Public Health Assessment for

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

HUDSON REFINERY NPL SITE
CUSHING, PAYNE COUNTY, OKLAHOMA
EPA FACILITY ID: OKD082471988
JUNE 22, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

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

Agency for Toxic Substances & Disease Registry.. Julie L. Gerberding, M.D., M.P.H., Administrator
Howard Frumkin, M.D., Dr.P.H., Director

Division of Health Assessment and Consultation…. .... William Cibulas, Jr., Ph.D., Director
Sharon Williams-Fleetwood, Ph.D., Deputy Director

Health Promotion and Community Involvement Branch ....Susan J. Robinson, M.S., Chief

Exposure Investigations and Consultation Branch... Susan M. Moore, Ph.D., Chief

Federal Facilities Assessment Branch .... Sandra G. Isaacs, B.S., Chief

Superfund and Program Assessment Branch ....Richard E. Gillig, M.C.P., Chief

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

Additional copies of this report are available from:
National Technical Information Service, Springfield, Virginia
(703) 605-6000

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

HUDSON REFINERY NPL SITE

CUSHING, PAYNE COUNTY, OKLAHOMA

EPA FACILITY ID: OKD082471988

Prepared by:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Superfund and Program Assessment Branch

Table of Contents

List of Acronyms iii
Summary 1
I. Purpose and Health Issues 2
II. Background 2
  A. Site Description 2
  B. Site Operational History 2
  C. Demographics 3
  D. Land and Natural Resource Use 3
III. Discussion 5
  A. Data Used 5
  B. Evaluation Process 5
  C. Exposure Pathways and Contaminants of Concern 6
    1. Soil Pathway 6
    2. Sediment Pathway 9
    3. Surface Water Pathway 11
  D. Potential Exposure Pathways 13
    1. Groundwater Pathway 13
    2. Air Pathway 14
    3. Biota Pathway 14
  E. Physical Hazards 15
  F. Past Exposures 16
  G. Future Use of the Site 17
  H. Children's Health Considerations 17
  I. Health Outcome Data 17
  J. Community Health Concerns 18
IV. Public Comments 19
V. Health Hazard Category 19
VI. Conclusions 20
VII. Recommendations 20
VIII. Public Health Action Plan 20
IX. Site Team 21
X. References 22
Appendix A. Explanation of Evaluation Process 25
  A. Screening Process 25
  B. Determination of Exposure Pathways 26
  C. Evaluation of Public Health Implications 26
  D. Noncancer Health Effects 28
  E. Calculation of Risk of Carcinogenic Effects 29
Appendix B. Exposure Pathways for Hudson Oil Refinery Site, Cushing, OK 30
Appendix C. Public Comments and Responses 31
  A. Comments from the Oklahoma Department of Environmental Quality: 31
  B. Comments from the U.S. Environmental Protection Agency: 31
Appendix D. ATSDR Plain Language Glossary of Environmental Health Terms 34

List of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
COC	Contaminant of Concern
CREG	Cancer Risk Evaluation Guide
CSF	Cancer Slope Factor
CV	Comparison Value
DEQ	Oklahoma Department of Environmental Quality
EMEG	Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Inspection
FS	Feasibility Study
LTHA	Lifetime Health Advisory
MCL	Maximum Contaminant Level
mg/kg/day	milligram per kilogram per day
MRL	Minimal Risk Level
NPL	National Priorities List
PHA	Public Health Assessment
ppb	part per billion
ppm	part per million
ppt	part per trillion
R9 PRG	U.S. EPA Region 9 Preliminary Remediation Goal
RfD	Reference Dose
RI	Remedial Investigation
RMEG	Reference Media Evaluation Guide
SSL	U.S. EPA Soil Screening Level
TEQ	Toxicity Equivalence Quotient
µg/L	microgram per liter
WHO	World Health Organization

Summary

The Hudson Refinery NPL site is a former refinery which operated from 1922 to 1982 in Cushing, Payne County, Oklahoma. Refinery structures containing hazardous chemicals were abandoned in place, leading to a public health advisory by the Agency for Toxic Substances and Disease Registry (ATSDR) in 1999 and a series of emergency removals by the U.S. Environmental Protection Agency (EPA). Removals were completed by 2003 and the site was turned over to remedial programs for long-term cleanup. ATSDR evaluated current site information to determine whether adverse health effects are possible from community exposure to contaminants currently at the site.

Because no exposure pathways were identified which would result in exposures high enough to cause adverse health effects, ATSDR classifies the Hudson Refinery NPL site as currently posing *no apparent public health hazard*. This classification may be modified on the basis of further information that might become available about the site. The site posed a *past public health hazard* due to the immediate threat posed by hazardous chemicals that were left at the site. These chemicals have since been removed. Not enough information exists to evaluate the risk of long term health effects resulting from potential past exposures to site chemicals. However, low-level, short duration exposures to the hazardous chemicals on which the public health advisory was based are unlikely to result in measurable long-term health effects.

On the basis of available data and use of the site, ATSDR made the following conclusions:

1. Immediately hazardous chemicals and structures leading to the 1999 public health advisory have been removed.
2. Assuming exposure is to children and adults occasionally trespassing on the site, no adverse health effects are expected from exposure to site contaminants in sediment, surface water, or surface soil at the Hudson Refinery site.
3. Because no one is using site groundwater for drinking purposes, the groundwater pathway is incomplete and therefore poses no hazard. The levels of some contaminants in groundwater are high enough to warrant further evaluation before being suitable for drinking water or other use.

ATSDR made the following recommendations about the site:

1. Fencing and warning signs should be maintained by DEQ to discourage trespassing.
2. Further investigation and/or cleanup of the site by DEQ is warranted to ensure the site's safety for future uses.
3. Groundwater at the site should not be used unless it is fully characterized and treated to meet drinking water standards.

I. Purpose and Health Issues

The Hudson Refinery site was proposed for the National Priorities List (NPL) on April 23, 1999 and listed on July 22, 1999. The Agency for Toxic Substances and Disease Registry (ATSDR) is required by Congress to conduct public health activities on all sites proposed for the NPL. In this public health assessment, ATSDR evaluates the public health significance of the Hudson Refinery site. ATSDR reviewed available environmental data, potential exposure scenarios, and community health concerns to determine whether adverse health effects are possible. In addition, this public health assessment recommends actions to prevent, reduce, or further identify the possibility for site-related adverse health effects.

Prior to 1999, refinery structures containing hazardous chemicals were abandoned in place on the site. ATSDR issued a public health advisory in March 1999 due to the immediate hazard posed to the public by hydrofluoric acid, asbestos, and tetraethyl lead remaining on the site at that time [1]. Emergency removal actions were conducted by the U.S. Environmental Protection Agency (EPA) [2,3]. Since the completion of these actions, the site no longer poses an immediate public health hazard. This health assessment will evaluate whether public health impacts could be expected from ongoing community exposure to site-related contaminants remaining on and around the site.

II. Background

A. Site Description

Site background information is from site documents [2–9].The site is located in Payne County, Oklahoma, on the west side of the city of Cushing. Cushing is about 70 miles northeast of Oklahoma City. The site comprises approximately 165 acres north of Oklahoma State Highway 33 and 35 acres south of Oklahoma State Highway 33. The “south refinery” is located in the northwest corner of Section 4, Township 17 North, Range 5 East. The “north refinery” is located in the southwest corner of Section 33, Township 18 North, Range 5 East.

The refinery structures on the site were removed during an EPA removal completed in 2003. The site is relatively flat with only a few buildings remaining today. The site also contains several wastewater ponds, two runoff ponds, a coke pond, and a firewater pond. Most of the site is vegetated with grasses, brush, and a few trees.

B. Site Operational History

The former refinery produced liquid propane, gasoline, aviation fuel, diesel fuel, fuel oils and coke from 1922 to 1982. In 1980, the facility produced about 20,000 barrels of gasoline per day. The refinery ceased operations in December 1982 and filed bankruptcy in January 1984. The then-current owners abandoned the facility without shutting it down properly and left process chemicals in tanks and pipes.

In 1997, the then-current owners began efforts to salvage equipment and metal from the south refinery site and hired a contractor to remove asbestos-containing material. The contractor left asbestos-containing materials torn and hanging from equipment and left aboveground storage tanks open to the environment. In November 1997, the Oklahoma Department of Environmental Quality (DEQ) requested EPA's assistance at the site. EPA initiated an emergency removal action to address immediate hazards at the site. In addition, the U.S. Coast Guard participated to address oily waste at the site. In support of the emergency removal and due to the immediate hazards posed by hydrofluoric acid, asbestos, and tetraethyl lead on the site, ATSDR issued a public health advisory on March 4, 1999 [1]. The emergency removal was completed on September 4, 1999 [2]. An expanded site inspection (ESI) conducted in December 1998 supported the site's proposal to the NPL on April 23, 1999 [5]. In 2001, the EPA, working with the U.S. Army Corps of Engineers, initiated non-time critical removal actions to disassemble and remove 22 towers, 216 process vessels, 8 buildings, two tanks containing tetraethyl lead, and aboveground piping at the site. The removals were completed by summer of 2003 [3]. DEQ has assumed the lead role for remediation of remaining site contamination and completed the remedial investigation/ feasibility study (RI/FS) in 2006 [6].

C. Demographics

Census 2000 data indicate a total population of 8,371 in the city of Cushing [8]. Figure 1 shows demographic information for the area around the site. About 3,795 people live within a 1-mile radius of the site border; the population is mostly Caucasian (82%), American Indian (7.0%), African-American (4.8%), or persons that identified themselves as two or more races (5.2%).

D. Land and Natural Resource Use

The site is located on the west side of Cushing. Residential areas border the refinery site to the east of the North Refinery and to the west of the South Refinery. Other nearby land is vacant or used for agriculture. The Cushing area, historically one of the world's largest oil producers, has scattered oil wells and oil fields and an extensive oil pipeline system.

