Public Health Assessment for

ALTERNATE ENERGY RESOURCES, INC.
AUGUSTA, RICHMOND COUNTY, GEORGIA
EPA FACILITY ID: GAD033582461
JANUARY 25, 2007

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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PUBLIC HEALTH ASSESSMENT

ALTERNATE ENERGY RESOURCES, INC.
AUGUSTA, RICHMOND COUNTY, GEORGIA

EPA FACILITY ID: GAD033582461

Prepared by:

Georgia Department of Human Resources
Division of Public Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Glossary of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
COC	Contaminants of Concern
CREG	Cancer Risk Evaluation Guide
CSF	Cancer Slope Factor
CVs	Comparison Values
EMEG	Environmental Media Evaluation Guide
EPA	United States Environmental Protection Agency
GEPD	Georgia Environmental Protection Division
GDPH	Georgia Division of Public Health
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Information System
LOAEL	Lowest Observed Adverse Effects Level
mg/kg/day	milligrams per kilogram per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MRL	Minimal Risk Level
NOAEL	No Observed Adverse Effects Level
NPL	National Priorities List
NTP	National Toxicology Program
ppb	parts per billion
ppm	parts per million
RfD	Reference Dose
ug/l	micrograms per liter
ppb	micrograms per liter
VOCs	Volatile Organic Compounds

Summary

Alternate Energy Resources (AER) operated as a commercial hazardous waste storage and treatment facility. AER's waste treatment processes included: blending high-BTU (British thermal unit) hazardous waste to be used as fuel in off-site industrial boilers and furnaces; recycling hazardous waste solvents by distillation; and treating used oils, hazardous and non-hazardous wastewater, and non-hazardous coolants. In 2000, the facility was abandoned and the owners declared bankruptcy. The AER site was proposed for the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA) in September 2005, and finalized in April 2006.

This public health assessment contains information about the extent of contaminated groundwater, soil, and surface water, and conclusions about the health risks posed to the public. A public health assessment is specifically designed to provide information about the public health implications of a specific site and to identify populations for which further health actions or health studies are needed. It is not intended address liability or other non-health issues.

GDPH has determined that in the past, site-related groundwater contaminants found in private wells located in the Hollywood subdivision approximately 0.5 miles south-southeast of AER posed **no apparent public health hazard**. Human exposure to contaminated media occurred in the past, but the exposure was below a level of health hazard. In 1987, residents living in the Hollywood subdivision were connected to municipal water. GDPH also found that the AER site poses **no apparent public health hazard** for past and current exposure to contaminated soil for children and adults occasionally trespassing on the property, and for past workers at AER.

Recommendations are: 1) resumption of groundwater monitoring in the surficial, Cretaceous, and bedrock aquifers by EPA in an effort to determine the vertical and horizontal extent of site-related contamination; 2) continue EPA efforts to determine the extent of contamination in surface and subsurface soils on site; 3) continue EPA effort to determine extent of off-site surface water and contamination attributable to AER. Once the remedial investigation/feasibility study for the AER site is completed, appropriate remediation measures should be undertaken by EPA along with continued monitoring of the effectiveness of such remediation actions. And, finally, the fence surrounding AER should be repaired by EPA and the gates locked to prevent access to the site. If additional data become available, the information will be reviewed by GDPH, and appropriate actions will be taken.

Statement of Issues

The Alternate Energy Resources (AER) site was proposed for the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA) in September 2005 and finalized in April 2006. Since 1986, the Agency for Toxic Substances and Disease Registry (ATSDR) has been required by law to conduct a public health assessment at each of the sites on the NPL. The aim of these evaluations is to find out if people have been exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. ATSDR requested that the Georgia Division of Public Health (GDPH) provide a public health assessment to explore the potential human exposure to site-related contaminants. GDPH has reviewed groundwater and surface water monitoring data, and soil sampling data related to the site. The information in this public health assessment is specifically designed to provide the community with information about the public health implications from exposure to hazardous substances at this site, and to identify populations for which further health actions are needed. It is not intended to address liability or other non-health issues.

Background

Site Description and History

The Alternate Energy Resources (AER) site is a 2.6 acre property located at 2936 Walden Drive in Augusta, Richmond County, Georgia (Figure 1). The property is located in an area which is zoned as heavy industrial, with surrounding property zoned as commercial and residential. From 1975 to 2000, AER operated as a commercial hazardous waste storage and treatment facility. In 2000, the facility was abandoned and the owners declared bankruptcy on December 13, 2000. The fence surrounding the site is breached in places, and the gates to the site are unlocked [1].

AER began operations in 1975 when AER purchased the Nimmons Oil Company property. AER's waste treatment processes included: blending high-BTU hazardous waste to be used as fuel in off-site industrial boilers and furnaces; recycling hazardous waste solvents by distillation; and, treating used oils, hazardous and non-hazardous wastewater, and non-hazardous coolants.

The sources of site contamination include: soil contamination that is present at low concentrations; a 3,000 gallon toluene and heptane spill; a 500-gallon release from a rainwater storage basin; a 13,191 gallon waste oil, inks, and oil processing residues spill; and a 70,000 gallon former unlined surface impoundment. Contaminants of concern associated with activities at the AER facility include trichloroethylene (TCE) and tetrachlorethene (PCE). TCE and PCE were detected in groundwater samples and soil samples at concentration significantly above background concentrations [1].

In 1986, a groundwater plume, believed to be caused by AER operations, impacted several domestic drinking water wells located between 0.5 mile and one mile southeast of the AER property. As a result of the contamination, the Georgia Environmental Protection Division (GEPD) issued a Consent Order to AER requiring that the affected domestic drinking water wells be connected to the Augusta Utilities Department (AUD) municipal water supply. In May 1987, the majority of the affected domestic private wells were connected to the AUD municipal water supply.

GEPD has issued six Consent Orders to AER in the past addressing violations and requesting corrective actions. The following is a summary of these orders:

- **May 19, 1983:** a Consent Order was executed to address an unpermitted discharge of 3000 gallons of heptane and toluene waste into the municipal storm sewer.

- **November 5, 1984:** a Consent Order was executed to address the discharge of hazardous waste to an on-site catchment basin. The Order required the removal of contaminated water, sediments and soils from the catchment basin, a groundwater monitoring program, and submittal of a Part B permit for the storage of hazardous waste.

- **October 25, 1986:** a Consent Order was executed to address contamination of residential drinking water wells downgradient of the facility, and the contamination of surface water on an adjacent property from the discharge of contaminated groundwater from the facility.

- **September 30, 1992:** a Consent Order was executed to address violations from a January 22, 1992 inspection.

- **July 31, 1997:** a Consent Order was executed to address violations during four inspections of the facility.

- **August 4, 1999:** a Consent Order was executed to address the prevention of soil contamination from offsite migration.

