuel. The drums were then crushed and either sold or given to a local contractor to be taken to a smelter in the Gulfport area (USAF 1978;U.S. Navy 2004). Since accurate records have not been identified by site personnel and may no longer exist, ATSDR is unable to confirm the final destination of the empty HO containers.

According to some Gulfport residents, soil and/or sediments along Canal # 1were reportedly transported to the Canal Road disposal area around 1970. ATSDR has not been able to confirm that contaminated soil from Canal # 1 was ever transported to the disposal area. There are no records or reports available that document the conditions of the HO storage area or the extent of off-site contamination at that time. The results of recent off-site sediment sampling along Canal # 1 do not indicate dioxin contamination at levels that would be harmful. However, these current levels do not necessarily reflect what dioxin levels were in the past, especially if contaminated sediments were removed from the drainage areas near Outfalls 1 and 3, which drained portions of the HO storage area (Site 8).

Concerns about drinking contaminated water from private shallow wells next to Turkey Creek or municipal supply wells.

As a result of community concerns about the potential for dioxin contamination in drinking water, NCBC tested two residential drinking water wells and a third potable well located on Canal Road for dioxin in October 2002. The results are presented in Table 10 below. Dioxin was not detected in any of the wells that were sampled. Since dioxins are not readily soluble in water it is unlikely that people would have been exposed at harmful levels from drinking water supplies near NCBC.

Table 10: Results of Drinking Water Sampling Off-Site Near NCBC

Location	**Number of Samples Collected**	**Dioxin (TEQ) Range or Max (ppq)**	**Sampling Time Frame**
Canal Road (Tap Sample)	1	ND	October 2002
Private Potable Wells	2	ND	October 2002

Source: Tetra Tech 2003e; 2003f.
ppq = parts per quadrillion

Concerns about the potential for exposure to dioxin-contaminated sediment and soil in residential areas south of NCBC Gulfport.

ATSDR evaluated concerns about dioxin contamination impacting residents living south of NCBC Gulfport. On the basis of environmental investigations conducted at NCBC Gulfport, there is no evidence that dioxin contamination from Site 8 (Former HO Storage Area) has migrated off-site to the south or southwest of the base. The water and sediment in the drainage ditches surrounding Site 8 generally flows to the west and northwest towards outfalls 1,3, and 4 and off site to the off-base area of contamination (OBAOC). There is also some drainage to the east and possibly southeast of NCBC on the eastern side of Site 8.

Surface water and sediments from Site 8 need to flow through two drainage areas (Drainage Areas 5 and 6) at NCBC Gulfport to migrate off-site to the south and southwest of the base. These drainage areas were investigated in 1995 and again in 1997. Results of these investigations showed that most sediment samples contained relatively low concentrations of dioxin. In 1995, the maximum concentration detected in sediment samples was 74 ppt where Canal #1 enters NCBC. In 1997, the maximum concentration detected in sediment samples was 31 ppt (ABB-ES 1995a; NCBC 1997). The dioxin levels detected in samples collected from these two drainage areas were lower than dioxin levels found off-site north of the base and are well below ATSDR's 1 ppb action level.

In order to respond to requests among residents for off-site sampling near NCBC Gulfport, the Navy conducted a community sampling effort in October 2002. Three samples were collected from sediments from within Bear Creek, approximately 1 mile south of NCBC Gulfport at the University of Southern Mississippi campus and one additional sample was collected about 1 mile south of NCBC at Gaston Point. The area of community concern is over 1.5 miles southwest of the HO storage area and is not hydrologically connected to surface water drainage at NCBC Gulfport. The results of the community sampling did not indicate dioxin levels at harmful levels. The dioxin TEQ concentrations in the four samples ranged from 0.6 to 12.7 ppt.

Concerns about the potential health effects of bauxite-contaminated soil and dust migrating off site.

Some residents expressed concern to ATSDR about potential exposures to a mineral named bauxite that NCBC has stored on site in recent years in piles that were roughly 10 feet tall. Bauxite is a naturally occurring compound from which aluminum is produced. It is comprised primarily of one or more hydroxide minerals (see Glossary for expanded definition and web-link for more information on bauxite). ATSDR evaluated bauxite to determine if it poses a health risk to NCBC personnel and the Gulfport community. There are no records of air sampling data taken in the past at NCBC to determine how much bauxite-related dust and particulate matter was released in the area. However, studies conducted in occupational settings have shown that bauxite dust has relatively few adverse effects on the lungs (Townsend et al. 1985); furthermore, there is little evidence that bauxite dust is associated with adverse effects on the respiratory system. As long as it is in its native state, bauxite is not likely to cause health effects (Bellot et al. 1984). Bauxite dust has been expressed more as a nuisance rather than a health risk. Moreover, bauxite is a hard rock like material that does not break up easily by touch. At NCBC, releases of Bauxite were minimal compared to occupational settings, where bauxite is often fractured in order to be processed resulting in large amounts of particulate matter being released.

The known disease caused by Bauxite exposure, Shaver's disease, is in fact caused by inhalation of fumes or dust produced during the processing of Bauxite at high temperatures (Bellot et al. 1984). Although there is a completed past and present route of exposure, exposure to bauxite dust is minimal; as previously stated, bauxite is a hard material that unless disturbed, it would not yield great amounts of dust.

ATSDR received two distinct concerns: one focused on residents' potential inhalation exposures to bauxite particles carried off site by wind-blown dust; and the other pertained to children who reportedly played in the bauxite piles. The following paragraphs address these two concerns separately.

Regarding potential exposures to bauxite in wind-blown dust, it is well established that winds can cause surface soils and dusts to become airborne and carried to downwind locations. The critical issue for this concern is whether winds blow large enough amounts of bauxite off site to cause health problems. To address this issue, ATSDR first researched the toxicity of bauxite. Material Safety Data Sheets for bauxite and studies in the scientific literature (e.g., Townsend et al. 1985) report that inhalation of bauxite dust can cause irritation and other affects to the respiratory system, but only when exposures reach high enough levels. The American Conference of Governmental Industrial Hygienists (ACGIH) has reviewed this information and published data on safe levels of exposure to bauxite in the workplace. Specifically, ACGIH has reported that the amount of bauxite in total airborne dust should not exceed 10,000 $\mu g/m^3$ (this is ACGIH's threshold limit value, or TLV, concentration). Although no dust sampling has been collected during the time that NCBC has stored the bauxite piles, past sampling has shown that airborne particulate levels during excavation activities have not exceeded 109 $\mu g/m^3$. Based on these past results, which were measured during a time when soils were being intentionally disturbed, ATSDR finds it highly unlikely that wind-blown dust could carry bauxite from the storage piles at NCBC to off-site locations at concentrations remotely close to the TLV. Based on this analysis, ATSDR concludes that residents are not being exposed to harmful airborne bauxite levels.

The second concern addresses exposures that trespassers to the site might have experienced when playing on the bauxite piles. Some local residents stated that prior to NCBC building a higher deterrent perimeter fence; children would go into NCBC and play on the mountains of Bauxite. When researching this concern, ATSDR found conflicting information on the extent to which this activity occurred. NCBC representatives were not aware of this activity occurring. To address this issue further, ATSDR seeks further information during the Public Comment Period for this PHA on the extent to which children entered the site and played in the bauxite piles (e.g., how often did this occur? for how long would children play in these piles?).

Concerns about drainage outfall areas that may have been used by children as play areas.

Children who came in contact with sediments in the outfall areas may have been exposed to dioxins in the past. Site-specific information about the average frequency and duration of children playing in the outfalls is not available. ATSDR uses exposure assumptions that are health-protective and likely over estimates the frequency for coming in contact with dioxin-contaminated soil for most children living in close proximity to NCBC. These assumptions are presented in Appendix D along with the estimated children's dose for coming in contact with dioxin-contaminated soil and sediment.

Concern about three things happening around the same time in 1970. The fish kill in canal #l and Turkey Creek, neighborhood trees defoliating, and 27 cows in a pasture 2 blocks north of site 8 dying. All of this happened simultaneously.

ATSDR learned of these past anecdotal stories primarily through long-time residents of Gulfport who either claimed to have witnessed these events first hand or heard about them through relatives and friends. ATSDR has not been able to confirm the occurrence of large fish kills, tree defoliations, and bovine deaths through reviewing the scientific literature or through published news articles. These events were said to have occurred around 1970 and, unfortunately, there is little more than anecdotal information about these events. ATSDR will continue to evaluate any new information that may provide additional perspective about past exposures to dioxins.

V EVALUATION OF HEALTH OUTCOME DATA

There have been numerous community concerns regarding what is believed by some residents to be a higher than normal occurrence of cancer and other illness in the NCBC Gulfport community. The Mississippi State Department of Health (MSDOH) has evaluated these concerns and provided a summary of the results to ATSDR.
MSDOH evaluated cancer mortality rates in residential areas near NCBC using the smallest geographic units feasible (e.g., county, zip code, or census tract). The findings are summarized below:

- *Methods*: An analysis was performed on mortality data for the years of 1998-2002 for the following: (1) all cancer deaths, (2) combined deaths due to lung cancer, breast cancer, non-Hodgkin's lymphoma, and leukemia, and (3) all causes of death. Standardized mortality rates (SMRs) were calculated for the following demographic groups: (1) total population, (2) population over 65, (3) total white, (4) total male, and (5) total female in each of the counties of Harrison, Jackson, and Hancock and for Mississippi (not including Hancock County). A statistical analysis (Chi-square) was performed in which SMRs for each condition in each demographic group for each of the years 1998-2002 in Harrison County were compared to corresponding SMRs for Jackson and Hancock Counties and to Mississippi (not including Hancock County).

- *Results*: There was no consistent evidence that Harrison county differed from Jackson and Hancock counties or from the state with regard to total cancer mortality rate, combined mortality rate from lung cancer, breast cancer, non-Hodgkin's lymphoma, and leukemia, or total mortality rate over time. These results were persistent even when controlled for demographic variables.

- *Notes*: 1) SMRs were not calculated for minority groups or individuals under 65 because the small cell sizes in these groups would have produced unstable statistical results. 2) Statistical significance was set at a p-value of <0.001 to ensure a robust inference because of low incidence rates. 3) Data from the years 1998-2002 were chosen for analysis since these are the most complete and recent data available. 4) Hancock County may not be a good control group because of its small population size (42,967 in 2000) and predominantly white population (90.2%) when compared to Harrison and Jackson Counties.

Note: For more information regarding the MSDOH's cancer evaluation, please contact Dr. Mills McNeill at 601-576-7725 or email at: mmcneill@msdh.state.ms.us

VI CHILD HEALTH CONSIDERATIONS

ATSDR recognizes that infants and children may be more sensitive to exposures than adults in communities with contamination in water, soil, air, or food. This sensitivity is the result of a number of factors. Children are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. Children are shorter than adults, which mean they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, potentially resulting in higher doses of chemical exposure per unit body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. Therefore, ATSDR is committed to evaluating their special interests at sites such as NCBC as part of the ATSDR Child Health Initiative.

Like other people living or working at or near NCBC, children may contact contaminated soils or sediments as well as other media (e.g., air and water). As discussed in the "Environmental Contamination, Human Exposure Pathways, and Public Health Implications" and "Community Health Concerns" sections of this PHA, past, current, and future exposures for children could include contact with contaminated soils or sediments in recreational areas or areas where children may play (e.g., drainage ditches or dumps), ingesting contaminated foods or non-food items (e.g., dirt), or breathing in contaminated air.

To evaluate whether children may experience adverse health affects through past, current, or future exposures to site contaminants, ATSDR estimated the potential doses for children. To estimate these doses, ATSDR used very health-protective assumptions that likely overestimate the levels of actual exposure. The assumptions used and estimated dosed are presented in Appendix D.

Conclusions about child health in areas impacted by dioxins

ATSDR evaluated the exposures children might experience from playing in areas with contaminated soils or sediments, from swimming or wading in surface waters, eating homegrown foods, and breathing air near NCBC. The results of the community survey and exposure assessment conducted in the area surrounding NCBC confirmed that children both played and waded in the ditch system and may have also played in the Canal Road dump. The estimated child-specific dose from coming in contact with dioxin-contaminated soil and sediment did not exceed ATSDR's chronic oral minimal risk level (MRL) using health-protective assumptions and average dioxin TEQ concentrations measured in sediment samples collected from the most contaminated off-site location (See Table 6; Tables D3 and D4 in Appendix D).

Off-site soil and sediment data are not available for the time periods when HO was being stored at Site 8 (i.e., late 1968 through 1977). Therefore, ATSDR relied on data collected during more recent investigations for its evaluation. It is possible that dioxin levels were higher in the off-site drainage areas. However, samples from the outfalls and on-site drainage canals collected in the late 1970s and 1980s do not support the theory that dioxin levels have declined significantly over time. Although children may have come in contact with low levels of dioxins in soils and sediment off site, ATSDR would not expect to see adverse health effects from contact with off-site soils and sediments. There is no evidence that children were exposed to harmful levels of contaminants in fish, homegrown foods, or from breathing contaminated air.

VII CONCLUSIONS

After evaluating available environmental information, ATSDR has reached the following conclusions regarding the identified exposure situations at NCBC. ATSDR has not identified any past, current or future public health hazards associated with site-related contaminants at NCBC. ATSDR's pathway-specific conclusions regarding the potential exposure pathways evaluated at NCBC are described below:

1. **Coming into contact with dioxin-contaminated soil and sediment off site:**

   Past Exposure: ATSDR concludes that past exposures to soil and sediments off site did not result in harmful exposures. Low-level dioxin exposure from coming in contact with contaminated soils and sediments may have occurred during the late 1960s and through the 1980s. However, even the most contaminated off-site locations (e.g., OBAOC) did not contain dioxins in soil and sediment at levels that have been demonstrated to cause illness or measurable adverse health effects. The average dioxin levels detected in off-site surface soils and sediments were well below ATSDR's established action level of 1 ppb for dioxin in soil. It is possible that dioxin concentrations in off-site soil and sediment could have been significantly higher when the HO-related contamination was initially transported off site through the drainage ditches. However, monitoring programs in place during the mid 1980s did not identify dioxin contamination off site at significantly higher levels than what was observed in more recent sampling efforts. ATSDR categorizes this pathway as no apparent public health hazard.

   Current and Future Exposure: ATSDR concludes that current and future exposures to soil and sediments off site do not pose a public health hazard. HO drums are no longer stored at NCBC and dioxin-contaminated soil at Site 8 was incinerated in 1988 under a RCRA approved permit. Other removal actions, both on site and off site, have occurred at locations where dioxins have been detected above state and federal regulatory cleanup levels for dioxin-contaminated soils. Since the source of dioxin exposure has been removed and most contaminated areas have been cleaned up, ATSDR categorizes current and future exposures to dioxin-contaminated soil and sediment off-site at NCBC as no public health hazard.

