AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

JERSEY MINIERE ZINC COMPANY
(A/K/A PASMINCO CLARKSVILLE ZINC PLANT)
CLARKSVILLE, MONTGOMERY COUNTY, TENNESSEE
EPA FACILITY ID: TND081460651
AUGUST 1, 2005

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

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

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Table of Contents

Summary 1
Introduction 2
  Background 2
  Current Land Use 3
  Demographics 3
  Community Concerns 3
Discussion 4
  Extent of Contamination 4
  TDEC Follow-up Activities 7
  ATSDR Exposure Investigation for Soil 8
Public Health Implications 14
  Contaminants of Concern 14
  Health Outcome Data 19
  Child Health Considerations 23
  Physical Hazards 23
Conclusions 23
Recommendations 24
Public Health Action Plan 27
  Completed Activities 27
  Planned Activities 27
Site Team/Authors 28
Appendix A: Site Maps and Demographics A-1
Appendix B: ATSDR Methodology and Air Pathway Table B-1
Appendix C: Air Dispersion Modeling - Methods and Results C-1
Appendix D. Air Sampling Results D-1
Appendix E: Soil, Sediment, and Groundwater Data E-1
Appendix F: Cancer Information for Cumberland Heights Residents F-1
Appendix G: Response to Public Comments G-1

Summary

In October and November of 1998, residents in the Cumberland Heights community in Clarksville, Tennessee petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct a public health assessment of the community surrounding the Pasminco Clarksville Zinc (PCZ) plant located in the same area. Residents were concerned about adverse health effects and deaths that they believed were the result of long-term exposure to emissions from the PCZ Plant.

ATSDR reviewed all available environmental and health outcome data and concludes that the data do not suggest a serious threat to human health. Data reviewed for this and previous documents indicate that environmental media may contain chemical contamination, but below levels that have been associated with serious adverse health effects. Sensitive residents, or those with respiratory illnesses such as asthma or emphysema, should avoid prolonged outside activity on days with poor air quality.

On the basis of all available data, ATSDR has made the following observations:

- Air: Current ambient air contamination and particulate matter concentrations in the areas where air monitors are located are not a public health hazard. Serious health effects from soil or dust and air concentrations of particulate matter and other chemicals are not likely. However, on days of poor air quality, sulfur dioxide concentrations in the community air can lead to respiratory (cough, asthma flare-ups, shortness of breath) and irritant problems (eye irritation and nose irritation) in sensitive people such as those with asthma and other lung conditions. According to modeling information, current air monitoring locations are not in areas that could have the highest levels of pollutants in the air. Sulfuric acid has not been evaluated in this document because of a lack of information, but will be evaluated if data become available.

- Soil/sediment: Soil and dust data do not indicate exposure to high levels of contamination.

- Cancer: Cancer rates for Montgomery County are about average for the state, with the exception of colon and pancreatic cancers. However, cancer statistics for Montgomery County are not specific to the Cumberland Heights community, so whether rates are elevated in residents that may be impacted by PCZ and other local facility emissions is unknown.

This public health assessment addresses all public comments received during the public comment period, which ended on December 13, 2001. Public comments and ATSDR responses are listed in Appendix G. ATSDR will continue to lend support to Tennessee health agencies, as appropriate, to investigate remaining health and environmental concerns.

Introduction

In October and November 1998, six members of the Cumberland Heights community petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct a public health assessment on the impact of industrial emissions from the Pasminco Clarksville Zinc (PCZ) plant on area residents [ATSDR 2000a]. ATSDR collected and analyzed soil data and reviewed and evaluated available data from the U.S. Environmental Protection Agency (EPA). ATSDR evaluated community concerns and available air, soil, and anecdotal health data to determine the potential and extent of the exposure of residents to environmental contamination. Three documents regarding this site have been released addressing separate issues in the community. Two health consultations were released in August of 1998 and September 1999 addressing air issues. An initial public health assessment that explained the ATSDR health assessment process and described facility operations in detail was released in January of 2000. This document is a follow-up health assessment reviewing air data from monitoring stations located in the vicinity of the facility from as early as 1972 (before the facility was built), and surface soil data collected by ATSDR in late October of 2000. The purpose of this document is to identify potential human exposures from the newly collected data and to recommend appropriate public health follow-up activities. This public health assessment was first released in 2001 for public comments. This current version lists the public comments received and the corresponding ATSDR responses in Appendix G.

Background

The Pasminco Clarksville Zinc Plant (PCZ) is located at 1800 Zinc Plant Road in Clarksville, Montgomery County, Tennessee. It is a zinc ore processing plant which has been operating since 1978. Union Miniere of Brussels, Belgium, initially operated the facility as the Jersey Miniere Zinc company from 1978 to 1994. In 1994, Savage Resources of Sydney, Australia purchased the facility and named it Savage Zinc, Incorporated. It operated until January 1999, when Pasminco Limited of Melbourne, Australia, purchased the facility and renamed it the Pasminco Clarksville Zinc Plant (PCZ) (ATSDR 2000a).

Operations at the facility consist of producing purified zinc metal from concentrated zinc ore by an electrolytic process. Ores arrive by river barge and truck. A conveyor belt transports the ore from the river front to the plant for processing. The ore is composed of zinc and sulfide and contains trace amounts of cadmium, copper, cobalt, lead, and germanium (EPA, 1995). Sulfuric acid is produced during processing of the ore, and stored in specialized tanks prior to loadout and sale. Annual production of the purified zinc ore averages 110,000 tons. The plant produces approximately 450 tons per year of cadmium metal and 160,000 tons per year of sulfuric acid as coproducts (Halliburton NUS Corp.).

The basic plant process includes: 1) roasting the zinc sulfide concentrate to produce a zinc oxide, 2) dissolving zinc oxide in sulfuric acid to produce a zinc sulfate solution, 3) purifying the zinc sulfite solution to remove undesirable constituents, 4) electrowinning zinc metal from the purified solution, and 5) alloying and casting zinc metal into marketable size ingots. The site generates lead residue and miscellaneous tailings, reported as characteristically hazardous. The PCZ Plant is listed as a Resource Conservation and Recovery Act (RCRA) Small Quantity Generator. Although no organic chemicals are used in processing the ore, carbon tetrachloride and diisopropyl ether are used in the laboratory. These chemicals are disposed of off-site. Three spills, two of which were reported and investigated, occurred at the plant. In 1983, there was a direct spill of sulfuric acid into the river. In 1981, a release of sulfur dioxide escaped in the direction of the nearby Cumberland Heights Elementary School. Jersey Miniere placed an ambient air monitor at the school to provide warning in the event of another air release. In 1993, a zinc-contaminated discharge occurred that violated the site's National Pollutant Discharge Elimination System (NPDES) permitted daily limit of 15 pounds for zinc. The facility reportedly took extra steps to limit the effluent discharged to the Cumberland River (ATSDR 2000a). No other parameters of the NPDES permit were exceeded, and no exceedances in the permit have occurred since 1993.

Current Land Use

The facility has a 1,500-acre "green belt" surrounding the 55-acre production area and maintains the property as farm operations and natural resource management (e.g., wetlands, tree farm) with selected recreation activities. The Cumberland River borders the site to the west, farmland to the north and south, and residential communities to the east.

Demographics

The Cumberland Heights community is southwest of the city of Clarksville, Tennessee, separated from Clarksville by the Cumberland River. Only one bridge connects Cumberland Heights with Clarksville. In fact, the Cumberland River loops around the Cumberland Heights community, surrounding it on three sides. Cumberland Heights began developing more than 50 years ago on land used previously for farming. The majority (62%) of homes were built more than 20 years ago; 42% were built 30 or more years ago. Many people have lived and owned land there all their lives. More people (73%) own homes in Cumberland Heights than the national average. The population of Cumberland Heights is approximately 3,000, predominately white, married couples that follow the national average of age ranges. Little or no retail or manufacturing industry has ever existed in this community, except for the PCZ plant. In 1978, the zinc plant employed 490 people, but today it employs 240 (ATSDR 2000a).

Community Concerns

Health

Residents expressed their concerns to ATSDR about potential environmental contamination and human exposure from site emissions. The public health assessment released in 2000 for this community addressed issues such as eye irritation, dry skin, immune system dysfunction, scleroderma, and allergies. This document will focus on lung fungal infections, breathing difficulties, and cancer. Air monitors have been installed in Clarksville for almost 30 years monitoring particulate concentrations and occasionally metals. After a sulfur dioxide release in 1981 that resulted in the evacuation of an area elementary school, PCZ installed a monitor at the school to warn students and faculty in the event of another release. A new elementary school was constructed about 3 miles away to accommodate increased enrollment and busing; the old elementary school is now used as offices for the local agricultural services.

Environment

Some residents also have environmental concerns. Residents report often smelling a foul odor outside that smells like "rotten eggs." Residents have also noticed a yellow or white film on cars and windows, and clouds of different colored smoke rising from the facility. Residents have noticed dying vegetation, acidic soils, prematurely decaying paint on cars and outside structures, and deformed and dead wildlife. The river has also caused residents concern because it smells bad and is perceived to be very unclean. Residents have asked if any regulatory activities are possible to improve air quality in the area.

Discussion

Methods

In preparing evaluations of environmental data, ATSDR uses established methodologies for determining how people may be exposed to potential contamination from surrounding industry, and what effects, if any, may result from exposure to those contaminants. The ways that people may come into contact with chemical contaminants, called “exposure pathways”, are also evaluated. The exposure pathways that ATSDR evaluates include ingestion (eating), inhalation (breathing), and skin contact.

If one or more of the exposure pathways is established, ATSDR then considers whether chemicals have been or still are present at levels that may be harmful to people. ATSDR first does this by screening the concentration of contaminants detected in air, water, or soil against their health-based comparison values (CVs). Comparison values are often based on animal studies because relevant human data are lacking. CVs are therefore derived using very conservative assumptions and often have large uncertainty factors built into them to be protective of human health. Some CVs may be hundreds or thousands of times lower than exposure levels shown to produce effects in laboratory animals or humans. Thus, ATSDR’s CVs are designed to be orders of magnitude lower than levels known to produce adverse health effects. Although chemicals detected at or below CVs are considered safe, any concentration that exceeds a CV would not necessarily be expected to produce adverse health effects. Chemicals detected above CVs require a more detailed evaluation of site-specific exposure conditions. ATSDR emphasizes that regardless of the contamination level, *a public health hazard exists only if people come in contact with, or are otherwise exposed to, harmful levels of contaminated air, soil, or water.*

If ATSDR has not established a CV for a chemical, then one developed by a different agency is used. If no CV of any kind is available for a chemical, then that chemical is further evaluated. For all site-related contaminants that are detected at levels above CVs, ATSDR reviews relevant scientific literature to determine if site-specific exposures could pose a hazard to public health.

For a complete discussion of these criteria (quality assurance considerations, human exposure pathway analyses, ATSDR’s health comparison values, and the methods of selecting contaminants above comparison values), refer to Appendix B.

Extent of Contamination

This health assessment reviewed air monitoring data, ambient air modeling, soil data, and community health concerns. These data were collected from the EPA Aerometric Information Retrieval System (AIRS), ATSDR soil sampling, Tennessee Department of Environment and Conservation (TDEC), the United States Geologic Survey (USGS), and an EPA Site Inspection Prioritization Report.

The EPA AIRS data for particulate matter and criteria air pollutants have been measured from 1972 to present in Montgomery and Stewart Counties. However, only a few of these monitors are close to the facility, and none have consistent data every year since 1972 (EPA 2000). ATSDR collected 11 surface soil samples in 2000 from area residences (ATSDR 2000b). The TDEC collected 19 surface soil samples in 1977, fourteen months before the PCZ plant opened for operation (Tennessee Department of Environment and Conservation 1977). The USGS collected more than 1,300 surface soil samples from the contiguous United States in the 1960s through the 1970s. Several of the samples were located in counties near Clarksville (Boerngen and Shacklette, 1981). The EPA site inspection report contains samples of surface soils, sediments, and groundwater located on site property collected in December 1994 and June 1999.

Potential Exposure Pathways

ATSDR has identified ways in which area residents may potentially come in contact with site-related contamination:

1. Previous or current inhalation of chemicals in ambient air

2. Skin contact with, inhalation and ingestion of chemicals in surface soils

3. Skin contact with and ingestion of chemicals in sediment

ATSDR evaluated human exposure to determine whether nearby residents are exposed to chemicals migrating from the site. An exposure pathway contains the following five elements: a source of contamination, transport through some kind of environmental medium (air, soil, or water), a point of exposure (a water well, or backyard soil), a route of exposure (breathing, eating, drinking), and an exposed population. In this assessment, ATSDR evaluated chemicals in the air, soil, and sediment that people living in the nearby residences may breathe or contact.

Air

Ambient air

ATSDR evaluated Total Suspended Particulate (TSP) data from 14 air monitors located in Montgomery and Stewart Counties. Two of these were in the vicinity of the Tennessee Valley Authority Cumberland Power Plant (TVA). Three monitoring locations were in the proximity of the community near PCZ. The monitors closest to the Cumberland Heights community are: the Meeks monitor, the JMZ Hill monitor, and the Cumberland Heights Elementary School monitor. Beside TSP data, sulfur dioxide data were also available for the Meeks property monitor and the Cumberland Heights Elementary monitor. Nitrogen dioxide and TSP data were available for the JMZ Hill site. A monitor near the county health center on Madison Street (1994) and one at the Meeks property (1995–1999) collected PM10 data. Metals were sampled in downtown Clarksville (business district) and near the county health center on Madison Street in 1976 (EPA 2000).

The TSP data revealed rare occurrences of particulate concentrations exceeding EPA regulatory levels for PM10 or the former TSP levels. These levels are discussed in the next section. ATSDR did not use the ambient air metals data collected in 1976. These data were unreliable, as they were collected for a single day in July (15th) and a single day in October (31st), and do not provide adequate information to make conclusions. However, most levels were at or below EPA limits and ATSDR air guidelines. ATSDR reviewed one-hour average concentrations of sulfur dioxide for the Cumberland Heights Elementary School and the Meeks property monitoring stations. ATSDR considered reviewing one-hour concentrations more protective of human health because they reveal more time specific trends, unlike 3- or 24-hour average concentrations. No National

Ambient Air Quality Standards (NAAQS), determined by EPA, exist for 1-hour concentrations for sulfur dioxide, so ATSDR compared the 1-hour concentrations to the 3-hour NAAQS (U.S. Environmental Protection Agency 1990). Only four samples were at or above the NAAQS levels, out of several hundred thousand sampling events. However, sulfur dioxide concentrations in air often exceeded ATSDR health based guidelines. Therefore sulfur dioxide has been selected for further investigation.

Particulates in Air

Air monitoring technology has the capability of monitoring air particles in a range of sizes, measured in micrometers. PM10 refers to particulates that are 10 micrometers in diameter or less, and PM2.5 refers to dust particulates that are 2.5 micrometers in diameter or less. Total suspended particulates (TSP) refer to particulate concentrations of all sizes. The total suspended particulate procedure captures measurable particulates as small as 0.1 micrometers. EPA has established regulatory limits of particulate concentrations that are safe to breathe in ambient air. EPA had specific regulations for TSP of 150 $\mu g/m^3$ (micrograms per cubic meter) for 24-hour averages and 75 $\mu g/m^3$ for annual averages, but decided that more specific limits for the size of the particle were necessary. These enforceable limits are given for both average 24-hour concentrations and for average annual concentrations. In addition, samples were collected for particulate matter equal to and less than 10 micrometers in diameter (PM10). The particulate sampling technique for collected PM10 is also published in the Federal Register (40 CFR50). EPA has established acceptable 24-hour average concentration averages for PM10 of 150 $\mu g/m^3$ and 50 $\mu g/m^3$ for PM10 annual averages.

TSP was sampled by 14 different monitors between the years 1972 and present. Samples were not collected every year from every monitor. That is, some monitors may have collected samples for two years, such as 1975 and 1976, and never sampled again. Others sampled for longer durations, and some for less than one year (EPA 2000). These data are presented in Appendix D.

The data collected from the air monitors suggest that although TSP levels are generally acceptable, they exceed EPA limits from time to time. In other words, although the levels of suspended particulates in air may at times affect sensitive residents, they are unlikely to pose a serious health threat to area residents. The effects of heavy TSP concentrations in air are most noticeable when air is humid and calm.

Surface Soil and Groundwater

Site analysis conducted by the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC)

On December 5, 1994, EPA’s Waste Management Division conducted a soil and sediment investigation at the PCZ facility (Halliburton NUS Corp.). These data were collected as part of the EPA Site Inspection Prioritization (SIP) Report for PCZ. The purpose of the SIP was to quantify health and environmental threats posed by the site, provide documentation for assessing site conditions, and offer a site-specific recommendation. The sampling efforts included the collection of three surface soil samples, three subsurface soil samples, and nine sediment samples, all from the PCZ property. Samples were collected from three impoundment areas, as well as from drainage ditches, the Cumberland River, and wetlands owned by the facility. By far, the highest concentrations of metals and organic materials on facility property were measured in facility impoundment areas. The metals exceeding background included cadmium, cobalt, copper, lead, manganese, mercury, nickel, and zinc. This is not unusual since PCZ uses the impoundment areas to store metallic valuables and recyclables from facility processes. The impoundment areas, which are permitted and designed to provide long term safe environmental storage, are used for metals recovery and wastewater neutralization. EPA noted elevations of cadmium, copper, manganese, mercury, and zinc in soils downgradient from the impoundment areas as well as sediment from wetland areas on site property. The wetland area drains into the Cumberland River. EPA noted that the river would likely dilute these levels a great deal. EPA determined that the facility did not warrant inclusion on the National Priorities List (NPL), since the severity of the contamination was not sufficient to justify a high level of regulatory attention. However, EPA did recommend further followup, and delegated follow-up activities to the TDEC.

TDEC Follow-up Activities

To address EPA concerns, the facility implemented additional groundwater, soil, and sediment sampling (EMPE 1999).

Groundwater

In 1999, the facility installed a monitoring well at a point considered to be *downgradient* (where water flows down) from Impoundments 1–3. The facility also collected samples flowing from two water springs downslope from Impoundment 4. None of the samples exceeded EPA guidelines for residential tap water. Because groundwater downgradient from the impoundment areas is not elevated and the impoundment areas are triple lined and with no outlet, impoundment areas are unlikely to affect local groundwater or pose a threat to area residents.

Soil

Four composite samples were collected from soils abutting the drainage ditch of Impoundment 4. Samples slightly exceeded EPA guidelines for arsenic in two samples. However, all other samples for all other metals did not exceed EPA risk based concentrations (RBCs) for industrial or residential soils. On the basis of these data, ATSDR concludes the following: because the ditch is in a fenced area and is not a residential property, and because the levels of arsenic detected are far below levels that have been associated with adverse health effects, the levels of metals in soil on-site are not a threat to human health.

Sediment

Seven sediment samples were taken from a drainage ditch west of the manufacturing facility and a “slough area” which drains into the Cumberland River. None of the sediment samples exceeded EPA industrial soil RBCs except arsenic. Arsenic levels were slightly exceeded in six of the samples, but at levels well below those associated with adverse health effects. On the basis of these data and the EPA data, sediment samples are not a threat to human health or to the Cumberland River.

Upon reviewing the data presented in the Site Inspection Prioritization Report and the follow-up TDEC report, ATSDR concludes that the levels present do not present a public health hazard onsite. The levels measured rarely exceed ATSDR and EPA health based guidelines, except in the impoundment areas. These impoundment areas have three liners and no outlet, so leaching into soils is unlikely. Also, these impoundment areas are fenced, and trespassing by community residents and children is unlikely. Please see Appendix E for detailed sampling data from these reports.

Table 1. EPA Sampling and Follow-up TDEC Sampling, 1995 and 1999

Comparison of 1995 EPA Data and 1999 TDEC data in parts per million (ppm)				
metal	**1995 range—soil**	**1999 range—soil**	**1995 range—sediment**	**1999 range—sediment**
aluminum	5,600–16,000	1,570–18,600	2,300–15,000	6,620–12,200
arsenic	3.5–9	1.75–7.42	3.3–100	3.94–5.91
barium	73–160	30.6–120	35–300	54.5–122
beryllium	ND–1.4	ND	not sampled	ND
cadmium	1.6–72	ND–32.2	ND–8,000	2.13–50.8
calcium	370–56,000	452–2,930	2,500–100,000	1,460–5,450
chromium	12–31	1.17–34	13–29	6.73–14.9
cobalt	3.8–22	ND	4–69	ND–5.12
copper	6.1–150	2.37–14	9.1–4,100	3.65–15.7
iron	11,000–26,000	2,660–18,200	13,000–88,000	9,020–16,600
lead	11–73	5.93–10.9	14–21,000	7.88–28.7
magnesium	640–4,200	227–1,170	290–6,400	587–1,210
manganese	110–2,000	161–735	440–6,900	340–1,280
mercury	0–0.57	ND–0.12	ND–13	ND–0.49
nickel	8.8–33	ND–11.9	4–65	6.54–15.7
potassium	450–1,700	ND–1,120	210–1,300	333–1,020
selenium	0–3.8	ND	ND–4.7	ND
sodium	0–110	ND–99.8	ND–250	ND–69.1
thallium	0–3	ND	ND–18	ND
vanadium	19–36	ND–34.4	10.5–29	12.5–19.4
zinc	25–3,400	166–1,750	72–240,000	112–1,170

ATSDR Exposure Investigation for Soil

In October 2000, ATSDR's Exposure Investigation Section collected 11 surface soil samples from residential yards. The soils were tested for heavy metals. The manganese level of a single sample (3,800 ppm) exceeded the ATSDR health based guidelines for children of 3,000 ppm. None of the other 26 metals exceeded child health based guidelines or adult health based guidelines [ATSDR 2000b]. These data are limited because only 11 samples were taken, and the samples were only tested for metals. No conclusions can be drawn about the entire Clarksville area from such a small sample size; however, the levels measured in residential yards do not pose a public health threat.

To put the contaminant concentrations of samples collected in the PCZ area in perspective, ATSDR attempted to locate background samples for comparison other than those collected during the EPA analysis. ATSDR located a data set of 19 samples from April 1977 at the planned location of the PCZ facility. The samples were taken 14 months before the PCZ facility was to begin operations. TDEC conducted the sampling to have comparison concentrations to determine future environmental impact of the facility on the surrounding property. Below is the comparison of metal concentrations in 1977, before the site was operating, and in 2000, when the plant had been operational for 23 years (Tennessee Department of Environment and Conservation 1977).

Table 2. Comparison of Soil Data—ATSDR Soil Collection (2000) and TDEC Soil Collection (1977)

Comparison of 1977 and 2000 Cumberland Heights soil concentrations[*] in parts per million (ppm)						
metal	**1977 range**	**2000 range**	**1977 average**	**2000 average**	**1977 maximum concentration**	**2000 maximum concentration**
aluminum	276.08–762.82	6,600–12,000	409.45	8,727.27	762.82	12,000
calcium	390–2,500	150–39,000	1,099.30	11,347.27	2,500.00	39,000.00
cadmium	0.00–0.41	0.00–4.10	0.13	1.53	0.41	4.10
copper	0.47–2.87	0.90–86.0	1.38	19.03	2.87	86.0
iron	22.24–149.92	7,300–17,000	64.24	11,390.90	149.92	17,000
lead	0.00–7.46	12.0–41.0	3.27	27.0	7.46	41.0
magnesium	56.04–456.40	430–3,800	121.96	1,174.55	456.4	3800
sodium	26.09–186.36	0.00–14,000	91.19	1,294.18	186.36	14,000[†]
zinc	3.61–56.79	34.0–960.0	16.39	236.18	56.79	960.0

[*]This analysis if for contaminants sampled for both 1977 and 2000; for complete results, see Appendix E.

[†]This sample was one of the three detects of all 11 samples collected. This sample was a dust sample from a resident's home. It contained a good deal of animal hair and may not represent actual concentrations from air. Sodium is salt and is found in the bodies and skin of animals and humans.

ATSDR used this data for screening purposes only. Using historical data has limitations. For example, the samples in 1977 and 2000 were not taken in the same locations, thus making direct comparison impossible. Also, many of the 1977 samples were taken in pasture or farm land. Certain metals commonly accumulate in soil with prolonged use of pesticides and herbicides. The 2000 ATSDR samples were taken within the Cumberland Heights community and all were taken in residential yards. While the 2000 data were analyzed according to the National Institute of Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM) method 7300, the method used to analyze the 1977 data is unknown. Instruments used to measure the levels of metals in soil have varying degrees of accuracy, and may or may nor reflect true concentrations in soil. The same instruments were not likely used to analyze the data in 1977 and 2000. The analysis methods are also certainly different. The data from 1977 were analyzed in a state lab, and the NMAM method 7300 was not created until 1990. Because of the potential for large amounts of variability between the two datasets, ATSDR cannot conclude with certainty what the data suggests.