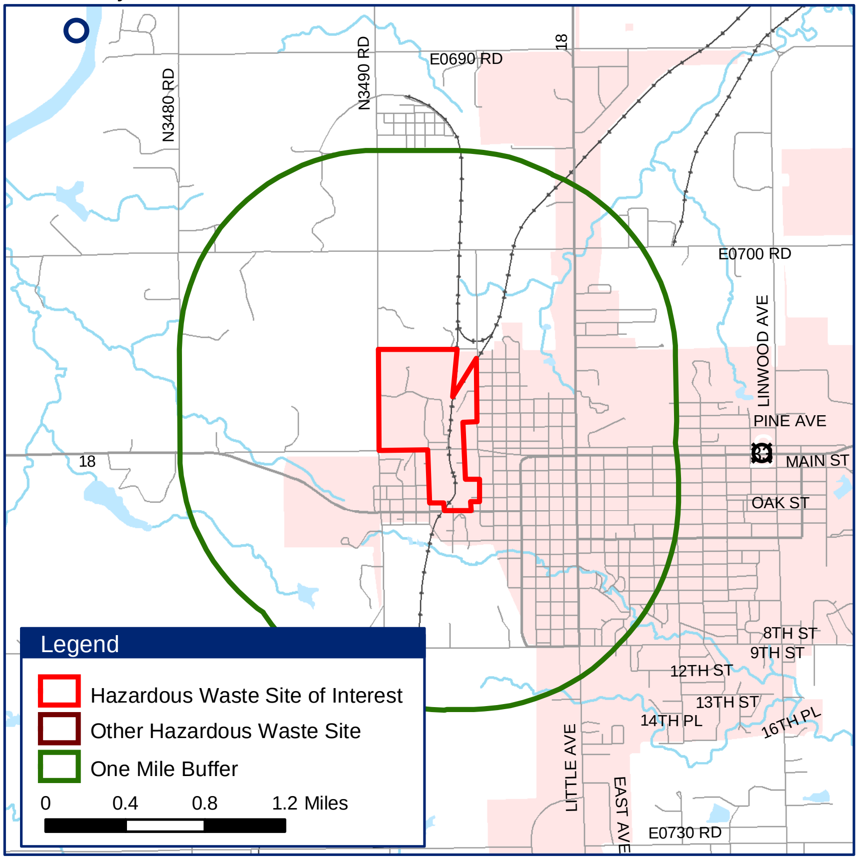
The site is part of the Cimarron River basin and is located just east of a watershed divide between two tributaries to the Cimarron River. Surface water drains generally to the east and northeast into the Skull Creek watershed [5].

The city of Cushing's municipal water is drawn from deep wells, the nearest of which is more than 1.5 miles east-northeast of the site. Groundwater elevations measured at the site in spring and fall of 2004 indicate that the groundwater flow is generally from south to north [6]. Site contaminants would not affect municipal water because confining layers in between shallow and deep aquifers limit contaminant transport and because municipal wells are out of line with the general direction of groundwater flow from the site. The residences immediately surrounding the site are all served by the Cushing municipal water system. One private well identified approximately ¼ miles north of the site collapsed several years ago and has not been replaced. [5,10].

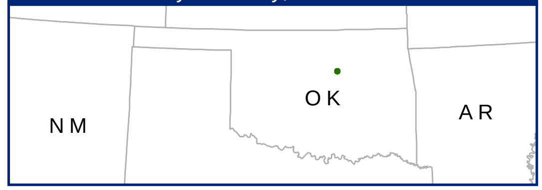
Figure 1. Site Location and Demographic Information, Hudson Refinery, Cushing, Oklahoma

Hudson Refinery
Cushing, OK

EPA Facility ID: OKD082471988



Site Location: Payne County, OK



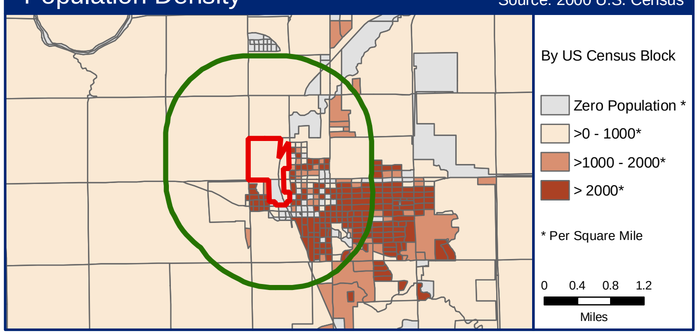
Demographic Statistics
Within One Mile of Site*

Total Population	3,795
White Alone	3,120
Black Alone	183
Am. Indian & Alaska Native Alone	261
Asian Alone	4
Native Hawaiian & Other Pacific Islander Alone	1
Some Other Race Alone	28
Two or More Races	198
Hispanic or Latino**	77
Children Aged 6 and Younger	345
Adults Aged 65 and Older	637
Females Aged 15 to 44	764
Total Housing Units	1,922

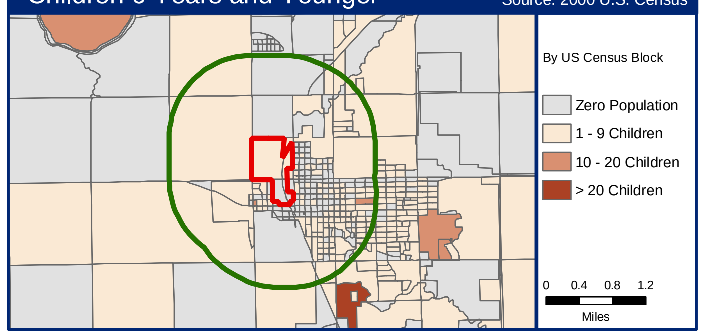
Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane Oklahoma North FIPS 3501 Feet

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.

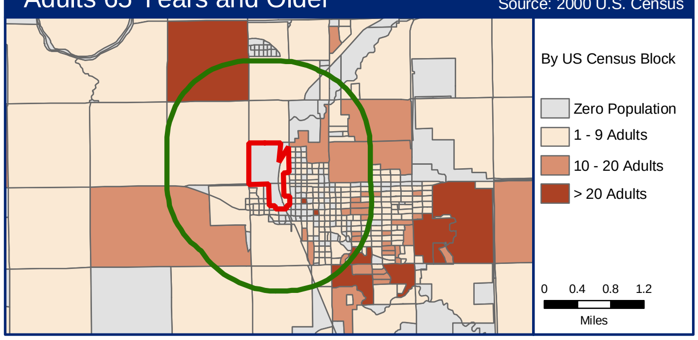
Population Density — Source: 2000 U.S. Census



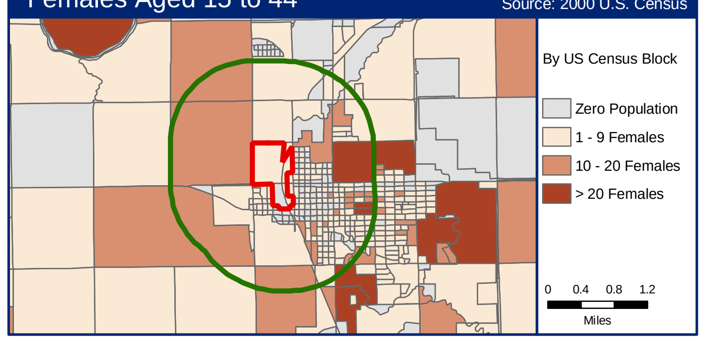
Children 6 Years and Younger — Source: 2000 U.S. Census



Adults 65 Years and Older — Source: 2000 U.S. Census



Females Aged 15 to 44 — Source: 2000 U.S. Census



GRASPMASTER 1.3 - GENERATED: 06-13-2006

FOR INTERNAL AND EXTERNAL RELEASE
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY | UNITED STATES DEPARTMENT OF HEALTH AND HUMAN SERVICES

III. Discussion

A. Data Used

The environmental data used in this evaluation came from the following sources:

- 2004 sampling of soil, sediment, surface water, groundwater, and air collected in Phase I of the RI/FS by DEQ [6].
- 2005 sampling of soil, sediment, surface water, groundwater, and fish tissue collected in Phase II of the RI/FS by DEQ [7].

The conclusions reached in this document are based on the data available at this time and might be modified on the basis of results of additional samples collected in the future.

ATSDR visited the site to better understand the physical setting of the site and its relationship to the people living and working nearby.[1] During these site visits, staff observed the following:

- The site was fully fenced and appropriate warning signs were posted.
- Land uses around the site include agricultural, residential, and vacant.

ATSDR met with residents during a public meeting about the site.[2] Health concerns expressed by community members are discussed in the Community Health Concerns section of this document. In addition, residents provided the following information about community use of the site:

- Children have accessed the site in the past, exploring and removing equipment from the site.
- Children swim in the open water and play in sludge ponds on the north side of the site.
- Similar areas are present throughout the entire town because of historic refining activities; the potential for exposure is not limited to the site.

B. Evaluation Process

The process by which ATSDR evaluates the possible health impact of contaminants is summarized here and described in more detail in Appendix A. ATSDR uses comparison values (CVs) to determine which chemicals to examine more closely. CVs are concentrations of chemicals in the environment (air, water, or soil) below which no adverse human health effects should occur. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

If the level of contamination at the site is greater than the CV, further evaluation will focus on identifying which chemicals and exposure situations could be a health hazard. Child and adult exposure doses are calculated for the exposure scenario of interest. Exposure doses are the

[1] Site visits were conducted on February 17, 1999 (ATSDR staff Laura Frazier, Moses Kapu, and George Pettigrew) and May 13, 2004 (ATSDR staff Jill Dyken and Mathew Martinson, DEQ representative Amy Johnson, and EPA representative Laura Stankosky).
[2] A public availability session was held by ATSDR, DEQ, and EPA in Cushing on May 13, 2004.

estimated amounts of a contaminant that people come in contact with under specified exposure situations. These exposure doses are compared to appropriate health guidelines for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this level. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is evaluated further by comparing it to known health effect levels identified in ATSDR's Toxicological Profiles. If the chemical of concern is a carcinogen, the cancer risk is also estimated. These comparisons are the basis for stating whether the exposure is a health hazard.