2. **Coming into contact with dioxin-contaminated surface water off site:**

   Past Exposure: The analytical results of most of the samples collected from surface water off site at NCBC are below EPA's MCL established for dioxin in drinking water. Site investigations indicate that the transport of dioxins along the drainage ditch systems to off-site locations is primarily a result of the migration of sediments and not from contamination of the surface water. ATSDR believes that the samples collected are representative of most of the surface water features near NCBC and the quality and quantity of samples is adequate to make a definitive public health determination. ATSDR categorizes contact with surface water off site near NCBC as no apparent public health hazard.

   Current and Future Exposure: ATSDR did not identify levels of dioxins in surface water that are a current health concern or would pose a concern in the future. Dioxins are not readily soluble in water and are unlikely to be found in harmful concentrations in surface or ground water. ATSDR categorizes contact with off-site surface water as no current or future public health hazard.

3. **Potential exposure through consuming fish:**

   Past Exposure: It is likely that dioxin-related contamination did migrate off site, impacting the nearby drainage areas and fish and wildlife habitats. Fish, especially bottom eating species, can accumulate contaminants such as dioxins from ingesting sediments directly or ingesting plants and animals that are found in the sediments. It is possible that frequent consumption of fish (e.g., subsistence fishers consuming greater than 16 [8-ounce] fish meals per month) over several years from the most heavily dioxin-contaminated locations could have resulted in harmful exposures. However, ATSDR has not identified any off-site locations where dioxins in sediments were at levels of public health concern. Reported dioxin levels in fish collected off site were low, but past sampling of fish from off-site drainage areas is inadequate and information about consumption patterns is not sufficient to make a definitive public health hazard statement. As a result, ATSDR categorizes past consumption of fish from drainage ditches, canals, and other surface waters near NCBC as an indeterminate public health hazard.

   Current and Future Exposure: NCBC has taken numerous actions to remove dioxin contamination at Site 8 and in on-and-off site drainage areas. The fish samples collected in 1999 contained low levels of dioxins that are below levels of health concern. ATSDR concludes that current and future consumption of fish in off-site drainage areas and surface waters near NCBC will not result in harmful effects. ATSDR classifies this exposure pathway as no apparent public health hazard.

4. **Potential exposure through consuming edible wildlife (e.g., frogs, crawfish) and homegrown produce.**

   Past Exposure: It is possible that some edible wildlife species (e.g., ducks, turtles, frogs) that fed almost exclusively on organisms found in the contaminated drainage ditches contained dioxin levels that were not safe for frequent human consumption. It is unlikely that people would have been exposed to dioxin levels in edible wildlife tissue in the past that would have resulted in health effects. However, ATSDR has not identified information about how frequently people harvested edible wildlife from the most contaminated off-site locations and classifies this exposure pathway as an indeterminate public health hazard.

   Average dioxin concentrations detected in surface soil and sediments off site, even in the OBAOC, were not sufficiently elevated to contaminate edible fruits and vegetables at levels that would cause health effects in people. Carefully washing fruits, garden vegetables, and any other edible plants obtained locally would have significantly reduced dioxin exposures resulting from the consumption of locally obtained fruits and vegetables. ATSDR concludes that consumption of homegrown vegetables did not result in past exposures that were harmful and classifies this exposure pathway as no public health hazard**.**

   Current and Future Exposure: Site-related dioxin contamination at Site 8 and in on-and-off site drainage areas have been cleaned up and currently meet acceptable state residential standards for dioxins in soil. ATSDR concludes that it is unlikely that current and future consumption of edible wildlife and homegrown produce that are harvested near off-site drainage areas and surface waters will result in harmful effects and, therefore, classifies this exposure pathway as no public health hazard.

5. **Breathing in air in the past from incineration of dioxin-contaminated soil.**

   Past Exposure: The incinerator was shown to be extremely efficient at destroying the organic compounds found in the soil at the former HO storage area. Moreover, the incinerator was equipped with several process control checks that would automatically shut the process down before different types of unsafe operations would occur. While the incinerator released trace amounts of contamination to the air, the available emissions data and ambient air sampling data suggest that the contaminants were not released at levels that would harm local resident's health. Therefore, ATSDR concludes that the past incinerator operation from November 1987 to November 1988 did not result in harmful exposures and classifies this exposure pathway as no apparent public health hazard.

VIII PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for NCBC contains a description of actions taken and to be taken by ATSDR, NCBC, EPA, and/or other agencies subsequent to the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, ongoing or planned, and recommended are listed below.

Completed Actions

1. Upon completion of the soil incineration program in 1988 the ash was tested and confirmed to contain less than 1 ppb TCDD. Every roll off box containing ash was tested during the program. All 302 samples that were collected contained well below 1 ppb TCDD and, therefore, met the criterion for on-site backfill.

2. NCBC completed a series of environmental investigations (Base-wide Sampling—1994, Off-base Sampling—1995), under the Department of Defense's Installation Restoration Program, to characterize the nature and extent of dioxin contamination at NCBC.

3. As part of the joint AO issued by MDEQ, a Community Survey and Exposure Assessment was conducted in 1996 to collect data on potential exposure routes to the ditches and canals surrounding NCBC.

4. A Creel Survey was conducted between January and April 1999 to determine fish consumption patterns (e.g., most common species collected and the frequency of consumption).

5. Additional environmental sampling (Phase I and II—1997) was conducted and a surface water and sediment dioxin delineation report was released in June 1999.

6. A Human Health Risk Assessment report was released in 2001 addressing dioxins associated with the former HO Storage Area. This report included the results of dioxin analyses for fish samples collected during fall and spring 1999.

7. Off-site sampling was conducted in October 2002 and a report was released in 2003. The areas selected for sample collection were based on examination of historical maps, aerial photographs, and through interviews with local residents.

8. Numerous removal actions have been conducted on and off site. Off-site soil and sediment removal actions have occurred at locations along 28th Street (1995), along Perry Street (1996), at residential properties located within the OBAOC (2002), and locations adjacent to Canal Road culverts (2003). Confirmatory sampling was conducted with all these removal actions to ensure that the areas met state and federal standards for dioxins in soil.

9. Based on further discussions with community members additional surface soil-site samples were collected in a drainage ditch along Papania Lane and from soil piles along Canal Road.

10. The Mississippi Department of Health conducted a review of available mortality data (1998-2002) to determine if any unusual patterns of cancer mortality have occurred in Harrison, Jackson, and Hancock counties compared to the state as a whole.

Ongoing Actions

1. SRTs have been installed over the past 10 years in ditches connected to Site 8 and are continuing to collect sediments that migrate of site from the NCBC drainage ditches.

2. NCBC has begun excavating the off-base area of contamination [OBAOC] and on-base ditches. All excavated material is being blended with Portland cement to create a non-leaching sub-base that will be used to create a twelve inch concrete cap over the former Herbicide Orange storage area.

3. Mississippi Department of Health is currently evaluating cancer incidence rates in the areas near NCBC to determine if any unusual patterns of illness are observed.

Planned Actions

1. NCBC plans to conduct additional sampling of waste piles on Canal Rd.

2. NCBC plans additional sampling in a residential neighborhood north of the base. This sampling is being conducted due to concerns related to a past outfall that no longer exists.

3. NCBC plans additional grid sampling of areas Eight B and C to assess the nature and extent of contamination with the expectation of removing any residual contamination that exceeds the states established remediation goals.

Recommendations

1. ATSDR supports NCBC Gulfport's ongoing investigations and remedial activities related to the Equipment Training Landfill (Site 5) and recommends continued monitoring of the soil cover. NCBC Gulfport should take appropriate actions to ensure that contaminants do not migrate to the Pinewood Housing Area or become accessible for contact.

2. The Navy's past searches and ongoing environmental investigations have not identified disposal locations for the empty HO containers. ATSDR recommends that the Navy continue its search for available information and document, as best possible, 1) the disposition of the empty HO drums from site 8 and; 2) the removal and transport of any soil and sediment from Canal # 1 to off-site disposal areas or other residential locations.

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How to contact ATSDR

You may contact ATSDR staff with questions, comments, or additional information by telephone, e-mail or regular mail. ATSDR's point of contact for NCBC Gulfport is Scott Sudweeks, toxicologist with the Federal Facilities Assessment Branch. You may contact ATSDR by calling the toll-free number **(888) 42-ATSDR (888-422-8737)**.

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Additional information about ATSDR services and the public health impacts of exposure to hazardous substances is available on the ATSDR web site at:
http://www.atsdr.cdc.gov.

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APPENDICES

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern

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Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Disaster Recovery Disposal Area **(Site 1)**	Site 1 is a 9-acre inactive landfill located in the west-central portion of the facility on the corner of Seventh Street and Colby Avenue. The Disaster Recovery Disposal Area was in operation from 1942 to 1948 and served as the primary disposal area for chemical wastes generated by public works shops and the supply department at NCBC Gulfport. Wastes such as paints, solvents (e.g., toluene, trichloroethylene, xylene), cleaning compounds, and oils were placed in 55-gallon drums and buried in trenches. Site 1 is primarily used for training activities.	In early 1984, 4 or 5 drums were identified during repair operations on a water line in the southwestern portion of the site. A number of chemicals (e.g. oils, grease, xylene, toluene) were present in samples taken from the drums. An Initial Assessment Study (IAS) was conducted in 1985. This study included a review of available waste disposal records and interviews with personnel who were knowledgeable about activities at Site 1. A Verification Study was completed in 1987. This included geophysical surveying and collection of environmental samples. A Basewide Sampling program was initiated in December 1984 and samples were collected and analyzed for metals, VOCs, SVOCs, and selected herbicides/pesticides at Site 1. Groundwater: Chromium concentrations from monitoring wells ranged from 81 to 415 ppb. Lead concentrations ranged from 52 to 79 ppb. Low concentrations of dioxins were detected in groundwater samples.	No remedial actions have occurred or have been recommended for Site 1	Site 1 does not pose a public health hazard because contaminants have not been detected in groundwater, surface water, or sediments at concentrations that are harmful.

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
World War II Landfill **(Site 2)**	This is an 11-acre site located in the northwest portion of NCBC, immediately southwest of Site 7. Site 2 was operated as a landfill from 1942 to 1948.	An IAS was conducted in 1985. The IAS included interviews with site personnel who were knowledgeable about activities at Site 2 and record reviews. A Verification Study was completed in 1987 and included geosurvey techniques and a limited collection of environmental samples; 2 groundwater, 1 surface water, and 1 sediment sample. Additional samples were also collected as part of the Base-wide Sampling program. The results of sampling at Site 2 did not identify concentrations of chemicals in any media (i.e., soil, sediment, surface water, or groundwater) above ATSDR's comparison values.	No remedial action has occurred or has been recommended for Site 2.	Site 2 does not pose a public health hazard because contaminants have not been detected in groundwater, surface water, or sediments at concentrations that are harmful.

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern

Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
The Northwest Landfill and Burning Pit **(Site 3)**	Site 3 contains a landfill, approximately 650 feet by 240 feet in area and a burn pit on the northwestern side of the landfill. The site is located in the northwestern portion of the base and is bordered on the south by Eighth Street, on the east by Colby Avenue, and on the north and west by wooded areas. The landfill was in operation from 1948 until the mid 1960's. An estimated 30,000 tons of solid waste and 130,000 gallons of flammable liquid were burned in the pit. Wastes were typically burned in the pit using diesel fuel. The ash and unburned materials were disposed of in the landfill and covered with soil. The pit was also used from the mid 1950's until 1965 for fire-fighting training. Flammable liquids such as paints, paint thinners, waste fuels, and solvents were used during the training. The pit was filled with soil upon closure in 1965.	An IAS was completed for Site 3 in 1985. The IAS included interviews with site personnel and record reviews. A verification Study was completed in 1987. Three soil samples, 3 groundwater samples, 1 surface water sample, and 1 sediment sample were collected and analyzed for metals and VOCs. Additional samples were also collected as part of the Base-wide Sampling program. Groundwater: Lead was detected at a maximum concentration of 35 ppb. Low concentrations of dioxins were detected (e.g., OCDD). No other contaminants were identified above ATSDR's screening values.	No remedial actions have occurred or have been recommended for Site 3.	Site 3 does not pose a public health hazard because contaminants have not been detected in groundwater, surface water, or sediments at concentrations that are harmful.

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Golf Course Landfill **(Site 4)**	Site 4 is a 4-acre former landfill located in the west-central portion of NCBC. The land is currently used as a golf course. Between 1966 and 1972, prior to construction of the golf course, chemical wastes were disposed at this site by burning and burial. Approximately 16,000 tons of solid waste and unknown quantities of other liquid wastes (e.g., fuel, oils, solvents, paints, and paint thinners) were stored at Site 4.	An IAS was completed for Site 4 in 1985. The IAS included interviews with site personnel and record reviews. A verification Study was completed in 1987. Three soil samples, 3 groundwater samples, 1 surface water sample, and 1 sediment sample were collected and analyzed for metals and VOCs. Additional groundwater samples were also collected as part of the Base-wide Sampling program. Groundwater: Lead was detected at a maximum concentration of 124 ppb. Other contaminants detected at low levels in groundwater include VOCs, SVOCs, pesticides (4,4'-DDE, 4,4'-DDD), and dioxins.	An RI was conducted for this site during 2002/2003.	Site 4 does not pose a public health hazard because contaminants have not been detected in groundwater, surface water, or sediments at concentrations that are harmful.