In addition, on June 14, 2000, GEPD issued a Proposed Consent Order for a number of operational and permit violations. Because GEPD was unable to resolve the violations in the Proposed Consent Order, GEPD ordered the facility to begin closure of all permitted units. AER initiated closure activities at the site; however, when AER failed to pay contractors for performing those activities, closure of the facility was suspended. Although a considerable amount of closure activities were performed, some of the waste was left at the facility when bankruptcy was filed and the property was abandoned. On May 4, 2001, GEPD inspected the AER property and reported that 499 drums, waste tanks, incompatible products, and liquids in a secondary containment system remained on-site. On August 17, 2001, AER was listed on the State of Georgia Hazardous Site Inventory. From February to August 2002, Georgia's Hazardous Site Response Program contractor removed the drums from the property, residual waste from the tanks, accumulated precipitation from the containment systems, chemicals from an on-site laboratory, decontaminated and removed tanks and associated piping for off-site disposal, decontaminated secondary containment structures for unpermitted units, and removed an abandoned tanker truck from the property [1]. In August 2004, GEPD completed a Preliminary Assessment/Site Inspection report for the AER property.

The AER site was proposed for the NPL on September 14, 2005 and finalized as an NPL site on April 19, 2006. In order to gather representative data necessary to address data gaps which currently prevent a complete evaluation of the nature and extent of contamination at the AER site, the U.S. Environmental Protection Agency (EPA) will begin a Remedial Investigation/ Feasibility Study (RI/FS) in late 2006/early 2007.

In April 2006, a health consultation was conducted for the nearby Peach Orchard Road groundwater PCE plume NPL site. GDPH concluded that this site posed no apparent past or current public health hazard [2].

Natural Resources Use

The vast majority of Richmond County that lies within a four-mile radius of the AER site is served by the AUD. The city obtains drinking water from three separate well fields and a surface intake on the Augusta Canal. One of the well fields - the Peach Orchard Well Field - is located approximately 2.5 miles southeast of the AER site, and consists of 14 municipal wells spread over 900 acres [1]. The depths of the wells range from 82 to 130 feet below ground surface. Seven of the fourteen wells are contaminated with tetrachloroethylene (PCE); only one well has been taken off-line permanently, five wells have been placed on emergency standby and one well with a very low concentration of PCE continues to operate [1, 3, 4].

AUD currently provides potable water to 66, 070 connections with water obtained from one surface water intake and 28 groundwater wells from the three well fields described (including the 5 standby wells maintained for emergency purposes). Based on the 2000 U.S. Census Bureau's persons per household value (2.55) for Richmond County, Georgia, AUD provides potable water to approximately 168,479 persons. Water from all water sources is blended prior to final distribution. Based on individual well and intake pumping capacities provided by AUD, the surface water intake presently contributes approximately 76 percent of the total water supply. The 28 groundwater wells contribute the remaining 24 percent of the total water supply [3].

There are an estimated 550 residential drinking wells located within a four miles of the AER site serving a population of 1,391 persons [1]. The nearest drinking water wells are located within a quarter mile south-southwest of the site off Gordon Highway [1].

Rocky Creek is located south of the AER site. The stream receives surface water run-off from intermittent streams and groundwater discharge from the AER site and outside the AER site [1, 2]. Four sources, all dry cleaners, were identified as possible sources of PCE contamination in the Peach Orchard Well Field [3, 4]. AER is not suspected to be a source of the Peach Orchard Well Field contamination due to its location from the well field, the contaminants originating from the AER site, and the fact that the AER plume appears to discharge into Rocky Creek [1].

Site Geology and Hydrogeology

The AER site is located in the Fall Line Hills physiographic district of the Coastal Plain. In the general vicinity of Augusta, the Coastal Plain has flat to gently rolling topography and is composed of unconsolidated sands, clays, and gravel, except for the marshy flood plains and the better drained, narrow stream terraces.

Three aquifers underlie the AER site. Those aquifers are: a shallow, surficial aquifer; a deeper, more productive Cretaceous aquifer; and the underlying crystalline bedrock aquifer. Both the surficial and Cretaceous aquifers are composed of sands, silts, clays, and gravels. The surficial water table aquifer consists of alternating and discontinuous layers of sand, silt and clay with occasional thin layers of gravel and layers of peat/organic material. The surficial aquifer extends from the water table to the top of the sands and gravel that form the Cretaceous aquifer. The bedrock aquifer is comprised of fractured crystalline rock and has not been extensively investigated since the Cretaceous aquifer is the primary water bearing source. Regionally, groundwater flow in the Cretaceous aquifer is toward the east-southeast. Groundwater in the vicinity of AER flows south toward Rocky Creek [1]. Rocky Creek normally flows year-round and maintains stream flows during periods of low rainfall, implying that groundwater discharges into the stream [3].

The prolific Cretaceous aquifer is comprised of the lower portion of the Gaillard Formation and underlies the surficial aquifer in the AER site. A portion of the City of Augusta's drinking water is obtained from this aquifer (Peach Orchard Well Field). City wells 126 and 127 fully penetrate the Cretaceous aquifer and enter the crystalline bedrock beneath the aquifer. Elevation contours for the Cretaceous aquifer show that the flow direction is east-southeast [1]. Hydrogeologic conditions show a significant hydraulic connection between the surficial and Cretaceous aquifer at or near the well field, indicating that the wells pumping from the Cretaceous aquifer also draw water from the surficial aquifer over the well field and from the area near the well field, including the locations of the dry cleaning facilities believed to be the source of PCE contamination in the well field [1].

Demographics

The population within one mile of the AER site is approximately 5,624 people. Using 2000 U.S. Census data, the Agency for Toxic Substances and Disease Registry (ATSDR) calculated population information for individuals living within a 1-mile radius of the AER site (Figure 2). The nearest residence is located 400 feet north of the site. There are no schools or day care facilities within 200 feet of the site.

Community Health Concerns

GDPH released the results of the current Alternate Energy Resources public health assessment for review and public comment from October 12, 2006 through November 13, 2006. No public comments regarding this public health assessment were received by GDPH.

Discussion

Environmental Sampling Data

Ongoing investigations have been conducted at the AER site since 1986 to characterize the extent of contamination released to environmental media (groundwater, surface water, and soil) from the site. Available data include groundwater samples collected from surficial monitoring wells, and deeper Cretaceous monitoring and municipal wells in the area (Figures 3 and 4). Surface water samples were collected from 6 locations along Rocky Creek, including a pond located on Clark Street approximately 0.5 miles south of AER (for location of Clark Street, see Figures 3 and 4) and a storm water pond located at the UPS property downgradient of the AER site. Subsurface soil samples were collected from the AER site in 1999, and surface soil samples were collected during closure activities in 2001 [1].

Pathway Analysis

GDPH identifies pathways of human exposure by identifying environmental and human components that might lead to contact with contaminants in environmental media (e.g., air, soil, groundwater, and surface water). A pathways analysis considers five principle elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and a receptor population. Completed exposure pathways are those in which all five elements are present, and indicate that exposure to a contaminant has occurred in the past, is presently occurring, or will occur in the future. GDPH regards people who come into contact with contamination as exposed. For example, people who reside in an area with contaminants in air, or who drink water known to be contaminated, or who work or play in contaminated soil are considered to be exposed to contamination. Potential exposure pathways are those for which exposure seems possible, but one or more of the elements is not clearly defined. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. However, key information regarding a potential pathway may not be available. It should be noted that the identification of an exposure pathway does not imply that health effects will occur. Exposures may, or may not be substantive. Thus, even if exposure has occurred, human health effects may not necessarily result [5].

GDPH reviewed the site's history and available environmental sampling data. Based on this review, GDPH identified an exposure pathway that warranted consideration. The completed and potential exposure pathways identified for the AER site are discussed in the following sections.