C. Exposure Pathways and Contaminants of Concern

The following sections describe the various ways people could come into contact with contaminants at the site. Each of these is called an exposure pathway. Appendix B summarizes the possible exposure pathways. If people are unlikely to be exposed to contaminants in a given pathway, then that pathway will not be evaluated further for human health risks.

1. Soil Pathway

People trespassing on or near the site could come into contact with soil contaminated by refinery wastes. They could get particles of the soil on their skin, or they might unintentionally swallow or breathe in the particles. Soil from the site has been sampled and analyzed for contaminants. Although people generally are exposed only to surface soil no more than 3 inches below ground surface, ATSDR used results from samples taken from 0–6 inches below ground surface to estimate surface concentration, since that was the only depth range available. This may overestimate or underestimate the actual concentration of contaminants to which people are exposed at the site. Table 1 indicates that 8 inorganic compounds and several polycyclic aromatic hydrocarbons (PAHs) were detected at least once in surface soil above the corresponding soil CV.

Table 1. Surface Soil Contaminants of Concern at Hudson Refinery NPL Site, Cushing, Oklahoma

Contaminant	Maximum concentration in soil, ppm	Average concentration in soil, ppm	Comparison value (CV), ppm	CV Source (defined in Appendix A)
Antimony	49	5	20	RMEG
Arsenic	272	12	20 / 0.5	EMEG / CREG
Cadmium	17	1	10	EMEG
Copper	609	34	500	iEMEG
Iron	84,700	20,395	23,000	R9 PRG
Lead	3,460	143	400	SSL
Manganese	3,000	753	3,000	RMEG
Thallium	14	3	5.2	R9 PRG
PAH TEQ †	17	0.6	0.1	CREG
Benzo(a)anthracene †	7	0.7	0.62	R9 PRG
Benzo(a)pyrene †	9	0.9	0.1	CREG
Benzo(b)fluoranthene †	1	0.2	0.62	R9 PRG
Benzo(k)fluoranthene †	16	3	6.2	R9 PRG
Dibenz(a,h)anthracene †	1	0.4	0.062	R9 PRG
Indeno(123cd)pyrene †	5	0.9	0.62	R9 PRG
† Detected values only.				
Source: [6]				

For further screening, a worst-case exposure dose for each of these soil contaminants was estimated for trespassers or residents as young as 7 years old who contact the maximum concentration of each contaminant in surface soil 3 times a week for 6 months of the year. This represents an overestimate of actual exposure, since long-term exposure would be to an average concentration rather than the maximum. Details of the assumptions used to perform exposure calculations can be found in Appendix A. The estimated maximum child and adult exposure doses for antimony, cadmium, copper, iron, manganese, and thallium were below noncancer health guideline values. In addition, none of these substances is a carcinogen by the oral route; therefore, exposure to these substances in surface soil is not expected to result in any adverse health effects. Worst-case exposure doses for arsenic was higher than screening health guideline values, and no health guideline values are available for lead and PAHs, so these contaminants were evaluated further to see if adverse health effects might be possible.

Arsenic

For the exposure scenario evaluated, no adverse health effects are expected from exposure to arsenic in surface soil. The worst-case exposure estimates exceeded the health guideline used for screening, but it is very unlikely that actual exposure would approach this level. The site is fenced and posted, and if children trespassed, they would access several areas of the site, not just an area with the highest contaminant level (individual surface soil samples exceeding the screening level for arsenic comprised less than 10% of the total number of samples and occurred in various areas of the site). Refining the exposure estimate by using the average arsenic concentration instead of the maximum results in a dose that is over 10 times smaller than the health guideline. The estimated average child and adult exposure doses for incidental contact with arsenic in surface soil were 0.00002 and 0.000004 and mg/kg/day, respectively, as compared with the minimal risk level for non-cancer effects of 0.0003 mg/kg/day [11]. Arsenic is a carcinogen, but the estimated increase in the risk of cancer from exposure to surface soil as assumed is so low as to be negligible.

Lead

Exposure to lead in the surface soil is unlikely to result in adverse health effects. This is based on the average levels of lead detected and the assumption that older children only occasionally play or trespass on the site. The highest levels of lead might have an adverse health effect on young children (less than 6 years old) only if they had regular contact with that level of lead in soil over many weeks or months. However, because the site is fenced and posted, a young child is not likely to regularly access the site, if at all. In addition, it is unlikely that any child would trespass exclusively in areas of the site with high lead levels (individual surface soil samples exceeding the screening level for lead comprised less than 10% of the total number of samples and occurred in various areas of the site). Older children (and adults) are less vulnerable to lead in the soil than younger children because they generally ingest less soil and less lead is absorbed into their bodies [12].

In general, the level of lead in a person's blood, typically measured in micrograms per deciliter (μg/dL), gives a good indication of recent exposure to lead and also correlates well with health effects. The Centers for Disease Control and Prevention (CDC) considers children to have elevated lead levels if the amount of lead in the blood is 10 μg/dL or above. However, some studies have indicated that levels of 10 μg/dL and less in children's blood may be associated with small decreases in IQ and slightly impaired hearing and growth. If we use the most protective correlation between blood lead levels and soil concentration found in epidemiological studies (0.0068 μg/dL increase in blood lead level per parts per million [ppm] of lead in soil) and the average lead concentration measured in soil (143 ppm), then children exposed regularly to this soil would be expected to increase their blood lead levels by less than 1 μg/dL [12].

Animal data indicate that lead is a probable human carcinogen [12]. However, the animal studies were based on very high doses of lead and are difficult to compare to low level environmental exposures, such as at those present at the site. Because no cancer slope factor for lead exists, it is impossible to numerically evaluate carcinogenic risk.

PAHs

PAHs are a group of chemicals that are formed during the incomplete burning of organic substances; they can also be found in crude oil and creosote. Low levels of PAHs are found throughout the environment. Individual PAHs often occur together in the environment, and many have similar toxicological effects and environmental fate [13].

For noncancer health effects, exposure doses were calculated from the maximum levels of the individual PAHs listed in Table 1. Details of the assumptions used in calculating these doses can be found in Appendix A. The estimated exposure doses for these exposure assumptions are hundreds of times smaller than effect levels seen in animal experiments on various PAHs. Dermal exposure to very high concentrations of PAHs can cause skin irritation and other disorders. However, exposure to the PAHs in surface soil is relatively infrequent, PAHs in soil are less likely to be absorbed into the skin compared the methods used in experimental studies, and the average concentration of PAHs is lower than the concentrations that caused effects in experimental studies. To summarize, no adverse noncancer health effects are expected from oral or dermal exposure to PAHs in surface soil.

Some PAHs may cause cancer. This evidence comes primarily from occupational studies of workers who were exposed to mixtures of PAHs in industries like coke production, roofing, oil refining, or coal gasification. The associated cancer occurred predominately in the lungs, following inhalation exposure, and in the skin, following dermal exposure. Certain PAHs also cause cancer in animals. In order to estimate the increased risk of cancer from this group of PAHs, a relative potency approach has been developed for carcinogenic PAHs based on benzo(a)pyrene, the most studied PAH compound [13]. To estimate the increased risk of cancer, a toxicity equivalence quotient (TEQ) was calculated by summing measured PAHs (corrected by their relative potencies compared to benzo(a)pyrene). Assuming a child trespasser contacts the average concentration of PAH in surface soil at the site three times a week for four months of the year for as many as 6 years, the increased risk of developing cancer is so low as to be negligible.

Residential Exposure

A small number of surface soil samples were collected from residential properties near the site. These samples were included with the other surface soil samples in evaluating the surface soil pathway for exposure to trespassers. In addition, the residential property samples were evaluated separately for their potential to pose a risk to residents who might be exposed in their yards. The only contaminants that were detected above the comparison values were arsenic and PAHs. Even using conservative exposure assumptions (a 10-kg child exposed to the highest detected value for 350 days a year), estimated doses were too low to result in an increased risk of cancer or noncancer health effects. No adverse health effects are expected from exposure to residential soil near the site.

2. Sediment Pathway

People who trespass on ponds or streams on or downstream from the site might unintentionally swallow some of the sediments or get the sediments on their skin. Sediment CVs were not available, so sediment CVs were set at 10 times the corresponding soil CV. Sediment was assumed to be contacted one tenth as much as soil particles, so the concentration of contaminant could be 10 times as high in sediment to result in the same dose as in soil. Samples of sediment from ponds on the site and from Skull Creek downstream from the site were collected during the RI/FS. Substances detected in this sampling were compared to the corresponding sediment CV. To be conservative, sediment chromium was compared to the CV for hexavalent chromium. The vast majority of chromium in soils and sediments is expected to be in the less toxic trivalant form [14]. In addition to analyzing compounds individually, a toxicity equivalent quotient (TEQ) was calculated for polycyclic aromatic hydrocarbons (PAHs) by weighting each detected PAH according to its toxicity relative to benzo(a)pyrene, the most studied PAH compound, and summing them [13]. As shown in Table 2, arsenic, chromium, iron, and several individual PAHs were detected above the corresponding sediment CV.

Table 2. Sediment Contaminants of Concern at Hudson Refinery NPL Site, Cushing, Oklahoma

Contaminant	Maximum concentration in sediment, ppm	Average concentration in sediment, ppm	Comparison value (CV) for sediment, ppm*	CV Source (defined in Appendix A)
Arsenic	13	**	200 / 5	Soil EMEG / CREG × 10
Chromium	16,000	910	2,000	Soil RMEG for hexavalent chromium × 10
Iron	910,000	50,279	230,000	Soil R9 PRG × 10
PAH TEQ †	1147	279	1	CREG × 10
Benzo(a)anthracene †	1,200	24	6	Soil R9 PRG × 10
Benzo(a)pyrene †	1,000	251	1	CREG × 10
Benzo(b)fluoranthene †	180	36	6	Soil R9 PRG × 10
Benzo(k)fluoranthene †	110	33	62	Soil R9 PRG × 10
Chrysene †	740	175	620	Soil R9 PRG × 10
* Sediment CV calculated as 10 times the soil CV because sediment ingestion was assumed to be one tenth of the average soil ingestion.				
† Detected values only.				
** Only one sample had arsenic detected, so an average was not calculated.				
Source: [6]				

For further screening, an exposure dose for each of these sediment contaminants was estimated for trespassers or residents as young as 7 years old who contact the maximum concentration of each contaminant in sediment 3 times a week for 4 months of the year. These assumptions were chosen to give a conservatively high estimate of exposure; further details can be found in Appendix A. The estimated child and adult exposure doses for arsenic, chromium, and iron were below noncancer health guideline values. Neither chromium nor iron are classified as carcinogenic by the oral route (there is limited but inconclusive evidence that hexavalent chromium may be an oral carcinogen), and the estimated increase in cancer risk from exposure to arsenic is so low as to be negligible. Therefore, exposure to arsenic, chromium, or iron in sediment is not expected to result in any adverse health effects. The estimated child and adult exposure doses for PAHs were evaluated further because there are no applicable noncancer health guideline values.