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Equipment Training Area Landfill **(Site 5)**	This site is a former 8.5-acre landfill that operated between 1972 and 1976. It is located approximately 200 feet west of the intersection of 4th Street and Colby Avenue, in an area currently used for heavy equipment training. The operation of the landfill coincided with the storage of HO at Site 8, and reports indicate that drums of DDT and other liquid wastes (e.g., fuels, oils, solvents, paints, and paint thinners) were disposed of in this landfill. According to site documents, DDT may have been transported to NCBC Gulfport by one of the battalions upon returning from deployment. The drums were reportedly buried at the site in the mid-1970s. Heavy equipment training exercises began at the landfill after closure in 1976. During these exercises equipment operators frequently uncovered buried wastes.	An IAS was completed for Site 5 in 1985. The IAS included interviews with site personnel and record reviews. In 1987, surface water, groundwater, and soil samples were collected as part of a confirmation study. Additional samples were also collected in December 1994 as part of the Base-wide Sampling program. In 1997, soil and groundwater samples were collected near magnetic anomalies identified during a geophysical investigation. In 1999, a Surface Water and Sediment Dioxin Delineation Report presented results of surface water, sediment, seep, and groundwater samples collected from the ditches in and around Site 5. An additional groundwater investigation focusing on potential dioxin and furan contamination at Site 5 was conducted in 1999. A Remedial investigation (RI) report was released in April 2003. During the RI investigation, groundwater, surface water and sediment, and surface soil samples were collected. Surface water:	A four to six foot soil cover was placed on top of the site during the late 1970's. Site 5 is currently under investigation and additional remedial actions are being considered.	Site 5 does not pose a public health hazard since access to the area is restricted. However, a family housing area (Pinewood Housing Area) is located approximately 50 feet to the south of the former landfill. A soil cover was placed on top of the landfill during the 1970s. Dioxins have been detected in soil at Site 5 at levels that are below ATSDR's action level of 1 ppb. ATSDR believes it is prudent to minimize any potential exposure to dioxins. Therefore, we recommends that NCBC review the integrity of the soil cover and, if dioxins or other contaminants are detected in surface soil at levels of concern, take actions to ensure that contaminants do not migrate to the housing area.

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
		Dioxins were detected at concentrations ranging from 39.1 — 80 parts per quadrillion. Six samples collected during the RI contained trace levels of dioxins (TEQ equivalent). Sediment: Dioxin (TEQ equivalent) was detected at a maximum concentration of 6.8 parts per trillion (ppt). Surface Soil: Dioxin (TEQ equivalent) was detected at a maximum concentration of 719 ppt. Groundwater: Benzene was detected at 6 ppb in one sample. Arsenic was detected at a maximum concentration of 51 ppb, lead was detected at a maximum concentration of 85.4 ppb, and dioxin (TEQ equivalent) was detected at a maximum concentration of 51 ppq.		

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Former Fire-Fighting Training Area **(Site 6)**	Site 6 is located in the southwest portion of NCBC. It consists of two unlined pits used for fire training activities from 1966 to 1975. One pit was approximately 50-feet long by 35-feet wide and the other 40-feet long by 25-feet wide. During operation liquid (e.g., fuels, oils, solvents, paints, and paint thinners) wastes were burned and disposed in unlined pits during firefighting training. Initially, burns were conducted once or twice per month and periodically increased in frequency (e.g., once or twice per week). Approximately 1,000 to 2,000 gallons per week of flammable liquids were burned at the site.	An IAS was completed for Site 6 in 1985. The IAS included interviews with site personnel and record reviews. In 1987, surface water, groundwater, and soil samples were collected as part of a confirmation study. Investigations completed as part of the Installation Restoration (IR) program in the Fall of 1992 found an oily liquid referred to as "free phase floating product" floating on the groundwater immediately beneath the soil. An assessment of Site 6 was conducted in 1994. The assessment discovered approximately 2.5 feet of free phase floating product from two burn pits. In groundwater, lead was detected at a maximum concentration of 70 ppb. VOCs were detected at very low concentrations.	A remediation plan to remove the free product was completed in December 1994. The remediation plan recommended constructing a recovery trench with three extraction wells. The extraction and treatment system was installed in September 1995 and was in operation through at least 1998 An Enhanced Bio-slurper (See Appendix E-Glossary for a description) was installed in November 2001, at Site 6 to improve the removal of fuel in the groundwater.	Site 6 does not pose a public health hazard. Access to Site 6 is restricted and groundwater underneath the site is not being used. The nature and extent of fuel contamination has been characterized and a system is in place to remove free product from the ground.

Appendix A: Evaluation of Public Health Hazards at NCBC Areas of Concern				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Rubble Disposal Area **(Site 7)**	Site 7 covers an area approximately 375 by 350 feet in the western portion of NCBC, near the northern border of the Center. It was used from 1978 to 1984 for disposal of concrete, lumber, scrap metal, and other debris. The source of much of the waste disposed of at the site was construction and building demolition debris. The discarded materials were buried just below the surface. According to NCBC representatives, there is no evidence that hazardous wastes were disposed of at this site. The site is currently an open, grassy area. Site 2 was combined with Site 7 shortly before the Draft Final Verification Report was released. According to the Verification Report, further reconnaissance at sites 2 and 7 showed that the two sites overlapped and could be considered as a single site.	An Initial Assessment Study (IAS) was completed in 1985 and a verification study was completed in 1987. Sampling at Site 7 was also conducted as part of the base wide sampling program completed in 1994. Phase 1 of the groundwater sampling activities took place in October 1998 and Phase 2 took place in February 1999. **Surface Soil:** Surface soil samples were not collected at Site 7. Surface Water and Sediment: Low levels of dioxin TEQ (maximum concentration = 0.7 ppq) were detected in surface water. Dioxin TEQ was detected at Site 7 at 150 ppt during the base wide sampling event. TPH was detected in sediment at a level of 320 ppm. **Groundwater:** Dioxin TEQ (51.6 parts per quadrillion [ppq]) was detected in a sample collected from monitoring well GPT-07-01.	No remedial action has occurred or has been recommended for Site 7.	Site 7 does not pose a public health hazard. Access to Site 7 is restricted and groundwater underneath the site is not being used.

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Herbicide Orange Storage Area **(Site 8)**	Site 8 is roughly a 30-acre storage area in the eastern portion of NCBC. It was used by the U.S. Air Force (USAF) between 1968 and 1977 as a storage area for approximately 850,000 gallons of the defoliant herbicide orange (HO). Based on the level of storage and handling of HO, Site 8 was subdivided into areas 8A, 8B, and 8C during site investigations. Site 8A (approximately 12 acres) was the primary storage area and Sites 8B and 8C were used to handle overflow HO stockpile. During the storage period, damaged and leaking drums of HO were removed from the site. In 1977, the USAF disposed of the entire HO liquid inventory by incinerating it at sea. During 1987 and 1988, approximately 30,000 cubic yards of dioxin-contaminated soil at the site was incinerated and the resulting ash was stored on Site 8A. Prior to receiving HO the storage area was stabilized with a soil/Portland cement mixture to provide a hardened surface. Additional fill material was added to the storage area at locations where	Initial environmental investigations were conducted between 1977 and 1984 by the Air Force Engineering and Service Center During this period, soil sampling was conducted at NCBC between September 1980 and November 1982; sediment, surface water, and biota sampling were conducted from September 1980 through March 1984. In 1985 and 1986 sediment and biota samples were collected from the drainage system that drains the former HO storage area at NCBC. In addition, groundwater samples (from 3 potable water wells) were collected in June 1986. In 2002, 71 confirmation samples were collected from the excavation site and analyzed for dioxin. **Surface Soil**: 2,3,7,8-TCDD was detected (310 ppb) above EPA's 1 ppb cleanup standard. None of the post-excavation confirmation samples were detected above EPA's 1 ppb clean-up standard (maximum concentration was 0.01 ppb). **Sediment:** No sediment samples were collected at	Several removal actions associated with Site 8 have occurred. In 1977, the U.S. Air Force disposed of the 850,000 gallons of HO stored at NCBC at sea by high-temperature incineration. Between 1985 and 1987 Site 8 was remediated to the standards that existed at that time (1 ppb). The excavated soil and sediment above 1 ppb was incinerated and placed on Site 8, Area A. The ash was tested and confirmed to contain less than 1 ppb TCDD. In August/September 2002, a site contractor removed dioxin-contaminated surface sediment in the ditches at Site 8B and Site 8C. A total of approximately 2,600 cubic yards of contaminated materials were excavated from ditches at Site 8. The excavated sediments and soil ash are being stored in a bermed	Site 8A has been fenced since 1977 and was inactive until initial remedial activities began in 1986. On the basis of site reports and discussions with NCBC representatives, Site 8 contained dioxin contamination in the past at levels ***on site*** that would be of health concern for people coming in frequent contact with the soils and storage containers [See ATSDR's evaluation of "drainage ditches, canals, and outfalls" and the "Off Base Area of Concern (OBAOC)" for an evaluation of potential off-site public health hazards]. Site 8 does not pose a current or future public health hazard. HO drums are no longer stored at Site 8 and the dioxin-contaminated soil has been cleaned up to levels that are well below ATSDR's action level of 1 ppb.

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
	known spills occurred, providing a cover ranging from 0 to 6 inches thick over the cement-stabilized soil.	Site 8. See evaluation of on-site drainage ditches for a discussion of sediment samples and dioxin analysis. **Surface Water:** No surface water samples were collected at NCBC Gulfport. **Groundwater:** 2,3,7,8-TCDD was detected (60 picograms /liter [pg/l]) above EPA's maximum contaminant level (MCL) for drinking water.	containment area on Site. These materials will be stabilized with cement, buried at Site 8A, and then covered with a protective liner. A Focused Feasibility Study was conducted in 2000/2001 to determine the best way to manage soils containing dioxin. The report has been reviewed and approved by MDEQ. The preferred remediation alternative involves returning excavated contaminated soil and sediments from ditches on and off base and returning the soil to Site 8. Site 8 will then be covered with a material (i.e., a cap) that is strong enough to support the storage of heavy equipment.	

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
PCB in the Drainage Ditch Adjacent to the Parade Field **(Site 10)**	Site 10 is located in the south-central portion of NCBC just north of the Parade Field. It covers roughly a100 foot by 10-foot long portion of the drainage ditch that is adjacent to the Parade Field. During an onsite Phase I dioxin delineation study, sample results obtained from this drainage ditch identified elevated levels of dioxins and furans, particularly hexachlorinated-dibenzo-furans (HxCDFs). During further investigation, it was suspected that the HxCDFs were introduced into the ditch from a transformer oil spill. Two samples originally collected during the Phase I field investigation were analyzed for PCBs. The results of these samples identified Aroclor-1260 (an indicator of electrical transformer oil). According to NCBC Gulfport personnel, Site 10 has been fenced since 2001.	During the Phase I dioxin delineation study conducted during April and May 1977, two samples were collected and analyzed for PCBs. The results of these analyses identified PCBs at levels as high as 180 parts per million (ppm). In July 1997, a total of 10 sediment samples were collected and analyzed for PCBs. During this sampling event PCBs in the drainage ditch were recorded at levels up to 140 ppm. After an initial excavation, several rounds of confirmation sampling were conducted because additional PCB contamination was identified. Post-excavation analytical results identified soils containing PCBs at levels up to 16,300 ppm.	Approximately 400 tons of ditch sediment and soil were removed in order to achieve a cleanup level of 1 ppm. Institutional controls were installed and maintained to prevent the public from entering the contaminated area during the remedial activities. During the removal action water flowing through the ditch was diverted and a by-pass pumping system was installed to divert ditch water from entering the open excavation. Groundwater or storm water that contacted the contaminated soil was collected, treated to below discharge standards, and analyzed prior to discharge. After the contaminated soil was removed, the project site was restored to its original condition. All disturbed areas were graded, and covered with either seed or sod.	Site 10 does not pose a current or future public health hazard since PCB-contaminated sediments and surface waters were removed. In the past, site personnel may have come in contact with PCB-contaminated sediments. However, access to this area is restricted and contact with sediments would likely have been infrequent and of short duration. PCB levels were not detected in high enough concentrations to be harmful to people who came in occasional contact with the drainage ditch area.

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Other On-Site Drainage Areas, Canals, and Outfalls	There are a series of drainage ditches that drain surface water from NCBC off base to Turkey creek and other nearby creeks. The surface water drainage systems were divided into the following six drainage areas across NCBC. ***Drainage Area 1:*** This is the largest of the designated drainage areas on base and includes the majority of the HO storage area (Site 8). ***Drainage Area 2:*** This area drains a small portion of the northern part of Site 8 (Areas A & B) and includes the drainage ditches that carry surface water north to Outfall 4. ***Drainage Area 3***: This drainage area contains the drainage ditches east of Holtman Avenue, including Site 8 (Area C). The ditches of this drainage area drain east exiting the base at Outfall 2.	Levels of dioxins in the surface water and sediments within the drainage ditches at NCBC have been measured during several different environmental investigations between the mid 1980s through the late 1990s. <u>Sediment:</u> The maximum dioxin concentration in sediments for each of the drainage areas along with some of the main outfalls and canal # 1 are presented below. Drainage Area 1 — 1 ppb Drainage Area 2 — 4 ppb Drainage Area 3 — 0.12 ppb Drainage Area 4 — 0.03 ppb Drainage Area 5 — 0.03 ppb Drainage Area 6 — 0.02 ppb Canal # 1 — 0.074 ppb	Dioxin-contaminated sediments have been excavated during a series of removal actions at drainage ditches surrounding the former HO Storage Area (Site 8). Sediment recovery traps have been installed along the northern perimeter and other strategically placed locations around the former HO Storage Area.	Access to these drainage areas is restricted to NCBC personnel. ATSDR has received anecdotal information from local residents about past reports of people fishing and collecting edible wildlife from the canals and outfalls along the boundary and immediately north of NCBC. ATSDR considers past consumption of fish and wildlife to be an indeterminate public health hazard because sampling information is not available to evaluate.

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
	Drainage Area 4: This drainage area primarily consists of the drainage ditches that run along 9th Street and Sylvester Drive in the northeastern portion of NCBC. This drainage area eventually flows south and merges with Drainage Area 3 at Outfall 2. ***Drainage Area 5***: This drainage area includes the southern part of the base from Bainbridge Avenue west to Canal No. 1, including Sites 4 and 5. ***Drainage Area 6:*** This drainage area encompasses a portion of the southern part of NCBC including Outfalls 3,4, and 5 South. According to site reports, the drainage area is not hydraulically connected to Site 8.	Outfall # 1 — 0.0002 ppb Outfall # 3 — 0.2 ppb Surface Water: The maximum dioxin concentration in surface water was detected at drainage area 2 at a maximum concentration of 40 parts per quadrillion (PPQ).		

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
On-Site Bauxite Piles	During the 1940s NCBC was used to store large quantities of aluminum ore called bauxite. Bauxite was stored in two places - about 500 feet north of the former HO storage area and the other pile is about 900 feet northwest of the former HO storage area.	ATSDR is not aware of any environmental investigations associated with the bauxite piles.	No corrective measures have taken place. According to NCBC personnel, small amounts of bauxite were transported off site over a long period of time. The last bauxite piles were removed in February 2004.	The bauxite piles at NCBC did not pose a public health hazard in the past and do not pose a current of future hazard. Access to this area is restricted and dust and particulates from the bauxite were not at levels that would cause respiratory health problems. As of January 2004, all the bauxite has been removed from NCBC Gulfport.