USGS levels of metals in soil-comparison to ATSDR and TDEC samples

To further validate background or "normal" concentrations of metals in Cumberland Heights soils, ATSDR attempted to locate background samples for comparison other than those collected during aforementioned analyses. The United States Geologic Survey (USGS) conducted soil sampling of the conterminous United States from 1961 through 1975, resulting in 1,318 sampling sites across the United States. From 1962 through 1967, the USGS took samples in Tennessee and Kentucky. Nine of these were within 70 miles of Clarksville, and five of those were within 40 miles (Boerngen and Shacklette 1981). ATSDR analyzed these metals concentrations, specifically those metals which were found to be elevated in the EPA analysis, in an effort to determine whether or not those elevated levels would be expected to naturally occur in the geographic area of Montgomery County.

Table 3. Comparison of All Soil Sampling Data Collected for the PCZ Facility and Community Residents

Comparison of all soils samples on-site and in the Cumberland Heights neighborhood 1962–2000 (ppm)[*]							
Metal	**1962–1967 contaminant range (ppm)**	**1977 contaminant range (ppm)**	**1995&1999 contaminant range (ppm)**	**2000 contaminant range (ppm)**	**1962–1967 contaminant mean (ppm)**	**1977 contaminant mean (ppm)**	**2000 contaminant mean (ppm)**
aluminum	**B**[†]–30,000	276–763	1,570–18,600	6,600–12,000	3,889	409	8,727
arsenic	2.3–17	not sampled	1.8-9	ND	8.6	not sampled	0
cadmium	not sampled	0–0.4	ND–72	0–4.1	not sampled	0.13	1.5
calcium	not sampled	390–2,500	370–19,000	150–39,000	not sampled	1,099	11,347
chromium	30–1,000	mot sampled	1.2–34	11–53	170	not sampled	18.7
copper	5–100	0.5–2.9	6.1–150	0.9–86.0	24	1.4	19
iron	20,000–70,000	22–150	2,660–26,000	7,300–17,000	45,555	64.2	11,391
lead	10–30	0–7.5	5.9–73	12.0–41.0	16.4	3.3	27
magnesium	**B**–50,000	56–456	227–4,200	430–3,800	700–50,000	122	1,174.6
manganese	not sampled	not sampled	110–2,000	77–770	1,294	not sampled	714.5
nickel	5**L**[‡]–700	not sampled	2–33	6.1–38	89	not sampled	10.7
sodium	**B**–5,000	26–186	ND–110	0–14,000	889	92	1,294.2
vanadium	30–150	not sampled	17.2–36	14–29	135.5	not sampled	19
zinc	**B**–150	3.6–56.8	25–3,400	34–960	33.9	16.4	236.2

[*] ppm = parts of contaminant per million parts of soil.

[†] B = no data for that particular element in the given sample. Shown in the data set as .0000B.

[‡] L = element was detected by technique, but below the detection limit. Shown in the data set as 1.0000L.

ND=not detected

The levels measured in 1977 are lower than those measured in 1962–1967, 1994, 1999, or 2000. Still, even the highest levels detected rarely exceed health based guidelines for children and never for adults. Children would most likely be exposed by eating large amounts of contaminated soil. However, no samples exceeded EPA health guidelines for inhalation, ingestion, and dermal contact with soil. It should also be noted that the 1977 samples possibly were unusually low for this geographic area of the country. The USGS samples collected in the region in the 1960s were more similar to those taken in the 1990s and 2000 than those taken in 1977. ATSDR concludes that the levels of metals in soil do not currently pose a health risk to children or adult residents. ATSDR did not identify any contaminants of concern in soil.

Air Modeling

Although many sources of air pollution in Clarksville may affect the overall air quality for Cumberland Heights residents, the Tennessee Valley Authority (TVA) Cumberland Fossil Fuel Plant and the Pasminco Zinc Plant are the two most likely facilities to impact the air quality in the community. Both facilities emit sulfur dioxide (SO_2) and sulfuric acid, chemicals of concern because the community reported breathing difficulties, which could be caused by SO_2 or sulfuric acid. ATSDR evaluated the potential impact and relative contributions of SO_2 and sulfuric acid from these two facilities using air dispersion modeling. ATSDR reviewed the impact of sulfuric acid from Pasminco because the pattern is similar to SO_2.

Wind speed and direction are two important parameters for determining how SO_2 emissions disperse in the air and affect air quality in the Clarksville community; therefore, wind speed and direction were two important inputs in the air modeling. At least three surface meteorologic stations that record wind speed and direction are within 20 miles of Pasminco. The names of these stations are based on their location: (1) the Clarksville Outlaw Airport (about 7.3 miles north/northwest of Pasminco and Clarksville, Tennessee); (2) Cumberland Power Plant, Cumberland City, Tennessee (about 16 miles from southwest of Pasminco and Clarksville); and (3) Fort Campbell, Kentucky (about 11.2 miles north/northwest of Pasminco and Clarksville). ATSDR very recently found three more sources of meteorologic data, but have not yet analyzed the data. The sources include Pasminco, EPA, and the American Weather Service. Pasminco may be collecting meteorologic data on-site, but the data, if they exist, were not available to ATSDR. EPA has a database on air monitors around the country. According to the EPA Aerometric Information System (AIRS) database, wind speed and direction were recorded at the Meeks particulate monitor from 1978 through 1983, but the existence of the data has not been confirmed and is not readily available. The American Weather Service is collecting data from a meteorologic station at the Clarksville City Hall[1].

A summary of the wind speed and direction from the three meteorologic stations with available data is presented as wind roses in Figure 1 in Appendix C. Data were not available for the same time periods from each of these stations, so comparisons between these figures need to be interpreted carefully. In general, multiple years of data collected at the Cumberland Power Plant and Fort Campbell generally represent average conditions for any 1 year, while the 1 year of data at Clarksville may not. From these data, wind patterns appear to be slightly different at each location. The Clarksville Outlaw Airport wind directions more closely resemble those at the Cumberland Power plant with a slightly lower wind speed. The Fort Campbell wind direction is the most dissimilar of the three with greater north and south directions. The predominant wind directions at the Clarksville Outlaw Airport and the Cumberland Power Plant are from the south/southwest to southwest.

For the modeling, ATSDR used the meteorologic data provided by Pasminco, which includes the surface meterologic data from the Fort Campbell station. The Fort Campbell dataset has been used by Pasminco and approved by Tennessee. However, the representativeness of the Fort Campbell data for the Clarksville area is uncertain, as indicated by the Clarksville Outlaw Airport data, the complex terrain next to Pasminco (river valley), and the distance from Pasminco to Fort Campbell. ATSDR tried to evaluate the effect of different meteorology by comparing model results using the Cumberland facility meteorologic data and the Fort Campbell data. ATSDR found that for the Pasminco emissions, the general pattern of predicted air concentrations are about the same regardless of the meteorologic data. The Fort Campbell meteorologic data, however, produce a concentration that is on average 3% greater than when the TVA Cumberland data is used. If Pasminco is not operating a meteorologic monitor for wind speed and direction, ATSDR recommends that one be installed to track where air emissions go.

1 See the website: http://www.wunderground.com/cgi-bin/findweather/getForecast?query=clarksville%2C+tn

ATSDR used the EPA Industrial Source Complex model (Version 3, short term). Modeling of emissions from the TVA facility used meteorologic data from the TVA Cumberland facility (Tennessee Valley Authority 2001) and modeling of emissions from Pasminco used meteorologic data from Fort Campbell. ATSDR modeled with and without downwash and found no difference in the model results. Further details of the modeling are presented in Appendix C.

Sulfur Dioxide

At Pasminco, sulfur dioxide enters the atmosphere from five emission points: the roaster preheater, auxiliary boiler, primary acid plant preheater, secondary plant preheater, and tail gas stack. The roaster preheater, auxiliary boiler, primary acid plant preheater, and secondary plant preheater emit sulfur dioxide during plant restarts. The primary acid plant preheater is used as a backup to the secondary plant preheater and not used regularly. When these units are operating during startup, emissions of SO_2 from the tail gas stack are not occurring. After the plant restarts, SO_2 emissions cease from these, and begin from the tail gas stack. Therefore, ATSDR modeled the roaster preheater, auxiliary boiler, primary acid plant preheater, and secondary plant preheater separately from the tail gas stack emissions. For comparisons with the TVA facility and general impact on the community, ATSDR used the tail gas stack emissions because the other units operated intermittently. Pasminco was not able to provide to ATSDR the number of actual hours that emissions from these sources occurred in 2000 (the year used for this comparison), but the Title V air permit has hour limits on these units as shown below (8,760 hours equals one year):

Source	Permitted Annual Hours of Operation
Tail Gas Stack	8,760
Auxiliary Boiler	720
Roaster Preheater	480
Acid Plant Preheater	1,440
Secondary Acid Plant Preheater	1,000

Figures 2 and 3 in Appendix C present the results of modeling actual year 2000 emissions of SO_2 from TVA and the tail gas stack at Pasminco. Figure 2 shows the results for 1-hour maximum concentrations and Figure 3 shows the results for average annual concentrations. Each figure contains three separate maps. One map shows the SO_2 concentrations from TVA alone (upper left), the second maps shows SO_2 concentrations from Pasminco (upper right), and the third map (bottom center) overlays the first two maps with SO_2 concentrations from TVA concentrations in color and SO_2 concentrations from Pasminco represented by isolines.

Depending on the location, the contribution of SO_2 concentrations to the air quality from the two facilities varies. Sulfur dioxide air concentrations north and south of Pasminco are predominately from Pasminco emissions. Although TVA emits more sulfur dioxide than Pasminco Zinc, TVA's stack height is more than three times higher than Pasminco's. The taller tail gas stack produces greater dispersion and dilution of chemicals. Two miles west of Pasminco, TVA contributes relatively more SO_2 to the air than Pasminco. Other facilities in the Clarksville area that emit sulfur dioxide are east and northeast from the Cumberland Heights community and are 5 to 15 miles away.

During the process of air modeling the emissions from Pasminco's tail gas stack, two maximum impact areas from sulfur dioxide emissions from Pasminco were identified (see Figures 2 and 3 in Appendix C). These impact areas are about two miles north and two miles south of Pasminco. Part of the community of Cumberland Heights is located in the southern area two miles south of the facility. Subdivisions are also located in the northern area. ATSDR believes that the terrain of the area, along with the wind direction, greatly impacts the location of the peak modeled areas. The ISC model has a high degree of uncertainty in hilly (complex) terrain such as Cumberland Heights; therefore, the results of the modeling must be used with caution. However, ATSDR feels that the air model is qualitatively correct in predicting the locations of the maximum impact areas.

ATSDR modeled the emissions from the roaster preheater, auxiliary boiler, primary acid plant preheater, and secondary plant preheater without the emissions from the tail gas stack. The modeled ambient air concentrations showed a different pattern of dispersion than those from the tail gas stack. The pattern becomes a north to south elongated oval mainly on-site, instead of the two peak off-site areas with the tail gas stack. This was expected since the release heights from these units are more than one-half lower than the tail gas stack.

In general, the modeled results show that EPA and Tennessee ambient air quality standards are met whether using actual year 2000 emissions or Title V Air Permit limits from the tail gas stack alone, or from the boilers and preheaters alone. However, when the SO_2 emission's permit limits from the tail gas stack are exceeded, the ambient air quality standards could also be exceeded. Pasminco monitors compliance of SO_2 from the tail gas stack using a continuous emissions monitor (CEM) with a limit of 650 parts per million. For 1999 through 2001, the permit limit was exceeded in June 1999 and once in July 1999. These readings represent 2-hour averages. The July 1999 event occurred during a restart of the facility.

During these times, the Meeks and the Cumberland Heights Elementary School SO_2 ambient air monitors did not report an increase in SO_2 levels. According to EPA reports, these monitors were operational at the time and were recording hourly values. The meteorologic conditions that existed at the time (wind speed, direction, vertical rise, and atmospheric turbulence) likely did not allow the monitors to capture the excess emissions. Because the wind blows in all directions, the monitors, if located in any other place, likely would not have observed the increase in SO_2 levels. The Meeks and Cumberland monitors are more suitable for monitoring the ambient air on a longer time scale, such as monthly, compared to the 2-hour time period of the increase reported in July 1999. These monitors are also more suitable for monitoring emissions from process operations that have low stacks such as the preheaters because the maximum emissions from the tail gas stack can overshoot the monitors.

The occurrence of health effects from Pasminco's emissions would be dependent on the ambient air concentration where people were located, the activity of the people, whether people were inside or outside, and the exchange rate of the air in the home with outside air. Exposure to the maximum ambient air concentration from the July 1999 emission maximum could have caused acute (short term), nonserious health effects, including breathing difficulties and eye irritation, for a person at certain locations in the surrounding community. The public health implications section provides move information on the health effects of sulfur dioxide exposure.

Public Health Implications

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. The EPA Office of Air Quality Planning and Standards (OAQPS) has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m3), and micrograms per cubic meter of air (µg/m3) (U.S. Environmental Protection Agency 1990).

ATSDR has evaluated sulfur dioxide, nitrogen oxide, and particulate data as contaminants of concern in this community. EPA standards exist for these three "contaminants of concern": sulfur dioxide, nitrogen oxide, and particulate matter. The standards are listed in the next table.

National Ambient Air Quality Standards— Contaminants of Concern

Contaminant	3-hour average	24-hour average	Annual average
Sulfur Dioxide (SO_2)	0.50 ppm	0.14 ppm	0.03 ppm
Nitrogen Dioxide (NO_x)	no 3-hour standard	no 24-hour standard	0.053 ppm
Particulate Matter (PM10)	no 3-hour standard	150 µg/m3	50 µg/m3

Source: EPA, Office of Air Quality

Contaminants of Concern

Sulfur Dioxide

Chemical properties

Sulfur dioxide (SO_2) is a colorless gas with a strong odor or a sulfur smell that is irritating to the eyes and nose (ATSDR 1998). Residents report smelling a "sulfur" smell fairly often in Cumberland Heights. SO_2 is a liquid when under pressure, and it dissolves in water very easily. Humans can smell sulfur dioxide at approximately 0.45 ppm, the odor threshold. Sulfur dioxide is formed during the burning of fuel containing sulfur (mainly coal and oil) and during metal smelting and other industrial processes. The highest concentrations of SO_2 are recorded in the vicinity of large industrial facilities. Fuel combustion, largely from coal-fired power plants, accounts for most of the total SO_2 emissions.

From 1988 to 1997, national SO_2 concentrations decreased 39 percent and SO_2 emissions decreased 12 percent. From 1996 to 1997, national SO_2 concentrations decreased 4 percent and SO_2 emissions increased 3 percent. Sulfur dioxide emissions from electric utilities decreased 12 percent from 1994 to 1997. These recent reductions are due, in large part, to controls implemented under EPA's Acid Rain Program. The 3 percent increase that occurred between 1996 and 1997 is primarily due to increased demand for electricity (EPA 1998).

Cumberland Heights and Sulfur Dioxide Exposure

The Meeks Property monitor and the Cumberland Heights Elementary monitor have been measuring SO_2 in ambient air for more than 20 years. ATSDR reviewed historical data to evaluate sulfur dioxide exposure in Cumberland Heights. *Sulfur dioxide measured at these two locations did not exceed EPA standards for 3-hour, 24-hour, or annual average concentrations for this 20-year period.* However, ambient air modeling for sulfur dioxide (see appendix C) shows that the Meeks monitor and the Cumberland Heights Elementary monitor may not be in the area where sulfur dioxide concentrations are the highest. Therefore, ATSDR is evaluating the data from these monitors on the basis that they reflect the population living close to the monitor, but it may not be representative for the entire Cumberland Heights community.

As mentioned previously, ATSDR examined 1-hour concentration averages to evaluate the potential that residents may be periodically and sporadically exposed to elevated levels of contamination. Scientific studies of humans exposed to sulfur dioxide find that levels as low as 0.1 ppm (parts per million) can cause physical changes in people breathing sulfur dioxide. This number is called the LOAEL, or lowest-observed-adverse-effect level. The LOAEL is the lowest concentration of sulfur dioxide that has been associated with adverse health effects. Also, a NOAEL, or no-observed-adverse-effect level, is a level of exposure to a contaminant that has not been associated with adverse health effects. The lowest LOAEL that has resulted in human health effects from sulfur dioxide exposure was in young adult asthmatics that were exposed to between 0.1 and 0.25 ppm of sulfur dioxide through a mouthpiece for 10 minutes. The people exposed experienced airway resistance or “bronchoconstriction,” which made it more difficult to breathe. Decreased lung function in asthmatics exposed by inhalation to 0.25 ppm sulfur dioxide has been reported by other investigators. In some studies, about one fourth of asthmatics exposed to between 0.25 and 0.5 ppm of sulfur dioxide experienced airway resistance 100% greater than the response to clean air when they were exposed for 5 minutes (Horstman, et al. 1986, Bethel et al. 1985, Myers et al. 1986a,b). Researchers concluded that about 25% of mild asthmatics who were sensitive to sulfur dioxide could exhibit bronchoconstriction if they were to perform exercise routinely in some highly industrialized areas of the Uniteds States (ATSDR 1998). Some studies have found that cold air may aggravate an asthmatic response to exposure to sulfur dioxide (Shappard et al. 1984, Bethel et al. 1984, Koenig et al. 1985, Balmes et al. 1987, Horstman et al. 1986, 1988, Linnet et al. 1984 a,b,c, Roger et al. 1985).Other studies found no association between sulfur dioxide exposure at low levels and asthmatic responses (Jorres and Magnussen 1990, Koenig et al. 1990). Asthmatic reactions to sulfur dioxide exposure at low levels seems to be varied and differs from person to person.

Studies of children have found an association between sulfur dioxide exposure of varying concentrations and respiratory effects. Dodge et. al. (1985) noted a significant correlation between coughing and annual levels of sulfur dioxide measured as low as 0.005–0.04 ppm. Other studies have reported that the forced expiratory volume (amount of breath a person breathes out after inhaling) of children was affected at levels ranging from 0.024 and 0.17 ppm (Dockery et al. 1982, Shy et al. 1973).

In general, scientific studies have demonstrated that difficult breathing, airway resistance, bronchoconstriction, cough, iritation, and wheezing has been observed in asthmatic individuals from exposure to sulfur dioxide levels as low as 0.1 ppm. The lowest LOAEL for nonasthmatic individuals is 0.6–0.8 ppm, which infers that even nonasthmatic individuals can experience discomfort from exposure to low levels of sulfur dioxide (ATSDR 1998).

The levels of sulfur dioxide measured at the two monitors ranged from 0–0.5 ppm for a 1-hour average. Levels were often high enough to result in health effects like those in the studies mentioned above. It is very important to note two things when considering this data. The first is that the data reviewed were for 1-hour *averages*. That means that for some of the hours where 0.5 ppm was the average concentration, at different times during that hour sulfur dioxide concentrations were both higher and lower than 0.5 ppm. The second, and most important point, which cannot be addressed by current scientific knowledge, is that of chronic human exposure. The subjects in the studies mentioned above were people exposed to sulfur dioxide concentrations for less than 1 hour, many for less than 20 minutes. No additional studies document human health effects for chronic exposure to sulfur dioxide in a residential setting. The residents in Clarksville are chronically exposed to low levels of sulfur dioxide for hours every day.

Source issues

In this community, residents are exposed to sulfur dioxide primarily through emissions from the Tennessee Valley Authority (TVA) Cumberland Fossil Fuel Plant and the Pasminco Zinc Facility (PCZ). In 1996 and 1999, TVA released 100% of the sulfur dioxide emitted in Stewart County, and PCZ released more than 55% of the sulfur dioxide emitted in Montgomery County. It is well documented that TVA is a major emitter of contaminants that contribute to acid rain, such as nitrogen oxide, PM10, SO_2, and volatile organic compounds. In 1996, TVA emitted more than 51,000,000 pounds of sulfur dioxide (U.S. Environmental Protection Agency 1996a). Although it releases much less SO_2 than TVA, PCZ emitted 3,563,840 pounds of SO_2 in 1996 (U.S. Environmental Protection Agency 1996b). Both of these facilities have pollution controls in place that greatly reduce sulfur dioxide emissions. Please see the air modeling maps in Appendix C for the contributions of SO_2 from both facilities. For Cumberland Heights residents, Pasminco Zinc is the main contributor of sulfur dioxide in air.

PCZ is not the only facility in Montgomery County that emits SO_2. Union Carbide, Fort Campbell, and the Vulcan Corporation also release SO_2. From 1996 through 1998, these facilities released SO_2 at an average of 1,566,880; 674,240; and 465,920 pounds per year, respectively (U.S. Environmental Protection Agency 1999a,b). However, ATSDR did not consider these facilities to be as important in contributing sulfur dioxide emissions to the Cumberland Heights community because the facilities are located 5 to 15 miles away.

Nitrogen Dioxide

Chemical Properties

Nitrogen dioxide (NO_2) belongs to a family of highly reactive gases called nitrogen oxides (NOx). These gases form when fuel is burned at high temperatures, and come principally from motor vehicle exhaust and stationary fuel combustion sources such as electric utilities and industrial boilers. Nitrogen dioxide is a suffocating, brownish gas and strong oxidizing agent that reacts in the air to form corrosive nitric acid, as well as toxic organic nitrates. NO_2 also plays a major role in the atmospheric reactions that produce ground level ozone (or smog) (U.S. Environmental Protection Agency 1998a, b).

Health Implications

Like sulfur dioxide, short term exposure (<3 hours) to low levels of NO_2 may lead to changes in airway responsiveness and lung function in people with pre-existing respiratory illnesses and increases in respiratory illnesses in children (5–12 years old). Long term exposure to NO_2 may lead to increased susceptibility to respiratory infection and may cause permanent alterations in the lung. Nitrogen oxides react in the air to form ground-level ozone and fine particle pollution which are both associated with adverse health effects (U.S. Environmental Protection Agency 1998a).

Cumberland Heights and nitrogen dioxide exposure

Nitrogen dioxide concentrations at the JMZ Hill monitor did not exceed NAAQS annual average standards. Also, the highest level of nitrogen dioxide recorded at the JMZ Hill monitor was 38 times lower than the lowest level that has caused health effects in asthmatic individuals (Hazardous Substance Data Bank, 2001). ATSDR does not expect any health effects to occur in residents as a result of exposure to nitrogen dioxide.

Source issues

In this community, residents are exposed to NO_2 primarily through emissions from TVA. PCZ emits a small portion of overall NO_2 emissions in this area. In 1996 and 1999, TVA released 100% of the NO_2 emitted in Stewart County, and PCZ released approximately 9.5% of the NO_2 emitted in Montgomery County. In 1999, TVA emitted more than 311,357,760 pounds of NO_2 (U.S. Environmental Protection Agency 1999a). PCZ emitted 52,240 pounds of NO_2 in 1999. Both of these facilities have pollution controls in place that reduce actual NO_2 emissions (U.S. Environmental Protection Agency 1999b).

PCZ is not the major emitter of NO_2 in Montgomery County. Union Carbide was the major emitter of NO_2 in Montgomery County in 1996 and 1999. In 1999, Union Carbide emitted 203,840, Vulcan emitted 153,320, and Quebecor emitted 112,000 pounds of NO_2. Together, these three facilities along with PCZ emitted 88.8% of all NO_2 in Montgomery County (U.S. Environmental Protection Agency 1996a,b; U.S.Environmental Protection Agency 1999a,b).

Particulate matter

Very sensitive residents may experience asthma attacks, difficult breathing, and aggravated emphysema because of exposure to industrial air on days with poor air quality. Residents without pre-existing health conditions should not be affected by the levels of particulate dusts measured by the air monitors.

Chemical properties

Particulate matter are fine dust molecules that originate from a variety of sources, including diesel trucks, power plants, wood stoves, and industrial processes. The chemical and physical composition of these particles varies widely. While individual particles in air cannot be seen with the naked eye, collectively they can appear as black soot, dust clouds, or grey hazes. Dust that is seen on cars or on the ground is evidence of particulates in air that have settled out. Those particles that are less than 2.5 micrometers in diameter are known as "fine" particles; those larger than 2.5 micrometers are known as "coarse" particles (U.S. Environmental Protection Agency 1998b). Total suspended particulates (TSP) refers to particles of all sizes.

Fine particles result from fuel combustion (from motor vehicles, power generation, industrial facilities), and residential fireplaces and wood stoves. Fine particles are also formed in the atmosphere from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. Coarse particles are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, crushing and grinding operations, and windblown dust (U.S. Environmental Protection Agency 1998b).

Health implications

Particulate matter is the term used for a mixture of solid particles and liquid droplets found in the air. Fine particles are of health concern because they easily reach the deepest recesses of the lungs. Numerous scientific studies have linked particulate matter, especially fine particles (alone or in combination with other air pollutants), with a series of significant health problems.

The TSP levels detected from the air monitors, while generally not exceeding annual average EPA limits, did exceed 24-hour average standards during sampling days multiple times each year. While ATSDR does not expect TSP concentrations to cause serious health effects for residents, the levels reported could cause respiratory aggravation and exacerbate asthma for sensitive residents. For example, residents with asthma, emphysema, or decreased lung function could potentially experience discomfort on days when the particulate concentrations outside are significantly higher than the health-based limit. However, although this sometimes happens, this scenario is not generally the case in Clarksville.