For the exposure scenario evaluated, no adverse health effects are expected from oral or dermal exposure to PAHs in sediment. Estimated average exposure doses are hundreds to thousands of times smaller than effect levels seen in animal experiments on various PAHs [13]. Dermal exposure to very high concentrations of PAHs can cause skin irritation and other disorders, but the levels in sediment at this site are too low to result in dermal effects from occasional exposure. To estimate the increased risk of cancer, the TEQ was calculated by summing measured PAHs (each corrected by its relative potency compared to benzo(a)pyrene). The estimated increase in the risk of cancer from exposure to PAHs in surface soil is so low as to be negligible.

3. Surface Water Pathway

No use of surface water runoff, streams, or ponds on or off the site for drinking water was identified, but people who wade or swim in this water will get surface water on their skin and could accidentally swallow some of it. Incidental ingestion (accidental swallowing) of the surface water was assumed to be no more than one tenth the normal drinking water ingestion per day. This means the concentration of contaminant in surface water could be 10 times as high to result in the same dose in drinking water. Therefore, surface water CVs were calculated as 10 times the drinking water CV. Samples of surface water from ponds on the site and from Skull Creek downstream from the site were collected during the RI/FS. Substances detected in this sampling were compared to the corresponding surface water CV. The value reported for chromium is total chromium, with no information on valence state. To be conservative, this level was compared to the CV for hexavalent chromium, the most toxic form of chromium. As shown in Table 3, 7 contaminants were detected at least once above the corresponding surface water CV.

Table 3. Surface Water Contaminants of Concern at Hudson Refinery NPL Site, Cushing, Oklahoma

Contaminant	Maximum concentration in surface water, µg/L	Surface water Comparison Value (CV), µg/L*	CV Source (defined in Appendix A)
Arsenic	221	30 / 0.2	Drinking Water EMEG / CREG × 10
Chromium	1,970	300	RMEG for hexavalent chromium × 10
Copper	2,990	1,000	iEMEG × 10
Lead	19,600	150	AL × 10
Mercury	554	30	RMEG × 10
Sodium	801,000	200,000	EPA Drinking Water Advisory for sodium-restricted diets × 10
PAH TEQ †	8	2 / 0.05	MCL / CREG × 10
Benzo(a)pyrene	7	2 / 0.05	MCL / CREG × 10
* Surface water CV calculated as ten times the drinking water CV.			
† Detected values only.			
Source: [6]			

For further screening, exposure doses for the contaminants of concern in surface water were estimated for trespassers or residents as young as 7 years old who contact the maximum concentration of arsenic measured in surface water 3 times a week for 4 months of the year. These assumptions were chosen to give a conservatively high estimate of exposure; further details can be found in Appendix A. The estimated child and adult exposure doses for arsenic, chromium, and copper were below noncancer health guideline values. Neither chromium nor copper are classified as carcinogenic by the oral route (there is limited but inconclusive evidence that hexavalent chromium may be an oral carcinogen), and the estimated increase in cancer risk from exposure to arsenic is so low as to be negligible. Therefore, exposure to arsenic, chromium, or copper in surface water is not expected to result in any adverse health effects. The estimated child and adult exposure doses for lead, mercury, sodium, and PAHs were evaluated further.

Lead

As described previously, levels of lead in children's blood of 10 micrograms per deciliter (μg/dL), and perhaps lower, have been associated with small decreases in IQ and slightly impaired hearing and growth. A slope factor for the increase in blood lead concentration per increase in water lead concentration for infants has been calculated as 0.04 μg/dL blood per microgram per liter (μg/L) lead for water lead levels above 15 μg/L [12]. The highest lead level measured in surface water was 19,600 μg/L; if regular exposure to this level of lead in surface water occurred, it could result in significant blood lead level increases in children. This high level was measured in water in an electrical vault on the site (personal communication, Amy Brittain, Oklahoma DEQ, March 22, 2006). It is not likely that children would or could gain access to this water since it is covered with a manhole cover. Other surface water samples ranged from less than 1 μg/L to 93 μg/L. These values would not be expected to pose a risk for occasional contact with surface water.

Mercury

Exposure to mercury in surface water is unlikely to result in health effects. The estimated doses for adult and child trespassers are 0.00026 mg/kg/day and 0.00036 mg/kg/day, respectively. The adult dose is lower than the minimal risk level for chronic oral exposure to organic mercury (the most toxic form of mercury) of 0.0003 mg/kg/day, and the child dose is only slightly higher [15]. No effects are expected from this exposure because the estimated dose would be to total mercury, which would be less toxic than organic mercury, and actual exposure would be to an average value rather than the maximum used for estimating dose.

Sodium

Sodium is an element that occurs naturally in soil and groundwater and is also found in food products, such as table salt. It is not generally considered toxic, but some individuals need to restrict their sodium intake for medical reasons [16]. The maximum concentration of sodium detected was 801,000 μg/L. This high value occurred in an electrical vault which would not be easily accessed; the next highest surface water sodium value was 229,000 μg/L. Although it is unlikely that a person would consume enough of this water to affect their health, incidental exposure to sodium in surface water could be an unrecognized source of sodium exposure to individuals on sodium restricted diets.

Polycyclic Aromatic Hydrocarbons

Exposure to PAHs in surface water is unlikely to result in health effects. Of all surface water tested, only 2 samples had PAHs detected, the coke pond (8 μg/L) and wastewater pond 2 (0.2 μg/L). If exposure to the highest level were to occur regularly over many years, it could increase the risk of cancer, but that is very unlikely. The site is fenced to discourage trespassing, it is unlikely that a trespasser would always swim in the coke pond rather than one of the other (less contaminated) ponds, and it is unlikely that trespassing activities would continue for more than a few years.

D. Potential Exposure Pathways

1. Groundwater Pathway

Contaminants from the source areas could infiltrate into the groundwater beneath the site. If people used this groundwater for drinking, they could be exposed to contaminants. All residences in the immediate area of the site use Cushing municipal water for drinking, and the municipal wells are not affected by site contamination (see page 3). The private well nearest the site is located about ¼ mile north of the site, but it has collapsed and does not produce water [5,10]. Because no one is using the water beneath the site, this pathway is considered incomplete, and it poses no hazard to public health. Since groundwater represents a potential exposure pathway, ATSDR did a preliminary evaluation of the available data on groundwater. Groundwater beneath the site was sampled from monitoring wells during the RI/FS. Table 6 lists the 11 substances detected at least once above the corresponding drinking water CV.

Table 6. Potential Exposure Pathway:
Groundwater Potential Contaminants of Concern at Hudson Refinery NPL Site, Cushing, Oklahoma

Contaminant	Maximum concentration detected in groundwater, µg/L	Groundwater comparison value (CV), µg/L	CV source (for drinking water, defined in Appendix A)
1,1,2-Trichloroethane	0.9	40 / 0.6	RMEG / CREG
Antimony	60	4	RMEG
Arsenic	7	3 / 0.02	EMEG / CREG
Benzene	9	40 / 0.6	RMEG / CREG
Bis (2-ethylhexyl) phthalate	19	600 / 3	EMEG / CREG
Iron	12,500	11,000	R9 PRG
Manganese	3,890	500	RMEG
Nitrate/Nitrite	35,000	10,000	MCL
Sodium	749,000	20,000	EPA Drinking Water Advisory for sodium-restricted diets
Sulfate	1,330,000	500,000	EPA Drinking Water Advisory
Thallium	8.8	0.5	LTHA
Source: [6]			

For further screening, worst-case exposure doses for the contaminants listed in Table 6 were then estimated for people who might drink the maximum concentration of this water every day over many years. Details of the assumptions used to perform these calculations can be found in Appendix A. The estimated maximum child and adult exposure doses for 1,1,2-trichloroethane, benzene, and bis(2-ethylhexyl)phthalate were below noncancer health guideline values and estimated increased cancer risk was so low as to be negligible. Worst-case exposure doses for the other contaminants were higher than screening health guideline values.

Immediate adverse health effects would not be expected if someone accidentally drank this groundwater, but longer term consumption could increase the risk of adverse health conditions and diseases. For example, if the water were routinely used to prepare formula for infants, the high nitrate/nitrite level could increase infant risk for methemoglobinemia, a condition where nitrite binds to hemoglobin in infant red blood cells, lowering oxygen carrying capacity and resulting in “blue baby syndrome” [17]. Other contaminants in the groundwater could cause increased risk of various noncancer or cancer health effects if the consumption was regular and prolonged for years. More evaluation of the groundwater would be necessary to determine which long-term adverse health effects would be more likely. Table 6 may not give a full picture of the groundwater contamination – at least one well is known to have light non-aqueous phase liquid floating on top of the water (personal communication, Laura Stankosky, U.S. Environmental Protection Agency, January 5, 2006). Since municipal water is available, ATSDR recommends site groundwater not be used unless it is fully characterized and treated to meet drinking water standards.

2. Air Pathway

Contaminants may evaporate into the air from contaminated areas on the site, or particles may be transported as fugitive dust. People could breathe in these contaminants or get them on their skin. DEQ collected air samples from certain areas on the site. Although several volatile, semi-volatile, and metallic compounds were detected in at least one of the samples, the highest value measured for each contaminant was lower than health-based air CVs. Therefore, exposure to contaminants through the air pathway is not expected to be of concern for this site.