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Known Contaminated Locations (Off Site)				
Off-base areas of concern (OBAOC)	The OBAOC is located in a wetlands area across 28th Street immediately north of Outfall 3. This area consists of several privately owned parcels of land. Dioxin-contaminated soil and sediments from Site 8A were discharged directly into the OBAOC until late 1995. Dioxin contamination originating from Site 8 has migrated off site via the drainage ditch system to three privately owned properties located down gradient (north- northeast) of Outfall 3, north of 28th Street and east of Canal Road.	Environmental investigations conducted between April 1997 and February 1999 identified dioxin-contaminated sediments in the swampy area north of Outfall 3 designated As OBAOC.	In the Fall of 1995, the flow of surface water and sediment from Site 8 was diverted from Outfall 3 to Canal # 1. This diversion greatly reduced the sediment deposition in OBAOC from the former HO storage area (Site 8). According to site documents, contaminated sediment in the OBAOC are in the process of being remediated under the State of Mississippi's Voluntary Clean-up and Redevelopment Act and the state's Brownfield regulations.	Past exposures from coming in contact with dioxin-contaminated sediment and soil may have occurred. Samples collected from the OBAOC during recent investigations did not contain dioxins at levels that exceeded ATSDR's action level of 1 ppb (i.e., 1,000 ppt).

Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at NCBC Gulfport				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards

Sources:

ABB Environmental Services, Inc. 1992. Final Documentation Support and Hazard Ranking System II Scoring NCBC, Gulfport, MS. October 1992.

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U.S. Navy. 2001. Letter Report: Site 7 Dioxin Groundwater Investigation, Addendum to Groundwater Monitoring Work Plan, Naval Construction Battalion Center (NCBC), Gulfport, Mississippi, Navy October 2001. [CD NCBC Gulfport 4/22/03]

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Appendix B: List of Comparison Values Used by ATSDR

Comparison Values

ATSDR comparison values are media-specific concentrations that are considered to be safe under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific “contaminants of concern.” The latter term should not be misinterpreted as an implication of “hazard.” As ATSDR uses the phrase, a “contaminant of concern” is a chemical substance detected at the site in question and selected by the health assessor for further evaluation of potential health effects. Generally, a chemical is selected as a “contaminant of concern” because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's comparison values.

Nevertheless, it must be emphasized that comparison values are not thresholds of toxicity. Although concentrations at or below the relevant comparison values could reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. The principal purpose behind conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health hazards before they become actual public health consequences. Thus comparison values are designed to be preventive—rather than predictive—of adverse health effects. The probability that such effects will actually occur does not depend on environmental concentrations alone, but on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

Listed and described below are the various comparison values that ATSDR uses to select chemicals for further evaluation, as well as other non-ATSDR values that are sometimes used to put environmental concentrations into perspective.

CREG	=	Cancer Risk Evaluation Guides
MRL	=	Minimal Risk Level
EMEG	=	Environmental Media Evaluation Guides
IEMEG	=	Intermediate Environmental Media Evaluation Guide
RMEG	=	Reference Dose Media Evaluation Guide
RfD	=	Reference Dose
RfC	=	Reference Dose Concentration
RBC	=	Risk-Based Concentration
MCL	=	Maximum Contaminant Level

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors, or cancer potency factors, using default values for exposure rates. That said, however, neither CREGs nor cancer slope factors can be used to make realistic predictions of cancer risk. The true risk is always unknown and could be as low as zero.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious non-cancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (#14 days), intermediate (15-364 days), and chronic (∃365 days) exposures. MRLs for specific chemicals are published in ATSDR toxicological profiles.

Environmental Media Evaluation Guides (EMEGs) are concentrations that are calculated from ATSDR minimal risk levels by factoring in default body weights and ingestion rates. They factor in body weight and ingestion rates for acute exposures (Acute EMEGs — those occurring for 14 days or less), for intermediate exposures (Intermediate EMEGs — those occurring for more than 14 days and less than 1 year), and for chronic exposures (Chronic EMEGs — those occurring for one year [365 days] or greater).

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRL, EPA's RfD is a dose expressed in mg/kg/day.

Reference Concentrations (RfC) is a concentration of a substance in air that EPA considers unlikely to cause noncancer adverse health effects over a lifetime of chronic exposure.

Risk-Based Concentrations (RBC) are media-specific concentrations derived by Region III of the Environmental Protection Agency from RfD=s, RfC=s, or EPA=s cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer (Ac@) or noncancer (An@) effects.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

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 obtained by contacting ATSDR at 1-888-42ATSDR (1-888-422-8737).

Appendix C: Calculation of 2,3,7,8-TCDD Toxic Equivalency (TEQ)

Calculating Total Dioxins

Dioxins and dioxin-like compounds, including certain PCBs and furans, are evaluated based on total toxicity equivalency factors (TEFs) as related to the most toxic dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The resulting toxic equivalency (TEQ) is used to evaluate concentrations and exposures. There are two main sets of TEFs, the International TEFs (I-TEFs), which is used by the EPA, and the World Health Organizations TEFs (WHO-TEFs). Both of these methods are protective. One of the primary differences between the two methods is that the WHO method uses TEFs for dioxin-like PCB congeners.

The TEFs are based on known toxicological information for each compound. A total equivalency (TEQ) is calculated by multiplying the chemical concentration by the TEF, and then summing all the values. There are two main sets of TEFs, the International TEFs (I-TEFs), which is used by the EPA, and the World Health Organization TEFs (WHO-TEFs). One of the primary differences between the two methods is that the WHO method uses TEFs for dioxin-like PCB congeners. It is often necessary to calculate the 2,3,7,8-TCDD TEQ using both methods because comparison values may be expressed as either I-TEQ or WHO-TEQ. The I-TEFs and the WHO-TEFs are listed in Table C-1.

Table C-1: Total Equivalency Factors (TEFs) for Dioxins, Furans, and PCB-like Congeners		
Compound	**WHO-TEF**	**I-TEF**
1,2,3,4,6,7,8,9-octachlorodibenzofuran	0.0001	0.001
1,2,3,4,6,7,8-heptachlorodibenzofuran	0.01	0.01
1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	0.01	0.01
1,2,3,4,7,8,9-heptachlorodibenzofuran	0.01	0.01
1,2,3,4,7,8-hexachlorodibenzofuran	0.1	0.1
1,2,3,4,7,8-hexachlorodibenzo-p-dioxin	0.1	0.1
1,2,3,6,7,8-hexachlorodibenzofuran	0.1	0.1
1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	0.1	0.1
1,2,3,7,8,9-hexachlorodibenzofuran	0.1	0.1
1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	0.1	0.1
1,2,3,7,8-pentachlorodibenzofuran	0.05	0.05
1,2,3,7,8-pentachlorodibenzo-p-dioxin	1	0.5
2,3,4,6,7,8-hexachlorodibenzofuran	0.1	0.1
2,3,4,7,8-pentachlorodibenzofuran	0.5	0.5
2,3,7,8-tetrachlorodibenzofuran	0.1	0.1
2,3,7,8-tetrachlorodibenzo-p-dioxin	1	1
octachlorodibenzo-p-dioxin	0.0001	0.001
PCB-105	0.0001	NA*
PCB-114	0.0005	NA
PCB-118	0.0001	NA
PCB-123	0.0001	NA
PCB-126	0.1	NA
PCB-156	0.0005	NA
PCB-157	0.0005	NA
PCB-167	0.00001	NA
PCB-169	0.01	NA
PCB-189	0.0001	NA
PCB-77	0.0001	NA
PCB-81	0.0001	NA

Appendix D: ATSDR's Methods, Assumptions, and Calculations

Contaminant Data Evaluation

In public health assessments, ATSDR addresses the likelihood that exposure to contaminants at the maximum or average concentrations detected would result in adverse health effects. While the relative toxicity of a chemical is important, the response of the human body to a chemical exposure is determined by several additional factors, including the concentration (how much), the duration of exposure (how long), and the route of exposure (breathing, eating, drinking, or skin contact). Lifestyle factors (i.e., occupation and personal habits) also have a major impact on the likelihood, magnitude, and duration of exposure. Individual characteristics such as age, sex, nutritional status, overall health, and genetic constitution affect how a human body absorbs, distributes, metabolizes, and eliminates a contaminant. A unique combination of all these factors will determine the individual's physiologic response to a chemical contaminant and any adverse health effects the individual could suffer as a result of the chemical exposure.

ATSDR has determined levels of chemicals that can reasonably (and conservatively) be regarded as harmless, based on the scientific data the agency has collected in its toxicological profiles. The resulting comparison values and health guidelines, which include ample safety factors to ensure protection of sensitive populations, are used to screen contaminant concentrations at a site and to select substances ("chemicals of concern") that agency environmental health scientists and toxicologists scrutinize more closely.

It is a point of key importance that ATSDR's (and EPA's) comparison values and health guidelines represent conservative levels of safety and not thresholds of toxicity. Thus, although concentrations at or below a comparison value could reasonably be considered safe, it does not automatically follow that any concentration above a comparison value will necessarily produce toxic effects. To the contrary, ATSDR's (and EPA's) comparison values are intentionally designed to be much lower, usually by orders of magnitude, than the corresponding no-effect levels (or lowest-effect levels) determined in laboratory studies. ATSDR uses comparison values (regardless of source) solely for the purpose of screening individual contaminants. In this highly conservative procedure, ATSDR may decide that a compound warrants further evaluation if the highest single recorded concentration of that contaminant in the medium in question exceeds that compound=s lowest available comparison value (e.g., cancer risk evaluation guides or other chronic exposure values) for the most sensitive, potentially exposed individuals (e.g., children or pica children). This conservative process results in the selection of many contaminants as "chemicals of concern" that will not, upon closer scrutiny, be judged to pose any hazard to human health. Still, ATSDR judges it prudent to use a screen that "lets through" many harmless contaminants rather than one that overlooks even a single potential hazard to public health. Even those contaminants of concern that are ultimately labeled in the toxicologic evaluation as potential public health hazards are so identified solely on the basis of the maximum concentration detected. The reader should keep in mind the protective nature of this approach when considering the potential health implications of ATSDR's evaluations.

Because a contaminant must first enter the body before it can produce any effect on the body, adverse or otherwise, the toxicologic discussion in public health assessments focuses primarily on completed pathways of exposure, i.e., contaminants in media to which people are known to have been, or are reasonably expected to have been, exposed. Examples are water that could be used for drinking, and air in the breathing zone.

To determine whether people were, or continue to be, exposed to contaminants originating from a site, ATSDR evaluates the factors that lead to human exposure. These factors or elements include (1) a source of contamination, (2) transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) an exposed population. Exposure pathways fall into one of three categories:

- *Completed Exposure Pathway*. ATSDR calls a pathway “complete” if it is certain that people are exposed to contaminated media. Completed pathways require that the five elements exist and indicate that exposure to the contaminant has occurred, is occurring, or will occur.

- *Potential Exposure Pathway*. Potential pathways are those in which at least one of the five elements is missing but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring, or could occur in the future. Potential exposure pathways refer to those pathways where (1) exposure is documented, but there is not enough information available to determine whether the environmental medium is contaminated, or (2) an environmental medium has been documented as contaminated, but it is unknown whether people have been, or could be, exposed to the medium.

- *Eliminated Exposure Pathway*. In an eliminated exposure pathway, at least one of the five elements is missing and will never be present. From a human health perspective, pathways can be eliminated from further consideration if ATSDR is able to show that (1) an environmental medium is not contaminated, or (2) no one is exposed to contaminated media.

Exposure Dose Methods

This section details the methods, assumptions, and calculations that ATSDR used to estimate potential exposure doses from exposure to dioxin-contaminated soil and sediment and from the consumption of contaminated fish. To be protective and account for the uncertainty surrounding how representative the exposure factors are for the residents of Gulfport, ATSDR used health-protective assumptions to estimate the reasonable maximum exposure level. This estimate calculates a daily exposure dose in milligrams of contaminant per kilogram body weight (mg/kg/day). It is intentionally protective and likely overestimates the amount of chemical exposure from coming in contact with soil and from eating fish.

Deriving Exposure Doses

Exposure doses are typically 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 residents living near NCBC Gulfport.

Calculating exposure dose from coming in contact with soil and sediment and from eating fish from the surface water bodies near NCBC.

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.

The following equation was used to estimate human exposure from coming in contact with dioxins in soil and sediment and from consuming fish:

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

See Tables D-1 and D-2 for equation definitions and assumptions used in calculating exposure.

Table D-1: Dose Assumptions: Exposure to Soil and Sediment			
Parameter	**Abbreviation**	**Child**	**Adult**
Chemical Concentration in Soil and Sediment[1]	C	Average Concentration at OBAOC	Average Concentration at OBAOC
Ingestion Rate[2]	IR	200 mg/day (i.e., 0.0002 kg/day)	100 mg/day (i.e., 0.0001 kg/day)
Exposure Frequency[3]	EF	208 days/year	104 days/year
Exposure Duration [3]	ED	6 years	30 years
Body Weight[3]	BW	13 kg	70 kg
Averaging Time[3]	AT	365 days	365 days
Averaging Duration[3] **Carcinogens**	AD	NA	70
Averaging Duration[3] **Non-carcinogens**	AD	ED (i.e., 6 years)	ED (i.e., 30 years)

Notes:

[1] ATSDR used the average dioxin (TEQ) concentration detected in sediment samples collected from the off-base area of concern (OBAOC), the most contaminated off site location.

[2] ATSDR's ingestion rate assumptions for both adults and children are based on EPA guidelines and on data compiled in EPA's Exposure Factors Handbook (EPA 1997). The soil ingestion rate of 100 mg/day for adults represents residential and agricultural scenarios and reflects the upper bound range of most studies. The soil ingestion rate of 200 mg/day for children represents a conservative average estimate for the amount of soil ingested by children.

[3]

mg = milligrams; kg = kilograms

Table D-2: Dose Assumptions: Exposure to Fish			
Parameter	**Abbreviation**	**Child**	**Adult**
Chemical Concentration in Fish[1]	C	Average Concentration	Average Concentration
Ingestion Rate[2]	IR	13 g/day (i.e., 0.013kg/day)	26 g/day (i.e., 0.026 kg/day)
Cooking Reduction[3]	CR	30 % (0.30)	30 % (0.30)
Exposure Frequency	EF	350 days/year	350 days/year
Exposure Duration	ED	6 years	30 years
Body Weight	BW	13 kg	70 kg
Averaging Time	AT	365 days	365 days
Averaging Duration Carcinogens	AD	NA	70
Averaging Duration Non-carcinogens	AD	ED (i.e., 6 years)	ED (i.e., 30 years)

Notes:

[1] ATSDR used the average dioxin (TEQ) concentration detected in fish from two common edible species (catfish and largemouth bass) collected at off-site sampling locations during 1994.