On the basis of the evaluation of the available site-specific data, ATSDR concludes that the particulate concentrations measured are unlikely to represent significant health risks. See Table D-2 in Appendix D for a summary of the TSP data that ATSDR used in this evaluation.

Mold/Fungi

Some residents have complained of fungal infections. Most fungi are found naturally in soil. Increased humidity tends to increase fungal growth. Molds can also be found frequently in homes or other indoor environments. Common sources of mold in the home occur in damp areas around garbage cans, food storage areas, wallpaper, near shower curtains, and near window moldings. Aspergilli, a type of fungus, were found in one residence in Clarksville. Aspergilli can be found in soil, compost, swimming pools, saunas, basements, humidifiers, crawl spaces, bedding, house dust, or areas of water damage in homes.

Infection from Aspergilli cannot be transmitted from person to person. People with diabetes, certain chronic lung problems, weak immune systems (for example, cancer and HIV) are known to be at increased risk of infection. Some types of surgeries can also increase the risk of infection. Aspergilli can be a common complication in individuals who have had previous tuberculosis infections. Aspergilli infections are not known to be associated with chemical exposures.

Acid Rain

Residents expressed concern to ATSDR about stressed vegetation and the acidity of the soil in Cumberland Heights. Sulfur dioxide and nitrogen oxides (NO_x) are the primary causes of acid rain. In the United States, about two thirds of all SO_2 and one fourth of NO_x comes from electric power generation that relies on burning fossil fuel, like coal. "Acid rain" occurs when these gases react with water, oxygen, and other chemicals to form various acidic compounds. Sunlight increases the rate of most of these reactions. The result is a mild solution of sulfuric acid and nitric acid. "Acid rain" is a term that describes how acids may fall from the atmosphere to the ground. Acid rain is also called "acid deposition." Acid deposition can either be "wet" (acid rain, fog, or snow) or "dry" (acid gases and particles) (U.S. Environmental Protection Agency 2001).

Acid rain could affect the Cumberland Heights community. TVA, PCZ, and the other facilities mentioned in previous sections contribute SO_2 and NO_X emissions that can lead to acid deposition. Acid deposition could lead to the types of environmental concerns that residents in Cumberland Heights have. Acid deposition can cause the following (U.S. Environmental Protection Agency 2001):

- Acidification of lakes and streams, which can lead to a number of effects like fish kills, reductions in the fish population, smaller fish, and the elimination of a fish species from a waterbody.
- Damage to forests, which can cause stunted forest growth, injury, or death of otherwise healthy trees. Acid rain may also make it easier for natural causes, such as insects, disease, drought, or severe weather, to harm trees and plants. Acid rain does not usually kill trees directly. It is more likely to weaken trees by damaging leaves, thereby limiting nutrient intake, or exposing them to toxins in the soil.
- Acceleration of the decay of building materials and paint.
- Decreased visibility; sulfates and nitrates that form in the atmosphere from SO_2 and NO_X emissions contribute to "visibility impairment," or a hazy effect in the air. Sulfate particles alone account for 50%–70% of the visibility impairment in the eastern part of the United States.

Acid rain can damage plants the same way it damages trees. Although damaged by other air pollutants, such as ground level ozone, food crops are not usually seriously affected because farmers frequently add fertilizers to the soil to replace nutrients that have washed away. Limestone is an alkaline material, and increases the ability of the soil to act as a buffer against acidity. As limestone often protects farm crops, it would also provide protection for trees and shrubs in residential areas. Acid rain also seems to affect fresh paint more so than older paint of cars and surfaces.

Health Outcome Data

Cancer Mortality Review- Montgomery County

Residents in Cumberland Heights asked ATSDR to obtain and review cancer data for Montgomery County. The Tennessee Department of Health (TDOH) provided ATSDR with cancer incidence rates and case numbers between 1992 and 1996 for Tennessee and also for Montgomery County. County cancer data are often compared to state data because the populations are likely to be more similar.

Almost all diseases or health outcomes occur at different rates in different age groups. Most chronic diseases, including most cancers, occur more often among older people while other outcomes, such as many types of injuries, occur more often among younger people. Therefore, the age distribution within the community will influence the most common health problems in a community.

One means of comparing the pattern of health outcomes in communities of different sizes is to calculate an incidence or mortality rate, which is the number of new cases or deaths divided by the size of the population. In chronic diseases and injuries, rates are usually expressed in terms of the number of new cases or deaths per 100,000 people per year. Adjusting rates for age allows for direct comparison between populations with potentially different age distributions. The cancer rates discussed below are age-adjusted cancer rates.

To explore whether cancer incidence rates in Montgomery County were higher than those in Tennessee, ATSDR used data provided by the state (Tennessee Department of Health 2001) to compare the rates. Residents have observed many new cancer cases in friends and family and were concerned that people in Montgomery County had higher rates of cancer incidence than in other places. For this investigation, the incidence rate for each kind of cancer was calculated by using the following formula:

$$\frac{\text{Number of new cancer cases for Montgomery County or the state of Tennessee}}{\text{Number of residents in Montgomery County or the state of Tennessee}} \times 100{,}000$$

Montgomery County has a medium-sized population of approximately 135,000. Some of its cancer incidence rates were based on a small number of cases, especially for rarer cancers. Incidence rates based on so few cases are unstable or highly variable. That is, an extra cancer case in Montgomery County can have a large effect on the cancer incidence rate, whereas an extra case would not have such an effect in Tennessee or the United States, which have much larger populations. Although some cancers may seem to be elevated in a population, another test is necessary to determine whether or not the difference between the two numbers is *statistically significant*-i.e., that the numbers are different not by chance, but by some other factor.

The test for significance commonly used in statistics is called a test of confidence. This test is to determine whether the observed number of cases is truly elevated or elevated because of other factors such as a small population size, years observed, inaccurate data, and lifestyle or other risk factors that may influence the results. Although the level of confidence is determined by the investigator, a 95% confidence level is generally accepted as the most common confidence test. This means that the likelihood that the rates are different by chance alone (and that the mortality ratio is greater than 1 by chance alone) is 5% or less. If the calculated confidence interval includes 1, then the mortality ratio is not considered to be statistically significant; the increase in the number of cancer cases observed in the population may possibly be due to some other factor.
The table below suggests no appreciable differences between the Montgomery County area and Tennessee for the incidence rates of all cancer sites between the years of 1992 and 1996. However, the table also shows that the rates appeared higher in the Montgomery County than Tennessee for stomach, colon, liver, pancreatic, bone, melanoma, cervical, testicular, bladder, and non-Hodgkin's lymphatic cancers. But, upon further investigation, only colon and pancreatic cancer proved to have statistically significant elevations of incidence above those of Tennessee. Specific information about these cancers is located in Appendix F. The data provided by TDOH is in the table on the following page.

With the data available to ATSDR, determining whether the people diagnosed with cancer in the Cumberland Heights Community work or live near TVA or PCZ was not possible. This information was not available from the cancer death database. Often, these kinds of statistics are not available at a community level to protect the privacy of residents.

In summary, more analysis is necessary to determine historical cancer trends in this area, and whether these trends are higher than the expected rates of cancer for Cumberland Heights residents. No cancer studies focus specifically on the residential area surrounding the facility. Furthermore, current environmental data do not support the association between environmental emissions and cancer in residents in this community.

Table 4. Counts and Age-Adjusted Incidence Rates* for All Reported Cancer Sites: Montgomery County and the State of Tennessee All Races and Sexes, 1992–1996

Site	*Montgomery County*		*Tennessee*	
	Count	Rate	Count	Rate
All Sites	1,623	331.7	103,054	337.1
Oral Cavity	41	8.3	2,688	9.0
Esophagus	12	2.6	1,091	3.6
Stomach/Sm. Intestine	30	5.8	1,798	5.7
Colon	171	35.3†	9,220	28.8
Rectum	51	10.7	3,534	11.4
Liver	14	2.8	570	1.9
Pancreas	50	10.3†	2,201	6.9
Lung	298	63.6	19,261	64.0
Bone	4	0.9	224	0.8
Melanoma	34	6.9	2,105	6.8
Female Breast	243	89.1	15,644	93.3
Cervix	31	10.5	1,668	10.1
Corpus Uteri	43	16.4	2,774	16.4
Ovary	28	10.5	1,976	11.9
Prostate	178	89.4	12,752	99.1
Testis	11	3.3	470	3.2
Bladder	73	15.6	4,152	13.1
Kidney	39	8.0	2,417	8.1
Nervous System	27	5.1	1,696	6.1
Hodgkin's Disease	9	1.3	650	2.3
Non-Hodgkin's Lymphoma	60	12.3	3,583	11.7
Myeloma	16	3.4	1,117	3.6
Leukemia	35	6.5	2,086	7.1
Other Sites	125	24.6‡	9,377	30.7

Source: Tennessee Cancer Registry.
* Rates are age-adjusted to the 1970 U.S. Standard and are per 100,000.
† Rate is significantly higher than the state rate.
‡ Rate is significantly lower than the state rate.
All other rates are not statistically different from the state rates.

Child Health Considerations

Children are at greater risk than adults for certain kinds of exposure to hazardous substances emitted from waste sites and emergency events. They have a greater risk of exposure for several reasons:

- Children play outside more than adults, and therefore have an increased likelihood of coming into contact with chemicals in the environment.
- Since they are typically shorter than adults, children breathe more dust, soil, and heavy vapors close to the ground.
- Children are also smaller, resulting in relatively higher doses of chemical exposure per body weight.

In addition, the developing systems of children can sustain damage if toxic exposures occur during certain growth stages. Therefore, ATSDR evaluated the types and quantities of chemicals detected in the air, soil, and sediment in the community to determine how children might be exposed. ATSDR also evaluated those chemicals to determine whether levels detected in the community could be associated with any reproductive or developmental effects.

Children live in this community, but do not have access to the PCZ facility. During site visits, ATSDR staff did not note any points of access for children to the plant property. ATSDR closely reviewed possible exposure situations for children while evaluating this site (for example, air exposure, trespassing, and soil deposition). In its evaluation, ATSDR used the environmental media evaluation guidelines for children (EMEGs), who are considered the most sensitive segment of the population. EMEGs are estimates of daily human exposure to a chemical that is unlikely to produce noncancer health effects over a specific duration of time. No special chemical hazards to children were identified on the basis of available soil or sediment data. On the basis of historical air data for the surrounding community, no serious health threats exist for Cumberland Heights children; however, children with asthma may experience respiratory aggravation on days when sulfur dioxide and TSP levels are high. See Appendix B for further explanation of comparison values used by ATSDR in this health assessment.

Physical Hazards

Access to the Pasminco Zinc Corporation is restricted by fences. ATSDR has not received any information suggesting that children have access or had access to the facility operations portion of the property in the past. Trucks regularly enter and exit the property and may pose traffic hazards to residents and playing children.

Conclusions

Available environmental data do not indicate the existence of a health hazard at this time for area residents of the Pasminco Zinc Corporation Cumberland Heights acility. Although sulfur dioxide is present at levels that could cause nonserious effects in sensitive people, no single facility can be identified as the source of the sulfur dioxide.

On the basis of data provided for this health assessment, ATSDR concludes the following:

- Air: On the basis of ambient air data from the air monitors, total suspended particulates, nitrogen dioxide, and sulfur dioxide are not expected to result in long-term serious health effects for area residents. However, sensitive individuals may experience respiratory discomfort on days when contaminant levels of sulfur dioxide and particulate matter are high. No data were available for sulfuric acid; thus, sulfuric acid represents an indeterminate public health hazard.

- Air modeling: On the basis of ATSDR's air modeling, areas in the Cumberland Heights community may have higher levels of sulfur dioxide and other pollutants than what was measured at the monitors. However, the levels of the pollutants are uncertain. Air modeling activities also identified sulfuric acid as a potential contaminant of concern.

- Soil and sediment: No soil samples taken in the residential area around the facility exceeded health based guidelines. The only samples collected onsite that exceed EPA regulatory guidelines for industrial soils are those collected in the impoundment areas.

- Foliage: Acidic soil in residential yards could possibly affect trees and shrubs in Cumberland Heights. The soils in Cumberland Heights are possibly affected by acid deposition by the many facilities that emit criteria pollutants, such as SO_2 and $NO_{X,}$ that are known to contribute to the effects of acid rain.

- Cancer: The cancer rates for Montgomery County seem to be fairly normal for the state of Tennessee. However, colon and pancreatic cancers were significantly elevated above state rates.

- Fungi: Fungal infections are not known to be associated with any chemical exposures. Fungi are commonly found in the indoor (homes) and outdoor environments.

Recommendations

- Continue to monitor for criteria pollutants, including sulfur dioxide, nitrogen oxide, and particulate matter, in Clarksville.

- Consider placing or relocating an air monitor in the maximum impact areas identified by the model to verify the impact areas and provide measured values for evaluation.

- Evaluate the potential health effects of sulfuric acid.

Best Public Health Practice

- Residents should limit their outdoor activity on days when visibility is poor, and the air seems thick and uncomfortable. Avoiding outdoor activity on days of poor air quality may reduce respiratory stress for residents with asthma or other respiratory problems.

- People with asthma and allergies can reduce symptoms by decreasing exposure to irritants in the home. Common irritants include cigarette smoke, dust (including dust mites in bedding), cockroaches, animal dander (cats, dogs), molds, some perfumes, cleaning products, or strong odors from other sources. *The following steps can be helpful to reduce these exposures at home:*

  - Avoid cigarette smoking.
  - When using gas stoves or gas and kerosene space heaters, ventilate the area to the outside. These appliances are a source of nitrogen dioxide in the home; therefore, higher levels of nitrogen dioxide may be found in unvented kitchens or other unvented areas. In some people with asthma or allergies, exposure to nitrogen dioxide can trigger symptoms.

  To control dust mites:
  - Decrease humidity to less than 50% in the home.
  - If possible, remove carpets; hardwood, tile or linoleum floors are better. Instead of wall-to-wall carpeting, use washable rugs that can be washed in hot water.
  - Wash bedding, sheets, pillowcases, mattress pads weekly in hot water (130 F) and dried in a hot drier.
  - Cover mattresses and pillows with plastic zippered covers to prevent dust mites (available at national supply stores).
  - Comforters and pillows made from down feathers or cotton should be replaced with items made from synthetic fibers or cover with plastic zippered covers.
  - Vacuum weekly with a HEPA filter or a double bag vacuum cleaner, as standard vacuum cleaners stir up dust in the air.

  To reduce exposure to mold/fungi in the home the following steps are helpful:
  - Repair areas of the home that have water damage.
  - Do not use carpeting on damp basement floors.
  - Keep relative humidity in the home below 50%.
  - Prevent outdoor fungal spores and pollen from entering the home by using air conditioning and closing windows.
  - Do not use water-spray humidifying devices in areas near asthmatics or people with a weak immune system, as molds can grow in these devices if not maintained properly
  - Clean humidifiers/vaporizers before each use.
  - Control local sources of excess moisture in kitchens or bathrooms by using fans vented to the outdoors.
  - Clean visible molds in areas such as the kitchen and bathroom with 5% bleach and a small amount of detergent.

For more information: visit the American Academy of Asthma and Allergy Web site, available at http://www.aaaai.org. On the web site, go to patient/public resource center.

- Residents should lime their yards, as appropriate, to protect the health of their trees and shrubs. Farm crops are often protected from acid deposition by the systematic application of lime to crop soils.

- Residents concerned about auto paint damage should protect their cars as much as possible in a garage or under an auto cover. If stored outside, new cars should be washed and hand dried frequently to eliminate the buildup of dry acid deposition.

Public Health Action Plan

Completed Activities

- August 5, 1998: ATSDR released a health consultation at the request of EPA Region 4. ATSDR evaluated air monitoring data for TSP and particulates from three locations, and determined that there was no current public health threat to residents.

- April 20, 1999: ATSDR staff conducted an initial site visit to the PCZ plant. ATSDR also conducted a public availability session with residents to gather community concerns.

- September 9, 1999: ATSDR released a second health consultation at the request of TDEC. ATSDR evaluated TDEC heavy metals data from an air monitor located in a residential yard.

- January 11, 2000: ATSDR released an initial public health assessment which served to educate community residents about PCZ processes and present and address community concerns. The public health assessment recommended a more thorough investigation of all available data. This document satisfies that recommendation.

- October 16, 2000: ATSDR completed an exposure investigation in Cumberland Heights. Eleven composite surface soil samples were collected and analyzed for heavy metals. All levels detected were within acceptable limits for residential soils.

- November, 2001: ATSDR released this public health assessment for public comment.

- In 2002 - 2003, ATSDR performed additional air modeling and addressed public comments.

- After addressing all comments and reviewing additional modeling data, ATSDR released this final public health assessment in July 2005.

Planned Activities

- ATSDR will conduct additional air modeling for sulfur dioxide and evaluate the results in a future health consultation as data become available.
- ATSDR will conduct air modeling for sulfuric acid and evaluate the results in a future health consultation as data become available.

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Appendix A: Site Maps and Demographics

Appendix B: ATSDR Methodology and Air Pathway Table

Quality Assurance

In preparing this report, ATSDR relied on the information provided in the referenced documents and contact with community members and representatives, the U.S. Environmental Protection Agency, Tennessee Department of Health, and the Tennessee Department of Environment and Conservation. ATSDR assumes that adequate quality assurance measures were taken during chain-of-custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions drawn in this document are dependent upon the availability and reliability of the data.

Comparison Values

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

However, it must be emphasized that comparison values are not thresholds of toxicity. Although concentrations at, or below, the relevant CV may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. The principle purpose behind protective health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health hazards before they become actual public health consequences. For that reason, ATSDR's comparison values are typically designed to be 1 to 3 orders of magnitude (or 10 to 1,000 times) lower than the corresponding no-effect levels (or lowest-effect levels) on which they are based. The probability that such effects will actually occur does not depend on environmental concentrations alone, but on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

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

CREG	=	cancer risk evaluation guide
EMEG	=	environmental media evaluation guide
IEMEG	=	intermediate environmental media evaluation guide
MCL	=	maximum contaminant level
MRL	=	minimal risk level
RBC	=	risk-based concentration
RfC	=	reference dose concentration
RfD	=	reference dose
RMEG	=	reference dose media evaluation guide

Cancer risk evaluation guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in 1 million people exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors, or cancer potency factors, using default values for exposure rates. However, neither CREGs nor cancer slope factors can be used to make realistic predictions of cancer risk. The true risk is always unknown and may be as low as zero.

Environmental media evaluation guides (EMEGs) are concentrations that are calculated from ATSDR minimal risk levels by factoring in default body weights and ingestion rates.

Intermediate environmental media evaluation guides (IEMEGs) are calculated from ATSDR minimal risk levels; they factor in body weight and ingestion rates for intermediate exposures (those occurring for more than 14 days and less than 1 year).

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

Minimal risk levels (MRLs) are estimates of daily human exposure to a chemical (doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (<14 days), intermediate (15–364 days), and chronic (>365 days) exposures. MRLs are published in ATSDR Toxicological Profiles for specific chemicals.

Risk-based concentrations (RBCs) are media-specific concentrations derived by Region 3 of the Environmental Protection Agency from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

Reference concentrations (RfCs) are concentrations of substances in air that EPA considers unlikely to cause noncancer adverse health effects over a lifetime of chronic exposure.

Reference doses (RfDs) are estimates of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRLs, EPA's RfDs are doses expressed in mg/kg/day.

Reference dose media evaluation guides (RMEGs) are the concentrations of contaminants in air, water, or soil that correspond to EPA's RfDs for that contaminant when default values for body weight and intake rates are taken into account.

Methodology of Evaluating Chemicals of Concern

The Agency for Toxic Substances and Disease Registry (ATSDR) has determined levels of chemicals that can reasonably (and conservatively) be regarded as harmless, on the basis of the scientific data the agency has collected in its toxicological profiles. The resulting comparison values and health guidelines, which include ample safety factors (also known as an uncertainty factor) to ensure protection of sensitive populations, are used to screen contaminant concentrations at a site and to select substances (referred to as "chemicals of concern") that warrant closer scrutiny. A "chemical of concern" is defined by ATSDR as any chemical that is detected in air, water, or soil at concentrations exceeding one or more of ATSDR's comparison values. (Refer to Appendix C for a more complete description of ATSDR's comparison values (CVs), health guidelines, and other values ATSDR uses to screen site contaminants.)

It is important to understand that CVs are not thresholds of toxicity. Although concentrations at, or below, the relevant comparison value may reasonably be considered safe, it does not necessarily follow that any concentration that exceeds a CV would be expected to produce adverse health effects. Indeed, the principle purpose behind protective health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health problems before that potential is realized. For that reason, ATSDR's comparison values are typically designed to be 1 to 3 orders of magnitude lower than the corresponding no-effect levels (or lowest-effect levels) on which they are based.

When screening individual contaminants, ATSDR staff members compare the highest single concentration of a contaminant detected at the site with the lowest comparison value available for the most sensitive of the potentially exposed individuals (usually children or pica children). Typically the cancer risk evaluation guide (CREG) or chronic environmental media evaluation guide (EMEG) is used. This "worst-case" approach introduces a high degree of conservatism into the analysis and often results in the selection of many contaminants as "chemicals of concern" that will not, upon closer scrutiny, be judged to pose any hazard to human health. In the interest of public health, it is prudent to use a screen that identifies many "harmless" contaminants, as opposed to one that may overlook even a single potential hazard to public health. The reader should keep in mind the conservativeness of this approach when interpreting ATSDR's analysis of the potential health implications of site-specific exposures.

As ATSDR's most conservative CV, the CREG requires special mention. ATSDR's CREG is a media-specific contaminant concentration derived from the chronic (essentially, lifetime) dose of that substance which, according to an EPA estimate, corresponds to a 1-in-1,000,000 cancer risk level. Note, this does not mean that exposures equivalent to the CREG are expected to cause one excess cancer case in 1,000,000 ($1x10^{-6}$) people exposed over a lifetime. Nor does it mean that every person in a population of 1 million has a 1-in-1,000,000 risk of developing cancer from the specified exposure. Although commonly interpreted in this way, EPA estimates of cancer "risk" are estimates of population risk only and cannot be applied meaningfully to any individual. EPA explicitly stated in its 1986 Cancer Risk Assessment Guidelines that "The true risks are unknown and may be as low as zero"[1].

[1] U.S. Environmental Protection Agency, 1986. Guidelines for carcinogenic risk assessment. Federal Register 1986 Sep;51:33997-33998.

ATSDR Methodology

Methods of Evaluation of Potential Public Health Implications

On the basis of available scientific data, much of which ATSDR has collected in its toxicological profiles, ATSDR has determined concentrations of hazardous substances that can reasonably (and conservatively) be regarded as harmless. The resulting comparison values (CVs) generally include ample safety factors to ensure protection of sensitive populations. They are used to screen contaminant concentrations at a site, and to select “contaminants of concern” that warrant closer scrutiny by agency health assessors and toxicologists. A “contaminant of concern” is defined as a substance that is detected in air, water, or soil at concentrations that exceed one or more of ATSDR’s comparison values and warrants further evaluation.

The derivation of a CV uses conservative exposure assumptions, resulting in values that are much lower than exposure concentrations observed to cause adverse health effects. This ensures that the comparison values are protective of public health in essentially all exposure situations. Therefore, if the concentration of a substance in an exposure medium is less than the CV, the exposure is not of health concern and no further analysis of the exposure medium pathway is required.

Comparison values are conservative values, and it is important to note that concentrations of substances that are higher than the CVs will not necessarily lead to adverse health effects. Exposure to levels of substances above their comparison values may or may not lead to adverse health effects. ATSDR's comparison values do not indicate thresholds of toxicity, and they are not used to predict the occurrence of adverse health effects.

A level of concentration that is equal to or below a relevant comparison value is considered safe. However, the fact that a concentration exceeds a CV does not mean that the concentration is expected to produce adverse health effects. ATSDR uses highly conservative, health-based standards and guidelines to assist health professionals in recognizing and resolving potential public health problems.

Table B-1 Pathway analysis for Cumberland Heights Community-Clarksville, Tennessee

Pathway Name	*Contaminants*	*Source*	*Environmental Media*	*Point of Exposure*	*Route of Exposure*	*Exposed Population*	*Time*	*Comments*
Completed Pathways								
Past Air Emissions	Metals NO_2 SO_2 Particulates	Agriculture Industry Traffic	Air	Community ambient air	Inhalation	Child Adult	Past	Levels present could cause nonserious respiratory aggravation on days of poor air quality.
Current Air Emissions	Metals NO_2 SO_2 Particulates	Agriculture Industry Traffic	Air	Community ambient air	Inhalation	Child Adult	Present	Levels present could cause nonserious respiratory aggravation on days of poor air quality.
Surface Soil Contamination	Metals	Agriculture Industry	Soil	Community soils	Inhalation Ingestion	Child Adult	Past Present	Current levels are below health concern.
Potential Pathway								
Sediment Contamination	Metals VOCs	Agriculture Industry	Sediment	Creek and river beds	Ingestion	Child Adult	Present	Most levels below health concern. Unlikely that anyone would be able to ingest riverbed soils.
Groundwater	Metals	Industry	River Water	Cumberland River	Ingestion Inhalation	Child Adult	Present	Current levels below health concern.