3. Biota Pathway

Fish in the surface waters on or near the site may have taken up contaminants into their tissues. A limited number of fish samples were collected from two ponds on site: wastewater pond 6 and the firewater pond. The firewater pond serves as a reference since it does not receive runoff from the site and was never used to treat site waste (personal communication, Laura Stankosky, U.S. Environmental Protection Agency, March 16, 2006). A summary of the sampling results in shown in Table 7. Although fishing from these small ponds, if it occurs, is likely infrequent, ATSDR evaluated the fish data as a potential exposure pathway. ATSDR estimated exposure doses for each contaminant measured, assuming a person ate 8 grams per day (the mean intake for freshwater anglers [18]) of fish containing the highest value measured in fish filet samples. Because of the limited number of samples, ATSDR used either the highest detected value or the detection limit, whichever was higher, for each contaminant. The estimates are conservative because it is unlikely a person would eat fish exclusively from the site ponds and because a person would, over time, be exposed to an average concentration rather than the maximum.

Table 7. Summary of Fish Sample Results

Contaminant	Highest Concentration in Fish Filet, milligrams per kilogram	
	Wastewater Pond	Firewater Pond
Antimony	Not Detected	Not Detected
Arsenic	0.36	0.28
Barium	Not Detected	Not Detected
Beryllium	Not Detected	Not Detected
Cadmium	Not Detected	Not Detected
Chromium	Not Detected	Not Detected
Cobalt	Not Detected	Not Detected
Copper	Not Detected	Not Detected
Lead	0.17	Not Detected
Manganese	5.4	10.9
Mercury	Not Detected	0.025
Nickel	0.22	Not Detected
Selenium	Not Detected	Not Detected
Silver	Not Detected	Not Detected
Thallium	Not Detected	Not Detected
Vanadium	2.2	0.05
Zinc	Not Detected	Not Detected

The results of the analysis do not indicate any immediate concern. In cases where contaminants were detected in the fish tissues, estimated exposure doses were within safe health guidelines, and no significant differences were noted between contaminants in fish in the wastewater pond and the reference firewater pond. However, the sample results had relatively large limits of detection, so that in some cases where there were no detections (specifically, antimony and cadmium), using the detection limit resulted in an estimated dose above health guidelines. If, in the near future, fishing (for consumption) is found to be a common activity at either of the site ponds, ATSDR would recommend further sampling to better characterize contaminant levels, including PAH levels, in fish tissue.

Produce grown on or near the site could also take up contaminants into plant tissues, or contaminated soil could fall onto the plants, posing a potential exposure pathway. No data on levels of contaminants in plants on or near the site have been collected, and therefore ATSDR is unable to evaluate this potential exposure pathway.

E. Physical Hazards

The most dangerous physical hazards (large storage tanks of corrosive or reactive chemicals) were removed during the emergency removal. There are still a number of physical hazards present on the site, such as broken glassware throughout one of the buildings, small equipment, and other tripping hazards. It is expected that access restrictions and ongoing cleanup activities will protect the public from these physical hazards.

F. Past Exposures

Prior to 1999, refinery structures containing hazardous bulk chemicals were abandoned in place on the site. ATSDR issued a public health advisory in March 1999 due to the immediate hazard posed to the public by hydrofluoric acid, asbestos, and tetraethyl lead remaining on the site at that time. Only very limited data were collected to determine levels of contaminants in the soil, sediment, surface water, groundwater, or air prior to the RI/FS. ATSDR reviewed the available data and found them insufficient to make accurate estimates of past exposures. However, the limited data available for metals and organics appeared to be similar to the data collected recently in the RI/FS.

A formerly used alkylation unit was left with about 6,000 gallons of hydrofluoric acid in it and was leaking prior to emergency removal activities. Hydrofluoric acid is a dangerous irritant and can cause severe burns to eyes and skin. The exposure may not be painful at first, but damage may occur over several hours or days, and deep, painful wounds may develop [19]. Serious skin damage and tissue loss can occur if prompt, appropriate treatment is not obtained. In the worst cases, exposure to hydrofluoric acid can lead to death caused by the fluoride affecting the lungs or heart. Breathing in hydrofluoric acid fumes can cause respiratory and skin irritation or damage to the lungs, heart, kidneys, or testes [19]. ATSDR found no reports of anyone being injured by past acute exposure to hydrofluoric acid before the emergency removal occurred. Few studies are available describing health effects resulting from exposure to low levels of hydrofluoric acid. In one study volunteers who breathed in a low level of hydrofluoric acid complained of nose and throat irritation. Long term exposure to fluoride compounds can result in skeletal fluorosis, a weakening of the bones and teeth cause by replacement of calcium with fluorine [19]. However, this requires relatively high exposures for many years and it is unlikely community exposures around the site were high enough and of long enough duration to result in long-term health effects.

Asbestos-containing material was left exposed during an incomplete removal and some asbestos probably blew into surrounding areas. Inhalation of asbestos fibers increases the risk of asbestosis (scarring of the lungs resulting in progressive loss of lung function), pleural disease (calcifications of the mesothelium, the pleural membrane surrounding the lung), lung cancer, and mesothelioma (a rare cancer of the mesothelium). The risk of disease increases with increasing fiber level and longer durations of exposure [20]. There is not enough information to determine the level of asbestos fibers to which various residents may have been exposed, so it is not possible to estimate risk of disease from potential past exposures. However, the asbestos-containing material was exposed for at most only three years before the emergency removal was complete, and residents who did not contact the material directly would probably not have had enough exposure to result in disease.

Tetraethyl lead was also present on the site in a waste vat. Tetraethyl lead is an organic lead compound once used widely as a gasoline additive. Exposure to high levels of this substance could result in damage to the brain and kidneys in adults and children, miscarriage in pregnant women, or damage to the testes in men [12]. ATSDR found no reports of persons being injured by past acute exposure to tetraethyl lead before the emergency removal occurred. Longer term exposure to lower levels of lead may contribute to chronic health effects, but as described in the pathway analysis sections beginning on page 6, no evidence of lead exposures high enough to result in adverse health effects was found.

G. Future Use of the Site

EPA asked ATSDR to evaluate potential future uses of the site. At this time, there is not enough known about projected cleanup levels and proposed uses of the site to perform a meaningful evaluation of potential future uses. However, ATSDR will evaluate proposed cleanup and future uses as they are developed to ensure that they remain protective of public health.

H. Children's Health Considerations

ATSDR recognizes that infants and children might be more vulnerable than adults to exposures in communities with contaminated air, water, soil, or food. This potential vulnerability results from the following factors: 1) children are more likely to play outdoors and bring food into contaminated areas; 2) children are shorter and therefore more likely to contact dust and soil; 3) children's small size results in higher doses of chemical exposure per kg of body weight; and 4) developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Because children depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at the site.

Because of the limited access to the site and the surrounding areas, ATSDR considers very small children unlikely to be directly exposed to site contaminants. Older children who trespass on the site or play nearby might be exposed to contaminants in soil, surface water, or sediments on the site or to contaminants in surface water or sediments of streams downstream of the site. ATSDR's evaluation indicated that no adverse health effects would be likely if children 7 years old or older occasionally trespassed on the site. Please refer to the appropriate exposure pathway section of this document for further discussion.

I. Health Outcome Data

Health outcome data can give a more thorough evaluation of the public health implications of a given exposure. Health outcome data can include mortality information (e.g., the number of people dying from a certain disease) or morbidity information (e.g., the number of people in an area getting a certain disease or illness). The review is most effective when (1) a completed human exposure pathway exists, (2) potential contaminant exposures are high enough to result in measurable health effects, (3) enough people are affected for the health effect to be measured, and (4) a database is available to identify disease rates for populations of concern.

No review of health outcome data was performed for this site. Although completed exposure pathways exist, the toxicological evaluation in the preceding sections indicated that potential exposures are too low to result in measurable health effects. In addition, the number of people potentially exposed to site contaminants is small compared to the number of people in the corresponding census tract, the smallest area for which cancer incidence data is available in Oklahoma (personal communication, Anne Bliss, Oklahoma Central Cancer Registry, October

27, 2005). This makes it impossible to make meaningful conclusions about the potentially exposed population around the site using cancer registry data.

J. Community Health Concerns

On May 13, 2004, ATSDR participated in a public availability session in Cushing with DEQ and EPA. The meeting was attended by approximately 15 residents of Cushing, as well as several officials from city, state, and federal organizations. During this meeting, community members conveyed their health concerns regarding the site. The health concerns are summarized and addressed below.

Concern: *There were lots of refineries in Cushing, so people were exposed to more chemicals than just those from this site.*

Response: ATSDR recognizes that people might be exposed to similar chemicals at other locations in Cushing. This report is focused on the Hudson Refinery NPL site and its effects. Additional exposures could increase the risk of health effects if the cumulative dose was high enough; however, determining whether this is possible or likely is beyond the scope of this PHA.

Concern: *I am concerned about site contaminants causing elevated rates of cancer around the site, especially pancreatic cancer and neuroblastoma.*

Response: No exposures to site contaminants were identified that would be high enough to increase the rate of cancer. It is unlikely that cases of cancer around the site are caused by site contaminants. It is not possible to use cancer registry data to evaluate cancer rates right around the site. This is because the number of people there is small compared to the number of people in the corresponding census tract, the smallest area for which cancer incidence data is available in Oklahoma.

It is possible that past emissions from the refinery (while it was in operation) resulted in greater or different exposures to the surrounding community. Unfortunately, no historical data exists that could be used for an evaluation of these past exposures.

Pancreatic cancer is the fourth leading type of cancer in the United States, according to the American Cancer Society. It is cancer of the pancreas, a gland that produces blood sugar-controlling hormones and digestive juices. The exact causes of pancreatic cancer are not known, but tobacco smoking, other lifestyle factors, genetic factors, and having other diseases like chronic pancreatitis can increase risk. Some studies have suggested that employment in the petroleum industry (which works with many PAHs) could increase the risk of pancreatic cancer, but the increases were generally not large or definitive [21–23]. A meta-analysis of available occupational epidemiology studies from 1969 to 1998 showed a slightly increased risk for exposure to PAHs, but the increase was not statistically significant [24]. Exposures to PAHs are not likely to be a major contributor to the development of pancreatic cancer.