[2] ATSDR's ingestion rate assumptions for both adults and children are based on the 95th percentile of recreational freshwater anglers reported in EPA's Exposure Factor Handbook (EPA 1997).

[3] The cooking reduction value is based on studies presented in EPA's NCEA 2000 Draft Final Report (full citation is provided in Reference section.

g = grams; kg = kilograms

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 (non-cancer 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.

Evaluation of Non-cancer Health Effects

As a first step in evaluating non-cancer effects, ATSDR compares estimated exposure doses to health-protective guideline values, including ATSDR's minimal risk levels (MRLs)[1] 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 non-cancer 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.

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. ATSDR compares the LOAEL and NOAEL from the chemical-specific toxicological profiles to determine the likelihood for the estimated doses to cause harmful effects in people. 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. 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.

Some limited epidemiological studies documenting adverse effects in humans from oral exposure to dioxins exists and a variety of adverse effects have been observed and are well documented in animal studies. The difference between human and animal studies may be attributed to differences in species susceptibility, or more likely, the fact that most animal studies administer doses that greatly exceed those found in human exposure scenarios.

Studies in Japan, Canada, Germany, Italy, and the Netherlands estimated daily total dioxin intakes in the general population from 1×10^{-9} to 7×10^{-9} mg/kg/day. A study of a group of people involved in a mass food poisoning of dioxins, furans, and PCBs over several months in western Japan showed that people consumed, on average, 14×10^{-9} mg/kg/day of total dioxins from contaminated rice oil. The only adverse health effects observed in this group of people was chloracne, a skin disease caused by chlorinated compounds that goes away once exposure stops

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[1] ATSDR used the chronic oral MRL for dioxin (1×10^{-9}) to compare estimated doses from exposure to dioxin in sediment and fish. The World Health Organization (WHO) has established a tolerable daily intake (TDI) for total dioxins at a range of 1 x 10 -9 to 4 x 10 -9 mg/kg/day. This range is based on the examination of adverse health effects seen in animal and human studies (WHO 1998).

(Masuda 1996). On the basis of health-protective exposure assumptions for residents living near NCBC Gulfport, the estimated total dioxin exposure dose calculated from coming in contact with dioxin-contaminated sediment and locally obtained catfish is 4.6×10^{-11} and 8.1×10^{-10} mg/kg/day respectively (see Tables D3 and D4). Both of these estimated dose values are lower than ATSDR's MRL, WHO's total daily intake (TDI) range, and the ranges found in other countries.

Evaluation of Cancer Health Effects

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.

Table D-3. Estimated TCDD TEQ Exposure Dose from Coming in Contact with Soil and Sediment near NCBC *Non-cancer effects*

Location	Average TEQ Conc. (ng/kg)	Adult Dose (mg/kg/day)	Child Dose (mg/kg/day)	MRL (mg/kg/day)
OBOAC	77	3.1×10^{-11}	6.8×10^{-10}	1×10^{-9}
Turkey Creek	13	5.3×10^{-12}	1.1×10^{-10}	1×10^{-9}

Conc = Concentration
MRL = Minimal Risk Level (oral, chronic)
OBOAC = Off Base Area of Concern
ng/kg = parts per trillion (ppt)

Note: ATSDR's MRL for dioxin can also be expressed as 1 picogram/kilogram/day

Table D-4. Estimated TCDD TEQ Exposure Dose from Eating Fish From the Surface Water Bodies near NCBC Gulfport *Non-cancer effects*

Type of fish	Average TEQ Conc. (ng/kg)	Adult Dose (mg/kg/day)	Child Dose (mg/kg/day)	MRL (mg/kg/day
Catfish	0.91	2.3×10^{-10}	6.1×10^{-10}	1×10^{-9}
Largemouth Bass	0.58	1.4×10^{-10}	3.9×10^{-10}	1×10^{-9}

Conc = Concentration
MRL = Minimal Risk Level (oral, chronic)
ng/kg = parts per trillion (ppt)

Note: ATSDR's MRL for dioxin can also be expressed as 1 picogram/kilogram/day

Appendix E: ATSDR Glossary of Environmental Health and Site Related Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

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

Acute
Occurring over a short time [compare with chronic].

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

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

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

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

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

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

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

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

Bauxite
Bauxite is the raw material from which aluminum is produced. It is a naturally occurring compound that is heterogeneous and composed primarily of one or more hydroxide minerals. Bauxite is also composed of various mixtures of silica, iron oxide, titania, aluminosilicate, and other impurities of minor or trace elements. (http://minerals.usgs.gov/minerals/pubs/commodity/bauxite/).

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

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

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

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

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

Bioslurper
A bioslurper is an updated version of pump-and-treat groundwater extraction system. Instead of drawing product into a single well, the bioslurper uses a number of pumps installed in a series of wells. The pumps work until the product ceases to flow then stops pumping to allow the well to

recharge. The system also brings oxygen into contact with the product the speeds up the bio-degradation of the product.

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

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

CAP [see Community Assistance Panel.]

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

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

Carcinogen
A substance that causes cancer.

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

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

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

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

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

Chronic
Occurring over a long time [compare with acute].

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

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

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

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

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

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

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

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

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

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

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

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

Disease prevention
Measures used to prevent a disease or reduce its severity.

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

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

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

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

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

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

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

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

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

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

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

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

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

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

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

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

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

Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

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

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

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

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

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

Mutagen
A substance that causes mutations (genetic damage).

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

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

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

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

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

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

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

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

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

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

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

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

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

ppb
Parts per billion.

ppm
Parts per million.

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

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

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

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

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

Public health action
A list of steps to protect public health.

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

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

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

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

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

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

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

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

Radionuclide
Any radioactive isotope (form) of any element.

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

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

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

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

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

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

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

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

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

Risk communication
The exchange of information to increase understanding of health risks.

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

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

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

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

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

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

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

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

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

Substance
A chemical.

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

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

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

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

Surveillance [see public health surveillance]

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

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

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

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

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

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

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

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

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

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

Wetlands
According to the U.S. Army Corps of Engineers and The EPA, wetlands are defined as “those areas that are inundated or saturated at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (40 CFR 230.3 and 33 CFR 328.3).”

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

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

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

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Appendix F: Explanation of Dioxin-like Compounds

1 Dioxins/Furans: An Overview

1.1 What are Dioxins/Furans?

Polychlorinated dibenzo-p-dioxins (PCDDs) and -furans (PCDFs) are two related classes of chlorinated organic compounds. They have similar structures and can be visualized as two 6-sided “benzene rings” connected by oxygen bridges, two in PCDDs and one in PCDFs (ATSDR 1998). There are 8 different positions on a PCDD molecule and 10 on a PCDF molecule, which can be occupied by a chlorine atom or other substitute. This makes possible the existence of 75 individual variations or “congeners” of PCDDs and 135 of PCDFs. The only difference between these various congeners of PCDDs and PCDFs is the specific number and location of the chlorine atoms in each. Different congeners that share the same number of chlorine atoms, but at different locations, are referred to as isomers. Groups of isomers that contain 1, 2, 3, 4, 5, 6, 7, or 8 chlorine atoms are called mono-, di-, tri-, tetra-, penta-, hexa-, hepta-and octa-chlorinated dioxins/furans, respectively (ATSDR 1998).

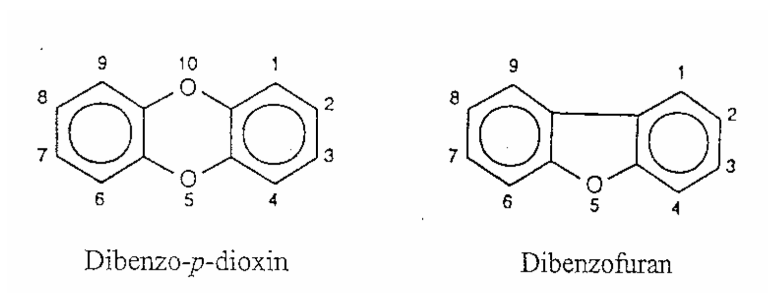

Figure 1 . Core Structures of Dioxins and Furans

The relative toxicity or potency of various PCDDs and PCDFs is strongly influenced by the number and position of the chlorine atoms in the molecule. The most toxic dioxin, and the most extensively studied, is 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD or TCDD). More highly chlorinated (i.e., penta- through octa-) PCDDs/PCDFs that also have chlorine atoms at the (lateral) 2, 3, 7 and 8 positions (among others) are often described as dioxin-like compounds in recognition of the possibility that they may share, to some extent, the established toxicities of 2,3,7,8-TCDD (ATSDR 1998).

1.2 What are the Sources of Dioxin Contamination and Exposure?

PCDDs and PCDFs are not produced deliberately; they are unwanted byproducts that can, under special conditions, be formed during combustion and certain industrial processes. Dioxins are formed as a contaminant during the manufacture of certain chlorinated organic chemicals (e.g., pentachlorophenol [PCP] and certain herbicides). Due, however, to significant refinements in the manufacturing process, emissions from the chemical industry no longer represent a major source of dioxins nationwide. Today in the U.S. older medical and municipal incinerators constitute one of the major remaining sources of dioxins still being released into the environment (ATSDR 1998). And, existing regulations are expected to reduce emissions from those sources by more than 95% (EPA 2001b).

According to the Environmental Protection Agency (EPA), levels of dioxin in the environment have declined substantially. In the 1994 draft of its dioxin reassessment, EPA estimated average daily background exposures in the U.S. general population to be 0.3 - 0.6 picograms TCDD per kilogram per day (pg/kg/day), and about 1 pg/kg/day of dioxin-like PCDDs and PCDFs (range, 1-3 pg/kg/day), principally from dietary sources (ATSDR 1998, EPA 1994a). In its 2000 draft, EPA added dioxin-like polychlorinated biphenyls (PCBs) to the total and concluded that the average adult daily intake of PCDDs/PCDFs/PCBs in the U.S. from food, soil, and air was still only 1 pg/kg/day for a 70-kg adult (EPA 2000b).

Over 90% of that exposure comes from eating meat, fish, and dairy products contaminated with residues that first entered the food chain many years ago (ATSDR 1998). Dioxins are very stable, highly lipophillic ("attracted to fat") compounds that, depending on the congener and the species, may also be relatively resistant to metabolism. As a result, dioxins have a strong tendency to bioaccumulate in fat, bind strongly to soils and sediments high in organic content, and persist in the environment for many years. Average concentrations of dioxins in biological and environmental samples have been declining since the 1970s and continue to do so (EPA 1994a, EPA 2000b, EPA 2001a, EPA 2001b). Due to the existence of natural sources, however, dioxins will never disappear completely from the environment (EPA 1998).

Before analytical techniques were sensitive enough to demonstrate otherwise, it was commonly thought that dioxins were produced exclusively as a man-made byproduct of industrial activities. It is now known, however, that dioxins pre-date not only the industrial revolution but also the human race itself; they have recently been detected in 30 million-year-old clay deposits (Hayward et al 1999). Dioxins are produced by both natural and anthropogenic combustion processes, including forest fires (EPA 1998). They are generated in very small amounts during the combustion of almost any organic material. The concentration of chlorine (which is always present in excess) is not a limiting factor (Rigo and Chandler 1998, Wikstrom and Marklund 2001). Thus the burning of materials containing polyvinyl chloride (PVC) does not necessarily produce any more dioxin than does the burning of other organic materials. Rural backyard trash burning actually produces more dioxin nationwide than does PVC manufacture (EPA 1998, Hayward et al 1999). According to EPA, "uncontrolled combustion such as burning of household waste is expected to become the largest quantified source of dioxin emissions to the environment" (EPA 2001b).

2 *Potential Adverse Health Effects of Dioxins*

Some natural substances like botulinum toxin are more toxic than dioxin, but TCDD produces adverse health effects in laboratory animals at lower concentrations than any other man-made chemical (Klaassen and Eaton 1991). Less than one-millionth of a gram per kilogram body weight (0.000001 g/kg or 1 microgram per kilogram (ug/kg)) can slowly kill a guinea pig or cause cancer in rats. Average background doses in the U.S. and Europe are in the range of 1 trillionth of a gram per kilogram of body weight per day (0.000000000001 grams/kg/day or 1 pg/kg/day). During the Vietnam War, the herbicide Agent Orange was contaminated with parts per million of dioxin (TCDD). Today, concentrations of dioxin in highly contaminated soil are measured in the low parts per billion (ppb), in food, dioxins occur in parts per trillion (ppt), in water, in parts per quadrillion (ppq), and in air, in parts per quintillion (ppqt). Each of these units of measure is 1,000 times smaller than the previous one. (See Appendix G for the definitions of standard units of concentration.) A millionth (10^{-6}) of a gram is called a microgram (μg), a billionth (10^{-9}) of a gram is a nanogram (ng), a trillionth (10^{-12}) is a picogram (pg), a quadrillionth (10^{-15}) is a femtogram , and a quintillionth (10^{-18}) of a gram is called an attogram. There are about 28 grams in one ounce. (In subsequent sections, doses will generally be converted to pg/kg/day to facilitate comparison to an average human background exposure of 1 pg/kg/day.)

The actual mechanism by which TCDD and other dioxins induce adverse effects in animals is still largely unknown (EPA 1989, EPA 2000a). Dioxin and dioxin-like compounds do bind to a common cellular macromolecule (the Ah-receptor) in both animals and humans (EPA 1989, EPA 2000a, EPA 2001a, EPA 2001b). The interim Toxicity Equivalency Factor (TEF) approach is based on the assumption that binding to this receptor represents the initial step in a toxic mechanism that is common to animals and humans. However, except for the chain of events leading to the induction of certain enzymes (for example, cytochrome P-450-IA1), clear evidence for such an assumption is still lacking (EPA 1994b). No causal relationship has ever been established between Ah receptor regulated gene expression and any of the toxic effects produced by TCDD (EPA 2000a).

2.1 Animal Effects

Relatively little is known about the adverse health effects of non-TCDD dioxins, but the most toxic congener, 2,3,7,8-TCDD, is one of the most extensively studied of all known environmental toxins. Wherever sufficiently high doses of TCDD have been administered, a variety of effects have been observed in almost every animal species tested. Observed effects in animals include, in order of declining associated dose levels: death, weight loss, liver toxicity, immune suppression, reproductive impairments, birth defects, and cancer (ATSDR 1998). The doses of dioxin required to produce these adverse health effects in animals vary enormously with species, as well as with strain, sex, tissue, and duration of exposure. For example, reported LD50 values for TCDD—an LD50 is the dose of a substance required to kill 50% of the exposed test animals—vary from 0.6 ug/kg (600,000 pg/kg) in male Hartley guinea pigs to 5,051 ug/kg (5,000,000,000 pg/kg) in Syrian hamsters (ATSDR 1998). This represents more than an 8,000-fold difference between two species of rodent that are much more closely related to one another than either is to humans. Virtually all known chronic, intermediate, and acute effects levels for TCDD range upward from one hundred, one thousand, and ten thousand pg/kg/day, respectively. For non-TCDD dioxins, known- effect levels in animals exceed a million pg/kg/day or 1 ug/kg/day (ATSDR 1998).