Appendix C: Air Dispersion Modeling - Methods and Results

ATSDR modeled the emissions of sulfur dioxide (SO_2) from the Tennessee Valley Authority's power plants (Cumberland, Tennessee) and from Pasminco Zinc (Clarksville, Tennessee) to estimate ambient air concentrations of sulfur dioxide. The details of the model and model inputs are provided below. The emission rates for SO_2 could have included permit limits or actual annual emissions. Both permit limits and actual emissions can change. Permit limits change much less frequently, but are often higher than actual emissions because facilities prefer to operate well within the permit limits given operational variations or changes in production output. Emissions are a function of production output.

Actual emissions can change frequently depending on the types of processes, amount of production output, or operational variations. For example, emissions from batch processes are cyclical, typically occurring during or at the end of the batch process, not in between batches. Processes that require steady state operations would have emissions relatively constant over longer periods of time.

The SO_2 emission rates used in the model in this report are actual emissions based on a single annual output and then divided evenly into each second of the year. This approach assumes a constant emissions rate and that the annual emission rate represents earlier or more recent years.

For the air dispersion modeling of Pasminco's SO_2 emissions, the 2000 year annual emissions rate of 11.4142 g/s [Editor's Note: g/s needs to be defined in its first useand the permit limit of 29.3575 g/s were used. For comparison, the July 2000 monthly SO_2 emissions from the tail gas stack averaged 11.1 g/s with 2-hour averages ranging from 0.4 to 55 g/s. The 2-hour averages are calculated from a continuous acid plant tail gas in-stack monitor for SO_2. At Pasminco, the tail gas stack is the predominant source of SO_2 emissions.

The model results shown in the figures present the air concentrations from TVA and Pasminco using 2000 actual emissions (annual average). One figure presents the predicted annual average concentration and the other figure shows 1-hour maximum concentrations. Each figure consists of three maps: 1) the map in the upper left displays the predicted air concentrations from TVA's emissions using shaded colors as contours; 2) the map in the upper right displays the predicted air concentrations from Pasminco's tail gas stack emissions using lines as contours; and 3) the map at the bottom displays a combination of the first two maps for comparison. The combined map also contain two graphs. These graphs contain cross-sections of the contours in two directions. Each graph has three lines: 1) one line shows the cross section of the air concentrations from TVA's emissions; 2) a second line shows the cross section of air concentrations from Pasminco's emissions; 3) and a third line shows the air concentrations using Pasminco's permit limit for SO_2 from the tail gas stack.

The SO_2 annual average air concentrations contributed by TVA plant run is approximately 0.5 $\mu g/m^3$. Annual average air concentrations from Pasminco emissions reach a maximum of about 3 $\mu g/m^3$ from actual 2000 year emissions to almost 8 $\mu g/m^3$ using permit limits.

For predicted 1-hour maximum air concentrations, TVA contributes about 50 μg/m^3 in the Pasminco area. Pasminco contribution in this same area reaches a maximum of almost 250 μg/m^3 using actual annual averages to a little more than 600 μg/m^3 using permit limits.

The peak locations of SO_2 concentrations contributed by Pasminco are located about 2 miles north and south of the facility.

Modeling Parameters – Sulfur Dioxide Modeled Emissions

Name	ID	x Coordinate (meters)	y Coordinate (meters)	Base Elevation (meters)	Release Height (meters)	Permitted or Actual Emission Rate* (g/s)	Exit Gas Temperature (^oK)	Gas Exit Velocity (m/s)	Stack Inside Diameter (meters)
Pasminco Zinc, Inc.									
Roaster Preheater	RSTRPRE1	463,659.00	4,041,163.00	118.87	18.29	2.472708	313.15	17.65	1.37
Auxiliary Boiler	AUX	463,649.00	4,041,219.00	118.87	18.29	3.179196	449.82	11.45	1.07
Primary Acid Plant Preheater	STANDBY	463,706.00	4,041,161.00	120.4	15.24	2.825952	810.93	20.44	0.76
Secondary Plant Preheater	SCNDYPRE	463,721.00	4,041,160.00	120.4	25.6	2.34356	672.04	28.12	0.91
Tail Gas Stack	TGS1	463,710.00	4,041,168.00	120.4	60.96	11.4142† 29.3575	344.26	19.2	1.22
TVA Cumberland									
Cumberland 1	CUF1	441,500	4,027,200	122	193.5	321.3	321	19.7	11.7
Cumberland 2	CUF2	441,500	4,027,100	122	193.5	356.1	321	19.7	11.7

g/s: grams per second
m/s: meters per second
* Pasminco emission rates are permit limits from the January 7, 2002 Title V operating permit for air except where indicated. TVA emission rates are actual emissions from year 2000. Only the tail gas stack emissions were modeled. The permit limits from the other units are shown as a comparison.
† Actual year 2000 emissions of 11.4142 g/s and permit limit of 29.3575 g/s were used.

Data Sources: Cumberland 1 and Cumberland 2 data from TVA. Pasminco data from Pasminco Zinc and Tennessee Department of Environment and Conservation.

Other model information:

- ISC3ST using Lakes Environmental Inc.'s ISC-AERMOD View Interface for U.S. EPA ISCST3 version 4.01.
- Meteorologic data supplied by TVA and Pasminco. TVA data consist primarily of Cumberland City surface data with Nashville surface data filling and data gaps. The TVA data also consist of Nashville upper air data. TVA data run from 1985 through 1987.
  The Pasminco surface data are from Fort Campbell, Kentucky, and upper air data are from Nashville. Pasminco data run from 1991 through 1995.
- 1-hour maximum and period averages of SO_2 were modeled.
- ATSDR assumed that SO_2 did not react in the atmosphere.
- ISCST3 Model Parameters
  - Terrain heights based on 1:250,000 DEM of Nashville-West Quadrangle
  - Receptor heights at 1.50 meters above surface
  - Dispersion option: Regulatory default
  - Dispersion coefficients: Rural
  - Downwash: None
  - Terrain height option: Elevated
  - Terrain calculation algorithms: Simple plus complex terrain
- The following receptor grids were used.

Grid	Spacing X	Spacing Y	Number of Point X	Number of Points Y	Point of Origin X	Point of Origin Y
Uniform Cartesian Grid 1	750	750	50	50	436,500	4,024,000
Uniform Cartesian Grid 2	150	150	80	80	457,549.03	4,035,305.33
Discrete Cartesian	836 locations surrounding Pasminco at 100-meter grid spacing					
Plant Boundary	62 locations					

Air Modeling Figures

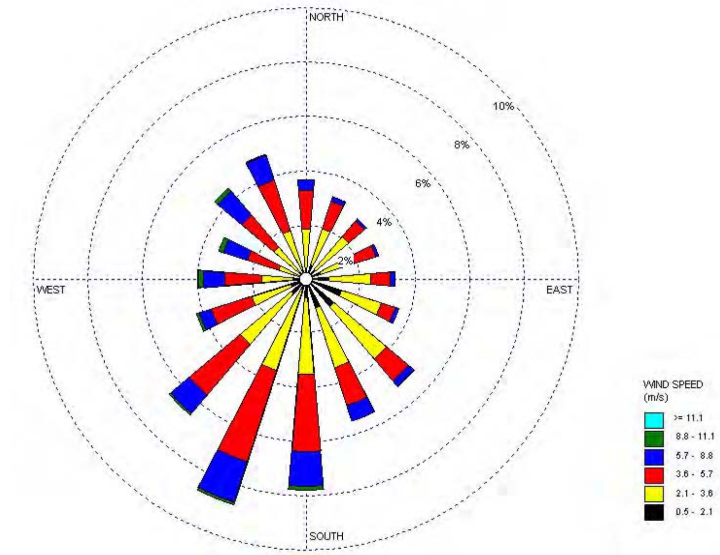
Figure 4 – Wind speed and direction

Figure 5 – Comparisons of Sulfur Dioxide Modeled Air Concentrations from Pasminco Zinc and TVA (1-hour maximum concentrations)

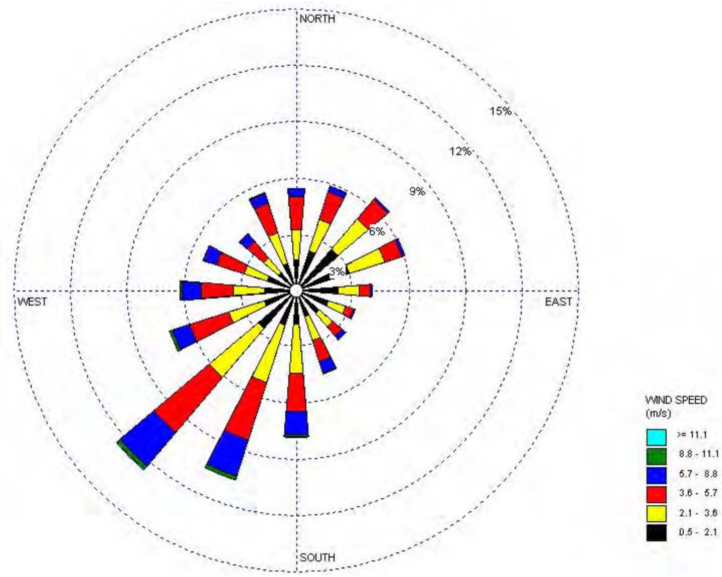
Figure 6 - Comparisons of Sulfur Dioxide Modeled Air Concentrations from Pasminco Zinc and TVA (annual average concentrations)

Figure 4 . Wind Rose Diagrams for Three Meteorological Stations

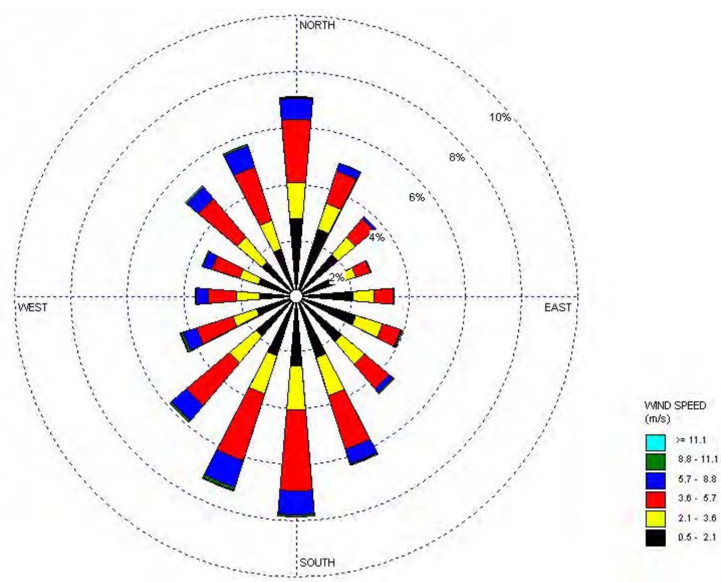
Clarksville Outlaw Airport, Tennessee
April 1, 2001 through March 20, 2002
10,189 reported hours
Calm Winds 26.07%
Average Wind Speed 3.58 m/s



Cumberland Power Plant, Tennessee
and supplemented with Nashville,
Tennessee data
January 1, 1985 through December 31,
1987.
26,280 reported hours
Calm Winds 1.86%
Average Wind Speed 3.35 m/s



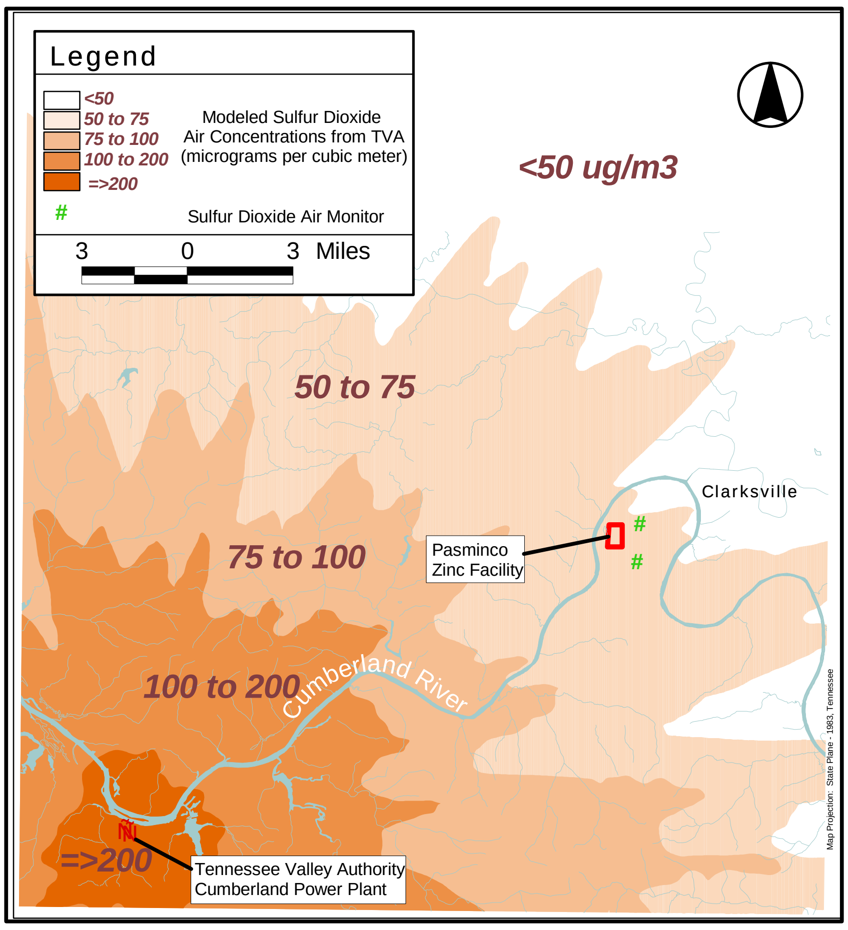
Fort Campbell, Kentucky
January 1, 1991 through December 31,
1995
43,824 reported hours
Calm Winds 19.89%
Average Wind Speed 3.21 m/s



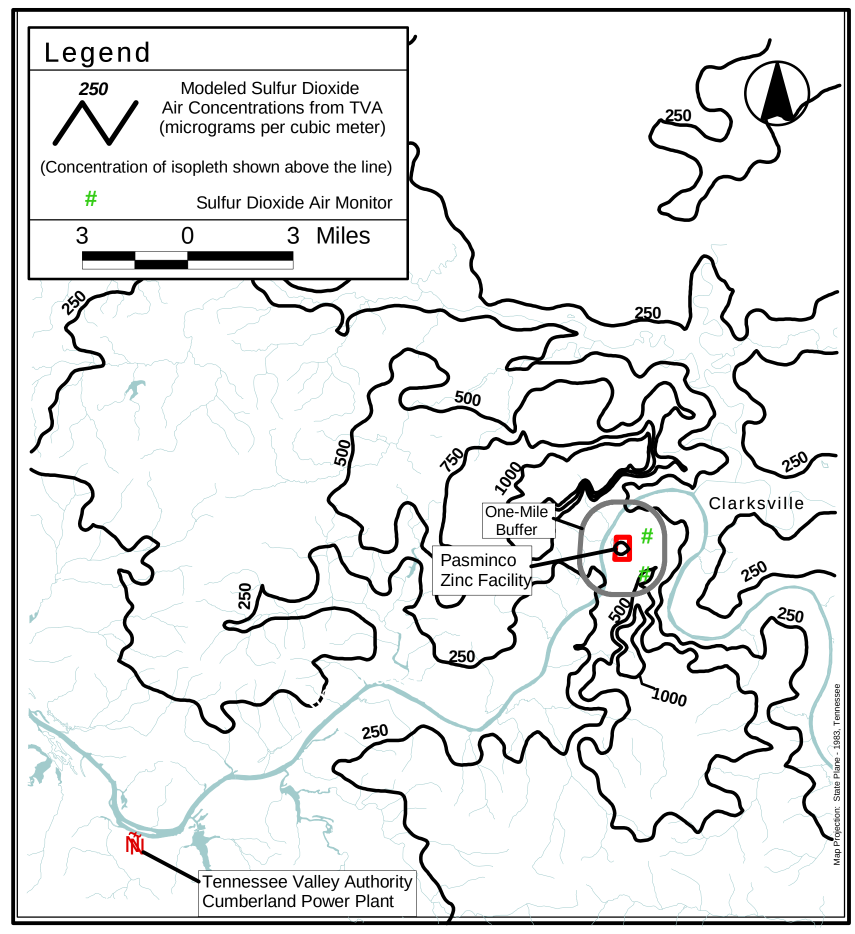
Comparisons of Sulfur Dioxide Modeled Air Concentrations from Pasminco Zinc and TVA Emissions

1-Hour Maximum Concentrations

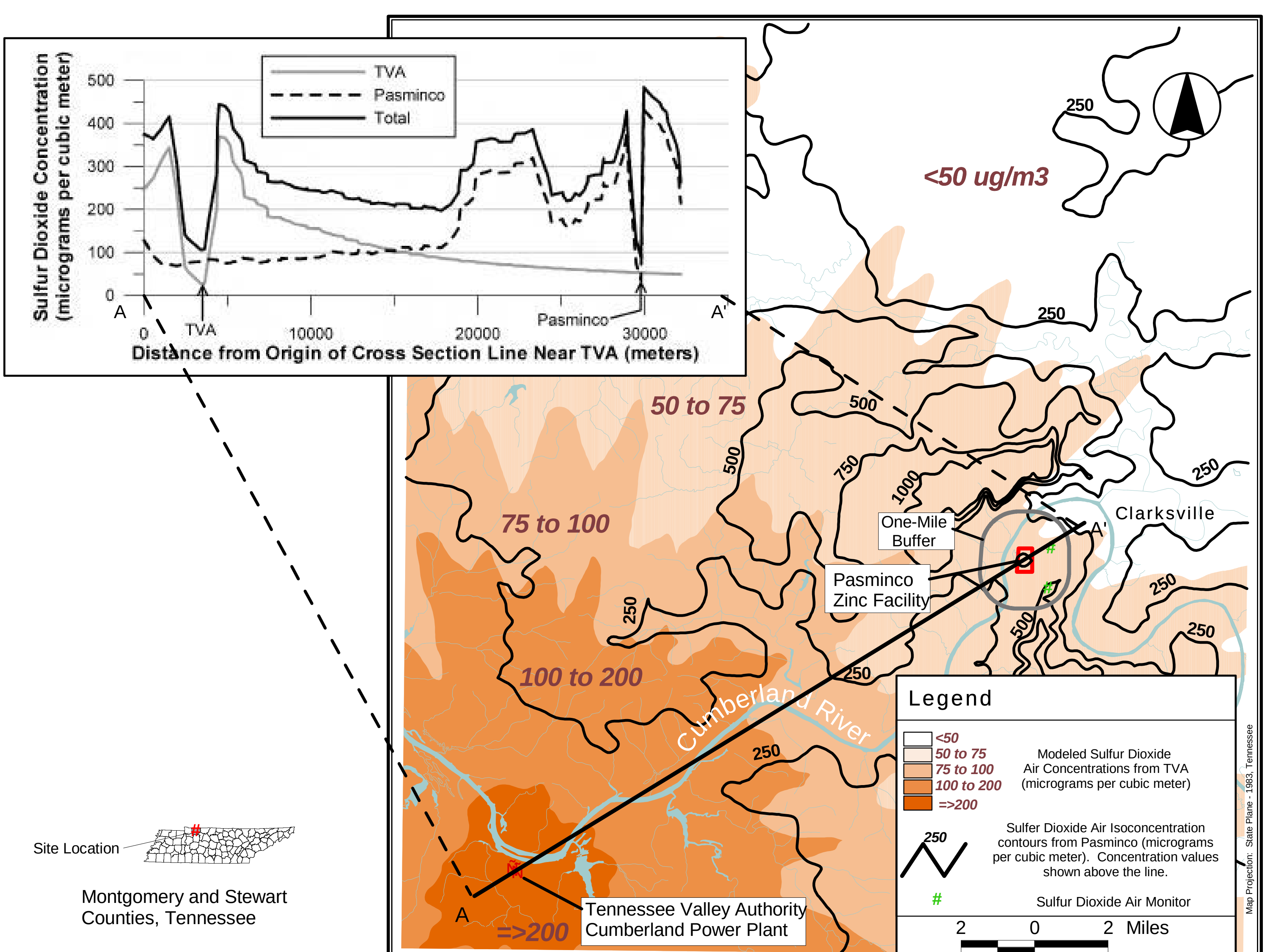
Sulfur Dioxide Modeled Air Concentrations from TVA



Sulfur Dioxide Modeled Air Concentrations from Pasminco



Combined Map of Sulfur Dioxide Modeled Air Concentrations from Pasminco Zinc and TVA



Sources: Wessex 98 TIGER Files, Tennessee Valley Authority, and Pasminco Zinc. Air modeling by the ATSDR Exposure-Dose Reconstruction Lab.

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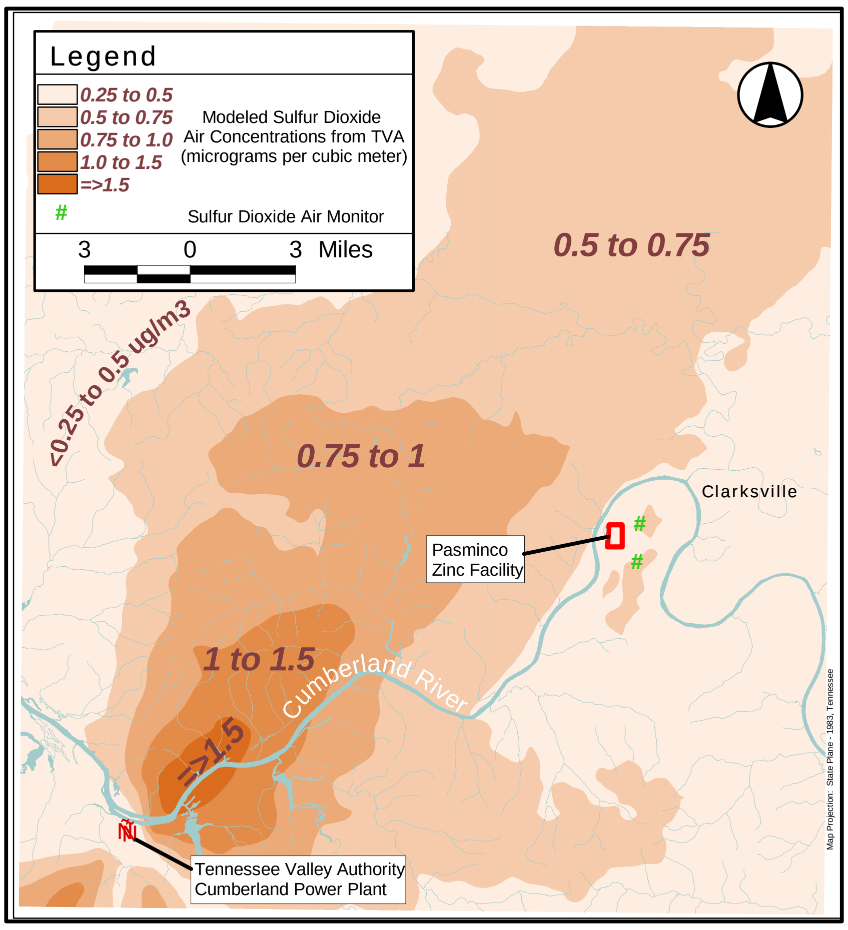
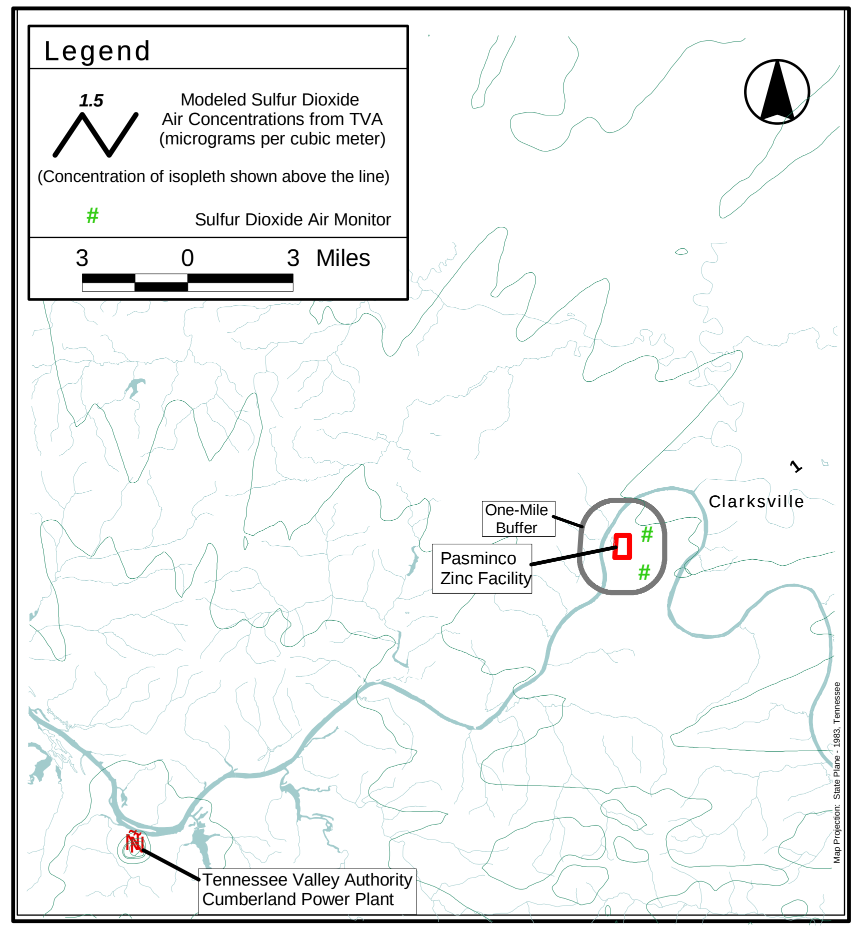
Comparisons of Sulfur Dioxide Modeled Air Concentrations from Pasminco Zinc and TVA Emissions