Neuroblastoma is a rare type of cancer that develops in the sympathetic nervous system and is diagnosed almost exclusively in infants and young children [25]. Neuroblastoma usually presents as a solid, cancerous mass in the abdomen or around the spinal cord. The disease may be present at birth but not diagnosed until symptoms develop later. Very little is known about underlying causes of neuroblastoma. Many studies have been inconclusive or conflicting, but research to date has suggested medications or hormones taken during pregnancy, certain birth characteristics, pesticide exposure, certain parental occupational exposures, and genetic factors as potential risk factors. There is no evidence that the risk of neuroblastoma would be increased by child or parental exposure to any of the contaminants found at the site.

Concern: *Could past exposure of former refinery workers lead to elevated rates of cancer or other diseases?*

Response: Because there are no past data on exposures experienced by former workers, it is impossible for ATSDR to answer this question. Certainly, working in a refinery involves potential exposures to many hazardous chemicals and carcinogens. Epidemiological studies such as those described on the previous page have shown associations between employment in the petroleum industry, or refineries in particular, with increased rates of various cancers. However, a limitation of these studies is the inability to specify adequately the nature and level of exposures experienced by workers.

IV. Public Comments

This public health assessment was available for public review and comment at the Cushing Public Library and at City Hall in Cushing, Oklahoma, and at the Tulsa City County Library in Tulsa, Oklahoma from April 24, 2006, through May 31, 2006. The document also was available for viewing or downloading from the ATSDR Web site.

The public comment period was announced to local media outlets. The public health assessment also was sent to federal, state, and local officials.

Comments were received from EPA and DEQ. They can be found in Appendix C, along with ATSDR's responses to them.

V. Health Hazard Category

Because no exposure pathways were identified which would result in exposures high enough to cause adverse health effects, ATSDR classifies the Hudson Refinery NPL site as currently posing *no apparent public health hazard*. This classification may be modified on the basis of further information that might become available about the site. The site posed a *past public health hazard* due to the immediate threat posed by hazardous chemicals that were left at the site. These chemicals have since been removed. Not enough information exists to evaluate the risk of long term health effects resulting from potential past exposures to site chemicals. However, low-level, short duration exposures to the hazardous chemicals on which the public health advisory was based are unlikely to result in measurable long-term health effects.

VI. Conclusions

1. Immediately hazardous chemicals and structures leading to the 1999 public health advisory have been removed.
2. Assuming exposure is to children and adults occasionally trespassing on the site, no adverse health effects are expected from exposure to site contaminants in sediment, surface water, or surface soil at the site.
3. Because no one is using site groundwater for drinking purposes, the groundwater pathway is incomplete and therefore poses no hazard. The levels of some contaminants in groundwater are high enough to warrant further evaluation before being suitable for drinking water or other use.

VII. Recommendations

1. Fencing and warning signs should be maintained by DEQ to discourage trespassing.
2. Further investigation and/or cleanup of the site by DEQ is warranted to ensure the site's safety for future uses.
3. Groundwater at the site should not be used unless it is fully characterized and treated to meet drinking water standards.

VIII. Public Health Action Plan

The public health action plan for the Hudson Refinery NPL site describes actions that have been or will be taken at the site by ATSDR or other government agencies. The purpose of the plan is to ensure that this public health assessment not only identifies public health hazards at the site, but also outlines a plan of action to prevent or minimize the potential for adverse human health effects from exposure to site-related hazardous substances. ATSDR will follow up on this plan to ensure that it is implemented.

Completed Actions

- ATSDR conducted a site visit to verify site conditions and to gather pertinent information and data for the site.
- ATSDR attended a public availability session to inform the community about the public health assessment process and to gather health concerns from the site community.

Planned Actions

- ATSDR will review additional environmental sampling results for the site to evaluate any changes in possible public health implications.
- ATSDR will work with DEQ and EPA to evaluate proposed cleanup levels and future uses of the site as they are developed to ensure that they remain protective of public health

IX. Site Team

Authors of Report

Jill J. Dyken, Ph.D., P.E.
Environmental Health Scientist
Superfund Site Assessment Branch
Division of Health Assessment and Consultation

Mathew J. Martinson, P.E.[3]
Environmental Engineer
Superfund Site Assessment Branch
Division of Health Assessment and Consultation

Regional Representative

Jennifer L. Lyke
Regional Representative
Division of Regional Operations, Region 6

Community Involvement

La Freta A. Dalton
Health Communication Specialist
Health Promotion and Community Involvement Branch
Division of Health Assessment and Consultation

[3] No longer with ATSDR.

X. References

1. Agency for Toxic Substances and Disease Registry. Public health advisory for Hudson Oil Refinery site, Cushing, Payne County, Oklahoma. Atlanta: U.S. Department of Health and Human Services; March 4, 1999.

2. Ecology and Environment. Removal support report for Hudson Refinery, Cushing, Payne County, Oklahoma. Prepared for the U.S. Environmental Protection Agency, Region 6. Dallas; July 10, 2000.

3. United States Environmental Protection Agency. POLREP No. 9 (final). Dallas; July 9, 2003.

4. Oklahoma Department of Environmental Quality. Hudson Oil Refining Company fact sheet, Cushing, Oklahoma. Oklahoma City; April 26, 2004.

5. Superfund Technical Assistance and Response Team. Expanded site inspection work plan for Hudson Refinery, Cushing, Payne County, Oklahoma. Prepared for the U.S. Environmental Protection Agency, Region 6. Dallas; December 2, 1998.

6. Burns & McDonnell. Remedial investigation/feasibility study, Phase I data summary, Hudson Refinery, Cushing, Oklahoma. Prepared for Oklahoma Department of Environmental Quality. Kansas City (MO); February 2005.

7. Oklahoma Department of Environmental Quality. Phase I and Phase II sampling results, files dated 2/14/06. Oklahoma City: Oklahoma Department of Environmental Quality. Provided electronically, February 2006.

8. United States 2000 Census. American fact finder, data set from 2000 summary file 1. Washington, DC: U.S. Department of Commerce. URL: http://factfinder.census.gov.

9. Oklahoma Department of Environmental Quality. Consultant scope of work for the Hudson Refinery Superfund site. Oklahoma City; November 21, 2003.

10. Oklahoma Water Resources Board. Multi-purpose well completion and plugging report. Well Number 11944. Oklahoma City: January 8, 1998. Available at URL: http://www.owrb.state.ok.us/wd/reporting/printreport.php?siteid=11944. Accessed October 17, 2005.

11. Agency for Toxic Substances and Disease Registry. Toxicological profile for arsenic (update). Atlanta: U.S. Department of Health and Human Services; September 2005.

12. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead (update, draft for public comment). Atlanta: U.S. Department of Health and Human Services; September 2005.

13. Agency for Toxic Substances and Disease Registry. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs) (update). Atlanta: U.S. Department of Health and Human Services; August 1995.

14. Agency for Toxic Substances and Disease Registry. Toxicological profile for chromium. Atlanta: U.S. Department of Health and Human Services; September 2000.

15. Agency for Toxic Substances and Disease Registry. Toxicological profile for mercury (update). Atlanta: U.S. Department of Health and Human Services; March 1999.

16. U.S. Environmental Protection Agency. Drinking water contaminant candidate list, sodium in drinking water. Washington, D.C.: U.S. Environmental Protection Agency, Office of Groundwater and Drinking Water. Available at URL: http://www.epa.gov/ogwdw/ccl/sodium.html . Accessed March 28, 2006.

17. U.S. Environmental Protection Agency. List of drinking water contaminants and MCLs. Washington, D.C.: U.S. Environmental Protection Agency, Office of Groundwater and Drinking Water. Available at URL: http://www.epa.gov/OGWDW/mcl.html#mcls . Accessed March 28, 2006.

18. U.S. Environmental Protection Agency. Exposure factors handbook. Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development; 1999. Rpt. No.: EPA/600/C-99/001.

19. Agency for Toxic Substances and Disease Registry. Toxicological profile for fluorides, hydrogen fluoride, and fluorine (update). Atlanta: U.S. Department of Health and Human Services; September 2003.

20. Agency for Toxic Substances and Disease Registry. Toxicological profile for asbestos (update). Atlanta: U.S. Department of Health and Human Services; September 2001.

21. Kernan GJ, Ji B, Dosemeci M, Silverman DT, Balbus J, Zahm SH. Occupational risk factors for pancreatic cancer: a case-control study based on death certificates from 24 U.S. states. Am J Ind Med 1999; 36: 260-270.

22. Hanis NM, Homes TM, Shallenberger F, Jones KE. Epidemiologic study of refinery and chemical plant workers. J Occup Med 1982; 24(3): 203-212.

23. Norell S, Ahlbom A, Olin R, Erwald R, Jacobson G, Lindberg-Navier I, Wiechel KL. Occupational factors and pancreatic cancer. Br J Ind Med 1986; 43(11): 775-778.

24. Ojajarvi IA, Partanen TJ, Ahlbom A, Boffetta P, Hakulinen T, Jourenkova N, Kauppinen TP, Dogevinas M, Porta M, Vainio HU, Weiderpass E, Wesseling CH. Occupational exposures and pancreatic cancer: a meta-analysis. Occup Environ Med 2000; 57:316-324.

25. Goodman MT, Gurney JG, Smith MA, Olshan AF. Sympathetic nervous system tumors. In: Ries LAG, Smith MA, Gurney JG, Linet M, Tamra T, Young JL, Bunin GR, editors. Cancer incidence and survival among children and adolescents: United States SEER program 1975-1995. Bethesda (MD): National Cancer Institute, SEER Program; 1999. NIH Pub. No. 99-4649.

26. U.S. Environmental Protection Agency. Risk assessment guidance for Superfund, volume 1, human health evaluation manual. Washington, DC: U.S. Environmental Protection Agency, Office of Emergency and Remedial Response; 1989.

27. Agency for Toxic Substances and Disease Registry. Cancer policy framework. Atlanta: U.S. Department of Health and Human Services; 1993.