ATSDR's chronic Minimum Risk Levels (MRLs) are estimates of daily doses that would not be associated with any detrimental effects over a lifetime of exposure. Most are based on animal effects and the application of conservative safety factors. For example, ATSDR=s chronic MRL for TCDD of 1 pg/kg/day, which approximates average background exposures in the United States, is based on less serious effects on social behavior in monkey offspring and a safety factor of 90 (ATSDR 1998).

2.2 Human Effects

A vast number of human health studies have been conducted to assess the human health consequences of dioxin exposure and related compounds. Various reviews of these studies have been conducted by the Institute of Medicine, the International Agency for Research on Cancer, the National Toxicology Program, the Environmental Protection Agency, and the Agency for Toxic Substances and Disease Registry. Exposures to dioxin have been associated with a wide-range of human health end points including a variety of cancers, birth defects and reproductive outcomes, chloracne (a skin condition), and diabetes. Even so, the weight-of-evidence for a causal association between each of these conditions and dioxin exposure varies with the quantity and quality of the research, the consistency across research studies, and the accuracy of the exposure assessment and disease classification. Summary assessments of human health risks from dioxin exposures tend to consider not only the human health evidence, but also evidence from animal toxicology and mechanistic research.

Several epidemiologic studies have examined dioxin exposures and cancer incidence or mortality. Conclusions about the human carcinogenicity of dioxin have varied because of differences in opinion regarding weight-of-evidence. For the most part, the weight-of-evidence appears stronger for TCDD dioxin as compared to assessments of dioxin TEQs. Most recently, TCDD dioxin was listed as a *known human carcinogen* in the 10^{th} edition of the *Report on Carcinogens* released by the National Toxicology Program (NTP). This conclusion was based on sufficient evidence of carcinogenicity from studies in humans, involving a combination of epidemiological and mechanistic information, which indicate a causal relationship between exposure to TCDD and human cancer. As reported by the NTP (NTP 2002):

"there have been a number of reports of studies examining cancers in human populations exposed to TCDD occupationally or through industrial accidents. There has also been a concerted research effort examining the molecular and cellular events that occur in tissues of humans and animals exposed to TCDD. Epidemiological studies of four high-exposure industrial cohorts in Germany, the Netherlands, and the United States reported an increase in overall cancer mortality (IARC 1997). Studies published through 1996 demonstrated statistically significant increases in relative risks for all cancers combined, lung cancer, and non-Hodgkin's lymphoma among highly exposed sub-cohorts. Increased risk for certain cancers was also reported in an updated examination of the population exposed to TCDD during the 1976 industrial accident in Seveso, Italy (Bertazzi et al 1997)."

The International Agency for Research on Cancer (IARC) has also reviewed the human studies. In 1997, IARC concluded that TCDD dioxin was a *known human carcinogen* based on the same studies reviewed by NTP and on the underlying evidence of carcinogenicity in animal studies and understanding of the mechanisms of action for TCDD dioxin.

It is well established that chloracne, a chronic skin condition, is clearly associated with exposure to TCDD and related compounds. However, there is considerable human variability in the chloracne response to TCDD, so the dose-response relationship is not well characterized. Other non-cancer effects associated with exposure to dioxin have been recently reviewed by ATSDR toxicologists (Pohl et al 2002):

"Hepatic changes observed in exposed populations include hepatomegaly, increased hepatic enzyme (GGT, AST, ALT) levels, induced hepatic microsomal activity (measured as increased D-glucaric acid excretion), alterations in porphyrin metabolism, and increases in serum lipid (cholesterol, triglycerides) levels. With the exception of long-lasting changes in GGT (Calvert et al 1992, USAF 1991) and in serum cholesterol (USAF 1991) in some exposed groups, hepatic effects were transient and appeared to have been associated with acute exposure to high TCDD concentrations.

Few long-term thyroid effects were found in Ranch Hand veterans (USAF 1991), but a recent study of nursing infants suggests that ingestion of breast milk containing CDD and chlorinated dibenzofurans (CDF) levels somewhat higher than those reported in most general population studies, may alter thyroid function (these data are not conclusive because the measured thyroid hormone levels were within the normal range) (Koopman-Esseboom et al 1994; Pluim et al 1992). Slightly increased risk of diabetes and abnormal glucose tolerance tests have been reported in populations exposed to high TCDD concentrations (Sweeney et al 1992, USAF 1991). In the former study, however, age and body mass index, both known risk factors for diabetes, appear to have a greater influence than TCDD level.

Dose–related trends for deaths from cardiovascular disease and ischemic heart disease were observed in individuals exposed to CDDs during the BASF accident (Flesch-Janys et al 1995). However, other studies found no relationship between TCDD exposure and cardiovascular deaths (Bertazzi et al 1989) or other cardiovascular effects (Hoffman et al 1986; Wolfe et al 1985). A few case reports indicate that acute exposure to high TCDD levels can produce respiratory irritation, but there is no indication that exposure to TCDD produces chronic respiratory effects (ATSDR 1998).

Although alterations in some immune end points have been reported in populations exposed to TCDD, there has not been a consistent pattern, and the clinical significance of the effects is not totally clear. The overall evidence for neurologic effects suggests that although neurologic effects are reported to have occurred shortly after exposure in occupationally exposed individuals, even high exposure to TCDD caused no long-term sequelae (Goetz et al 1994; Sweeney et al 1993). More recent data suggest that exposure to TCDD and related chemicals in humans during the prenatal and neonatal periods may affect neurological development (Huisman et al 1995), but these data need to be interpreted cautiously because the neurological optimality score in infants was within the normal range and CDD/CDF levels may have only contributed a small amount to the variance in scores.

Of the many reproductive end points studied in populations exposed to TCDD, the available data suggest evidence of altered sex ratios in children of exposed parents (Basharova 1996; Dimich-Ward et al 1996; Mocarelli et al 1996); additionally, alterations in reproductive hormone levels in males (Egeland et al 1994) are possibly associated with increased serum TCDD levels."

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Appendix G: ATSDR's Responses to Public Comments

The Agency for Toxic Substances and Disease Registry released the NCBC Gulfport Public Health Assessment (PHA) for public review and comment on August 12, 2004. The public comment period, which ended on September 14, 2004, was announced in a press release on August 15, 2004. The PHA was made available for public comment at the following location in Gulfport, MS: The Isiah Fredericks Community Center, 3312 Martin Luther King Jr. Blvd.

For those comments that questioned the factual validity of a statement made in the PHA, ATSDR verified and, when appropriate, corrected any errors. The following responses to public comments do not include editorial comments such as word spelling or sentence syntax received during the public comment period.

Comment
Page 18 of PHA- ATSDR's media evaluation guide for dioxin is 50 parts per trillion (ppt). The action level is 1 part per billion (ppb) TEQ. Why are these standards higher than the state of Mississippi's standards?

Response
State and federal agencies often use different reference or screening values for chemical contaminants because their goals and stated objectives differ. For example, ATSDR's objectives are different than regulatory agencies such as EPA or the Mississippi Department of Environmental Quality [MDEQ]) that are responsible for establishing clean-up action levels. The Mississippi Department of Environmental Quality (MDEQ) has established a clean-up action level of 4.7 ppt for dioxin-containing soil and sediment, which is based on a one in a million lifetime residential exposure scenario for developing cancer. The objective of this clean-up action level is to remove dioxin contamination to the extent it effectively eliminates any human health concerns and minimizes the ecological impacts to the environment in the future. ATSDR emphasizes that the clean-up standard used by MDEQ is not a threshold for dioxin toxicity.

ATSDR's primary responsibility in conducting public health assessments is to determine whether people are being or have been exposed to chemical contaminants and, most importantly, whether any exposures are likely to result in human health effects. ATSDR evaluates current or past exposures to make this determination. ATSDR relies on the best toxicological and epidemiological data available at the time of the evaluation to evaluate whether people's exposures may have resulted in illness or other harmful effects. ATSDR acknowledges the uncertainty of extrapolating human health effect levels from animal studies by using conservative screening or reference values and exposure assumptions. ATSDR's evaluation does not consider potential impacts to ecological receptors, but rather focuses on human health.

ATSDR published policy guidance on dioxin in soil in 1999 and the policy states that the action level of 1 part per billion (ppb) (1,000 ppt) for dioxin and dioxin-like compounds in residential soils is protective of public health (DeRosa et al., 1999). ATSDR's conclusions are based on the most recent toxicological studies available in the published literature. ATSDR derived a minimal risk level (MRL) that was at least 2 orders of magnitude (90-100 times) lower than the lowest observed non-cancer and cancer effect levels. It is important to understand that it is possible to be exposed to a chemical without it causing observable harm.

Comment

Page 40 of the PHA states that the most contaminated area did not exceed ATSDR's action level of 1 ppb. Outfall 3 swamp contained elevated dioxin concentrations with sample results as high as 254 ppt in the organic rich sediment (1998-1999 phase 1 sampling). The state of Mississippi's action level is 4.26 ppt – so, if you were using the states action level, this would be considered very high.

Response

As stated in the response above, ATSDR does not rely on state or federal regulatory agency's clean-up standards to make public health conclusions. ATSDR carefully weighed the available information about what levels of dioxin people living near NCBC Gulfport are or were exposed to and what is known about the toxicity of dioxin and concluded that current and future dioxin levels in the soil, sediments, water, and biota do not pose a public health hazard. ATSDR also concluded that past exposures to contaminated soil and sediments were unlikely to pose a public health hazard since levels in the past were unlikely to be much higher than what was found in undisturbed portions of the off-base area of concern (i.e., swampy area north of Outfall 3).

Comment

There will be public comments made about this PHA. How will ATSDR address these and will the community know what other people's comments were; even if names are kept confidential, can we see the comments?

Response

It is standard practice for ATSDR to compile all public comments it receives and present them in an appendix along with corresponding responses or, when appropriate, ATSDR will group certain comments together and respond accordingly. ATSDR does not identify the name of the commenter, but the actual comments, usually as originally submitted, are presented in the appendix.

Comment
Page 5 of the PHA states dioxins in the biological samples collected off-site were not detected at levels of health concern and it is unlikely that people were exposed to edible wildlife tissue in the past that would result in health effects. Table A-I of the 1979 USAF report shows high levels of contamination in turtles, frogs, crayfish and fish off site in common fishing and hunting areas. The PHA also states there is some uncertainty about how frequently people harvested edible wild life other than fish from the most contaminated off-site locations. We did tell ATSDR representatives that hunting and fishing in these contaminated areas was a way of life for us. For decades people have eaten frogs, crayfish, fish, rabbits, squirrels, deer and other wild life hunted and caught in the contaminated area from Outfall 3.

Response
On the basis of dioxin levels detected in off-site biological samples, ATSDR concluded that it is unlikely that people who consumed wildlife from the off-site drainage ditches, canals, and other surface water bodies were exposed at levels that would result in health effects. The 1979 U.S. Air Force report (Table A-1) showed that the highest levels of dioxins in crayfish and other invertebrates sampled were detected within the NCBC boundary. Biological samples collected off site ranged from non-detect to a maximum of 31 ppt, the average being below FDA's tolerance level of 25 ppt for dioxins in fish tissue.

A creel study conducted in 1999 did not find any evidence that crayfish were being consumed from the drainage ditches near NCBC Gulfport. However, it is possible that consumption patterns have changed in recent years due to reports of dioxin contamination. Although ATSDR recorded anecdotal information about Gulfport residents eating frogs, crayfish, and other wildlife, there are no consumption surveys available that document the most commonly consumed species and the frequency of consumption of wildlife that are found near NCBC Gulfport. The limited sampling data and anecdotal information about consumption patterns indicates that people may have been exposed to low concentrations of dioxins, but below levels believed to cause harm.
ATSDR acknowledged the lack of information about levels of dioxin in edible fish and wildlife species collected from the drainage ditches, canals, and other surface water bodies in the past and, as stated in the PHA, considers past exposures to dioxins in fish to pose an indeterminate public health hazard.

ATSDR also considered people who may have hunted and consumed other wildlife such as deer, rabbits, squirrels, and frogs. Most studies that have analyzed dioxins and other similar compounds (e.g., PCBs and chlorinated pesticides) in wildlife species generally show that the lowest concentrations are found in lean herbivores such as deer and rabbits and the highest concentrations are found in bottom feeding, fish eating species such as ducks. ATSDR does not have any specific information about what species were most frequently harvested by Gulfport residents in the past. It is likely that people who harvested and consumed large numbers of ducks and other bottom feeding wildlife species from drainage canals and surface water bodies close to the NCBC Gulfport boundary would have likely been most exposed to dioxins that accumulate in the animal fat.

Comment
PHA summary mailed to the neighborhood (2nd page left. column 2nd paragraph) ATSDR states historical data on levels of dioxin in fish collected in previous decades would not result in a ban or limit on fishing. Refer to levels in USAF 1979 report and the summary stating the MS Office of Pollution Control - 5 ppt consumption is limited 25 ppt consumption is not allowed. How does ATSDR explain this statement that it would not have called for an advisory at the high levels of contamination found in fish, turtles, crayfish and frogs in 1979? These were high levels and some were caught off site of NCBC.

Response
The statement in the summary mailed to the neighborhood *only* pertains to fish and not turtles, crayfish (which are not fish, but crustaceans), and frogs. The paragraph in the PHA summary statement regarding fish is not, however, entirely accurate. The paragraph begins by stating:

"Historical data on levels of dioxins in fish collected in previous decades would not result in a ban or limit on fishing. However, adequate information about past consumption rates and chemical contamination levels in fish is not available."

This statement needs clarification because samples of edible fish species were not collected at or near NCBC Gulfport until 1999. Prior to 1999, only small mosquito fish, which are not edible, crayfish, and a couple of other species of invertebrates were sampled from drainage ditches and canals near NCBC Gulfport. There is no historical fish data from previous decades. The levels of dioxin detected in edible fish samples collected in 1999 were below the recommended safe limits established by the state of Mississippi. However, these more recent fish data may not be representative of dioxin levels in the past. ATSDR regrets the inaccuracy in the statement and will make the necessary corrections for any future fact sheets distributed to the community.