Evaluation Process

For each environmental medium, in this case, groundwater; GDPH examines the types and concentrations of contaminants of concern (COCs). In preparing this document, GDPH used the ATSDR comparison values, and other agencies' reference values, to screen contaminants that may warrant further evaluation. Comparison values (CVs) are concentrations of contaminants that can reasonably (and conservatively) be regarded as harmless, assuming default conditions of exposure. The CVs generally include ample safety factors to ensure protection of sensitive populations. Because CVs do not represent thresholds of toxicity, exposure to contaminant concentrations above CVs will not necessarily lead to adverse health effects. CVs and the evaluation process used in this document are described in more detail in Appendix A. GDPH then considers how people may come into contact with the contaminants. Because the level of exposure depends on the route and frequency of exposure and the concentration of the contaminants, this exposure information is essential to determine if a public health hazard exists.

The contaminants identified for the completed exposure pathway are discussed in the following sections and presented in Table 2. Other contaminants not exceeding CVs were reviewed, but not selected for additional evaluation in this assessment. The tables also include the chemical-specific CVs, which GDPH considered in the selection process.

Exposure to site related contaminants at the AER site could occur through three routes: ingestion, inhalation, and dermal adsorption of contaminated groundwater. Ingestion is defined as *direct ingestion* or actively drinking water. However, it is important to note that the other routes of exposure; inhalation of vapors into the lungs, and direct skin contact (dermal absorption) through bathing activities, may contribute additional exposure to contaminants at this site.

At the AER site, exposure to contaminated groundwater, surface water, and soil are the only exposure pathways that encompasses the five principal elements of a completed exposure pathway: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and a receptor population.

Exposure Pathways

Completed Exposure Pathway

Table 1: Completed Exposure Pathways

Pathway	Exposure Pathway Elements					Time
	Source	Transport	Point of Exposure	Route of Exposure	Exposed Population	
Drinking water	Movement of contaminants from the surficial to Cretaceous aquifer from various sources	Surficial and Cretaceous aquifers	Residential taps served by private wells water	Ingestion, Inhalation, Dermal	Residents using private well water as water supply source	Past
Surface Water	Movement of contaminants from surficial and Cretaceous aquifers to Rocky Creek and storm water ponds	Surface water	Contact with water from Rocky Creek and storm water ponds	Dermal	Recreational fishing and swimming	Past, current, future
Soil	Surface soil contamination resulting from past spills and operations at AER	Surface soil	Contact with soil on the AER site	Ingestion, Dermal	Workers, trespassers	Past, current, future

<u>Private Wells</u>

Approximately one hundred twenty-nine private wells are located within one mile of the AER site serving a population of 305 persons [1]. The nearest drinking water wells are located within a quarter mile south-southwest of the site off Gordon Highway.

In September 1986, GEPD confirmed that drinking water wells located in the Hollywood subdivision, approximately 2500 feet south and downgradient of the AER site, were contaminated from a plume emanating from the AER property. A house-to-house survey was conducted, identifying all residences with drinking water wells. Of the twenty-seven wells identified, twenty-six were found to be contaminated with TCE above the Maximum Contaminant Level (MCL) for safe drinking water (5 ug/L). Other volatile organic compounds (VOCs) were also found in the private wells; however, those detections were below their respective MCLs and CVs. Four (4) wells located directly southwest and side-gradient of the site were found to contain 1,2-dichloropropane (all below the MCL), a contaminant not associated with the AER site. A Consent Order issued by GEPD in October 1986 required that all affected residents within the Hollywood subdivision be connected to the AUD water supply. The connections to the AUD water supply were completed on May 18, 1987 [1].
Table 1 summarizes historical sampling data from private wells in which exposure occurred in the past [1].

Table1: Summary of 1986 private well water sampling results

Private Wells	Contaminant	Range of Concentrations (ppb)	Health-Based Comparison Value (ppb)	Type of CV
Rozella Street	trichloroethylene	8.9 to 29.1	5	MCL
Farris Street	trichloroethylene	11 to 22.2	5	MCL
Hopie Street	trichloroethylene	10.8 to 17.4	5	MCL
Clark Street	trichloroethylene	17.1	5	MCL
Milledgeville Road	trichloroethylene	18.1	5	MCL

ppb: parts per billion
MCL: Maximum Contamination Level
Source: ATSDR Drinking Water Comparison Values

Surface Water

When GEPD first learned of the private water well contamination in the Hollywood subdivision in 1986, Rocky Creek was sampled for VOCs near Clark Street to determine if the surface water had been impacted. No VOCs were detected in that sample. Surface water and fish tissue (catfish) samples were also obtained in 1987 from a pond located on Clark Street. Both samples were analyzed for VOCs, and none were detected [1].

Several releases from the AER facility were directed through the facility's stormwater drain through drainage ditches and an intermittent creek to Rocky Creek. Additionally, groundwater from the AER site is most likely discharging into Rocky Creek [1]. Water samples obtained by GEPD in February 2000 indicate the presence of PCE and TCE downstream of an area where the AER groundwater plume is believed to discharge. PCE and TCE levels were below CVs and the Water Quality Standards of 8.85 ug/L PCE and 81 ug/L TCE for Georgia Streams [1].

A UPS facility, located hydraulically downgradient of the AER site, installed a french drain on their property to prevent flooding of their parking lot. The french drain was designed to capture groundwater migrating on the property and to discharge the captured groundwater to two stormwater collection ponds. Sampling of the ponds by GEPD in 1986 indicated the presence of AER site related VOCs; however, none of the substances were found above the Water Quality Standards for Georgia Streams [1].

Although it is likely that people can come into contact with PCE and TCE only from infrequent exposure to intermittent streams and Rocky Creek (as well as the UPS stormwater ponds), dermal absorption is the route of most concern with surface water. Ingestion of surface water is possible, but the likelihood of swallowing water from Rocky Creek in volumes large enough to be of concern is not very high. Furthermore, there are no known drinking water intakes located within the 15-mile downstream surface water pathway which ends at the Savannah River [1]. The actual contribution to exposure dose via dermal absorption would be minuscule; therefore, this dose is negligible for the purpose of estimating exposure doses in this health consultation.

Soil

Currently, there are no employees at the AER site, and the facility has been abandoned. Access to the site is unlimited because of several breaches in the fence surrounding the site.

Soil sampling was conducted during a 1999 RCRA Facility Investigation; however, only subsurface samples from 4 feet below ground surface (bgs) to the top of the water table (39 to 41 feet bgs) were obtained during the investigation. Subsurface soil samples indicted that VOCs, polycyclic aromatic hydrocarbons (PAHs), and metals were present on site (Figure 5). Although arsenic was the only contaminant detected above a CV in two sample locations at depths of 2 feet and 4 feet bgs, exposure to arsenic at these depths are unlikely.