28. International Programme on Chemical Safety. Environmental health criteria 85, lead - environmental aspects. Geneva: World Health Organisation, International Programme on Chemical Safety; 1989.

Appendix A. Explanation of Evaluation Process

A. Screening Process

In evaluating these data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are health-based contaminant concentrations found in a specific media (air, soil, or water) and are used to screen contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone might inhale or ingest each day.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and noncancer health effects. Noncancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are based on a one-in-a-million excess cancer risk for an adult exposed to contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and noncancer levels exist, we use the lower level to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

CVs used in this document are listed below:

Environmental Media Evaluation Guides (EMEGs) are estimated contaminant concentrations in a media where noncarcinogenic health effects are unlikely. EMEGs are derived from the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk level (MRL).

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a lifetime. CREGs are calculated from the U.S. Environmental Protection Agency's (EPA) cancer slope factors (CSFs).

Reference Media Evaluation Guides (RMEGs) are estimated contaminant concentrations in a media where noncarcinogenic health effects are unlikely. RMEGs are derived from EPA's reference dose (RfD).

Lifetime Health Advisories (LTHAs) are derived by EPA from a drinking water equivalent level below which no adverse noncancer health effects are expected to occur over a 70-year lifetime.

Maximum Contaminant Levels (MCLs) are enforceable standards set by EPA for the highest level of a contaminant allowed in drinking water. MCLs are set as close to MCL goals (MCLGs, the level of a contaminant in drinking water below which there is no known or expected risk to health) as feasible using the best available treatment technology and taking cost into consideration.

Preliminary Remediation Goals (PRGs) are the estimated contaminant concentrations in a media where carcinogenic or noncarcinogenic health effects are unlikely. The PRGs used in this public health assessment were derived using provisional reference doses or CSFs calculated by EPA's Region 9 toxicologists.

EPA Soil Screening Levels (SSLs) are estimated contaminant concentrations in soil at which additional evaluation is needed to determine if action is required to eliminate or reduce exposure.

Some CVs may be based on different durations of exposure. Acute duration is defined as exposure lasting 14 days or less. Intermediate duration exposure lasts between 15 and 364 days, and chronic exposures last 1 year or more. Comparison values based on chronic exposure studies are used whenever available. If an intermediate or acute comparison value is used, it is denoted with a small *i* or *a* before the CV (e.g., iEMEG refers to the intermediate duration EMEG).

B. Determination of Exposure Pathways

ATSDR identifies human exposure pathways by examining environmental and human components that might lead to contact with contaminants of concern (COCs). A pathway analysis considers five principal elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population. Completed exposure pathways are those for which the five elements are evident, and indicate that exposure to a contaminant has occurred in the past, is now occurring, or will occur in the future. Potential exposure pathways are those for which exposure seems possible, but one or more of the elements is not clearly defined. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. The identification of an exposure pathway does not imply that health effects will occur. Exposures might be, or might not be, substantive. Therefore, even if exposure has occurred, is now occurring, or is likely to occur in the future, human health effects might not result.

ATSDR reviewed site history, information on site activities, and the available sampling data. On the basis of this review, ATSDR identified numerous exposure pathways that warranted consideration. Additional information regarding the completed and potential exposure pathways identified for the Hudson Refinery site is provided in Appendix B of this public health assessment. Summaries of these pathways are discussed below.

C. Evaluation of Public Health Implications

The next step is to take those contaminants present at levels above the CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using our assumptions of who goes on the site and how often they contact the site contaminants. The exposure dose is the amount of a contaminant that gets into a person's body. Following is a brief explanation of how we calculated the estimated exposure doses for the site.

Ingestion of Groundwater

Potential exposure doses for groundwater ingestion were calculated using the highest concentration for a contaminant in a monitoring well, in milligrams per liter (mg/L), multiplied by the EPA default drinking water rate of 2 L/day for adults or 1 L/day for children. The multiplication product was divided by the average weight for an adult (70 kg or 154 pounds), or for a 1-year-old child (10 kg or 22 pounds).

Incidental Ingestion of Surface Soil

Exposure doses for ingestion of contaminants present in surface soil were calculated using the concentration measured, in milligrams per kilogram (mg/kg), or parts per million (ppm), multiplied by the soil ingestion rate for adults (100 mg/day) or children (200 mg/day). The multiplication product was divided by the average weight for an adult, 70 kg (154 pounds) or a 7-year-old child, 25 kg (55 pounds). The resulting dose was then multiplied by a factor of 78/365, because the exposure was assumed to occur 3 times per week for 6 months (26 weeks) out of the year.

For estimating child exposures to surface soil in residential yards, the ingestion rate was 200 mg/day, the body weight was that of a 1-year-old child, 10 kg (22 pounds), and exposure was assumed to occur 350 days per year.

Incidental Ingestion of Surface Water

Exposure doses for ingestion of contaminants from surface water were calculated using the maximum concentration measured in the surface water, in milligrams per liter (mg/L), multiplied by an incidental surface water ingestion rate of 0.2 L/day for adults or 0.1 L/day for 7-year-old children. These ingestion rates are 1/10th of the EPA default drinking water rates. The multiplication product was divided by the average weight for an adult (70 kg or 154 pounds), or for a 7-year-old child (25 kg or 55 pounds). The resulting dose was then multiplied by a factor of 48/365, because the exposure was assumed to occur 3 days per week during 4 months of the year.

Incidental Ingestion of Sediment

Exposure doses for ingestion of contaminants from the sediment were calculated using the average concentration measured in the sediment, in mg/kg or ppm, multiplied by 1/10th of the soil ingestion rate, 10 mg/day for adults or 20 mg/day for children. The multiplication product was divided by the average weight for an adult (70 kg or 154 pounds), or for a 7-year-old child (25 kg or 55 pounds). The resulting dose was then multiplied by a factor of 48/365, because the exposure was assumed to occur 3 days per week during 4 months of the year.

Dermal (Skin) Exposure

In this public health assessment, we evaluated dermal exposure to groundwater, soil and/or tailings, surface water, and sediment. Dermal absorption depends on numerous factors including the area of exposed skin, anatomic location of exposed skin, length of contact, concentration of chemical on skin, chemical-specific permeability, soil adherence, medium in which the chemical is applied, and skin condition and integrity. Because chemicals differ greatly in their potential to be absorbed through the skin, each chemical needs to be evaluated separately and is discussed as needed in the main body of the public health assessment. The assumed receptor body weights, exposure frequency, and exposure duration are the same as described in the above calculations of the ingestion route. The skin surface area and soil-to-skin adherence factors used in this public health assessment were taken from EPA's *Exposure Factor Handbook* [18]. Absorption factors and other chemical-specific factors were taken from the ATSDR *Toxicological Profile* for each specific chemical.

D. Noncancer Health Effects

The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, and/or the use of the lowest study doses that resulted in harmful health effects (rather than the highest dose that did not result in harmful health effects). For noncancer health effects, the following health guideline values are used.

Minimal Risk Level (MRLs) —Developed by ATSDR

An MRL is an estimate of daily human exposure – by a specified route and length of time – to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

Reference Dose (RfD) —Developed by EPA

An RfD is an estimate, with safety factors built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause noncancerous health effects. RfDs can be found at http://www.epa.gov/iris.

If the estimated exposure dose for a chemical is less than the health guideline value, then the exposure is unlikely to cause a noncarcinogenic health effect in that specific situation. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared to known toxicologic values for that chemical and is discussed in more detail in the public health assessment (see Discussion section). These toxicologic values are doses derived from human and animal studies that are summarized in the ATSDR *Toxicological Profiles*. A direct comparison of site-specific exposure and doses to study-derived exposures and doses that cause adverse health effects is the basis for deciding whether health effects are likely or not.

E. Calculation of Risk of Carcinogenic Effects

The estimated risk of developing cancer resulting from exposure to the contaminants was calculated by multiplying the site-specific adult exposure dose by EPA's corresponding CSF (which can be found at http://www.epa.gov/iris). The results estimate the maximum increase in risk of developing cancer after 70 years of exposure to the contaminant.

The actual increased risk of cancer is probably lower than the calculated number, which gives a worst-case excess cancer risk. The method used to calculate EPA's cancer slope factor assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The method also assumes that no safe level exists for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, the method computes the upper 95th percent confidence limit for the risk. The actual cancer risk can be lower, perhaps by several orders of magnitude [26].

Because of uncertainties involved in estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data [27]. Therefore, the carcinogenic risk is described in words (qualitatively) rather than giving a numerical risk estimate only. The numerical risk estimate must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure.

Appendix B. Exposure Pathways for Hudson Oil Refinery Site, Cushing, OK

Source for All Pathways: Bottoms Material from Defunct Refinery Tanks							
Pathway Name	**Environmental Media & Transport Mechanisms**	**Point of Exposure**	**Route of Exposure**	**Exposed Population**	**Time**	**Notes**	**Complete?**
Surface water	Surface water runoff over wastes to creek and wetlands; surface water in ponds on site	Along creek, water in pond	Incidental ingestion, inhalation, dermal exposure	Residents, workers, trespassers	Past, present, future	Population may include children 10 years and older	Y
Sediments	Deposition from surface water runoff into and alongside creek and ponds	Along creek, water in pond	Incidental ingestion, dermal exposure	Residents, workers, trespassers	Past, present, future	Population may include children 10 years and older	Y
Soil	Erosion of waste to surface soils; redeposition of fugitive dust	Site or nearby residences	Incidental ingestion, inhalation, dermal exposure	Residents, workers, trespassers	Past, present, future	Population may include children 10 years and older	Y
Groundwater	Infiltration to groundwater	Groundwater wells supplying drinking water taps	Ingestion, inhalation, dermal exposure	Residents, workers, trespassers	Past, present, future	No domestic use of groundwater identified	N
Air	Volatilization of contaminants; fugitive dust	Site or nearby residences	Inhalation, dermal exposure	Residents, workers, trespassers	Past, present, future	No contaminants detected above CVs	N
Biota	Bioaccumulation of contaminants from surface water and sediments and vegetation into fish and/or deer	Meal prepared using fish or animals affected by site contaminants	Ingestion	Local hunters and/or fishers and their families	Past, present, future	No use of biota from site identified	N

Appendix C. Public Comments and Responses

This public health assessment was available for public review and comment at the Cushing Public Library and at City Hall in Cushing, Oklahoma, and at the Tulsa City County Library in Tulsa, Oklahoma from April 24, 2006, through May 31, 2006. The document also was available for viewing or downloading from the ATSDR Web site.