Annual Average Concentrations

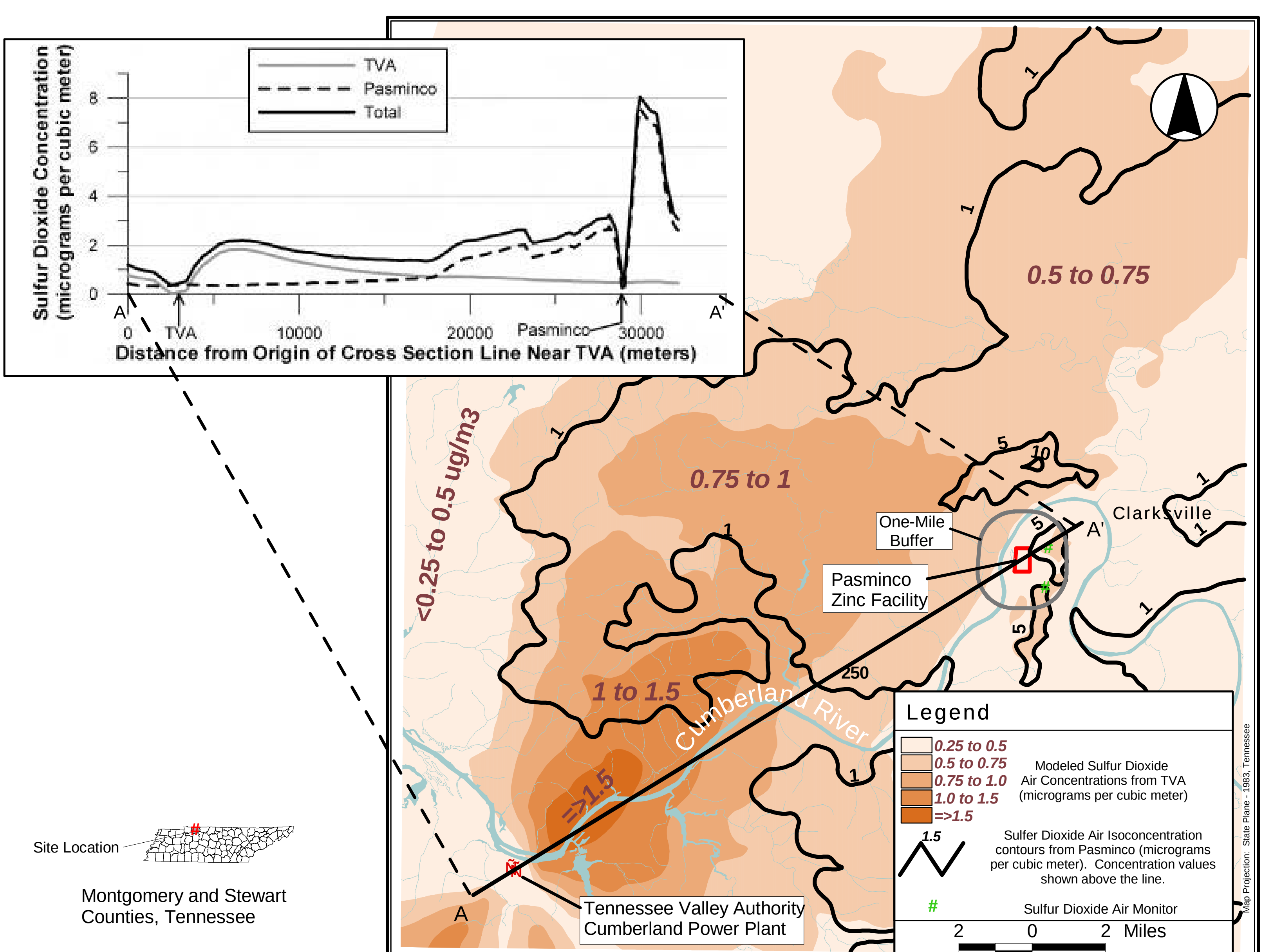
Sulfur Dioxide Modeled Air Concentrations from TVA



Sulfur Dioxide Modeled Air Concentrations from Pasminco



Combined Map of Sulfur Dioxide Modeled Air Concentrations from Pasminco Zinc and TVA



Sources: Wessex 98 TIGER Files, Tennessee Valley Authority, and Pasminco Zinc. Air modeling by the ATSDR Exposure-Dose Reconstruction Lab. bck011102

Appendix D. Air Sampling Results

Table D-1 Sulfur Dioxide Concentrations by Month

Average 1-hour sulfur dioxide concentrations and average maximum 1-hour sulfur dioxide concentrations by monitor location and year (ppm)

Meeks Property-monthly average 1-hour sulfur dioxide concentrations												
Year	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
1980	0.015	0.015	0.005	0.003	0.003	0.003	0.003	0.005	0.005	0.007	0.009	0.012
1981	0.018	0.007	0.008	0.007	0.004	0.006	0.005	0.005	0.007	0.004	0.007	0.009
1982	0.010	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	0.001	0.004	0.003	0.003	0.006	0.007
1996	0.007	0.007	0.005	0.005	0.004	0.003	0.003	0.002	0.003	0.003	0.005	0.005
1997	0.007	0.007	0.005	0.005	0.005	0.004	0.006	0.006	0.006	0.006	0.007	0.008
1998	0.007	0.008	0.005	0.004	0.005	0.006	0.006	0.006	0.006	0.005	0.005	0.006
1999	0.005	0.006	0.006	0.003	0.002	0.003	0.003	0.003	0.003	0.002	0.003	0.003
2000	0.003	0.002	0.004	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.005
2001	0.004	0.004	0.003	0.002	0.003	-	-	-	-	-	-	-
Meeks property-monthly *maximum average* 1-hour sulfur dioxide concentrations												
1980	0.135	0.195	0.056	0.117	0.110	0.050	0.095	0.172	0.179	0.210	0.131	0.098
1981	0.095	0.164	0.160	0.357	0.169	0.160	0.085	0.185	0.318	0.130	0.175	0.090
1982	0.197	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	0.008	0.029	0.037	0.030	0.030	0.049
1996	0.049	0.043	0.026	0.038	0.019	0.120	0.032	0.026	0.027	0.040	0.026	0.032
1997	0.062	0.055	0.050	0.038	0.050	0.055	0.055	0.043	0.068	0.076	0.030	0.081
1998	0.041	0.072	0.028	0.023	0.047	0.049	0.040	0.067	0.047	0.028	0.070	0.040
1999	0.075	0.035	0.025	0.015	0.018	0.023	0.031	0.029	0.021	0.015	0.057	0.034
2000	0.044	0.018	0.022	0.014	0.013	0.029	0.019	0.043	0.028	0.035	0.023	0.032
2001	0.028	0.050	0.014	0.011	0.009	-	-	-	-	-	-	-

Average 1-hour sulfur dioxide concentrations and average maximum 1-hour sulfur dioxide concentrations by monitor location and year (ppm)												
Cumberland Heights Elementary School -monthly average 1-hour sulfur dioxide concentrations												
Year	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
1982	0.005	0.012	0.006	0.004	0.003	0.004	0.003	0.004	0.005	0.005	0.004	0.004
1983	0.008	0.007	0.006	0.004	0.002	0.002	0.003	0.005	0.003	0.004	0.004	0.011
1984	0.012	0.005	0.006	0.003	0.003	0.003	0.001	0.003	0.002	0.003	0.002	0.002
1985	0.017	0.010	0.014	0.003	0.002	0.003	0.002	0.001	0.004	0.003	0.006	0.010
1986	0.012	0.011	0.010	0.005	0.004	0.002	0.003	0.003	0.004	0.005	0.008	0.016
1987	0.007	0.005	0.007	0.004	0.003	0.004	0.002	0.004	0.004	0.009	0.008	0.007
1988	0.013	0.008	0.008	0.012	0.009	0.019	0.012	0.008	0.006	0.007	0.007	-
1989	0.010	0.013	0.013	0.006	0.004	0.004	0.004	0.007	0.004	0.004	0.005	0.014
1990	0.009	0.007	0.009	0.006	0.004	0.003	0.004	0.006	0.008	0.007	0.008	0.008
1991	0.010	0.008	0.005	0.005	0.003	0.004	0.006	0.005	0.006	0.004	0.008	0.007
1992	0.012	0.009	0.010	0.013	0.008	0.007	-	0.007	0.008	0.008	0.008	0.008
1993	0.013	0.017	0.012	0.009	0.015	0.010	0.010	0.008	0.005	0.006	0.007	0.009
1994	0.010	0.008	0.009	0.005	0.007	0.008	0.008	0.010	0.006	0.004	0.005	0.008
1995	0.006	0.006	0.005	0.005	0.006	0.008	0.002	0.004	0.006	0.005	0.008	0.006
1996	0.007	0.007	0.005	0.005	0.006	0.006	0.010	0.002	0.004	0.004	0.006	0.005
1997	0.006	0.007	0.004	0.004	0.004	0.003	0.002	0.003	0.005	0.006	0.007	0.008
1998	0.008	0.010	0.007	0.007	0.007	0.003	0.002	0.004	0.005	0.005	0.006	0.008
1999	0.006	0.007	0.008	0.005	0.002	0.002	0.002	0.005	0.006	0.006	0.006	0.008
2000	0.006	0.006	0.007	0.005	0.003	0.002	0.006	0.005	0.005	0.006	0.006	0.008
2001	0.009	0.009	0.008	0.002	0.002	0.006	-	-	-	-	-	-

Average 1-hour sulfur dioxide concentrations and average maximum 1-hour sulfur dioxide concentrations by monitor location and year (ppm)												
Cumberland Heights Elementary School -monthly *maximum average* 1-hour sulfur dioxide concentrations												
yYear	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
1982	0.025	0.150	0.080	0.075	0.233	0.062	0.067	0.100	0.074	0.110	0.146	0.086
1983	0.204	0.107	0.144	0.073	0.098	0.124	0.092	0.107	0.078	0.092	0.057	0.137
1984	0.168	0.125	0.150	0.159	0.092	0.114	0.003	0.221	0.059	0.057	0.040	0.031
1985	0.250	0.124	0.250	0.054	0.054	0.223	0.042	0.036	0.186	0.095	0.177	0.238
1986	0.221	0.315	0.350	0.074	0.500	0.075	0.118	0.154	0.119	0.410	0.398	0.144
1987	0.047	0.087	0.049	0.076	0.075	0.148	0.075	0.386	0.102	0.294	0.385	0.137
1988	0.395	0.134	0.156	0.500	0.199	0.490	0.400	0.200	0.170	0.134	0.155	-
1989	0.270	0.343	0.278	0.126	0.094	0.123	0.226	0.188	0.045	0.139	0.217	0.125
1990	0.256	0.081	0.089	0.051	0.068	0.126	0.086	0.152	0.192	0.233	0.126	0.151
1991	0.148	0.090	0.119	0.141	0.092	0.086	0.170	0.211	0.174	0.096	0.085	0.063
1992	0.209	0.145	0.150	0.180	0.155	0.131	-	0.072	0.250	0.213	0.118	0.069
1993	0.160	0.500	0.221	0.106	0.357	0.500	0.153	0.086	0.080	0.144	0.120	0.127
1994	0.061	0.076	0.105	0.057	0.122	0.247	0.198	0.220	0.092	0.074	0.040	0.092
1995	0.043	0.042	0.038	0.044	0.045	0.049	0.033	0.048	0.047	0.020	0.037	0.064
1996	0.053	0.078	0.045	0.044	0.077	0.037	0.069	0.029	0.044	0.030	0.039	0.029
1997	0.031	0.051	0.051	0.041	0.063	0.020	0.021	0.027	0.157	0.036	0.039	0.095
1998	0.054	0.072	0.052	0.028	0.037	0.045	0.026	0.061	0.027	0.042	0.090	0.044
1999	0.078	0.179	0.045	0.019	0.034	0.023	0.015	0.020	0.044	0.025	0.040	0.040
2000	0.054	0.025	0.029	0.016	0.019	0.018	0.025	0.034	0.045	0.043	0.026	0.046
2001	0.078	0.076	0.050	0.035	0.017	-	-	-	-	-	-	-

- ppm: parts per million

Table D-2 Total Suspended Particulates in Montgomery County Ambient Air

TSP concentrations, 1972–present in Montgomery County, Tennessee (μg/m³)					
Monitor ID number and location	**Years of data**	**Years data collected**	**Range of Maximum Values**	**Range of mean of yearly concentrations**	**Former EPA NAAQS for TSP***
47-125-0006 (Meeks Property)	18	1978–1995	62–185	31–49	24-hour averages:

					150 µg/m^3 Annual averages: 75 µg/m^3
47-125-0007 (JMZ Hill Site)	18	1978–1995	76–227	36–58	
47-125-0001 (County Health Center, Madison Street)	23	1972–1996	27–225	21–67	
47-125-0002 (Central Business District)	7	1972–1978	100–265	59–95	
47-125-1008; 47-125-0009 (Union Carbide)	4	1981–1989; 1995	56–90	23–41	
47-125-1009 (Near golf course neighborhood)	2	1997–1998	40–49	22–23	
47-161-0029 (near TVA)	10	1975–1988	74–143	39–46	
47-161-0028 (5 miles west/southwest of TVA)	3	1975–1978	58–133	32–47	
47-161-0007 (1.13 miles south/southeast of TVA)	6	1973–1979	78–165	48–56	
47-161-0006 (6.24 miles northeast of TVA)	3	1973–1975	83–247	40–50	
47-161-0005 (4.6 miles northeast of TVA)	8	1973–1981	91–343	43–52	
47-125-0005 (near Austin Peay University)	3	1975–1978	104–337	63–77	
47-125-0004 (near Austin Peay University)	2	1974–1975	105–112	44–48	
47-125-0003 (near Austin Peay University)	1	1973	144–195	76	

µg/m^3: micrograms per cubic meter of air

***** EPA discarded the TSP standard in 1987 for more specific regulations for PM2.5 and PM10; many states still use the former TSP regulation as a state standard.

Source: EPA AIRS database

Appendix E: Soil, Sediment, and Groundwater Data

Table E-1 Summary of Metals Concentrations of Surface and Subsurface Soils, Collected by EPA on December 5, 1994, on the Pasminco Zinc Facility Property

Parameter (mg/kg)	*Background*						*EPA Risk-Based Concentrations (RBCs)**	
	Dry drainage ditch above administrative building		**Downgradient of Impoundment 4**		**Downgradient of Impoundments 1,2,3**		**industrial soil**	**residential soil**
	Surface soil sample 1	**Subsurface soil sample 1**	**Surface soil sample 2**	**Subsurface soil sample 2**	**Surface soil sample 3**	**Subsurface soil sample 3**		
aluminum	5,600	7,700	15,000	12,000	16,000	15,000	2,000,000	78,000
arsenic	**6.1**	3.5	**5.8**	**9**	**5.1**	**4.4**	3.8	0.43
barium	73	140	140	83	160	120	140,000	5,500
beryllium	-	1U	-	-	-	1.4	4,100	160
cadmium	13J	0.34UJ	72J	20J	3.3J	1.6J	1,000	390
calcium	19,000	1,400	1,400	370	56,000	3,300	Essential nutrient-NA	Essential nutrient-NA
chromium	31	12	22	16	18	17	6,100	230
cobalt	22	12	16	11J	3.8J	21	41,000	1,600
copper	13	6.1	150	11	31	14	82,000	3,100
iron	15,000	11,000	23,000	21,000	20,000	26,000	610,000	23,000
lead	73J	11J	22J	13J	40J	21J	400†	400†
magnesium	4,200	640	1,300	1,400	1,600	2,200	Essential nutrient-NA	Essential nutrient-NA
manganese	1,800	1,400	990	770-	110	2,000	41,000	1,600
mercury	0.12U	-	-	10J	0.57	-	NA	NA
nickel	33	8.8J	15	930	15	23	41,000	1,600
potassium	450	490	1,000	-	1,700	860	Essential nutrient-NA	Essential nutrient-NA
selenium	0.62U	-	-	-	3.8J	-	10,000	390
sodium	70U	50U	-	-	98	110	NA	NA
thallium	0.95U	-	-	-	3	-	140	5.5
vanadium	25	19	36	31	32	30	14,000	550
zinc	570	25	3,400	1,100	250	94	610,000	23,000

- **Metal analyzed for, but not detected**
J **Estimated value**
U **Material analyzed for, but not detected. The number is the sample quantitation limit (SQL)**

mg/kg: milligrams of contaminant per kilograms of soil.

* **Risk-based concentrations (RBCs)** are media-specific concentrations derived by EPA Region 3 from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

† 400 mg/kg is a risk-based screening level from Region 6 of the U.S. Environmental Protection Agency (EPA).

Source: Site Inspection Prioritization Report for Jersey Miniere Zinc Company. EPA, 1995.

Highlighted values exceed the EPA Industrial Soil Standard

Table E-2 Summary of Metals Concentrations of Sediment, Collected by EPA on December 5, 1994, on the Pasminco Zinc Facility Property

Parameter (mg/kg)	*Background*									*EPA Risk-Based Concentrations (RBCs)* for Industrial Soil*
	Upgradient in wet drainage ditch	**Downgradient in drainage ditch near outfall**	**Upper wetland area**	**Lower wetland area**	**Upgradient of the pipeline on the Cumberland River**	**Downgradient of the pipeline on the Cumberland River**	**Impoundment 1**	**Impoundment 2**	**Impoundment 3**	
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Sample 6**	**Sample 7**	**Sample 8**	**Sample 9**	
aluminum	7,000	15,000	13,000	13,000	12,000	8,900	2,300	2,200	1,300	2,000,000
arsenic	**4.2UJ**	-	-	-	-	-	33J	-	-	3.8
barium	4.7	4.7	5.7	4.7	3.3	4.2	100	7	12	140,000
beryllium	55	170	120	120	89	76	300	35	100	4,100
cadmium	14J	64J	5.3J	91J	-	-	**2,100J**	27J	**8,000J**	1,000
calcium	5,800	32,00	2,500	5,200	6,400	7,700	51,000	100,000	43,000	Essential nutrient-NA
chromium	14	18	22	23	14	13	29	16	12	6,100
cobalt	6.6J	21	14J	15	9.3J	9.4J	38	4J	69	41,000
copper	12	29	13	24	9.1	8.7	3,400	74	4,100	82,000
iron	15,000	24,000	21,000	20,000	15,000	13,000	88,000	13,000	48,000	610,000
lead	19	39J	21J	38J	14J	15	**21,000J**	**420**	**10,000J**	400†
magnesium	1,500	2,100	1,500	1,500	13,000	940	5,700	290	6,400	Essential nutrient-NA
manganese	450	1,700	880	1,500	440	960	6,900	1,100	5,500	41,000
mercury	0.18U	0.39	-	0.87	-	-	1.2	13	1.2	NA
nickel	11	25	17	19	15	12J	65	4	54	41,000
potassium	600	1,300	1,300	1,100	1,300	670	930	210	950	Essential nutrient-NA
selenium	0.90U	-	-	-	-	-	-	4.7	-	10,000
silver	0.69U	-	-	-	-	-	61JN	1.6J	45JN	1,000
sodium	60U	-	-	-	96	-	290	150	250	NA

thallium	1.4U	-	-	-	-	-	-	-	18	140
vanadium	24	29	29	27	20	19	10.5	14J	4.7J	14,000
zinc	560	1,800	280	1,400	90	72	130,000	2,700	240,000	610,000

Table E-2 notes:

- **Metal analyzed for, but not detected**

J **Estimated value**

U **Material analyzed for, but not detected. The number is the sample quantitation limit (SQL)**

mg/kg: *milligrams of contaminant per kilograms of soil*

*** RBCs: Risk-based concentrations (RBCs)** are media-specific concentrations derived by Region 3 of the Environmental Protection Agency from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

† 400 mg/kg is a risk-based screening level from Region 6 of the U.S. Environmental Protection Agency

Please note that impoundment areas at this facility are used for metals recovery (recycling metals from plant process waste) and neutralization. Therefore, it is expected that impoundment levels of metals would be high. However, the impoundment areas are triple-lined and fenced and are not expected to cause risk to residents in the area.

Source: Site Inspection Prioritization Report for Jersey Miniere Zinc Company. EPA, 1995.

Highlighted values exceed the EPA Industrial Soil Standard

Table E-3 Groundwater Results for Groundwater Sampling at Pasminco Zinc, *on Facility Property*

Metals concentrations in on-site groundwater, Pasminco Zinc Plant, 1999 (mg/l)					
Metal	**Monitoring well**	**Monitoring well (filtered)**	**Middle Spring**	**South Spring**	**EPA RBC* for tap water**
aluminum	1.17	0.1380	ND	ND	37
antimony	ND	ND	ND	ND	0.015
arsenic	ND	ND	ND	ND	.000045
barium	0.0460	0.0410	0.0310	0.0120	2.6
beryllium	ND	ND	ND	ND	0.073
cadmium	ND	ND	0.002	ND	0.018
calcium	38.10	40.00	93.60	83.60	NA-Essential nutrient
chromium	ND	ND	ND	ND	0.11
cobalt	ND	ND	ND	ND	2.2
copper	ND	ND	ND	ND	1.4
iron	1.990	ND	ND	ND	11
lead	ND	ND	ND	ND	0.015†
magnesium	6.890	6.990	7.120	5.270	NA-Essential nutrient
manganese	1.450	1.340	ND	ND	1.7
mercury	ND	ND	ND	ND	0.011
nickel	ND	ND	ND	ND	0.73
potassium	ND	ND	1.410	ND	NA-Essential nutrient
selenium	ND	ND	0.0130	0.0120	0.18
silver	ND	ND	ND	ND	0.18
sodium	21.70	22.6	3.490	1.900	NA
thallium	ND	ND	ND	ND	0.0026
vanadium	ND	ND	ND	ND	0.26
zinc	ND	ND	0.0540	ND	11

mg/l: milligrams of contaminant per liter of water
ND: Not detected at laboratory reporting limit

*** RBC: Risk-based concentrations (RBCs)** are media-specific concentrations derived by Region 3 of the U.S. Environmental Protection Agency from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

† **TDSWM-SRS** Remediation Guidance Limit (RGLs) as regulated by EPA.

Table E-4 Results for Soil Sampling at Pasminco Zinc, *on Facility Property*

Metals concentrations in on-site soils, Pasminco Zinc Plant, 1999 (mg/l)					
Metal	**sample 1**	**sample 2**	**sample 3**	**sample 4**	**EPA RBC* for industrial soil**
aluminum	1,570	18,600	8,100	3,890	2,000,000
antimony	ND	ND	ND	ND	820
arsenic	1.75	**7.42**	**5.19**	2.77	3.8
barium	50.5	80.1	120	30.6	140,000
beryllium	ND	ND	ND	ND	4,100
cadmium	32.2	ND	24.2	10.1	1,000
calcium	2,930	895	452	765	NA
chromium	1.17	34.0	7.88	14.2	6,100
cobalt	ND	ND	ND	ND	41,000
copper	14.0	7.03	11.0	2.37	82,000
iron	2,660	18,200	12,400	11,600	610,000
lead	6.02	10.9	10.6	5.93	400†
magnesium	1,170	1,040	675	227	NA
manganese	565	508	735	161	41,000
mercury	ND	ND	ND	0.12	20.0‡
nickel	ND	11.9	6.35	1.98	41,000
potassium	ND	1,120	362	77.9	NA
selenium	ND	ND	ND	ND	10,000
silver	ND	ND	ND	ND	10,000
sodium	99.8	ND	15.0	ND	NA
thallium	ND	ND	ND	ND	140
vanadium	ND	34.4	17.3	17.2	14,000
zinc	1,750	166	844	508	610,000

mg/kg: milligrams of contaminant per kilogram of soil.
ND: Not detected at laboratory reporting limit.

*** RBC: Risk-based concentrations (RBCs)** are media-specific concentrations derived by Region 3 of the U.S. Environmental Protection Agency (EPA) from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

† 400 mg/kg is a risk-based screening level from EPA Region 6.