During the closure of the facility in January 2001, surface soil samples (from 0 to 2 feet bgs) were obtained for verification purposes. The samples indicated that surface soils at the AER site are contaminated with VOCs, PAHs, and metals. PCE (1.8 mg/kg) and TCE (2.4 mg/kg) were the only VOCs detected above residential and industrial soil cleanup levels[1], and arsenic was the only metal detected above soil cleanup levels (Figure 5). However, arsenic was the only contaminant detected above a CV at one location west of the former container storage warehouse (see Figure 1). The concentration of arsenic found at this location is 110 mg/kg (110 parts per million [ppm]). Ingestion of soil located at this "hotspot" would be the most likely route of exposure for past workers at AER and trespassers. However, the area where arsenic was found at this level is very small relative to the entire 2.6 acre site. Therefore, it is unlikely that either past workers or trespassers would be exposed to default quantities of ingested soil assuming that exposure is occurring for at least 8 hours per day.

Table2: Summary of 2001 soil sampling results above a comparison value

Sampling Location	Contaminant	Concentration (ppm)	Health-Based Comparison Value (ppm)	Type of CV
West of Container Storage Warehouse	Arsenic	110	0.5 20 200	CREG $EMEG_{(child)}$ $EMEG_{(adult)}$

ppm: parts per million
CREG: Cancer Risk Evaluation Guide
EMEG: Environmental Media Evaluation Guide
Source: ATSDR Soil Comparison Values

Potential Exposure Pathways

Groundwater

Because of past releases from the AER site, groundwater underlying and downgradient of the site has become contaminated with VOCs (Figures 3 and 4). A majority of groundwater contamination that has migrated from the AER is confined to the Cretaceous aquifer; however, a TCE concentration of 1.1 ug/L was detected in bedrock monitoring well DW-1 in 1999, and has

[1] U.S. EPA Region 9 Preliminary Remedial Goals (PRGs).

not been sampled since [1]. Of the VOCs detected in the monitoring wells at the facility, only TCE, PCE, and 1,1-dichoroethene (1,1-DCE) exceed their respective CVs. Currently, the plume is not fully delineated.

According to groundwater monitoring data from the AER site, the contaminant plume discharges into Rocky Creek. Contaminants have not been detected in monitoring well B-16, which is screened throughout the Cretaceous aquifer and is located on the opposite side of the creek from AER. Although this is proof of groundwater discharge from the Cretaceous aquifer, this does not provide that all contaminated groundwater discharges to the creek. There is a possibility that contaminated groundwater in the bedrock could quickly migrate under Rocky Creek if induced by pumping in the bedrock aquifer. There are no bedrock aquifer monitoring wells on the opposite side of Rocky Creek from AER.

No groundwater sampling has been conducted at the site since 1999. The groundwater recovery system at the site discontinued operation in 2000. The current vertical and horizontal extent of the VOC-impacted groundwater plume is not known. Additionally, there is a possibility that contaminated groundwater underlying residences, particularly in the Hollywood subdivision, could contaminate the indoor air of these residences via vapor intrusion.

<u>Surface Water</u>

Surface soil runoff from the AER site continues to be a source of potential surface water contamination.

Toxicological Evaluation

When a contaminant exceeds a CV, the toxicological evaluation presented requires a comparison of calculated site-specific exposure doses (e.g., amount of the contaminant believed to enter the body at the person's body weight for an estimated duration of time) with an appropriate health guideline. The health guidelines are health-protective values that have incorporated various safety factors to account for varying human susceptibility. These guidelines are developed using human exposure data when it is available and animal data when human exposure data is not available. Health guidelines used are ATSDR's Minimal Risk Levels (MRLs). MRLs are described in more detail in Appendix A. Usually little or no information is available for a site to know exactly how much exposure is actually occurring, so in some cases, health assessors assume worse case scenarios where someone received a maximum dose. As a result, actual exposure is likely much less than the assumed exposure. In the event that the calculated, site-specific exposure dose for a chemical is greater than the established health guideline, it is then compared to exposure doses from individual studies documented in the scientific literature that have reported health effects. If a contaminant has been determined to be cancer causing (carcinogenic), a cancer risk is also estimated [5] (Appendix A).

Using private well sample results from the AER site, exposures were evaluated to determine the likelihood of adverse health effects. Estimated exposure doses were calculated for adults and children based on the mean of the highest concentrations of TCE found above the health-based comparison value in private wells on the various streets where TCE was found.

Similarly, using soil sample results from the AER site, exposures were evaluated to determine the likelihood of adverse health effects. Estimated exposure doses were calculated for adults and children based on the highest concentrations of arsenic found above health-based comparison values. This is considered the most conservative approach to estimating exposure levels. However, as is true with most sites, assuming use of the maximum concentration is not reasonable; therefore, any conclusions based on a highly exposed person should be viewed as an overestimation of true risk.

For the purpose of this public health assessment, exposures to drinking water were assumed to occur seven days a week, for a period of four years (from May 1983 to May 1987). Adults were assumed to drink two liters of water per day, and children were assumed drink one liter of water per day. Bathing was also assumed to be a daily activity, so GDPH assumed that exposure doses for dermal contact and for inhalation were equal to those from ingestion of contaminants in water. Potential adverse health effects from chronic exposure will be considered in this discussion.

Similarly, exposure to contaminated soil was conservatively assumed to occur 1 day a week, for a period of thirty-one years (1975 to 2006) for workers and trespassers at the facility. Adults were assumed to ingest 100 mg of contaminated soil per day, and children were assumed to ingest 200 mg per day. Potential adverse health effects from chronic exposure will be considered in this discussion.

The only contaminant of concern detected in private wells was TCE. Levels of other chemicals were detected below MCLs and are, therefore; not of public health concern. Using the above assumptions, calculated exposures doses resulting from ingestion, inhalation, and dermal contact with TCE from the AER site are presented in Table 3.

Table 3: Calculated exposure doses from exposure to the average highest concentration found in private wells contaminated with TCE

Contaminant	Total Estimated Dose mg/kg/day	Health Guideline* mg/kg/day	Numeric Cancer Risk
Trichloroethylene	Adult: 0.0012 Child: 0.0017	0.0003	2.7×10^{-5} 3.8×10^{-5}

* RfD: U.S. EPA's chronic reference dose value (currently provisional, under EPA review)
Numeric Cancer Risk: based on EPA's oral cancer slope factor of 0.4 $(mg/kg/day)^{-1}$

The only contaminant of concern detected in on-site soil was arsenic. Levels of other chemicals were detected below clean up levels and CVs and are, therefore, not of public health concern. Using the above assumptions, calculated exposures doses resulting from ingestion arsenic contaminated soil from the AER site are presented in Table 4.

Table 4: Calculated exposure doses from exposure to the highest concentration of arsenic contaminated soil found at AER

Contaminant	Total Estimated Dose mg/kg/day	Health Guideline* mg/kg/day	Numeric Cancer Risk
Arsenic	Adult: 0.00002 Child: 0.0001	0.0003	3.9×10^{-6}

* RfD: U.S. EPA's chronic reference dose value (currently provisional, under EPA review)
Numeric Cancer Risk: based on EPA's oral cancer slope factor of 0.4 $(mg/kg/day)^{-1}$

Non-cancer Health Effects

Private Wells

The site-specific child and adult exposure doses calculated using the mean of the highest (21.9 ppb) TCE concentrations measured in drinking water from different residences in the Hollywood subdivision was 0.0017 and 0.0012 milligrams per kilogram per day (mg/kg/day), respectively. Estimated exposure doses for children and adults are approximately 4 to 6 times higher than the health guideline of 0.0003 mg/kg/day. The health guideline used is EPA's oral RfD, calculated for chronic exposure. This RfD is currently provisional; and undergoing review by EPA. Calculated exposure doses for the populations assessed were at least 147,000 times lower for children and 208,000 times lower for adults than the - No Observed Adverse Effects Level (NOAEL) – established in animal studies of 250 mg/kg/day. Some recent reviews show that a lower NOAEL or lowest observed adverse effect level (LOAEL) of 50 mg/kg day might be considered [6]. Using the newly considered NOAEL or LOAEL, the calculated exposure doses for the populations assessed were still at least 29,000 times lower for children and 41,000 times lower for adults than the newly consider NOAEL or LOAEL for TCE. Because the difference between calculated exposure doses and exposure doses that are known to be associated with health effects is so great, GDPH concludes that adverse (non-cancer) health effects are not likely in children or adults from past exposure to TCE in drinking water in the Hollywood subdivision.