The public comment period was announced to local media outlets. The public health assessment also was sent to federal, state, and local officials. Comments were received from DEQ and EPA.

A. Comments from the Oklahoma Department of Environmental Quality:

Comment A1: *On page 3 the end of the top paragraph it says that the RI/FS was completed in 2005. Please change that to 2006.*

Response: Thank you for the clarification. The document has been modified accordingly.

B. Comments from the U.S. Environmental Protection Agency:

Comment B1: *Preliminary Remediation Goals used in the document were derived using provisional reference doses or cancer slope factors calculated by EPA Region 9 toxicologists. EPA Region 6 has human health media-specific screening levels which may be useful to you. These screening levels may be found at: http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm*

Response: Thank you for the information. ATSDR checked the Region 9 screening values used with those of Region 6; use of values from either region would not have changed any of the results or conclusions made in the document.

Comment B2: *Section III, C, page 7 – It may not be appropriate to use a site-wide average concentration as a comparison to screening values. Average concentrations in the areas of potential concern may vary based on past use and patterns of activity in various areas of the site may impact actual exposures.*

Response: For surface soil screening, the maximum soil concentration was compared to CVs. Contaminants whose maximum value exceeded screening CVs were evaluated further. None of the maximum values were high enough to result in acute effects for shorter exposures (over several days, for example). For further evaluation of chronic effects, an average soil concentration was used because over the long term (months to years), trespassers would be exposed to an average soil concentration of each contaminant from the various areas on the site. Even if a higher assumed concentration, such as the 95^{th} percentile of each contaminant, was used to estimate long-term exposure concentration, the exposure would not be expected to result in adverse health effects.

Comment B3: *Section III, C, page 10, Table 2 – Please provide the basis for using the screening values times 10 in this table. This approach may not be a conservative enough approach to estimate risk. The trespasser scenario does not directly relate to a residential screening value but a multiplication factor of 10 seems arbitrary. Given the potential cumulative effects of multiple chemical exposure, this approach may not be conservative enough.*

Response: The factor of 10 results from professional judgment that sediment would be contacted about one-tenth as much as soil, due to factors such as water cover, different activities, etc. This was done because there are no CVs developed specifically for sediment. The correction does not relate to the assumption of trespasser vs. residential exposure, but only to assumed exposure to sediment as opposed to surface soil.

Comment B4: *Section III, C, page 11 – Lead in Surface Water – This may represent a potentially significant exposure concern. The statement in the summary stating that the Hudson Refinery is currently posing no apparent public health hazard may be premature. The site is accessible to trespassers and this route of exposure should result in a more protective statement about the potential risk of the site. The potential for fishing on site ponds increases the level of concern due to potential exposure through sediment, surface water, swimming (incidental ingestion) and fish consumption. The levels in both sediment and surface water are of concern and potentially contribute to fish uptake.*

Response: As discussed in the document, it is considered unlikely that kids could gain access to the electrical vault where the one very high lead level (19,600 μg/L) was measured. The other levels in surface water ranged from non-detect to 96 μg/L; occasional contact to this water as evaluated in the PHA is not expected to result in measurable health effects. (It should be noted that some of the lead levels in surface water are above EPA drinking water action levels, indicating that untreated surface water would not be appropriate for regular use for drinking.) Sediment was also evaluated and, for the trespassing scenario evaluated, was not found to be likely to result in adverse health effects. It is not likely that eating fish would contribute a significant lead exposure to occasional fishers. Fish can concentrate lead within their tissues, with most accumulation in the gill, liver, kidney, and bone. A progressive buildup throughout the food chain (biomagnification) does not occur [28].

Comment B5: *Section III, D, page 13, Table 6 – Use of the maximum contaminant level (MCL) for all constituents with a ground water value would be an appropriate reference. The MCL term should be added to the Appendix C Glossary.*

Response: The definition of maximum contaminant level (MCL) has been added to the discussion and definition of comparison values used for screening given in Appendix A. ATSDR has established a 3-tier hierarchy for selecting comparison values to use for screening. For water, chronic environmental media evaluation guides (EMEGs) and cancer risk evaluation guides (CREGs) are in tier 1 and are selected preferentially; intermediate EMEGs, reference media evaluation guides (RMEGs), and lifetime health advisories (LTHAs) are in the second tier and are used if no tier 1 CVs are available. MCLs are in the third tier and are selected as screening CVs if no tier 1 or tier 2 CVs are available.

Comment B6: *Section III, G, page 17 – While the future site use is undetermined at this time, the current zoning is industrial. A future use evaluation should include a potential industrial reuse.*

Response: Because Hudson Refinery is still undergoing cleanup activities and future uses are not determined completely, ATSDR feels any evaluation using current site conditions would be misleading for determining potential future health impacts from the site. ATSDR will, upon request, evaluate whether planned cleanup goals and planned future site uses are protective of public health and share the findings in a separate document or letter.

Comment B7: *Section IV, page 19 – It appears that there are significant information gaps remaining at the site. Specifically, the use of ponds for swimming and fishing could result in exposures of concern. Fencing around the site does not completely limit access to the site; therefore, it may be premature to state that no apparent public health hazard exists.*

Response: ATSDR used the available data and protective assumptions to evaluate the most likely exposure scenario occurring at the site, that of occasional trespassing. The evaluation showed that occasional trespassers as young as 7 years old, who might also swim at the site, would not be likely to experience adverse health effects. In addition, while the data on fish tissue was very limited, it was evaluated and no immediate exposure concerns were identified. If fishing does occur on site, it is not likely to be a significant source of exposure; the number and size of fish in the site ponds was reportedly quite small (personal communication, Amy Brittain, ODEQ, December 2005). Because human exposure to contaminated media at the site is not expected to cause adverse health effects, ATSDR classifies the site as posing no apparent public health hazard. If the ways in which people access the site change significantly or if further environmental data very different than the RI data results becomes available, ATSDR may revisit the conclusions and recommendations of this PHA and modify them accordingly.

Comment B8: *Section VI, page 20 – It would be appropriate to include language advising against swimming and fishing from on site ponds in addition to discouraging trespassing.*

Response: ATSDR recommends that all trespassing at the site be discouraged to reduce the chance for any exposure (even though no exposures evaluated were found to be likely to cause adverse health effects). Singling out the activities of fishing and swimming for additional discouragement could send the unintended message that other trespassing on the site is OK.

Appendix D. ATSDR Plain Language Glossary of Environmental Health Terms

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

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

Additive Effect A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

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

Antagonistic Effect A response to a mixture of chemicals or combination of substances that is **less** than might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

ATSDR The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

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

Bioavailability See **Relative Bioavailability**.

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

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

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

Chronic Exposure	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway	See **Exposure Pathway**.
Community Assistance Panel (CAP)	A group of people from the community and health and environmental agencies who work together on issues and problems at hazardous waste sites.
Comparison Value (CV)	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	**CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. This act created ATSDR and gave it the responsibility to look into health issues related to hazardous waste sites.
Concentration	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant	See **Environmental Contaminant**.
Delayed Health Effect	A disease or injury that happens as a result of exposures that may have occurred far in the past.
Dermal Contact	A chemical getting onto your skin. (see **Route of Exposure**).
Dose	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".
Dose / Response	The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration	The amount of time (days, months, years) that a person is exposed to a chemical.
Environmental Contaminant	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
Environmental Media	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.
US Environmental Protection Agency (EPA)	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Epidemiology	The study of the different factors that determine how often, in how many people, and in which people will disease occur.
Exposure	Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)
Exposure Assessment	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.
Exposure Pathway	A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts: 1. Source of Contamination, 2. Environmental Media and Transport Mechanism, 3. Point of Exposure, 4. Route of Exposure, and 5. Receptor Population. When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.
Frequency	How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste	Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.
Health Effect	ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).
Indeterminate Public Health Hazard	The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.
Ingestion	Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).
Inhalation	Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).
LOAEL	Lowest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.
Malignancy	See **Cancer**.
MRL	Minimal **R**isk **L**evel. An estimate of daily human exposure **–** by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.
NPL	The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.
NOAEL	No **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.
No Apparent Public Health Hazard	The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected

	to cause adverse health effects.
No Public Health Hazard	The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.
PHA	Public **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.
Plume	A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).
Point of Exposure	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Population	A group of people living in a certain area; or the number of people in a certain area.
PRP	**P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.
Public Health Assessment(s)	See **PHA**.
Public Health Hazard	The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.
Public Health Hazard Criteria	PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are: – Urgent Public Health Hazard – Public Health Hazard – Indeterminate Public Health Hazard

– No Apparent Public Health Hazard
– No Public Health Hazard

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

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

Relative Bioavailability The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.

Route of Exposure The way a chemical can get into a person's body. There are three exposure routes:
– breathing (also called inhalation),
– eating or drinking (also called ingestion), and
– getting something on the skin (also called dermal contact).

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

SARA The **S**uperfund **A**mendments and **R**eauthorization **A**ct in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects resulting from chemical exposures at hazardous waste sites.

Sample Size The number of people that are needed for a health study.

Sample A small number of people chosen from a larger population (See **Population**).

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

Special Populations People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex,

	or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Statistics	A branch of the math process of collecting, looking at, and summarizing data or information.
Superfund Site	See **NPL**.
Survey	A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.
Synergistic effect	A health effect from an exposure to more than one chemical, where one of the chemicals worsens the effect of another chemical. The combined effect of the chemicals acting together are greater than the effects of the chemicals acting by themselves.
Toxic	Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.
Toxicology	The study of the harmful effects of chemicals on humans or animals.
Tumor	Abnormal growth of tissue or cells that have formed a lump or mass.
Uncertainty Factor	See **Safety Factor**.
Urgent Public Health Hazard	This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.