‡ **TDSWM-SRS** Remediation Guidance Limit (RGLs) as regulated by EPA.

Highlighted values exceed the EPA Industrial Soil Standard

Table E-5 Sampling Analysis for Metals in Sediment, *on the Property of Pasminco Zinc*

Metal (mg/kg)	Sediment Analytical results for Pasminco Zinc, 1999 (mg/kg)							
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	EPA RBC* for industrial soil
aluminum	9,250	6,620	11,000	7,780	12,200	7,320	11,400	2,000,000
antimony	ND‡	ND	ND	ND	ND	ND	ND	820
arsenic	**4.40**	**4.04**	**4.26**	**5.91**	**5.35**	**3.94**	**4.26**	3.8
barium	98.3	86.9	97.3	122	101	54.5	77.2	140,000
beryllium	ND	ND	ND	ND	ND	ND	ND	4,100
cadmium	15.9	2.31	23.1	21.7	9.50	50.8	2.13	1,000
calcium	2,200	1,460	2,870	2,200	1,960	5,450	3,540	NA
chromium	10.5	6.73	14.9	9.06	13.1	9.06	13.9	6,100
cobalt	8.8	ND	ND	12.0	ND	5.12	ND	41,000
copper	10.1	3.65	15.7	8.66	7.52	13.2	8.12	82,000
iron	16,600	9,020	14,500	15,900	14,900	9,170	12,500	610,000
lead	13.4	7.88	28.7	17.5	13.7	23.2	13.3	400†
magnesium	1,210	587	1,090	811	1,060	833	1,210	NA
manganese	340	1,280	424	748	475	602	702	41,000
mercury	ND	ND	0.34	0.49	ND	0.11	ND	20.0‡
nickel	14.1	6.54	15.7	14.0	13.7	8.86	14.3	41,000
potassium	597	333	831	490	1,020	549	907	NA
selenium	ND	ND	ND	ND	ND	ND	ND	10,000
silver	ND	ND	ND	ND	ND	ND	ND	10,000
sodium	14.7	ND	30.2	32.7	36.4	69.1	17.4	NA
thallium	ND	ND	ND	ND	ND	ND	ND	140
vanadium	15.5	12.5	18.0	16.5	19.4	12.8	19.0	14,000
zinc	478	134	740	520	380	1,170	112	610,000

mg/kg: milligrams of contaminant per kilogram of sediment.
ND: Not detected at laboratory reporting limit.

* **RBC**: **Risk-based concentrations (RBCs)** are media-specific concentrations derived by Region 3 of the U.S. Environmental Protection Agency (EPA) from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

† 400 mg/kg is a risk-based screening level from EPA Region 6.

‡ **TDSWM-SRS** Remediation guidance limit (RGLs) as regulated by EPA.

Highlighted values exceed the EPA Industrial Soil Standard

Table E-6 ATSDR Exposure Investigation Results; Contaminant Concentrations of Metals in Soil, 2000

Soil sampling results in residential yards, Cumberland Heights 2000 (mg/kg)											
metal	**sample 1**	**sample 2**	**sample3**	**sample 4**	**sample 5**	**sample 6**	**sample 7**	**sample 8**	**sample 9**	**sample 10**	**sample 11**	**EPA RBCs* for residential soil**
aluminum	7,900	8,100	9,800	9,200	7,100	6,600	7,300	10,000	9,700	8,300	12,000	2,000,000
arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.8
beryllium	0.35	0.41	0.51	0.31	0.49	0.37	0.53	0.47	0.39	0.43	0.43	4,100
calcium	150	570	34,000	2,000	2,200	1,400	3,200	3,500	5,800	33,000	39,000	NA-essential nutrient
cadmium	ND	ND	2.3	ND	1.1	ND	ND	4.0	4.1	3.2	2.1	1,000
cobalt	12.0	7.8	7.2	3.4	6.4	7.3	6.1	5.5	6.1	5.2	3.7	41,000
chromium	16.0	14.0	16.0	19.0	16.0	11.0	12.0	23.0	14.0	12.0	53.0	6,100
copper	7.0	5.4	33.0	8.3	9.4	6.9	7.3	14.0	13.0	19.0	86.0	82,000
iron	12,000	9,800	10,000	16,000	12,000	9,800	8,400	17,000	12,000	11,000	7,300	610,000
lithium	5.8	5.6	ND	3.4	1.3	2.9	ND	2.6	ND	ND	ND	1,600
magnesium	430	530	1,800	790	570	580	630	880	910	2,000	3,800	NA-essential nutrient
manganese	460	480	3,500	280	550	450	570	410	600	360	200	41,000
molybdenum	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	390
nickel	6.1	7.0	9.3	6.4	7.7	6.5	6.7	12.0	8.9	9.3	38.0	41,000
lead	19.0	14.0	26.0	12.0	41.0	36.0	18.0	28.0	36.0	28.0	39.0	400†
phosphorus	160	210	1,600	550	380	430	400	590	510	1,100	5,300	NA
platinum	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10,000
silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10,000
sodium	ND	ND	86.0	ND	ND	ND	ND	ND	ND	150.0	14,000	NA
tellurium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	140
titanium	43.0	47.0	98.0	21.0	29.0	36.0	37.0	30.0	50.0	110	110	310,000
vanadium	22.0	17.0	17.0	29.0	18.0	14.0	16.0	27.0	18.0	14.0	17.0	14,000

Soil sampling results in residential yards, Cumberland Heights 2000(mg/kg)[1] Soil											
zinc	36.0	34.0	210	88.0	100	180	110	330	280	270	960	610,000
zirconium	7.4	4.3	7.8	9.2	4.7	2.4	3.2	7.3	7.5	7.8	16.0	NA

mg/kg: milligrams of contaminant per kilogram of sediment.

ND: Not detected at laboratory reporting limit.

*** RBCs**: **Risk-based concentrations (RBCs)** are media-specific concentrations derived by Region 3 of the Environmental Protection Agency (EPA) from RfDs, RfCs, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

† 400 mg/kg is a risk-based screening level from EPA Region 6.

Highlighted values exceed the EPA Industrial Soil Standard

Appendix F: Cancer Information for Cumberland Heights Residents

Montgomery County Cancer Profiles

The following information was made possible with excerpts from fact sheets distributed by the American Cancer Society and the National Cancer Institute. The cancers listed are the types of cancers diagnosed in Newtown between 1980 and 1996. Hopefully, this information will help residents understand each type of cancer, its symptoms, and risk factors a little better. The cancers described in this section are the more common cancers in the United States and were also present in Montgomery County.

What is Cancer?

Cancer is a group of many related diseases. All forms of cancer involve out-of-control growth and spread of abnormal cells. Normal body cells grow, divide, and die in an orderly fashion. During the early years of a person's life, normal cells divide more rapidly until the person becomes an adult. After that, normal cells of most tissues divide only to replace worn-out or dying cells and to repair injuries.

Cancer cells, however, continue to grow and divide, and can spread to other parts of the body. These cells accumulate and form tumors (lumps) that may compress, invade, and destroy normal tissue. If cells break away from such a tumor, they can travel through the bloodstream, or the lymph system (part of the body that fights off infection) to other areas of the body. There, they may settle and form "colony" tumors. In their new location, the cancer cells continue growing. The spread of a tumor to a new site is called *metastasis*. When cancer spreads, though, it is still named after the part of the body where it started. For example, if prostate cancer spreads to the bones, it is still prostate cancer, and if breast cancer spreads to the lungs it is still called breast cancer.

Leukemia, a form of cancer, does not usually form a tumor. Instead, these cancer cells involve the blood and blood-forming organs (bone marrow, lymphatic system, and spleen), and circulate through other tissues where they can accumulate. It is important to realize that not all tumors are cancerous. *Benign* (noncancerous) tumors do not metastasize and, with very rare exceptions, are not life-threatening.

How is cancer detected?

Cancer is often detected after a patient notices changes in their normal body functions, pain, or discomfort. A doctor does tests (*called screening*) because a patient is having symptoms or because it is routine to *screen* for some conditions. An example of a routine screening for cancer is a Pap smear, at a woman's annual gynecologic exam. Screening may involve a physical exam, lab tests, and/or procedures to look at internal organs, either directly or indirectly. During a physical exam, the doctor looks for anything unusual and feels for any lumps or growths. Examples of lab tests include blood and urine tests, the Pap test (microscopic examination of cells collected from the cervix), and the fecal occult blood test (to check for hidden blood in stool). Internal organs can be seen directly through a thin lighted tube (such as a sigmoidoscope, which lets the doctor see the rectum and the lower part of the colon) or indirectly with x-ray images (such as mammograms to check the breasts).

Doctors consider many factors before recommending a screening test. They weigh factors related to the individual, the test, and the cancer that the test is intended to detect. For example, doctors take into account the person's age, medical history and general health, family history, and lifestyle. These factors greatly influence a person's health and well-being. In addition, they assess the accuracy and the risks of the screening test and any followup tests that may be necessary. Doctors also consider the effectiveness and side effects of the treatment that will be needed if cancer is found. People may want to discuss any concerns or questions they have with their doctors, so they can weigh the pros and cons and make an informed decision about whether to have a screening test.

What are the symptoms of cancer?

A symptom is an indication of disease, illness, injury, or that something is not right in the body. Symptoms are felt or noticed by a patient, but not easily observed by anyone else. For example chills, weakness, achiness, shortness of breath, and a cough are symptoms that might indicate pneumonia. A sign is also an indication of illness, injury, or that something is not right in the body. But, signs are defined as observations made by a physician, nurse or other health care professional. Fever, rapid breathing rate, abnormal breathing sounds heard through a stethoscope are signs that may indicate pneumonia.

The presence of one symptom or sign may not provide enough information to suggest a cause. For example a rash in a child could be a symptom of a number of things including poison ivy, a generalized infection like rubella, an infection limited to the skin, or a food allergy. But, if the rash is associated with a high fever, chills, achiness and a sore throat, then all of the symptoms together provide a better picture of the illness. In many cases, a patient's signs and symptoms do not provide enough clues to determine the cause of an illness, and medical tests such as x-rays, blood tests, or a biopsy may be needed.

Although some generalized symptoms and signs such as unexplained weight loss, fever, fatigue, or lumps may be due to several types of cancer, they are often caused by other types of diseases. Other signs and symptoms are relatively specific to a particular type of cancer. ***It is important to see your doctor so they can correctly determine if your symptoms are an indication of cancer or something less serious.***

How is cancer treated?

Treatment choices for the person with cancer depend on the stage of the tumor, that is, if it has spread and how far. Treatment options may include surgery, radiation, chemotherapy, hormone therapy, and immunotherapy:

- *Surgery* is the oldest form of treatment for cancer. Before the discovery of anesthesia and antisepsis (methods such as sterilization of instruments to prevent infection), surgery was performed with great discomfort and risk to the patient. Today surgery offers the greatest chance for cure for many types of cancer. About 60% of people with cancer will have some type of surgery, or operation.
- *Radiation therapy* uses high-energy particles or waves, such as x-rays or gamma rays, to destroy or damage cancer cells.
- *Chemotherapy* is the use of medicines (drugs) to treat cancer. Systemic chemotherapy uses anticancer drugs that are usually given into a vein or by mouth. These drugs enter the bloodstream and reach all areas of the body, making this treatment potentially useful for cancer that has spread.
- *Hormone Therapy* is treatment with hormones, drugs that interfere with hormone production or hormone action, or surgical removal of hormone-producing glands to kill cancer cells or slow their growth.
- *Immunotherapy* is the use of treatments that promote or support the body's immune system response to a disease such as cancer.

- Alternative and Complementary Therapies
  Unproven therapy is any therapy that has not been scientifically tested and approved. Use of an unproven therapy instead of standard therapy is called *alternative therapy*. Some alternative therapies have dangerous or even life-threatening side effects. For others, the main danger is that a patient may lose the opportunity to benefit from standard therapy. *Complementary therapy*, on the other hand, refers to therapies used in addition to standard therapy. Some complementary therapies may help relieve certain symptoms of cancer, relieve side effects of standard cancer therapy, or improve a patient's sense of well-being. The American Cancer Society recommends that patients considering use of any alternative or complementary therapy discuss this with their health care team.

What are risk factors for cancer and how can cancer be prevented?
A *risk factor* is anything that increases a person's chance of developing a disease such as cancer. Different cancers have different risk factors. For example, smoking is a risk factor for cancers of the lungs, mouth, throat, larynx, bladder, and several other organs. It is important to remember, however, that these factors increase a person's risk but do not always "cause" the disease. ***Many people with one or more risk factors never develop cancer, while others with this disease have no known risk factors.*** It is important, however, to know about risk factors so that appropriate action can be taken, such as changing a health behavior or being monitored closely for a potential cancer.

All cancers caused by cigarette smoking and heavy use of alcohol could be prevented completely. The ACS estimates that in 2000 about 171,000 cancer deaths are expected to be caused by tobacco use, and about 19,000 cancer deaths may be related to excessive alcohol use, frequently in combination with tobacco use. Many cancers that are related to dietary factors could also be prevented. Scientific evidence suggests that up to one-third of the 552,200 cancer deaths expected to occur in the US in 2000 are related to nutrition and other lifestyle factors and could also be prevented. Certain cancers are related to viral infections-for example, hepatitis B virus (HBV), human papillomavirus (HPV), human immunodeficiency virus (HIV), human T-cell leukemia/lymphoma virus-I (HTLV-I), and others-and could be prevented through behavioral changes. In addition, many of the 1.3 million skin cancers that are expected to be diagnosed in 2000 could have been prevented by protection from the sun's rays.

Regular screening examinations by a health care professional can result in the detection of cancers of the breast, colon, rectum, cervix, prostate, testis, oral cavity, and skin at earlier stages, when treatment is more likely to be successful. Self examinations for cancers of the breast and skin may also result in detection of tumors at earlier stages. The screening-accessible cancers listed above account for about half of all new cancer cases. The 5-year relative survival rate for these cancers is about 80%. If all Americans participated in regular cancer screenings, this rate could increase to 95%.

Cancer Diagnosed in Montgomery County
(note: cancers are in alphabetical order)

Bladder Cancer

Where is the bladder located and what does it do?
The bladder is a hollow organ in the lower abdomen. It stores urine, the waste that is produced when the kidneys filter the blood.

How common is bladder cancer?
Each year, nearly 55,000 people in the United States learn that they have bladder cancer.

What are the symptoms of bladder cancer?
Some common symptoms of bladder cancer include: blood in the urine (slightly rusty to deep red in color), pain during urination, and frequent urination, or feeling the need to urinate without results. When symptoms occur, they are not sure signs of bladder cancer. They may also be caused by infections, benign tumors, bladder stones, or other problems. A screening should be done by a doctor to make a diagnosis.

Who is most at risk for bladder cancer?
Researchers have found that white people in the United States get bladder cancer twice as often as African-Americans, and men are affected about three times as often as women. People with family members who have bladder cancer may be more likely to get the disease as well. Most bladder cancers occur after the age of 55, but the disease can also develop in younger people. Smoking cigarettes can increase risk of developing bladder cancer two to three times that of a nonsmoker. Also, occupational hazards have been associated with developing bladder cancer. Increased risk is seen in people in the rubber, chemical, and leather industries, as well as in hairdressers, machinists, metal workers, printers, painters, textile workers, and truck drivers (NCI).

Breast Cancer

How common is breast cancer?
Beyond skin cancer, breast cancer is the most common cancer among women, accounting for nearly one of every three cancers diagnosed in the United States. Last year, 215,000 new cases of breast cancer were diagnosed.

What are the risk factors for breast cancer?
Breast cancer has a number of risk factors including: age, race, gender (male breast cancer is rare), a family or personal history of breast cancer, use of birth control pills, use of estrogen replacement hormones, alcohol, and diet. Breast cancer is most common in older women, with 84 percent of breast cancer deaths occurring in women 50 years of age and older. Generally, breast cancer is more common in white women, however, black women under age 50 have higher incidence rates of breast cancer than white women under age 50. There is also evidence that suggests women who breastfeed their babies have a lower risk of breast cancer than women who do not.

What should I do to detect breast cancer early?
Following the American Cancer Society's guidelines for the early detection of breast cancer improves the chances that breast cancer can be diagnosed at an early stage and treated successfully.

- Women aged 40 and older should have a screening mammogram every year.
- Between the ages of 20 and 39, women should have a clinical breast examination by a health professional every 3 years. After age 40, women should have a breast exam by a health professional every year.
- Women aged 20 or older should perform breast self-examination (BSE) every month. By doing the exam regularly, you get to know how your breasts normally feel and you can more readily detect any change. If a change occurs, such as development of a lump or swelling in the breast or underarm area, skin irritation or dimpling, nipple pain or retraction (turning inward), redness or scaliness of the nipple or breast skin, or a discharge other than breast milk, you should see your health care provider as soon as possible for evaluation. However, remember that most of the time, these breast changes are not cancer.

Cervical Cancer

What is the cervix?
The cervix is the lower part of the womb (uterus). The uterus has two parts. The upper part, called the body of the uterus, is where the baby grows. The cervix, in the lower part, connects the body of the uterus to the vagina, or birth canal. Cervical cancer begins in the lining of the cervix.

How common is cervical cancer?
Cervical cancer is diagnosed in approximately 12,800 women annually, and approximately 4,600 women will die from it this year.

What are the symptoms of cervical cancer?
It is important to remember that cervical precancers and early cancers usually show no symptoms or signs. A woman usually develops symptoms when the cancer has become invasive. An unusual discharge from the vagina (separate from your normal monthly menstrual period) can be a sign of cervical cancer. Such discharges may include blood spots or light bleeding and may occur in between or following your periods. Bleeding following intercourse is a common symptom. Pain during intercourse may also indicate cervical cancer. However, all of these signs and symptoms can be caused by conditions other than cervical cancer. For example, an infection can cause pain or bleeding.

What are the risk factors for cervical cancer?
The most important risk factor for cervical cancer is infection with the Human Papilloma Virus (HPV), which often manifests itself as genital warts. It is transmitted from one person to another during sex. Black women have a death rate from cervical cancer over twice the national average. Unprotected sex makes infection more likely. HIV (the virus that causes AIDS) infection also makes a woman more likely to develop cervical cancer, as well as smoking, and diet. Regular Pap tests during a woman's annual exam can result in early detection and increase chances of surviving the cancer. Primary prevention of this disease is use of condoms, monogamous sexual relationships, and smoking cessation. Beyond smoking cigarettes, no other chemical risks have been identified.

Colon and Rectal Cancers

Where do colon and rectal cancers develop?
Colon and rectal cancer develop in the digestive tract, which is also the gastrointestinal, or GI, tract. The colon is the first part of the large bowel, or large intestine and is connected to the small intestine. The first part of the large bowel, called the colon continues to absorb water and mineral nutrients from the food matter and serves as a storage place for waste matter. The waste matter left after this process goes into the rectum, the final 6 inches or so of the large bowel. From there it passes out of the body through the anus. The digestive system processes food for energy and rids the body of solid waste matter (fecal matter or stool).

How common are colon and rectal cancers (also called colorectal cancer)?
Among men and women, colorectal cancer is the third most common cancer diagnosed in Americans. About 93,800 new cases of colon cancer (43,400 men and 50,400 women) and 36,400 new cases of rectal cancer (20,200 men and 16,200 women) will be diagnosed in 2000. Colon cancer is expected to be responsible for about 47,700 deaths(23,100 men and 24,600 women) during 2000. About 8,600 people(4,700 men and 3,900 women) will die from rectal cancer during 2000.

What are the symptoms people with colorectal cancers have?

Common signs and symptoms of colorectal cancer include:

- A change in bowel habits
- Diarrhea, constipation, or feeling that the bowel does not empty completely
- Blood (either bright red or very dark) in the stool
- Stools that are narrower than usual
- General abdominal discomfort (frequent gas pains, bloating, fullness, and/or cramps)
- Weight loss with no known reason
- Constant tiredness
- Vomiting

What are the risk factors for colorectal cancer?

Certain things can put a person at higher risk for developing colorectal cancers, such as: a family history of colon or rectal cancers, having had colon or rectal cancer before, a history of intestinal polyps (small growths), history of inflammatory bowel syndrome, aging (90% of colorectal cancers are in people over 50 years old), high fat diets, physical inactivity, and obesity. Some of these risk factors can be controlled and others are *genetic* (hereditary, or passed down in families) and cannot. However, early detection can greatly increase the chances that a person diagnosed with colorectal cancer will survive the disease (ACS).

Esophageal Cancer

What does the esophagus do?

Esophageal cancer starts in the muscular tube that connects the throat to the stomach, the esophagus. This tube allows food to enter the stomach for digestion. The esophagus is about 10-13 inches long. At its smallest point, it is a little less than one inch wide.

How common is esophageal cancer?

Approximately 12,300 people are diagnosed annually with esophageal cancer.

What are the symptoms of esophageal cancer?

Trouble swallowing (dispahgia) is the most common symptom of cancer of the esophagus. It means that you feel as if food is lodged in the chest. Other symptoms include: pain swallowing or pain, weight loss, in the chest that feels like heartburn, hoarseness, hiccups, pneumonia, and high calcium levels are usually signs of more advanced cancer.

Who is at greatest risk, or is most likely to get esophageal cancer?

Esophageal cancer is three times more common in men than women, and three times more common among African American than whites. It is also more common in the elderly. Other risk factors also include drinking and smoking.

Kidney Cancer

What are kidneys and what do they do?

The kidneys are two reddish-brown, bean-shaped organs located just above the waist, one on each side of the spine. They are part of the urinary system. Their main function is to filter blood and produce urine to rid the body of waste. As blood flows through the kidneys, they remove waste products and unneeded water (NCI).

How common is kidney cancer?

The American Cancer Society predicts that there will be about 31,200 new cases of kidney cancer in the year 2000 in this country. About 11,900 people, adults and children, will die from this disease (ACS).

What are the symptoms of kidney cancer?

If the disease is found early, the chances of surviving kidney cancer are very good. Noticing early symptoms often helps in early diagnosis. Blood in the urine is the most common sign of renal cell cancer. Blood in the urine can also be caused by a bladder infection or some other non-cancerous kidney disease. Signs and symptoms of renal cell cancer include: blood in the urine, low back pain (not from an injury), mass or lump in the belly, tiredness, weight loss (rapid, and without a known reason), fever (not from a cold, the flu, or other infection), swelling of ankles and legs, and high blood pressure.

What increases the risk of someone developing kidney cancer?

Risk factors for kidney cancer include:

- Smoking: smoking doubles the risk of getting kidney cancer.
- Overuse of certain painkillers: pain killers containing phenacetin were once popular non-prescription medications, but they have not been available in the United States for over 20 years.
- Asbestos: some studies show a link between exposure to asbestos in the workplace and kidney cancer.
- Cadmium: there may be a link between cadmium exposure and kidney cancer. Also, cadmium may increase the cancer-causing effect of smoking. Workers can be exposed to cadmium in the air from working with products such as batteries, paints, or welding materials.
- Gene changes (mutations): Genes are made up of DNA and are the basic units of heredity. They are the reason we resemble our parents. Changes or mutations in certain genes can increase the risk of developing kidney tumors. Some of these changes are inherited (people with a family history of renal cell cancer have an increased risk) and some can be caused by later damage, for example, by cigarette smoke.
- von Hippel-Lindau syndrome: this disease, caused by an inherited gene mutation (change), increases the chances of renal cell cancer and other types of cancer.
- Tuberous sclerosis: patients who have this disease often have cysts in the kidneys, liver, and pancreas and are more likely to get renal cell cancer.
- Diet and weight: some studies show a link between being overweight, a diet high in fat, and renal cell cancer.
- Long-term dialysis: people who have been on dialysis for a long time may develop cysts in their kidneys that can give rise to renal cell cancer.
- Age: RCC is rare in children and young adults; it is found mostly in adults between the ages of 50-70 years.
- Sex: men are twice as likely to get renal cell cancer as are women.

Chronic Lymphoproliferative and Myeloproliferative Disorders

What is leukemia and how does it affect the body?

Leukemia is cancer of the white blood cells. This cancer starts in the bone marrow but can then spread to the blood, lymph nodes, the spleen, liver, central nervous system and other organs. In order to understand the different types of leukemia, it is helpful to have some basic knowledge of the blood and lymph systems. Following is an explanation of some of the parts of these systems.

Bone marrow is the soft, spongy, inner part of bones. All of the different types of blood cells are made in the bone marrow. In babies, bone marrow is found in almost all the bones of the body. But by the teen-age years, it is found mostly in the flat bones such as those of the skull, shoulder blades, ribs, pelvis, and back bones. Bone marrow is made up of blood-forming cells, fat cells, and tissues that aid the growth of blood cells. Early (primitive) blood cells are called stem cells. These stem cells grow (mature) in an orderly process to produce red blood cells, white blood cells, and platelets. Red blood cells carry oxygen from the lungs to all other tissues of the body. They also carry away carbon dioxide, a waste product of cell activity. A shortage of red blood cells (anemia) causes weakness, shortness of breath, and tiredness.