Comment
Page 4 of the PHA states ATSDR has not identified any subsistence populations -the availability of edible fish was not sufficient. There were plenty of edible fish in canal # 1 and Turkey Creek and not only did residents of the area fish there but people from all over Gulfport would drive there to fish (Except for 1970 & 1974 when there were fish kills in the canal and creek).

Response
ATSDR relied on several sources to assess the existence of subsistence populations and the likely availability of edible fish in the drainage ditches and canals. A community survey and exposure assessment was conducted in 1997 and a creel study was conducted in 1999, both of which were funded by the Navy. In addition to reviewing these two Navy studies, ATSDR contacted officials from state environmental and natural resource agencies and spoke with community members during site visits and public meetings. These studies confirmed what community members have communicated to ATSDR, which is that people have harvested fish from the drainage ditch system around NCBC Gulfport. This information is clearly stated on page 43 of the PHA. However, according to the community survey, most respondents reported consuming fish infrequently from the drainage ditches around NCBC Gulfport and there were no subsistence populations identified at the time the survey was conducted.

ATSDR acknowledges that the information collected in the surveys does not necessarily reflect past consumption patterns. The PHA states that information about historical dioxin levels in fish and past consumption patterns is not sufficient to make a definitive public health hazard conclusion. The specific language ATSDR used on page 4 is provided below:

> "historical investigations of the drainage ditches, both on-site and off-site ditches near NCBC Gulfport suggest that the availability of edible fish was not sufficient for a subsistence population."

This is not intended to be a definitive statement about consumption patterns in the past, but simply reflects our assessment based on the best available information. It should be noted that the statement also refers specifically to the drainage ditches and not to the canals or Turkey Creek, where edible fish were sampled and appeared to be plentiful during site investigations. ATSDR's overall conclusion is that past exposures to dioxins from consuming fish from the drainage ditches, canals, and other surface water bodies near NCBC Gulfport poses an indeterminate public health hazard.

Comment

Page 9 of the PHA -Did ATSDR base this finding of NO Harm To Human Health On two trial burns? Why did ATSDR not look at the year-long documents on the incineration? They were told that they existed and that they were at Tyndall Air Force Base. Basing a decision about health on two trial burns is inadequate and should have been found to be "indeterminate."

Response

ATSDR's conclusion on the incinerator is based on multiple observations. These include the two trial burns, the fact that the incinerator was designed with process monitoring equipment to ensure that adequate destruction efficiencies are achieved, and to a lesser extent on the reported results of ambient air sampling data. With respect to the ambient air monitoring data, ATSDR attempted to obtain the original source document rather than just the summary of the findings that were presented in Volume VI of the Full Scale Incinerator Report. According to the information presented in the Full Scale Incinerator Report (Volume VI), a 30-day summary report was prepared and submitted to EPA for review. Despite several attempts at locating the summary report, we could not obtain it. A summary of the findings is provided below.

The summary of the ambient monitoring data gives a very general overview of what was measured. The text indicates that the sampler at one particular station "did not detect TCDD migration from the site." According to the information presented in Volume VI, the sampling program was subsequently terminated based on the observations that were made. Therefore, we can confirm that an ambient air-monitoring plan was in place and that the program was implemented. We can also say that results were communicated to EPA, and that the results apparently supported the decision to terminate the monitoring program. However, without a review of the actual data presented in the "30 day summary report" we cannot say for certain what the monitoring program found.

Based on this information, ATSDR concluded that potential inhalation exposures to past air emissions from the incinerator were "no apparent public health hazard." That is the conclusion category ATSDR selects when environmental exposures are known to occur, but not at levels expected to be harmful. ATSDR uses the conclusion category "indeterminate public health hazard" only when a professional judgment about an exposure scenario cannot be made because critical information is lacking. In ATSDR's judgment, the information sources listed above are sufficient for evaluating likely exposures during the incinerator's operations. Ideally, we would like to review the 30-day summary report that was submitted to EPA. If this report becomes available the information will be reviewed and ATSDR will revise its conclusions if necessary.

The comment also implies that a conclusion should only be made if sampling occurred throughout the entire year that the incinerator operated. ATSDR disagrees with this statement for two reasons:

1) While ATSDR acknowledges that ambient air sampling data are very useful for evaluating the public health implications of an air emissions source, scientifically defensible conclusions can be based on other observations as well. In this case, ATSDR notes that NCBC was first required to demonstrate that the incinerator could efficiently destroy organic contaminants in waste, after which NCBC was required to operate the incinerator in a manner consistent with those demonstrations. Moreover, key operating parameters at the incinerator were continuously monitored, and the entire operation would shut down if any parameters were observed outside of the recommended bounds. These observations give greater confidence that NCBC did not operate the incinerator in a manner that would compromise public health.

2) For most pollution sources, continuous monitoring is too costly and simply unrealistic. For this site, it is worth noting that NCBC collected ambient air samples daily for the first month of the incinerator's operations. After reviewing these results, regulatory agencies decided that NCBC did not need to collect any additional air samples. This decision suggests that regulators were reasonably convinced that, provided that the air permit conditions were met, the routine operations at the incinerator were safe without the need for continuous ambient air sampling. ATSDR reached the same finding.

Comment
Page 9 of the PHA - ATSDR mentions the EPA's NPL list and mentions that NCBC Gulfport is not on there. But they do not mention that only two out of ten sites were scored and that they scored a 62.33. And if ATSDR were going to bring that subject up they should have went on to mention that a score of 28.5 gets consideration for the NPL list. (Refer to info on executive summary HRS)

Response
ATSDR's intent in describing the regulatory process for evaluating hazardous sites and mentioning that NCBC Gulfport has not placed on EPA's NPL list was to simply provide historical perspective and background information. EPA's hazard ranking (i.e., scoring) system has no relevance to ATSDR's responsibility as an advisory agency

Comment
Page 25 of the PHA - ATSDR refers to anecdotal evidence that the HO drums were crushed or sold and smeltered down. ATSDR knows there is some question about this since previously NCBC said the barrels were buried at Stennis. By putting that statement in this report it lends it credibility.

Response
The term "anecdotal" was not used in reference to the disposal of HO drums at NCBC Gulfport. ATSDR researched the disposal of HO drums at NCBC Gulfport and presented the information obtained from historical site documents and from communications with Navy personnel. A summary of what ATSDR found is provided on page 65 of the PHA and is presented below for reference:

> "ATSDR has not located any records that document the disposal of empty drums containing HO stored at Site 8. According to NCBC personnel and site documents released by the US Air Force's Occupational and Environmental Health Laboratory, the HO-containing drums were drained using a suction wand, inverted, and allowed to drain again for a minimum of two minutes, and then rinsed with diesel fuel. The drums were then crushed and either sold or given to a local contractor to be taken to a smelter in the Gulfport area (USAF 1978;U.S. Navy 2004). Since accurate records have not been identified by site personnel and may no longer exist, ATSDR is unable to confirm the final destination of the empty HO containers."

ATSDR concluded that this information was credible and should be presented because it provides very detailed information about the procedures that were reportedly in place to decontaminate and dispose of the drums. As clearly stated in the last sentence, ATSDR cannot confirm the final destination of the drums because records are not available for the site and it is not possible to track the chain of custody of HO drums at any point during their disposal.

Comment
Page 39 of the PHA states the lack of extensive off-site soil and sediment sampling during the actual storage and removal of HO at NCBC adds a level of uncertainty to our evaluation. Since ATSDR says there is a level of uncertainty about the past off-site soil and sediment why is this not an indeterminate public health hazard?

Response
Although ATSDR acknowledges uncertainty in past off-site dioxin levels in soil and sediments, the available data and understanding about the persistence of dioxins in certain environmental media provide sufficient information to make a public health hazard determination. As ATSDR notes in the second part of the paragraph on page 39, the sediments at OBAOC have not been excavated. Dioxins are generally stable compounds with long half-lives, especially in the subsurface sediments where the absence of ultraviolet light results in a slower breakdown of the dioxin molecules. Therefore, recent dioxin analyses of sediment samples collected are likely to closely reflect some of the highest dioxin concentrations in any off-site locations.

Comment
Page 43 of the PHA states although some of the on-site drainage ditches contain fish, access to NCBC is restricted. Residents (both on and off-site) are not permitted to fish in these locations. This is not true. The drainage ditch on base leading to outfall 3 swamp is still currently and often a fished in location. on the weekends you see men with small children fishing there. It is not posted in any way.

Response
ATSDR's statement pertaining to fishing referenced by the commenter specifically refers to fishing within the property owned and operated by the Navy. According to NCBC representatives, access to all portions of NCBC Gulfport is restricted and only military and other authorized personnel are allowed on site. ATSDR has conducted site visits to NCBC Gulfport and toured the perimeter of the installation. The entire site appears to be fenced and there are signs along the fence line warning people not to trespass. ATSDR acknowledged that fishing has occurred in the drainage ditches and surface water bodies immediately north of NCBC Gulfport. There is no evidence, however, to corroborate the statement that residents routinely fished in drainage ditches in on-site locations.

Comment
Page 43 of the PHA -Therefore, crayfish were not collected for dioxin analysis. If the crayfish were contaminated in 1979 and people around here still catch and consume crayfish this should be followed up on. A TSDR should have recommended it.

Response
Dioxin was detected in crayfish that were collected in 1979 at varying levels depending on the distance from the HO storage area. The crayfish samples collected in off-site locations contained lower levels of dioxin than the ones sampled from on site. Bottom feeding species of fish (e.g., catfish) were sampled in 1999 and the maximum concentrations of dioxin detected were 2.3 ppt,

which is below the 5 ppt level the state recommends using to trigger a limited consumption advisory. Given that recent fish, sediment, and water samples collected from off-site canals and Turkey Creek did not contain dioxins at levels of health concern, ATSDR did not recommend additional biological sampling. It is unlikely that current dioxin levels in crayfish will be elevated because the source areas have been removed for a considerable period of time.

Comment
Page 44 of the PHA states *most* of the samples collected off site either contained very low concentrations of dioxins or it was not detected in the sample at all. According to the 1979 USAF report these levels would be very high. High enough they would fall under a ban on consumption. Page 44 also states, A crayfish sample collected in 1976 from the site 8 drainage ditch contained tcdd at a maximum concentration of 3.2 ppb. A person usually eats a huge amount of crayfish in one setting. This could bioaccumulate. There were no SRT traps back then and crayfish were free to move through the ditch system on and off base.

Response
ATSDR will revise this paragraph because as currently phrased, it is misleading to state that most of the samples collected off site either contained very low concentrations of dioxins or it was not detected in the sample at all. Only a very small number of biological samples were collected off site in 1979 and there is clearly not enough data from this investigation to infer about the nature and extent of dioxin contamination in fish and other biota in the off site drainage canals.

Comment
Page 48 of the PHA states ATSDR relied primarily on the 1999 fish sampling effort for its public health evaluation of past exposures. The time frame we told ATSDR we were concerned about was 1968 to present. We supplied ATSDR with reports showing how contaminated the fish, frogs, turtles and crayfish were in 1979. OFF BASE.
Apparently A TSDR chose not to consider this information. I believe the explanation was it was not adequate enough. But ATSDR used two trial burns to assume a whole year of incineration was safe. What standard does ATSDR use to consider which information they pick and choose to use?

Response
ATSDR carefully reviewed and considered all the documents and data that were available before making a public health hazard determination. The statement that ATSDR relied primarily on the 1999 fish sampling effort for its public health evaluation of past exposure was intended to place the available data in perspective. The only sampling data available for edible fish species was from the 1999 sampling effort. Earlier data from 1979 did not sample edible fish species.

Furthermore, although ATSDR reviewed the 1979 data the value of the information was limited because of the sample size and the lack of information about the methodology used to collect and analyze the biological samples. ATSDR did request copies of the original investigation reports, but was unable to obtain them. ATSDR's overall conclusion was that past exposures to dioxins from consuming fish collected from drainage ditches, canals, and other surface water bodies near NCBC posed an indeterminate public health hazard. The rationale for this public health hazard conclusion was that earlier fish sampling data was not available and this was considered a critical data gap.

The comment also implies that the 1979 U.S. Air Force report provided evidence of dioxin contamination in off-site sampling locations that would be sufficient to cause illness or adverse health effects. ATSDR disagrees with this interpretation of the data. The levels that were detected in a couple of the crayfish samples in off site drainage canals exceeded the state of Mississippi's acceptable levels for dioxins in fish. However, a review of the toxicological literature shows that the lowest observed adverse health effects for dioxin occur at much higher exposure levels (usually more than 2 orders of magnitude [i.e., 100 times] higher) than estimated doses using the maximum dioxin concentration detected in off-site crayfish samples.

Comment
Page 49 of the PHA states-Likely it was not significant, given that historically detected levels were below state and federal guidelines specifying restrictions on fish consumption based on dioxin concentrations. This is not true. A TSDR was supplied with a 1979 USAF report showing high levels of contamination in fish crayfish, frogs and turtles. On- and off-base. They certainly do fall into levels above state and federal guidelines specifying restrictions.

Response
The sentence on page 49 that cites "historically detected levels" is specifically referring to the fish sampling effort conducted in 1999. ATSDR has revised the paragraph to make this more transparent. Although the 1999 sampling data can be considered to be historical data, it is misleading because NCBC Gulfport residents are specifically concerned about past exposures that occurred during the late 1960s through the 1990s. In this context the 1999 data should not be referred to as historical. The 1999 fish sampling data did, in fact, show that dioxin levels were below state and federal guidelines specifying restrictions on fish consumption. As previously discussed in other responses to comments, the 1979 U.S. Air Force report was carefully reviewed, but the data was not used to calculate past dose exposures. ATSDR believes that there was a completed exposure pathway for those people who consumed fish and crayfish from the drainage canals and other surface water bodies near NCBC Gulfport and considers past exposures to pose an indeterminate public health hazard.

Comment
Page 49 of the PHA states if dioxins were present at harmful levels in the past in the off-site creeks near NCBC, current sampling data should at least reflect some levels in the sediment. The creek and canal # 1 were excavated in the early 1970s and when we showed the Navy where the mounds of dirt that came from the excavation was they tested it and found it to be at higher levels of contamination than they have previously found in Canal # 1. Meaning at one time the levels of contamination in the canal and creek were much higher than thought. ATSDR should follow up on this.

Response

Two samples were collected from the mounds of dirt adjacent from the unnamed pond and analyzed for dioxin. The dioxin concentrations measured in the two samples were 23 ppt and 1.9 ppt. These concentrations are well below any levels known to cause health effects in the scientific literature. ATSDR uses its guidance of 1 ppb (1,000 ppt) as a "level of concern," where the agency may recommend actions to limit exposure.