Soil

The site-specific child and adult exposure doses calculated using the highest (110 ppm) arsenic concentration measured in soil at the AER facility was 0.0001 and 0.00002 milligrams per kilogram per day (mg/kg/day), respectively. Estimated exposure doses for children and adults are approximately 3 to 15 times lower than the health guideline of 0.0003 mg/kg/day, and at least 4-20 times lower than the NOAEL of 0.0004 mg/kg/day established for humans with chronic exposure when gastrointestinal irritation, diarrhea, and nausea were looked at [9]. The health guideline used is ATSDR's chronic oral MRL. Although the difference between calculated exposure doses and exposure doses that are known to be associated with health effects is small, the use of the highest concentration found in on-site soil (found at one small location on the property) for estimating exposure dose serves a conservative approach. Therefore, GDPH concludes that adverse health effects from past exposure to soil arsenic are not expected to result from exposure to soil at AER.

Cancer Risk

TCE

The International Agency for Research on Cancer [7] considers TCE to be probably carcinogenic to humans based on sufficient evidence in animals, while the National Toxicology Program considers TCE as reasonably anticipated to be a human carcinogen. The EPA considers TCE to be a probable human carcinogen based on inadequate human, but sufficient animal studies. Some studies with mice and rats have suggested that high levels of trichloroethylene may cause liver, kidney, or lung cancer. Some studies of people exposed over long periods to high levels of TCE in drinking water or in workplace air have found evidence of increased cancer. Although, there are some concerns about the studies of people who were exposed to TCE, some of the effects found in people were similar to effects in animals [8].

Numeric risks of contracting cancer estimated for individuals exposed to TCE concentrations found in private drinking water wells in the Hollywood subdivision near the AER site, based on estimated exposure doses are approximately 3 in 100,000 for children exposed four years and approximately 4 in 100,000 for adults exposed over a four year period.

Arsenic

Data used to develop the health guideline and assess carcinogenic effects of arsenic exposure are based on the ingestion of drinking water, not the ingestion of soil or food containing arsenic. The EPA classifies inorganic arsenic as a human carcinogen based on sufficient evidence from human data. Increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic [9]. The numeric risk of contracting cancer estimated for adults exposed to the highest soil arsenic concentrations found at AER, based on estimated exposure doses, is approximately 4 in 1,000,000 for adults exposed for 31 years.

Child Health Considerations

To protect the health of the nation's children, ATSDR has implemented an initiative to protect children from exposure to hazardous substances. In communities faced with contamination of the water, soil, air, or food, ATSDR and GDPH recognize that the unique vulnerabilities of infants and children demand special emphasis. Due to their immature and developing organs, infants and children are usually more susceptible to toxic substances than are adults. Children are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are also more likely to encounter dust, soil, and contaminated vapors close to the ground. Children are generally smaller than adults, which results in higher doses of chemical exposure because of their lower body weights relative to adults. In addition, the developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

At the AER site, children may have been exposed to TCE in groundwater if they consumed contaminated private well drinking water in the area of the Hollywood subdivision where groundwater contamination was found. Drinking small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear. Children may have also been exposed to arsenic in soil past if they trespassed regularly on the property. However, except for under a very conservative and relatively unlikely exposure scenario, where only one small location on the entire property contained arsenic above a CV, the level of exposure to arsenic otherwise is not at a level of health concern.

Conclusions

GDPH developed the following conclusions and assigned a public health hazard category to the site based on past, present, and future exposures to contamination from the AER site. A description of public health hazard categories is provided in Appendix B.

1. Exposure to TCE above health guidelines has occurred for residents consuming drinking water from private wells located in the Hollywood subdivision approximately 0.5 miles south-southeast of AER. For the purposes of this public health assessment, the average of the highest concentrations of TCE measured on each street in the Hollywood subdivision where contaminants were found in private drinking water wells was used as a conservative measure for estimating the highest exposure doses one could have received. Children and adults exposed to TCE from private well water are likely not at any increased risk for non-cancer health effects from past exposure to TCE. Therefore, GDPH has determined that in the past, the AER site posed **no apparent public health hazard** from exposure to TCE from private wells located in the Hollywood subdivision.

2. Because residents of the Hollywood subdivision were connected to municipal water in 1987, **no public health hazard** currently exists for residents living in this subdivision.

3. Although past groundwater sampling data exists, the current vertical and horizontal extent of groundwater contamination from the AER site is unknown. Also, the possibility for vapor intrusion in residences overlying the groundwater plume has not been addressed. Therefore, GDPH has determined that future exposure to groundwater south and southeast of the AER site, either from direct exposure to groundwater or from vapor intrusion, poses a **potential/indeterminate public health hazard** because we do not have enough data to support a judgment regarding the level of public health hazard.

4. GDPH has determined that the AER site poses **no apparent public health hazard** for past and current exposure to arsenic contaminated soil for children and adults occasionally trespassing on the property, and for past workers at AER because only one small area located west of the container storage warehouse contained arsenic above a CV.

5. GDPH has determined that past and current exposure to site-related contaminants found in Rocky Creek poses **no apparent public health hazard** because the levels found were below CVs and the actual contribution to exposure dose via dermal absorption would be minuscule.

Recommendations

1. EPA should continue monitoring the surficial, Cretaceous, and bedrock aquifer plumes in an effort to determine the vertical and horizontal extent of TCE contamination, as well as continue their efforts to determine the extent of contamination in surface and subsurface soils at the AER site, and the extent of off-site surface water contamination attributable to AER.
2. Once EPA completes the remedial investigation/feasibility study in the AER site, appropriate remediation measures should be undertaken, along with continual monitoring of the effectiveness of such remediation actions.
3. Once groundwater monitoring is resumed, if data show significant groundwater contamination underlying the Hollywood subdivision, EPA should consider evaluating indoor air for the possibility of vapor intrusion.
4. The fence surrounding AER should be repaired and the gates locked to prevent access to the site.

Public Health Action Plan

Actions Completed

- In May 1987, the residents of the Hollywood subdivision located south-southeast of the AER site whose private wells were contaminated with site-related contaminants were connected to municipal water
- The final NPL listing for the AER site was completed in April 2006. This allows for remediation of the AER site.

Actions Planned

- EPA will complete their remediation investigation/feasibility study of the AER site. The total extent of AER site contamination will be determined.