White blood cells (leukocytes) help defend the body against germs--viruses and bacteria. There are quite a few types (and sub-types) of white blood cells. Each has a special role to play in protecting the body against infection. The three main types of white blood cells are granulocytes, monocytes, and lymphocytes. The suffix--cyte means cell. Platelets are actually pieces that break off from certain bone marrow cells. They are called platelets because they look a little bit like plates when seen under the microscope. Platelets help prevent bleeding by plugging up areas of blood vessels damaged by cuts or bruises.

The lymphatic system consists of lymph vessels, lymph nodes, and lymph fluid. Lymph vessels are like veins except that they carry a clear fluid, lymph, instead of blood. Lymph is composed of excess fluid from tissues, waste products, and immune system cells. Lymph nodes (sometimes called lymph glands) are pea-sized organs found along the lymph vessels. Lymph nodes collect immune system cells. The nodes get bigger when they fight infection. Swollen lymph nodes are not usually serious, especially in children but rarely they can be a sign of leukemia when the cancer has spread outside the bone marrow.

There are four major types of leukemia: acute versus chronic and lymphocytic versus myelogenous. Acute means rapidly growing. Although the cells grow rapidly, they are not able to mature properly. Chronic refers to a condition where the cells look mature but they are not completely normal. The cells live too long and cause a build-up of certain kinds of white blood cells. Lymphocytic and myelogenous (or myeloid) refer to the two different cell types from which leukemias start. Lymphocytic leukemias develop from lymphocytes in the bone marrow. Myelogenous leukemia develops from either of two types of white blood cells: granulocytes or monocytes.

How common is leukemia?

The American Cancer Society predicts that, in the year 2000, there will be about 30,800 new cases of all types of leukemia in this country. Of these, about 12, 500 will be chronic leukemia: 8,100 chronic lymphocytic leukemia (CLL) and 4,400 chronic myelogenous leukemia (CML). The remaining cases are of other chronic types. Chronic leukemia affects mostly older adults. Only about 2% of chronic leukemia patients are children.

What are the symptoms of leukemia?

At least one-fifth of people with chronic leukemia have no symptoms at the time their cancer is diagnosed. Their cancer is diagnosed by blood tests performed during an evaluation some unrelated health problem or during a routine checkup. Even when symptoms are present, they are often vague and nonspecific. Most symptoms of chronic leukemia, such as weakness, fatigue, reduced exercise tolerance, weight loss, fever, bone pain, and pain or a sense of "fullness" in the abdomen (especially after eating a small meal) can also occur with other cancers as well as many noncancerous conditions. Many of the signs and symptoms of chronic leukemia occur because the leukemic cells replace the bone marrow's normal blood-producing cells. As a result, people do not have enough properly functioning red blood cells, white blood cells, and blood platelets.

Other symptoms include:

- Anemia, a shortage of red blood cells, causes excessive tiredness, a "pale" color to the skin, and in more serious cases, shortness of breath.
- Not having enough normal white blood cells increases the risk of infections. Although leukemia is a cancer of white blood cells and patients with leukemia may have very high white blood cell counts, the leukemic cells do not protect against infection the way normal white blood cells do.
- Thrombocytopenia (not having enough of the blood platelets needed for plugging holes in damaged blood vessels) can lead to excessive bruising, bleeding, frequent or severe nosebleeds, and bleeding gums.
- Leukemia cells may spread to other organs and can cause symptoms there. For example, spreading to the brain may cause headaches, weakness, seizures, vomiting, difficulty in maintaining balance, or blurred vision.
- Some patients have bone pain or joint pain caused by leukemic cells spreading from the marrow cavity to the surface of the bone or into the joint.
- Leukemia often causes enlargement of the liver and spleen, organs located on the upper right and upper left side of the abdomen, respectively. Enlargement of these organs may be noticed as a fullness, or even swelling, of the belly. These organs are usually covered by the lower ribs but when they are abnormally large, they can be felt by a doctor.
- Leukemia may spread to lymph nodes. If the affected nodes are close to the surface of the body (for example, lymph nodes on the sides of the neck, in the groin, the underarm areas, and above the collarbone), the patient or health care provider may notice the swelling. Swelling of lymph nodes inside the chest or abdomen may also occur, but can be detected only by imaging tests.

What are the risk factors for developing leukemia?
There are some factors in the environment that are linked to chronic leukemia. For example, high-dose radiation exposure (such as from an atomic blast or nuclear reactor accident) increases the risk of CML but not CLL. Long-term contact with herbicides or pesticides among farmers can increase their risk of CLL. There is some concern about very high-voltage power lines as a risk factor for leukemia. The NCI has several large studies going on now to look into this question. So far, the studies show either no increased risk or a very slightly increased risk. Clearly, most cases of leukemia are not related to power lines. The only known inherited risk factor for chronic leukemia is having first-degree relatives (parents, siblings, or children) who have had CLL. Most people who develop leukemia, however, do not have any of the above risk factors. The cause of their leukemia remains unknown at this time. Because the cause is not known, there is no way to prevent most cases of leukemia. The exception is smoking, which has been shown to increase the risk of leukemia.

Liver Cancer

Where is the liver and what does it do?
Liver cancer begins in the liver, the largest organ in the body. The liver weighs about three pounds. It is found under the right lung. The liver has two sections, called lobes. Each is divided into segments. It is one of the most important organs and has a number of vital tasks, such as storing and changing vitamins and nutrients so they can be used by the body, creating the agents responsible for allowing blood to clot, and controlling the level of blood glucose in the body.

How common is liver cancer and who is at highest risk?

In this country, liver cancer is found more often in men than in women. The American Cancer Society predicts that there will be about 15,300 new cases of liver cancer in the year 2000 in this country. About 13,800 people will die of the disease. Liver cancer is fairly rare in the United States and Europe. However, in the United States, rates in the black populations and Hispanic populations are roughly twice as high as the rates in whites. Liver cancer is very common in Asian countries and the highest rate of liver cancer in the United States is found in Vietnamese males and other Asian Americans.

What are the symptoms of liver cancer?
There are signs and symptoms of liver cancer in later stages. These could include weight loss, lack of appetite, pain in the stomach area and sudden jaundice (yellow-green color of skin and eyes). These problems can also be caused by many illnesses other than cancer. Physicians can perform the appropriate tests to determine whether the symptoms are cancer, or a less serious condition.

What are the risk factors of developing liver cancer?
Having certain diseases can increase a person's risk of getting liver cancer. These include infection with the hepatitis B or hepatitis C virus. Cirrhosis of the liver (formation of scar tissue in the liver) is another risk factor for liver cancer. Cirrhosis can be caused by alcohol abuse or by a disorder that causes iron to build up in the liver. Exposure to certain chemicals can also increase the risk of liver cancer. These include:

- Aflatoxin: This substance is made by a fungus found in tropical and subtropical regions. It often infects wheat, peanuts, soybeans, corn, and rice in those areas.
- Vinyl chloride and thorium dioxide: These chemicals are used far less often today or are strictly controlled.
- Anabolic steroids: These are male hormones. They are sometimes given for medical reasons, but some athletes also take them to increase their strength.
- Arsenic: In some parts of the world, drinking water contains traces of arsenic. This can increase the risk of liver cancer.
- Tobacco: Some studies suggest a link between tobacco use and liver cancer. Others do not.
- Birth control pills: Most of the studies linking birth control pills to liver cancer involved types of pills no longer in use. We do not know whether current birth control pills increase liver cancer risk.

Lung Cancer

How common is lung cancer?
Lung cancer is the leading cause of cancer death for both men and women. During the year 2000 there will be about 164,100 new cases of lung cancer in this country. About 156,900 people will die of lung cancer: about 89,300 men and 67,600 women. More people die of lung cancer than of colon, breast, and prostate cancers combined. Lung cancer is fairly rare in people under the age of 40. The average age of people found to have lung cancer is 60.

What are the symptoms of lung cancer?
Symptoms of lung cancer include:
- A cough that does not go away
- Chest pain, often made worse by deep breathing
- Hoarseness
- Weight loss and loss of appetite
- Bloody or rust-colored sputum (spit or phlegm)

- Shortness of breath
- Fever without a known reason
- Recurring infections such as bronchitis and pneumonia
- New onset of wheezing

When lung cancer spreads to distant organs, it may cause:
- Bone pain
- Weakness or numbness of the arms or legs, dizziness
- Yellow coloring of the skin and eyes (jaundice)
- Masses near the surface of the body, caused by cancer spreading to the skin or to lymph nodes in the neck or above the collarbone

What are the risk factors for lung cancer?
Smoking is by far the leading risk factor for lung cancer. More than 8 out of 10 lung cancers are thought to result from smoking. Nonsmokers who breathe the smoke of others also increase their risk of lung cancer. Non-smoking spouses of smokers, for example, have a 30% greater risk of developing lung cancer than do spouses of nonsmokers. Workers exposed to tobacco smoke in the workplace are also more likely to get lung cancer. There are other risk factors for lung cancer besides smoking. People who work with asbestos have a higher risk of getting lung cancer. If they also smoke, the risk is greatly increased. Besides smoking and asbestos, there are a few other risk factors for lung cancer. These include certain cancer-causing agents in the workplace, radon gas, and lung scarring from some types of pneumonia. Also, people who have had lung cancer in the past have a higher chance of having it again and, as mentioned earlier, the risk of lung cancer increases with age. Some studies have shown that the lung cells of women who smoke may develop cancer more easily than those of men. While some people believe that air pollution is a major cause of lung cancer, the truth is that air pollution only slightly increases the risk. Smoking is by far the more important cause. Even so, some people who have never smoked or worked with asbestos still get lung cancer. Since we do not know why this happens, there is no sure way to prevent it.

Multiple Myeloma

How does multiple myeloma affect the immune system?
The immune system is composed of several types of cells that work together to fight off infections and other diseases. Lymphocytes (lymph cells) are the main cell type of the immune system. There are two types of lymphocytes: T-cells and B-cells. When B-cells respond to an infection, they mature and change into plasma cells. Plasma cells produce and release proteins called immunoglobins (antibodies) to attack and help kill disease-causing germs such as bacteria.

Multiple myeloma is a type of cancer formed by malignant plasma cells. Normal plasma cells are an important part of the immune system. When plasma cells grow out of control they can produce a tumor. These tumors can grow in several sites, particularly in the soft middle parts of bone called the bone marrow. When these tumors grow in multiple sites they are referred to as multiple myeloma.

How common is multiple myeloma?
Approximately 13,000 people are diagnosed with multiple myeloma a year.

What are the symptoms of multiple myeloma?
Symptoms of multiple myeloma depend on how advanced the disease is. In the earliest stage of the disease, there may be no symptoms. When symptoms do occur, patients commonly have bone pain,

often in the back or ribs. Patients also may have broken bones, weakness, fatigue, weight loss, or repeated infections. When the disease is advanced, symptoms may include nausea, vomiting, constipation, problems with urination, and weakness or numbness in the legs. These are not sure signs of multiple myeloma; they can be symptoms of other types of medical problems. A person should see a doctor if these symptoms occur.

What are the risk factors for multiple myeloma?
The following risk factors can make developing multiple myeloma more likely:

- Aging: Age is the most significant multiple myeloma risk factor. Only 2% of cases are diagnosed in people younger than 40. The average age at diagnosis is about 70.
- Race: Multiple myeloma is about twice as common among African Americans as white Americans. The reason is not known.
- Radiation exposure: Exposure to radioactivity has been suggested as a risk factor but accounts for a very small number of cases.
- Family history: This cancer may seem to be more common in some families. This is quite rare, however, and most patients have no affected relatives.
- Occupational exposure: Some studies have suggested that workers in certain petroleum-related industries may be at a higher risk.
- Other plasma cell diseases: About 20% of people with monoclonal gammopathy of undetermined significance (MGUS) or extramedullary plasmacytoma will eventually develop multiple myeloma.

Oral and Oropharyngeal Cancers

What are oral and oropharyngeal cancers?
Oral cancer is cancer that starts in the oral cavity (mouth). The oral cavity starts at the skin edge of the lips. It includes the lips, the buccal mucosa (inside lining of the lips and cheeks), the teeth, the gums, the front two-thirds of the tongue, the floor of the mouth below the tongue, the hard palate (bony roof of the mouth), and the retromolar trigone (area behind the wisdom teeth). Oropharyngeal cancer develops in the oropharynx (the part of the throat just behind the mouth). The oropharynx begins where the oral cavity stops. It includes the base of tongue (back third of the tongue), the soft palate, the tonsillar area (tonsils and tonsillar pillars), and the posterior pharyngeal wall (back wall of the throat).

How common are oral and oropharyngeal cancers?
The American Cancer Society estimates that there are 30,200 new cases of oral and oropharyngeal cancers diagnosed each year.

What are the symptoms of oral and oropharyngeal cancers?
Signs and symptoms of oral and oropharyngeal cancers include:

- a sore in the mouth that does not heal (most common symptom)
- a lump or thickening in the cheek
- a white or red patch on the gums, tongue, tonsil, or lining of the mouth
- a sore throat or a feeling that something is caught in the throat
- difficulty chewing or swallowing
- difficulty moving the jaw or tongue
- numbness of the tongue or other area of the mouth
- swelling of the jaw that causes dentures to fit poorly or
- become uncomfortable
- loosening of the teeth or pain around the teeth or jaw

- voice changes
- a lump or mass in the neck
- weight loss

What are the greatest risk factors of oral and oropharyngeal cancers?
The greatest risk factors for these cancers are drinking and smoking. Approximately 90 percent of people with this type of cancer are smokers, and approximately 75 to 80 percent of those diagnosed are frequent drinkers. Being male is also a risk factor. Males are diagnosed twice as often as women for oral and oropharyngeal cancers.

Pancreatic Cancer

What is the pancreas and what does it do?
The pancreas is a gland found behind the stomach. It is shaped a little bit like a fish with a wide head, a tapering body, and a narrow pointed tail. It is about six inches long but less than 2 inches wide. The pancreas extends horizontally across the abdomen (ACS). The pancreas is like an organ with two separate glands. It produces pancreatic juice, or enzymes, that break down food in the small intestine so it can be digested and its nutrients absorbed by the body to help tissue repair itself and grow. Some cells in the pancreas are arranged in clusters called islets. Islets release two hormones, insulin and glucagon, that are important in controlling the amount of sugar in the blood. Insulin and glucagon are released from the islet cells directly into the bloodstream and not into the ducts of the pancreas.

How common is pancreatic cancer and who is at greatest risk for the disease?
The American Cancer Society estimates that 28,300 Americans (13,700 men and 14,600 women) will be diagnosed with cancer of the pancreas during 2000. An estimated 28,200 Americans (13,700 men and 14,500 women) will die of pancreatic cancer in 2000, making this type of cancer the fourth leading cause of cancer death in men and in women. Men have higher incidence and mortality rates for pancreatic cancer than women in each racial/ethnic group. Black men and women have incidence and mortality rates that are about 50% higher than the rates for whites. Pancreatic cancer is rare in the 30-54 years age group. In the 55-69 years age group, incidence rates in the black populations exceed those for whites by about 60%. This difference diminishes somewhat among persons aged 70 years and older.

What are the symptoms of pancreatic cancer?
Pancreatic cancer has been called a "silent" disease because it usually does not cause symptoms early on. The cancer may grow for some time before it causes pressure in the abdomen, pain, or other problems. When symptoms do appear, they may be so vague that they are ignored at first. For these reasons, pancreatic cancer is hard to find early. In many, the cancer has spread outside the pancreas by the time it is found. When symptoms appear, they depend on the location and size of the tumor. If the tumor blocks the common bile duct so that bile cannot pass into the intestines, the skin and whites of the eyes may become yellow, and the urine may become dark. This condition is called jaundice. As the cancer grows and spreads, pain often develops in the upper abdomen and sometimes spreads to the back. The pain may become worse after the person eats or lies down. Cancer of the pancreas can also cause nausea, loss of appetite, weight loss, and weakness. Islet cell cancer can cause the pancreas to make too much insulin or other hormones. When this happens, the person may feel weak or dizzy and may have chills, muscle spasms, or diarrhea. Cigarette smoking has been identified consistently as an important risk factor for cancer of the pancreas. Other risk factors which have been suggested, but not confirmed include coffee drinking, high fat diets, diabetes mellitus and some occupations.

Prostate Cancer

Where is the prostate and what does it do?
The prostate is about the size of a walnut. It is just below the bladder and in front of the rectum. The tube that carries urine (urethra) runs through the prostate.

How common is prostate cancer?
Prostate Cancer is the second leading cause of death in men, second only to lung cancer. Approximately 180,400 men will be diagnosed with prostate cancer this year. The chance of having prostate cancer increases rapidly after age 50. More than 80% of all prostate cancers are diagnosed in men over the age of 65.

What are the symptoms of prostate cancer?
Most cases of early prostate cancer cause no symptoms and are found by a PSA blood test and/or DRE. Some prostate cancers may be found because of symptoms such as slowing or weakening of the urinary stream or the need to urinate more often. These symptoms are not specific, and can also be caused by benign diseases of the prostate, such as nodular hyperplasia. Symptoms of advanced prostate cancer include hematuria (blood in the urine), impotence (difficulty having an erection), and pain in the pelvis, spine, hips, or ribs. These symptoms may also be present with other diseases.

What are the risk factors of prostate cancer?
The greatest risk factor for prostate cancer is age. The majority of prostate cancers are diagnosed in men over the age of 65. Prostate cancer is about twice as common among African-American men as it is among white American men. Results of most studies suggest that men who eat a lot of fat in their diet have a greater chance of developing prostate cancer. Other risk factors, such as lack of physical activity and family history also increase risk of developing prostate cancer.

Testicular Cancer

What are the testis and what is their role in body functioning?
The testicles (also called testes or gonads) are a pair of male sex glands. They produce and store sperm, and are also the body's main source of male hormones. These hormones control the development of the reproductive organs and male characteristics. The testicles are located under the penis in a sac-like pouch called the scrotum.

How common is testicular cancer (cancer of the testis)?
The American Cancer Society estimates that in the year 2000 about 6,900 new cases of testicular cancer will be diagnosed in the United States. An estimated 300 men will die of testicular cancer in the year 2000. Testicular cancer is one of the most curable forms of the disease. Studies show that the cure rate exceeds 90% in all stages combined. Although testicular cancer accounts for only 1 percent of all cancers in men, it is the most common form of cancer in young men between the ages of 15 and 40. Any man can get testicular cancer, but it is more common in white men than in black men.

What are the symptoms of testicular cancer?
Symptoms of testicular cancer are usually markedly obvious. In about 90% of cases, men have a painless or an uncomfortable lump on a testicle, or they may notice testicular enlargement or swelling. Men with testicular cancer often report a sensation of heaviness or aching in the lower abdomen or scrotum.

What are the risk factors of testicular cancer?
The main risk factors for testicular cancer include:

- Age: Most men who develop testicular cancer are between the ages of 15 and 40.
- Undescended testicle (cryptorchidism): Normally, the testicles descend into the scrotum before birth. Men who have had a testicle that did not move down into the scrotum are at greater risk for developing the disease.
- Family history: A family history of testicular cancer increases the risk.
- Occupational risks: A recent study, found that nonseminoma germ cell tumors occur more frequently among men with certain occupations (miners, oil and gas workers, leather workers, food and beverage processing workers, janitors, and utility workers). It may be that exposure to certain chemicals contributes to development of the disease
- Race and ethnicity: The risk of testicular cancer among white American men is about five times that of African-American men and more than double that of Asian-American men. The risk for Hispanics is intermediate between that of Asians and non-Hispanic whites. The reason for this difference is not known. Testicular cancer risk has more than doubled among white Americans in the past 40 years but has remained the same for African-Americans.
- Testicular injury, HIV infection, and cancer of the other testicle are all other risk factors for testicular cancer.

Uterine Cancer

Where is the uterus located?
The uterus is a hollow, pear-shaped organ. It is located in a woman's lower abdomen between the bladder and the rectum. Attached to either side of the top of the uterus are the fallopian tubes, which extend from the uterus to the ovaries.

How common is uterine cancer?
An estimated 36,100 new cases of cancer of the uterine corpus (body of the uterus), usually of the endometrium, will be diagnosed in the United States during 2000. It is estimated that about 6,500 women in the United States will die from cancer of the uterine corpus during 2000.

What are symptoms of uterine cancer?
Abnormal vaginal bleeding, especially after menopause, is the most common symptom of uterine cancer. Bleeding may start as a watery, blood-streaked flow that gradually contains more blood. Although uterine cancer usually occurs after menopause, it sometimes occurs around the time that menopause begins. Abnormal bleeding should not be considered simply part of menopause; it should always be checked by a doctor. A woman should see a doctor if she has any of the following symptoms:

- Unusual vaginal bleeding or discharge
- Difficult or painful urination
- Pain during intercourse
- Pain in the pelvic area

These symptoms can be caused by cancer or other less serious conditions.

What increases a woman’s risk of developing uterine cancer?
Some factors increase the likelihood of developing uterine cancer, such as prior pelvic radiation therapy (used to treat other types of cancer), race (one type of uterine sarcoma, leiomyosarcoma, is more

common among African Americans than among whites or Asians), age (uterine sarcomas tend to occur in middle aged and elderly women, although they may affect younger women as well), and Endometrial cancer risk factors. Factors that increase a woman's risk of developing endometrial cancer also increase her risk for developing carcinosarcoma, but not any of the other types of uterine sarcoma. These factors tend to be related to levels of the female hormones, estrogen and progesterone. Obesity, certain types of estrogen replacement therapy, treatment with tamoxifen (a hormonal drug used for breast cancer treatment and breast cancer risk reduction), infertility, diabetes, starting menstrual periods before age 12, and reaching menopause after age 52 all increase the amount of estrogen a woman's uterus is exposed to, increase the duration of that exposure, or alter the balance between estrogen and progesterone toward a relative excess of estrogen.

To receive more detailed cancer information, please contact:

The American Cancer Society:
Toll free: 1-800-ACS-2345
Internet address: www.cancer.org

National Cancer Institute
Cancer Information Service 1-800-4-CANCER
Internet address: www.nci.nih.gov

You may want more information for yourself, your family, and your health care provider. The following National Cancer Institute (NCI) services are available to help you.

Telephone Cancer Information Service (CIS)
Provides accurate, up-to-date information on cancer to patients and their families, health professionals, and the general public. Information specialists translate the latest scientific information into understandable language and respond in English, Spanish, or on TTY equipment.

Toll-free: 1-800-4-CANCER (1-800-422-6237) TTY (for deaf and hard of hearing callers): 1-800-332-8615

Internet
These web sites may be useful:

- http://www.cancer.gov NCI's primary Web site; contains information about the Institute and its programs.
- http://cancertrials.nci.nih.gov cancerTrials™; NCI's comprehensive clinical trials information center for patients, health professionals, and the public. Includes information on understanding trials, deciding whether to participate in trials, finding specific trials, plus research news and other resources.
- http://cancernet.nci.nih.gov CancerNet™; contains material for health professionals, patients, and the public, including information from PDQ® about cancer treatment, screening, prevention, supportive care, and clinical trials; and CANCERLIT®, a bibliographic database.

E-mail
CancerMail includes NCI information about cancer treatment, screening, prevention, and supportive care. To obtain a contents list, send e-mail to cancermail@icicc.nci.nih.gov with the word "help" in the body of the message.