Comment

Page 51 of the PHA states ATSDR is unable to make determination about the pond. Other results have not detected significant contaminate concentrations so it is unlikely the pond sediment would be at levels posing a health hazard. The pond is a separate body of water than the creek or canal it currently has the mounds of contaminated dirt eroding into it. When I first showed Bob Safay the pond and mounds of dirt he said if the mounds were found to be contaminated then the fish in the pond would need to be tested. Why doesn't A TSDR back this up and suggest that the fish in this pond be tested?

Response

After discussions with a community member, ATSDR recommended, as a precautionary measure, sampling the mounds of dirt that were originally excavated from Canal # 1. As noted in the response to the previous comment, dioxin was detected at a maximum concentration of 23 ppt. ATSDR does not consider this concentration to be a public health concern. While it is always recommended that people minimize their exposures to hazardous compounds such as dioxin to the extent possible, ATSDR's primary goal is to ensure that human exposures do not result in illness or adverse health effects. The dioxin levels detected in the mounds do not warrant recommending fish or other biota sampling in the pond.

Comment

Page 58 of the PHA states -provided that the incinerator was operated under the same conditions used during the two burns---ATSDR is assuming there were no accidental releases. Again, this should be indeterminate.

Response

The comment raises the possibility that conditions during routine operations of NCBC's incinerator might have differed from those used during the trial burns. ATSDR considered this possibility when reviewing the site documents. The reality is that the entire purpose of the trial burn is to establish lower and upper limits on critical operating parameters to ensure that the incinerator adequately destroys wastes. Once these permit limits were set, the critical operating parameters at the incinerator were continuously monitored, and the entire operation was shut down whenever operating parameters were found at levels outside those specified in the permit. This information provides some comfort that elevated emissions did not occur during times of year when ambient air sampling did not occur.

Regarding the issue of accidental releases, ATSDR cannot confirm or reject the suggestion that some unplanned releases might have occurred at the incinerator. For reasons stated previously, it is highly unlikely that the incinerator operated for any extended period of time at temperatures, feed rates, or stack gas concentrations outside what was permitted. However, it is conceivable that some losses occurred over narrow windows in time. At greater issue is whether such releases would have compromised public health. Recognizing that the contaminated soils that were being incinerated contained only trace amounts of dioxin, it is highly unlikely that any losses (e.g., fugitive emissions during waste handling) would have caused exposures of significance over the long term. As previously stated, ATSDR believes this exposure scenario was assigned the appropriate conclusion category (i.e., "no apparent public health hazard").

Comment

Nowhere does ATSDR mention our concern about three things happening around the same time in 1970.The fish kill in canal #l and Turkey Creek, Neighborhood trees defoliating and 27 cows in a pasture 2 blocks north of site 8 dying. All of this happened simultaneously.

Response

ATSDR has added this concern to section IV (Community Health Concerns). Unfortunately, there is very little additional perspective that ATSDR can add regarding these events that occurred in the past.

Comment

Page 63 of the PHA states the drums were not transported to any off-site locations- ATSDR is aware that this is uncertain. ATSDR and NCBC have been told that dirt from a 1980 ditch excavation from NCBC' s ditches was taken to the dump on canal road. So contamination was transported off base and NCBC refuses to look for the mounds of dirt from the ditches that were put into the far south comer of the dump. away from everything else.

Response

ATSDR has added some text in the paragraph that discusses the uncertainty regarding the disposition of the drums. Since specific records are not available, ATSDR cannot confirm specific locations where the drums may have been transported. If any Gulfport residents know of a specific location within the Canal Road dump that is likely to contain dioxin-contaminated soil or materials ATSDR will review the information and make sampling recommendations on a case by case basis. ATSDR does not have sufficient specific information to identified the need and locations for sampling.

Comment
Page 63 states that the most direct measure of exposure would be ambient air sampling results. ATSDR doesn't believe the leaking barrels would be an air exposure pathway, but there are reports from Vietnam that just a barrel with the lid off would defoliate trees nearby. Also, the trees along the transport route for HO in Vietnam were all defoliated. This area was not sprayed. Although reports from Project Pacer HO for NCBC cannot be found, reports from PROJECT PACER HO on JOHNSTON ATOLL (the same procedures used in Gulfport) read there was a persistent and intense odor, the sewage samples showed concentrations of HO from 20.7 ppb to 137.8 ppb, damage to two tomato plants downwind of the operation, There still remained some TCDD in the barrels even after the third rinse, two plants downwind continued to be affected by the herbicide. It was suspected that the vaporization of the HO from rows of crushed drums compounded this phenomenon.

Response
The comment correctly notes that ambient air sampling provided the most direct measure of inhalation exposures. It is exactly for this reason that ATSDR requested and attempted to obtain the original ambient air sampling studies that were conducted during the incinerator's operations. A noted previously (See Comment # 7), a 30-day summary report was prepared and submitted to EPA for review. Despite several attempts at locating the summary report, we were unable to obtain it.

The comment also provides an anecdotal account of the toxicity of "Agent Orange." ATSDR emphasizes that the incinerator at NCBC was not treating pure Herbicide Orange. To the contrary, pure Herbicide Orange from NCBC was incinerated at sea, far from the continental United States. The only wastes treated at NCBC were soils that contained trace contamination of Herbicide Orange. Regardless, it is important to note that ATSDR's evaluation in this PHA was based on an evaluation of the most toxic constituents in Herbicide Orange (i.e., dioxin, 24-D, 245-T).

Comment
I do not see any mention of bioaccumulation in the PHA. at low dose exposure from 1968 to present (That is 35 years) wouldn't this add up in a person's body? Especially those of us who were babies in 1968 to the early 1970's.

Response
ATSDR does mention the potential for dioxins to accumulate in the food chain and specifically discusses the tendency to bioaccumulate in fatty tissues in Appendix F of the document.

Extracted from Page F2: Dioxins are very stable, highly lipophillic compounds that, depending on the congener and the species, may also be relatively resistant to metabolism. As a result, dioxins have a strong tendency to bioaccumulate in fat, bind strongly to soils and sediments high in organic content, and persist in the environment for many years. Average concentrations of dioxins in biological and environmental samples have been declining since the 1970s and continue to do so (EPA 1994a, EPA 2000b, EPA 2001a, EPA 2001b). Due to the existence of natural sources, however, dioxins will never disappear completely from the environment (EPA 1998).

Everyone is exposed to low levels of dioxins and other chemicals such as polychlorinated biphenyls (PCBs) and pesticides that bioconcentrate in the food chain. Chlorinated compounds such as dioxins do bioaccumulate in the body and are mostly stored in fatty tissues and the liver. Metabolic processes in living organisms also slowly break down these chemicals over time and the metabolites (i.e., breakdown products) are eventually removed from the body.

Given that everyone is exposed to low levels of dioxins over their lifetime it makes sense that there will be some cumulative body burden from years of exposure. It is possible that some people living near NCBC Gulfport may have been exposed to somewhat higher levels of dioxins than in the general population. However, our evaluation shows that levels in off-site soils and sediments, even in the past, were not likely high enough to cause adverse health effects in people. Although ATSDR concluded that past human exposures to dioxins in fish were indeterminate public health hazards, it should be emphasized that there is no supporting evidence that past levels in fish would have likely caused health effects. However, the necessary data to support this statement is not available and thus the hazard category is considered to be "indeterminate."

Comment

I found the PHA to be very contradictory from page to page. The final findings did not support the data. And with many documents and much information from the past missing or unavailable most of this should have been indeterminate which should take us to the next level. We have asked to be used as a study group and for blood samples of people living here since late 1960's to early 1970's to present.

Response

ATSDR's public health evaluation and conclusions are based on site-specific documents, discussions with community members and NCBC personnel, with additional perspective provided by a review of the most recent toxicological and human health (i.e., epidemiological) studies obtained in the scientific literature. ATSDR stands by the conclusions in the PHA and believes the findings to be supported by the data and by what is currently known about dioxin exposure and human health effects. Unfortunately, as is often the case with evaluating past exposures to contaminants, information is not sufficient to make a public health hazard call for people who consumed fish in the past near NCBC Gulfport. It is ATSDR's strong opinion based on past experience at other sites that human blood sampling will not provide any additional insight into past exposure or answer questions about potential health effects from dioxin exposure. Current dioxin exposures near NCBC Gulfport are not expected to be significantly greater than typical background exposures and there is no justification for recommending blood sampling at this time.

Comment
I found it unprofessional and rude as the citizen petitioner to find out what was going to be occurring next with ATSDR concerning our neighborhood, from meetings with the Navy. Scott Sudweeks should have kept me equally as informed through out this process.

Response
ATSDR used several methods to keep community members informed about the public health activities for the NCBC site. Staff met one-on-one with citizens to discuss health concerns about the site and to provide information about the public health assessment process. In addition, ATSDR staff communicated with citizens via e-mail and telephone calls to provide updates, hosted meetings to receive community input for the public health assessment, participated and provided updates for the NCBC Restoration Advisory Board Meetings and Stakeholder Newsletter, mailed ATSDR fact sheet updates to the community, and provided update information through the local media. ATSDR has worked diligently to respond to questions from community members and to address concerns promptly using the best available science.

Comment
Table 1, Page 23: The comments within the table conclude that ATSDR does not have sufficient information about past consumption rates and dioxin levels in fish to make a public health determination. Bioconcentration sediment values have been developed for fish based upon sediment concentration levels. Given that dioxin are fairly stable in the environment and that data is available on consumption rates we question whether estimated exposure concentrations could be developed using these factors. Biota-sediment accumulation factors for 2378 TCDD range from 0.03 to 0.85 for freshwater systems and from 0.03 to 0.93 for marine/estuarine systems. ATSDR could probably use these to bound tissue concentrations for estimated doses to humans from consumption of fish. We suggest this as a means to possibly answer community concerns over past dioxin exposure.

The reference is: Environment Canada, 2000. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life and Canadian Tissue residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota: Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs). Technical Supporting Document, 2 volumes, National Guidelines and Standards Office, Environmental Quality Branch, Ottawa.

Also see http://www.cciw.ca/wqrjc/27-3/27-3-487.htm for bioaccumulation factors in fish, which are much higher.

We recommend developing a Table containing the results of the Creel Study or adding a section outlining the results.

Response
ATSDR agrees that the use of bio-transfer (bioconcentration) factors can be a useful tool to estimate upper bound contaminant concentrations in animal tissues. This type of quantitative evaluation is, for example, most applicable where recent soil/sediment data is being used to predict current or future tissue contaminant concentrations.

However, the more uncertainty there is in the input data the less reliable the upper bound estimates become. Although dioxin concentrations in sediments tend to be relatively stable, the concentrations do decline over time. Additionally, due to natural transport and dispersion mechanisms such as floods or seasonal surface water flow, it is possible that sediment concentrations near NCBC Gulfport could have been higher in the past. Also, contrary to what was stated in the comment, site-specific fish consumption rates are not available from the Community Survey and Exposure Assessment. According to the report released in May 1997, information was collected on fishing activity (e.g., how many people reported ever fishing in a particular location). However, information concerning the frequency of consumption, serving size, and fish species consumed were not collected. Due to the uncertainty or lack of site-specific underlying data, it is ATSDR‘s opinion that using available bio-transfer factors to estimate human exposure would result in unreliable upper bound estimates and would not add value to the report.

ATSDR agrees with the comments about incorporating the findings of the Creel Study and has added a section that summarizes the findings of both the 1996 Community Survey and Exposure Assessment and the 1999 Creel Study.

Comment
The concentration information presented within the text and the Tables is difficult to grasp. For example, it is hard to determine which sample concentrations exceed EPA and ATSDR acceptable levels. Given the very low levels of dioxins detected and the relatively low comparison values results are reported as ppm, ppb, and ppt. The concentrations throughout the text should be converted to the same units. We also suggest including the comparative values within the Tables rather than as a footnote. This will enable the reader to compare maximum and average concentrations to acceptable concentration values.

Response
ATSDR has reviewed the document to ensure that the units are consistent among the different media (e.g., soil, water, and biological tissues). However, ATSDR does not agree that all units across media should be the same. It is common for dioxin units in water to be measured in parts per quadrillion (ppq); whereas in soil and sediments it is common to present dioxin results as parts per billion (ppb).

Comment
ATSDR's CV for TCDD is a couple of orders of magnitude higher than the EPA RBC. Although the report states how CVs are determined it does not discuss why it is acceptable to use a significantly less conservative value for screening purposes. Also the EPA RBC listed in the footnote for TCDD is the industrial value. The residential RBC may be more appropriate.

Response
ATSDR typically relies on EPA’s Region III RBCs for screening purposes when there is no suitable ATSDR comparison value to use. For example, ATSDR will rely on EPAs RBC for fish tissue because ATSDR has not developed comparison values for fish tissue samples. There may

be some exceptions if the health assessor believes that one screening value is more appropriate than another. ATSDR reported the industrial RBC value for samples collected on site since it is known that the land use for these sampling locations will be industrial and not residential.

Comment
Page 19 of the text lists the ATSDR action level of 1 ppb for dioxin. This is higher than the EPA residential screening level of 0.39 ppb. The text states that ATSDR utilizes a human health based soil screening level of 50 ppt and a cleanup/action level of 1 ppb. The text (page 19, paragraph 1) subsequently disregards the 50 ppt screening level and describes the 1 ppb concentration as a trigger for a need for public health actions, implying that 1 ppb is a human health based screening/cleanup value. The text should be reworded and clarified to accurately describe the difference between action levels, screening levels and human health based cleanup levels. The incorrect implication that1 ppb is a human health based action level is repeated throughout the text.

Response
Some addition perspective has been added to the text to help clarify ATSDR's guidance for dioxins in soil.

Comment
Page 75 lists ATSDR's conclusion on the potential exposure through consuming fish. Please consider the information presented above in considering removal of the "indeterminate public health hazard category." Our interpretation of the information is that it is unlikely past consumption of fish was a public health hazard. This is based on the relatively low concentrations detected and the stableness of dioxins in the environment; subsistence populations have not been identified through either the consumption studies or interviews with concerned community members; and it has not been shown that the ditches and canals have the stock to provide the volume of fish required to create a health concern to any size population.

Response
ATSDR has taken this under advisement. However, although the evidence *is not* compelling to indicate a past health hazard, the lack of extensive biological sampling data in the past along with anecdotal information from community members about past fishing and recreational activities along the canals creates enough uncertainty to conclude that past exposures to fish and other edible wildlife are "indeterminate."