- Once EPA decides on a remedial solution for the AER site, remediation of the site will begin

- If additional data become available, the information will be reviewed by GDPH and appropriate actions will be taken at that time.

- GDPH will respond to all requests for information regarding health issues associated with the AER site.

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9. Agency for Toxic Substance and Disease Registry, *Toxicological Profile for Arsenic,* September 2000.

CERTIFICATION

This Alternate Energy Resources site public health assessment was prepared by the Georgia Division of Public Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the public health assessment was initiated. Editorial Review was completed by the Georgia Division of Public Health.

Technical Project Officer, CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this public health assessment and concurs with its findings.

Team Lead, CAT, CAPEB, DHAC, ATSDR

FIGURES

Figure 1: AER Site in Augusta, Georgia

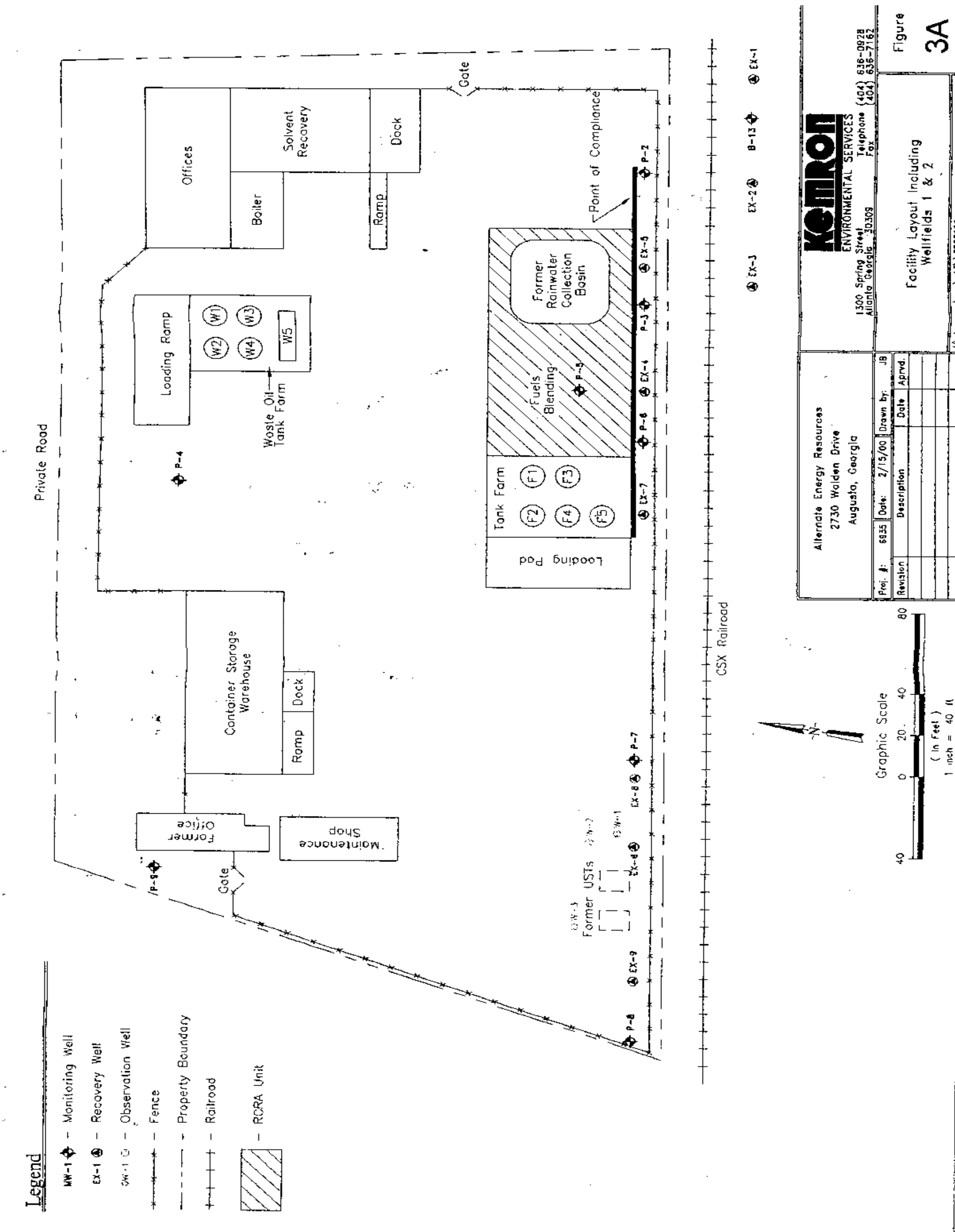


Figure 2: AER Site Demographics

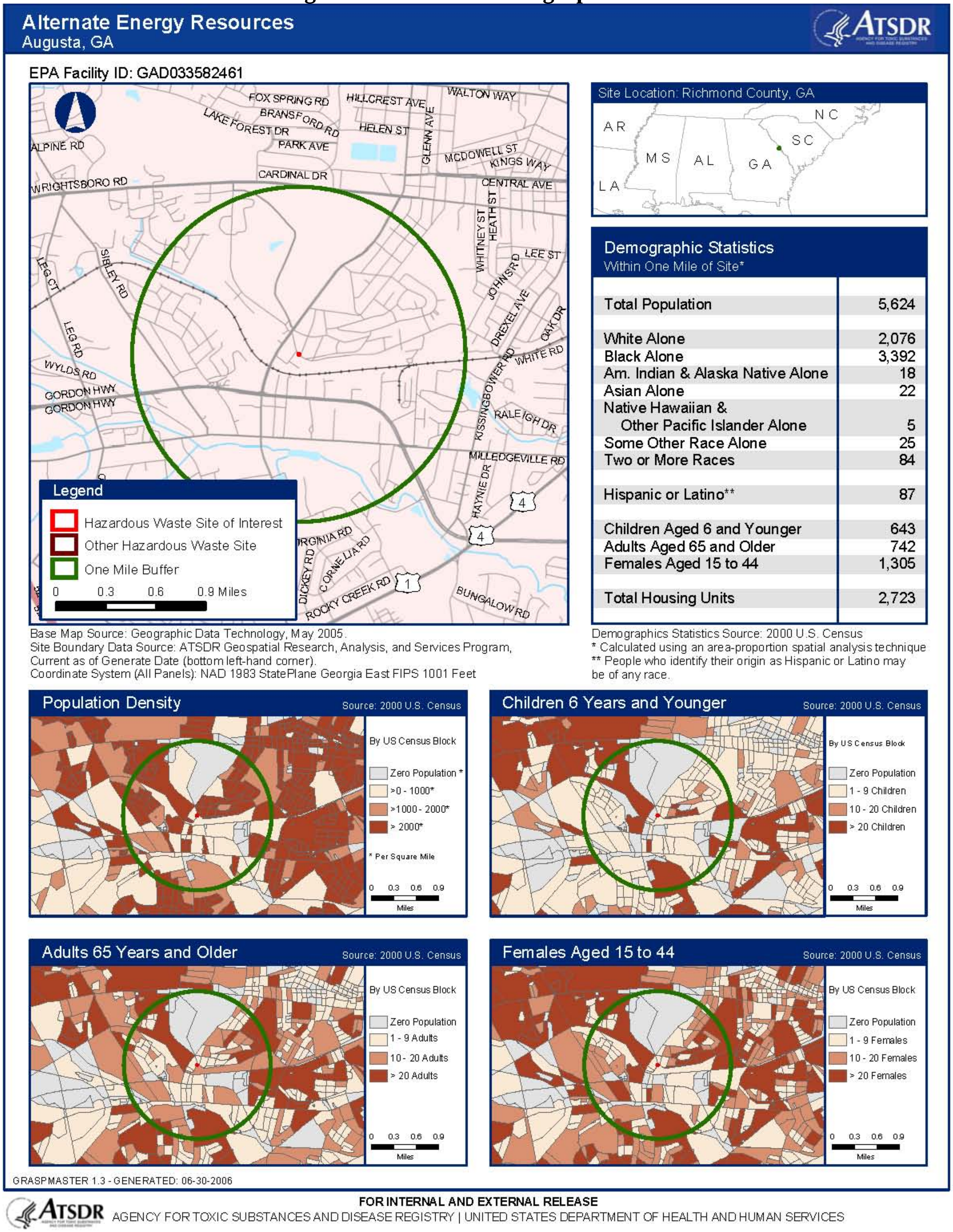


Figure 3: Groundwater TCE Plume