Fax

CancerFax® includes NCI information about cancer treatment, screening, prevention, and supportive care. To obtain a contents list, dial 301-402-5874 from a fax machine hand set and follow the recorded instructions

Cancer Glossary

acute leukemia : Cancer of the blood-forming tissue (bone marrow) that progresses rapidly.

anemia (a-NEE-mee-a): A condition in which the number of red blood cells is below normal.

antibiotic (an-tih-by-AH-tik): A drug used to treat infections caused by bacteria and other microorganisms.

biological therapy (by-o-LAHJ-i-kul): Treatment to stimulate or restore the ability of the immune system to fight infection and disease. Also used to lessen side effects that may be caused by some cancer treatments. Also called immunotherapy or biological response modifier (BRM) therapy.

blasts : Immature blood cells.

blood-brain barrier : A network of blood vessels with closely spaced cells that makes it difficult for potentially toxic substances (such as anticancer drugs) to penetrate the blood vessel walls and enter the brain.

bone marrow : The soft, sponge-like tissue in the center of bones that produces white blood cells, red blood cells, and platelets.

bone marrow aspiration (as-per-AY-shun): The removal of a small sample of bone marrow (usually from the hip) through a needle for examination under a microscope.

bone marrow biopsy (BY-ahp-see): The removal of a sample of tissue from the bone marrow with a needle for examination under a microscope.

bone marrow transplantation (trans-plan-TAY-shun): A procedure to replace bone marrow destroyed by treatment with high doses of anticancer drugs or radiation. Transplantation may be autologous (the person's marrow saved before treatment), allogeneic (marrow donated by someone else), or syngeneic (marrow donated by an identical twin).

cancer : A term for diseases in which abnormal cells divide without control. Cancer cells can invade nearby tissues and can spread through the bloodstream and lymphatic system to other parts of the body.

catheter (KATH-i-ter): A flexible tube used to deliver fluids into or withdraw fluids from the body.

central nervous system : CNS. The brain and spinal cord.

cerebrospinal fluid (seh-REE-bro-SPY-nal): CSF. The fluid flowing around the brain and spinal cord. Cerebrospinal fluid is produced in the ventricles in the brain.

chemotherapy (kee-mo-THER-a-pee): Treatment with anticancer drugs.

chronic leukemia (KRAHN-ik): Cancer of the blood-forming tissues that progresses slowly.

clinical trial : A research study that tests how well new medical treatments or other interventions work in people. Each study is designed to test new methods of screening, prevention, diagnosis, or treatment of a disease.

colony-stimulating factors : Substances that stimulate the production of blood cells. Colony-stimulating factors include granulocyte colony-stimulating factors (also called G-CSF and filgrastim), granulocyte-macrophage colony-stimulating factors (also called GM-CSF and sargramostim), and promegapoietin.

digestive tract (dye-JES-tiv): The organs through which food passes when food is eaten. These organs are the mouth, esophagus, stomach, small and large intestines, and rectum.

erythrocytes (eh-RITH-ro-sites): Cells that carry oxygen to all parts of the body. Also called red blood cells (RBCs).

fertility (fer-TIL-i-tee): The ability to produce children.
genetic : Inherited; having to do with information that is passed from parents to children through genes in sperm and egg cells.
graft-versus-host disease : GVHD. A reaction of donated bone marrow or peripheral stem cells against a person's tissue.
hairy cell leukemia : A type of chronic leukemia in which the abnormal white blood cells appear to be covered with tiny hairs when viewed under a microscope.
hematologist (hee-ma-TOL-o-jist): A doctor who specializes in treating diseases of the blood.
immune system (im-YOON): The complex group of organs and cells that defends the body against infection or disease.
interferon (in-ter-FEER-on): A biological response modifier (a substance that stimulates the body's response to infection and disease). Interferons affect the division of cancer cells and slow tumor growth. There are several types of interferons, including interferon-alpha, interferon-beta, and interferon-gamma. These substances are normally produced by the body. They are also made in the laboratory for use in treating cancer and other diseases.
interleukins (in-ter-LOO-kins): Biological response modifiers (substances that can improve the body's natural response to disease) that help the immune system fight infection and cancer. These substances are normally produced by the body. They are also made in the laboratory for use in treating cancer and other diseases.
intrathecal chemotherapy (in-tra-THEE-kal KEE-mo-THER-a-pee): Anticancer drugs infused into the thin space between the lining of the spinal cord and brain to treat or reduce the risk of cancers in the brain and spinal cord.
intravenous (in-tra-VEE-nus): IV. Injected into a vein.
kidneys (KID-neez): A pair of organs in the abdomen that remove waste from the blood (as urine), produce erythropoietin, and are responsible for the long-term regulation of blood pressure.
leukemia (loo-KEE-mee-a): Cancer of blood-forming tissue.
leukocytes (LOO-ko-sites): Cells that help the body fight infections and other diseases. Also called white blood cells (WBCs).
liver: A large, glandular organ, located in the upper abdomen, that cleanses the blood and aids in digestion by secreting bile.
lumbar puncture : The insertion of a needle into the lower part of the spinal column to collect cerebrospinal fluid or to give anticancer drugs intrathecally. Also called a spinal tap.
lymph node : A rounded mass of lymphatic tissue that is surrounded by a capsule of connective tissue. Also known as a lymph gland. Lymph nodes are spread out along lymphatic vessels and they contain many lymphocytes, which filter the lymphatic fluid (lymph).
lymphocytic (lim-fo-SIT-ik): Referring to lymphocytes, a type of white blood cell.
lymphoid (LIM-foyd): Referring to lymphocytes, a type of white blood cell. Also refers to tissue in which lymphocytes develop.
monoclonal antibodies (MAH-no-KLO-nul AN-tih-BAH-deez): Laboratory-produced substances that can locate and bind to cancer cells wherever they are in the body. Many monoclonal antibodies are used in cancer detection or therapy; each one recognizes a different protein on certain cancer cells. Monoclonal antibodies can be used alone, or they can be used to deliver drugs, toxins, or radioactive material directly to the tumor.
myelogenous (mye-eh-LAH-jen-us): Produced by or originating in the bone marrow.
myeloid (MYE-eh-loyd): Pertaining to, derived from, or manifesting certain features of the bone marrow. In some cases also pertains to certain types of non-lymphocyte white blood cells found in the bone marrow, including granulocyte, monocyte, and platelet lineages. Also called myelogenous.

Ommaya reservoir (o-MYE-a REZ-er-vwahr): A device surgically placed under the scalp and used to deliver anticancer drugs to the fluid surrounding the brain and spinal cord.

oncologist (on-KOL-o-jist): A doctor who specializes in treating cancer.

pathologist (pa-THOL-o-jist): A doctor who identifies diseases by studying cells and tissues under a microscope.

pediatric (pee-dee-AT-rik): Pertaining to children.

petechiae (peh-TEE-kee-a): Pinpoint, unraised, round red spots under the skin caused by bleeding.

plasma (PLAS-ma): The clear, yellowish, fluid part of the blood that carries the blood cells. The proteins that form blood clots are in plasma.

platelets (PLAYT-lets): A type of blood cell that helps prevent bleeding by causing blood clots to form. Also called thrombocytes.

prognosis (prog-NO-sis): The likely outcome or course of a disease; the chance of recovery.

radiation therapy (ray-dee-AY-shun): The use of high-energy radiation from x-rays, neutrons, and other sources to kill cancer cells and shrink tumors. Radiation may come from a machine outside the body (external-beam radiation therapy) or from material called radioisotopes. Radioisotopes produce radiation and are placed in or near a tumor or near cancer cells. This type of radiation treatment is called internal radiation therapy, implant radiation, or brachytherapy. Systemic radiation therapy uses a radioactive substance, such as a radiolabeled monoclonal antibody, that circulates throughout the body. Also called radiotherapy.

recur : To occur again. Recurrence is the return of cancer, at the same site as the original (primary) tumor or in another location, after it had disappeared.

red blood cells : RBCs. Cells that carry oxygen to all parts of the body. Also called erythrocytes.

relapse : The return of signs and symptoms of cancer after a period of improvement.

remission : Disappearance of the signs and symptoms of cancer. When this happens, the disease is said to be "in remission." A remission may be temporary or permanent.

risk factor : Anything that increases the chance of developing a disease.

seizures (SEE-zhurz): Convulsions; sudden, involuntary movements of the muscles.

spleen : An organ that is part of the lymphatic system. The spleen produces lymphocytes, filters the blood, stores blood cells, and destroys old blood cells. The spleen is on the left side of the abdomen near the stomach.

splenectomy (splen-EK-toe-mee): An operation to remove the spleen.

supportive care : Treatment given to prevent, control, or relieve complications and side effects and to improve the person's comfort and quality of life.

testicles (TES-tih-kuls): The two egg-shaped glands found inside the scrotum. They produce sperm and male hormones.

thrombocytes (THROM-bo-sites): Blood cells that help prevent bleeding by causing blood clots to form. Also called platelets.

transfusion (trans-FYOO-zhun): The infusion of components of blood or whole blood into the bloodstream. The blood may be donated from another person or it may have been taken from the person earlier and stored until needed.

white blood cell : A type of cell in the immune system that help the body fight infection and disease. White blood cells include lymphocytes, granulocytes, macrophages, and others.

x-ray : High-energy radiation used in low doses to diagnose diseases and in high doses to treat cancer.

Appendix G: Response to Public Comments

This appendix addresses technical and grammatical issues submitted by the public during the public comment period of November 13, 2001 through December 31, 2001. ATSDR will maintain public comments for the Pasminco Clarksville Zinc (PCZ) Plant petitioned public health assessment as part of the administrative file for the PCZ Plant site. ATSDR's responses to the public comments are below each numbered comment.

1. Page 1, last sentence, we suggest changing "North Carolina" to "Tennessee".

Response: "North Carolina" was changed to "Tennessee".

2. Page 13, the 3-hours National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2) is 0.50 ppm, not 0.03 ppm. We also suggest stating all the values in this table as micrograms per cubic meter ($\mu g/m^3$), rather than a mixture of ppm and $\mu g/m^3$, for the sake of clarity and consistency.

Response: 0.03 ppm was changed to 0.5 ppm in the NAAQS table. The units were not changed because that is how it is shown in EPA's NAAQS table, and particulates are typically shown in $\mu g/m^3$ not ppm.

3. Throughout the text, the NAAQS are referred to as "guidelines". The NAAQS are not guidelines. Rather, they are legally enforceable limits.

Response: The word "guidelines", when referring to NAAQS has been changed to "limits" or "standards" where appropriate.

4. Page 14, opening paragraph, the sentence beginning "Lung function in asthmatics exposed...." appears to be missing a word. Should it be "Lung function decreases in asthmatics exposed..." or something similar?

Response: The word "decreased" has been added to the beginning of the sentence.

5. Page 14, next to the last paragraph, it would be helpful to state the exposure time during which these LOAELs were determined.

Response: Exposure times can be found in the previous paragraphs.

6. Page 16, third paragraph, first sentence, should this not read "PCA is not the only major emitter of NO_2 in Montgomery County"?

Response: No. The statement is intended to make the point that the major emitter of NO_2 in Montgomery County is Union Carbide, not PCZ.

7. Page 21, bullet points, we suggest moving the first bullet point into the paragraph text following the bullet points since the bullet points highlight why children are at greater risk for exposure, per se. The first bullet point describes what can happen after exposure occurs. It does not describe why exposure may be greater.

Response: The bullet point in question has been moved into the following paragraph.

8. It is unclear what the purpose of the modeling was since ATSDR's conclusions appear to be based solely on a comparison of data from the air monitors to levels that would potentially cause health effects. There is

very little supporting information and discussion relating to the modeling that was done (1-page summary + 2 maps of the model output). It is difficult to fully evaluate whether the modeling was done correctly and how it could impact the conclusions of the report.

On the basis of the brief discussion on Page D-3, it appears that the primary purpose of the modeling was to evaluate the relative impacts of SO_2 emissions from Pasminco Zinc's facility with those from the nearby TVA power plant. However, the text on page 15 indicates that there are also other significant SO_2 emissions sources nearby. Why were all significant local sources of SO_2 emissions not included in the modeling? The combined impacts of the sources listed on page 15 could be significant.

Response: The initial purpose of the air modeling was to show that TVA, since it is such a high emitter of sulfur dioxide, contributes to the overall air quality in the Cumberland Heights community. However, upon completion of the modeling, it was found that there may be maximum impact areas north and south of the Pasminco facility (from its emissions) that the monitors may not be capturing.

This final draft of the document clarifies the purpose of the modeling and expands the information given about the modeling.

The other three sources of sulfur dioxide in the county were not found to be significant to the Cumberland Heights community as they are 5–15 miles away, and emit a much smaller amount of sulfur dioxide. In addition, the focus of the document is Pasminco, and public health assessments are not intended to be comprehensive reports of all possible sources of environmental contamination.

9. The report states that the peak locations of SO_2 concentrations predicted by the modeling are "about 2 miles north and south of the facility." Having no apparent monitors located in the general areas of predicted maximum concentration detracts from ATSDR's analysis and conclusions, which rely on a comparison of monitored values with the health based limits.

Response: ATSDR agrees that having no monitors in the locations of estimated maximum impact to the community detracts from the conclusions in the draft report. ATSDR is still including the monitored data because it may be representative to some community members that live close to the monitor. However, ATSDR has modified its recommendations in this final document by recommending that a monitor be put or moved in the areas that were estimated to be maximum impact areas to verify our modeling, and to determine if these areas have elevated levels of sulfur dioxide or other criteria pollutants.

10. For clarity, maximum SO_2 concentrations predicted from the modeling should be compared to the EPA's NAAQS limit. A discussion of the model vs. monitored data would also be useful to evaluate the uncertainty of the conclusions presented in the report.

Response: The two maximum impact areas modeled showed concentrations of 500–1,000 $\mu g/m^3$ for one isopleth and > 1,000 $\mu g/m^3$ for the highest ranging isopleth. 500 $\mu g/m^3$ corresponds to 0.2 ppm, and 1,000 $\mu g/m^3$ corresponds to 0.4 ppm. The Cumberland Heights monitor falls on the border of the 500–1,000 $\mu g/m^3$ isopleth and the >1,000 $\mu g/m^3$ isopleth. The modeled 1-hour maximum was 563 $\mu g/m^3$ which equals 0.24 ppm. For 1999, the year of the modeled data, the Cumberland Heights monitor recorded a maximum 1- hour concentration of 0.18 ppm. For the location of the Meeks monitor, the modeled concentration was 0.22 ppm and the 1-hour maximum recorded by the monitor was 0.075 ppm. Because ATSDR prefers to rely on measured values, these comparisons were not included in the document and, therefore, did not contribute to the conclusions made in the document.

Another reason ATSDR chose not to base conclusions on the values of ambient sulfur dioxide concentrations is because the ISCST model used has greater uncertainty in complex terrain like the Clarksville area. The uncertainty could be up to one order of magnitude. For instance, a modeled result of 1 $\mu g/m^3$ could represent 10 $\mu g/m^3$ to 0.1 $\mu g/m^3$.

Although the modeled concentrations are highly uncertain, the locations of the highest concentrations are less uncertain. In other words, ATSDR is not confident about the quantitative results of the model, but more confident about the qualitative results. What can be concluded about the model with the most confidence, is that the current monitor locations may not be in areas where contaminant concentrations are the highest.

11. The fact that various parameters, such as stack heights, stack gas velocities, diameters of the stacks, stack gas flows, and temperatures are all presented as identical for the 3 different units on Page D-3 for the TVA Plant and Pasminco Zinc is questionable (except possibly the SO_2 emission rate). These parameters should be verified, especially since there appears to be a discrepancy between the overall concentrations of SO_2 contributed by Pasminco as compared to TVA, in spite of the fact that TVA (from your model inputs) appears to have about 14 times the emissions of Pasminco. For example, the area of maximum 1 hour impact from Pasminco is about 1000 mg/m^3, while TVA's maximum impact at distance appears to be around about 370 mg/m^3 (as read from the cross section contour). Also, the 1-hour maximum cross section contours do not match the colored contours for TVA on the 1-hour maximum isopleth. Similar discrepancies exist on the annual isopleth figure.

Response: There was a mistake in the parameters for Pasminco that were displayed in Appendix D. However, the model was run using the correct facility-specific numbers. The parameters have been corrected and definitions of each parameter used have been included. See the revised "model details" section.

The maps of modeled concentrations do not have a discrepancy; the discrepancy referred to in this comment results from an incorrect reading of the cross section and isocontour maps. The maps and contours were reformatted to improve the readability of the maps.

12. The "model details" section on page D-3 does not indicate whether downwash caused by turbulence of wind blowing over and around buildings near the stacks was included in the modeling. If building downwash was not included in the modeling, the model's predictions of the SO_2 concentrations occurring close to the stacks may be too low.

Response: Downwash was not used in the modeling because ATSDR did not have information on building heights, widths, or lengths. Furthermore, the effect of downwash is generally not an issue if the stack is 2.5 times the height of nearby buildings. The height of the stack at Pasminco is 200 feet and the stack at TVA is 635 feet. At TVA, downwash is definitely not an issue. At Pasminco, a building 24.4 feet or higher (approximately 2 stories) could influence the plume through downwash. Pictures of the stack and adjacent buildings show many different types of structures adjacent to and at the facility. The structures adjacent to the stack are open, which reduces the effect of downwash. The effects of downwash become less significant as distance increased downwind.

Downwash may increase or decrease downwind concentrations depending on downwind location because downwash creates greater turbulence, mixing, and dispersion[2]. With downwash, portions of the plume are

[2] Fundamentals of Dispersion Modeling. Course Notebook, Atlanta, Georgia 1996. Schulze RH and Turner DB. Trinity Consultants, Dallas, Texas.

brought closer to the ground, but the greater dispersion may offset this. The parameters that would affect the downwash results were not evaluated here because the modeling was a preliminary investigation and, on the basis of the stack heights, were not assumed to be a significant influence on the results. In addition, the model is only being used in this document for qualitative purposes. ATSDR has not based any conclusions on the numbers produced by the model. If this work needs to be refined in the future, the effects of downwash could be investigated.

13. On page 17, there is an indication that particulate matter (TSP) modeling was done. If this was done, why are the results of this modeling not presented in the report?

Response: TSP modeling was not performed; therefore, the statement that indicates it was done is an error and has been corrected.

14. The report should provide a detailed explanation of why the contaminants of concern in the air pathway were limited to SO_2, NO_2, and PM. Why were other air toxics not included in the evaluation (e.g., metals)? If metals are not to be considered, why does the recommendation on page 23 indicate that metals monitoring should be continued? Are there other chemical data for this facility (e.g., volatiles) that should also be considered?

Response: Metals were not selected as a contaminant of concern because there have been no elevated levels of metals in the past (the metals data were reviewed in a previous document). ATSDR may still recommend that metals be monitored because the facility is permitted to release metals into the air. ATSDR did not see any indication that would warrant the monitoring of VOCs or any other contaminants besides criteria pollutants and metals.

15. Page 23, recommendations for air, we suggest clarifying what is meant by “priority pollutants”.

Response: The phrase “Priority pollutants” was intended to mean criteria pollutants regulated under the Clean Air Act: PM10, PM2.5, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. The phrase was changed to “criteria pollutants” in the document.

16. Foreword. The Pasminco Clarksville Zinc plant is not a CERCLA (Superfund) NPL site and is not the subject of proposed CERCLA action by any regulatory agency. The ATSDR investigation was in response to a citizen complaint.

Response: The “Foreword” section of the document is a general statement included in all public health assessments. It is not intended to be a reflection of the facility that the document desribes. It is noted in the foreword that in addition to conducting public health assessments at NPL sites, ATSDR also conducts public health assessments when petitioned by a concerned individual.

17. Page 1, Summary. Since sensitive individuals are predisposed to very low levels of environmental media contamination, health effects can by caused by natural processes and unrelated to industry operations.

Response: ATSDR believes that “days with poor air quality” captures all sources of contamination in the air, whether natural or from industrial processes, or both.

18. Page 1, Air. Poor air quality days are often associated with natural conditions of high atmospheric temperatures, high humidity, and very little currents or movements, along with various sources of air pollutants not associated with the Clarksville plant.

Response: ATSDR agrees that many factors contribute to "poor air quality days," including natural sources and other industry in the Clarksville area, as well as mobile sources, such as vehicle emissions. However, this summary paragraph on air is intended to provide an evaluation of the air emissions specifically from Pasminco.

19. Page 1, Cancer. Because no data infer a relationship between cancer incidence in the local population and zinc plant operations, the report should affirmatively state "there is no known relationship."

Response: ATSDR cannot positively or negatively confirm a relationship between zinc plant operations and cancer incidence due to insufficient data.

20. Pasminco believes the North Carolina reference should actually be Tennessee agencies.

Response: This has been corrected in the document.

21. Page 2, Background. The word electrolytic should be substituted for electrolyte in paragraph #2.

Response: This has been corrected in the document.

22. Page 2, Background. Sulfuric acid is a product, the word "excess" should be deleted in paragraph #2. Once the acid is produced, it is stored in specialized tanks prior to loadout and sale.

Response: This has been corrected in the document.

23. Page 3. The disposal of spent laboratory solvents is not a "contaminant," it is the proper disposition of a regulated waste.

Response: The word "contaminants" has been changed to "chemicals."

24. Page 3. The 1981 air episode was related to a release of SO_2, not acid vapor.

Response: The words "acid vapor" was changed to "sulfur dioxide."

25. Page 3. In 1993, there was a single excursion for the zinc parameter in the NPDES permitted discharge; no other parameters were exceeded and there has been none since.

Response: This has been noted in the document.

26. Page 3, Current Land use. The facility has a 1,500-acre "green belt" surrounding the 55-acre production area and maintains the property as farm operations and natural resource management (wetlands, tree farm, etc.) with selected recreation activities.

Response: This information has been added to the section "Current Land Use."

27. Page 4. The elementary school building described in the first paragraph is now offices for the local agriculture services, a new school was constructed some 5 miles away to accommodate increased enrollment and busing.

Response: This information has been added to the section "Community Concerns."

28. Page 4, Environment. The term "some" should be used to quantify that only some residents have reported concerns, odors or visual impacts.

Response: This has been noted in the document.

29. Page 4, Methods. ATSDR comparison values are multiples of ten times (order of magnitude) lower than levels known to produce adverse health effects.

Response: This is generally true. ATSDR uses comparison values to screen out low levels of contaminants that do not need further evaluation.

30. Page 5, Potential Exposure Pathways. The Clarksville plant is permitted and inspected through state and federal regulatory agencies for quantified emissions that are established to protect the environment and public health. These are part of the process and not contaminants.

Response: ATSDR uses the word "contamination" or "contaminants" to describe a potential exposure pathway; however, this does not mean that contamination is occurring— only that the potential for contamination exists. Where appropriate, ATSDR has used the word "chemicals" in place of contaminants.

31. Page 6, Ambient Air. Since the Clarksville zinc plant is not a major source for Nox gases, there is no ambient monitoring and no nitrogen dioxide data are available from the JMZ Hill site.

Response: The Clarksville plant is not the major emitter for nitrogen dioxide; however, data for nitrogen dioxide were available from the JMZ Hill site. ATSDR evaluated this data and acknowledged other sources in the county and in the neighboring county.

32. Page 6, paragraph #2. Ambient monitoring for TSP near the Clarksville zinc plant has never recorded an exceedence of the NAAQS primary standard level. Pasminco cannot account for state samples collected far away from the site on traffic intense Madison Street.

Response: ATSDR evaluated all the air monitors for TSP in the Clarksville area, and did not attribute a source to the levels that were found.

33. Page 7, paragraph 3. TSP samples collected from a variety of points throughout Clarksville cannot be correlated to a single source such as the Clarksville zinc plant.

Response: See the response to the previous question.

34. Page 7, last paragraph. The impoundment described is used for storage of metallurgical valuable and recyclable materials. It is permitted and designed and constructed to provide long term environmental safe storage.

Response: This information has been added to the document.

35. Page 9, paragraph #1. The U.S. Environmental Protection Agency site inspection followup by the Tennessee Department of Environment and Conservation resulted in the TDEC issuing a "no further action recommended" letter. A more recent EPA inspection agreed with the state.

Response: ATSDR uses environmental data from other agencies to make our own conclusions and recommendations for public health.

36. Page 10, last paragraph. Residential soil samples are subject to localized impacts of lawn and garden care and are often altered by home, landscape, and construction activities. The absence or low levels of air contamination would likewise support the importance of home site impacts. Additionally, soils are very variable in mineral content and concentrations due to their origin and prior conditioning.

Response: Comment noted.

37. Page 13, Sulfur dioxide. SO_2 gas is a colorless gas that is irritating to the eyes and nose with a sulfur smell. It does not smell like the "rotten eggs" (hydrogen sulfide) which is added to residential propane tanks to alert and detect leaking propane gas.

Response: This has been corrected in the document.

38. Page 13, third paragraph. State and federal environmental regulatory agencies use enforcement activities when environmental permits, permit conditions or environmental standards are exceeded. Because Pasminco is in compliance with its permit and conditions, no enforcement is necessary.

Response: Comment noted.

39. Page 14, last paragraph. The ATSDR has earlier noted that very sensitive and predisposed individuals may experience health effects caused by natural conditions which simulate aspects caused by poor air quality. The levels of SO_2 in Cumberland Heights were evaluated using a variety of data sources.

Response: Comment noted.

40. Page 15, first paragraph, last sentence. The statement misleads the reader to interpret that long term exposure to low levels of SO_2 results in documented adverse health effects and is directly related to the zinc plant. The statement cannot be supported and available data indicate the opposite. Such exposure is not known to cause adverse health effects and SO_2 levels are caused by numerous sources, some of which are much more significant than the Clarksville zinc plant.

Response: ATSDR stated that information regarding health effects from chronic exposure to low levels of sulfur dioxide is unknown. ATSDR discussed only the levels of sulfur dioxide in the community and did not attribute a source.

41. Page 18, paragraph 1. The entire southeast region of the United States has a history of low pH rainfalls (acid rain) for the last several decades. However, natural carbonate minerals in our limestone-based soils act to buffer and neutralize any impacts. Local soils surrounding the zinc plant are not acidic, surface waters are neutral, agricultural crops are not impacted, and localized vegetation (including forested areas) are diverse and healthy.

Response: ATSDR states in the document that limestone increases the ability of the soil to act as a buffer. Comment noted.

42. Page 21, second paragraph. If no data link the Clarksville zinc plant and cancer rates in the county or localized community, then the Report should state such, and not say it is "difficult to determine."

Response: The sentence in question has been deleted. ATSDR's point in that paragraph was to communicate that the relationship between emissions from Pasminco Zinc and cancer rates in the community is unknown, and that the current environmental data do not support an association.

43. Conclusion. Pasminco agrees that "available environmental data do not indicate the existence of a health hazard at this time for area residents of the Pasminco Zinc Plant..."

Response: Comment noted.