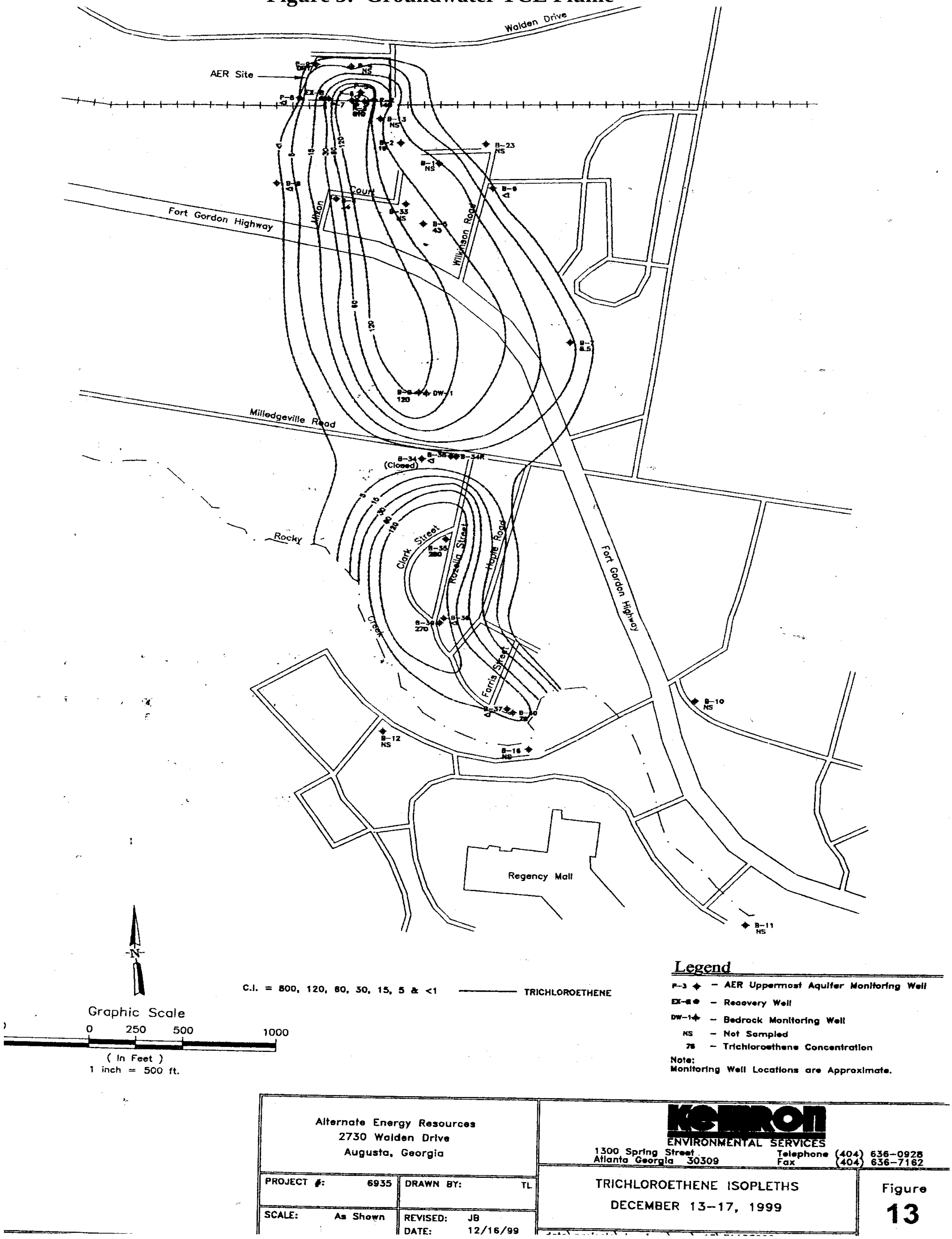


Figure 4: Groundwater PCE Plume

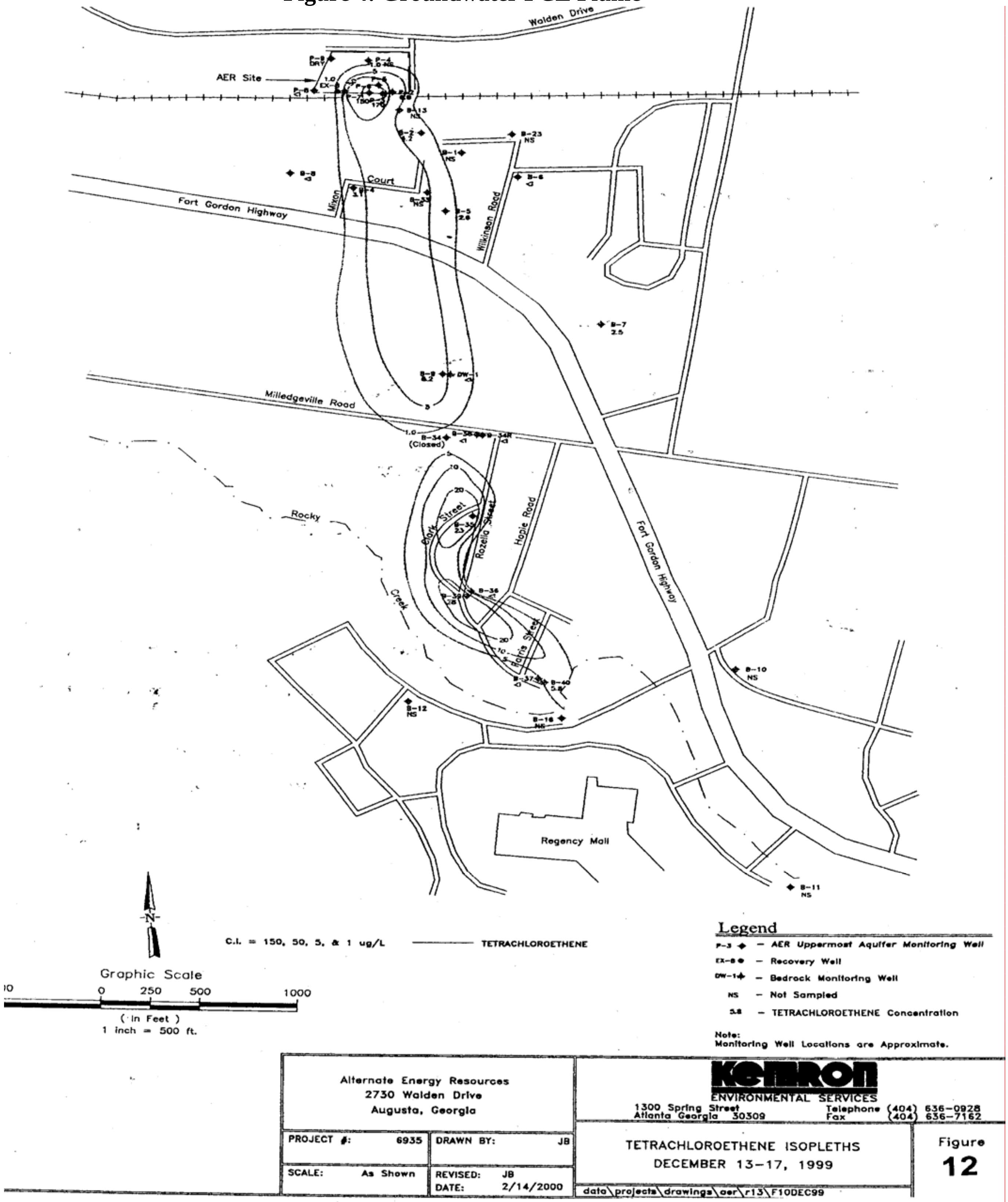
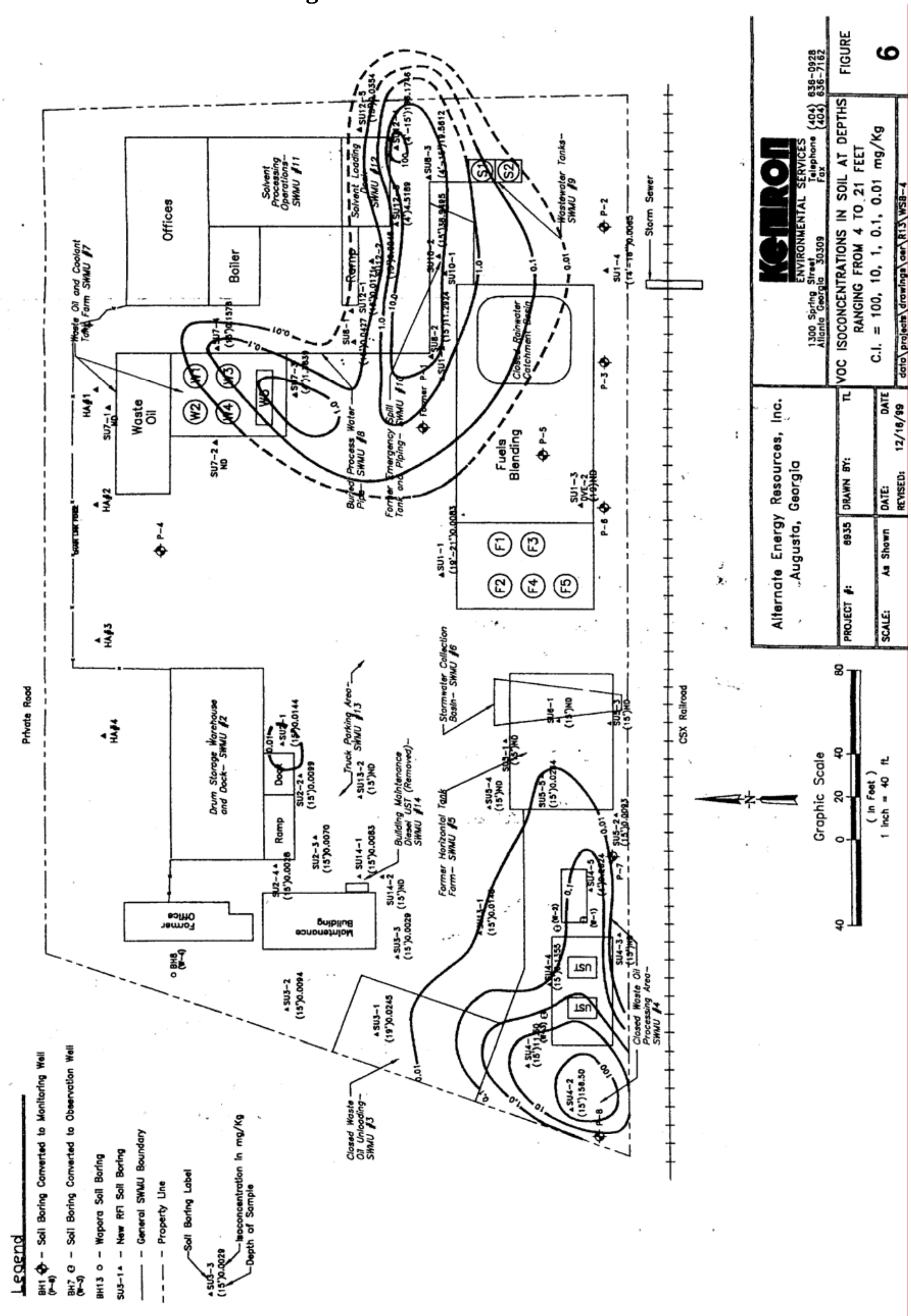


Figure 5: Soil Contamination



APPENDICES

APPENDIX A: Explanation of Evaluation Process

Step 1--The Screening Process

In order to evaluate the available data, GDPH used comparison values (CVs) to determine which chemicals to examine more closely. CVs are contaminant concentrations found in a specific environmental media (for example: air, soil, or water) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, soil, or water that someone may inhale or ingest each day. CVs are generated to be conservative and non-site specific. The CV is used as a screening level during the public health assessment process where substances found in amounts greater than their CVs might be selected for further evaluation. CVs are not intended to be environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

CVs can be based on either carcinogenic (cancer-causing) or non-carcinogenic effects. Cancer-based CVs are calculated from the U.S. Environmental Protection Agency's (EPA) oral cancer slope factors for ingestion exposure, or inhalation risk units for inhalation exposure. Non-cancer CVs are calculated from ATSDR's minimal risk levels, EPA's reference doses, or EPA's reference concentrations for ingestion and inhalation exposure. When a cancer and non-cancer CV exist for the same chemical, the lower of these values is used as a conservative measure. The chemical and media-specific CVs used in the preparation of this public health assessment are listed below:

An **Environmental Media Evaluation Guide (EMEG)** is an estimated comparison concentration for exposure that is unlikely to cause adverse health effects, as determined by ATSDR from its toxicological profiles for a specific chemical.

A **Reference Dose Media Evaluation Guide (RMEG)** is an estimated comparison concentration that is based on EPA's estimate of daily exposure to a contaminant that is unlikely to cause adverse health effects.

A **Cancer Risk Evaluation Guide (CREG)** is an estimated comparison concentration that is based on an excess cancer rate of one in a million persons exposed over a lifetime (70 years), and is calculated using EPA's cancer slope factor.

Step 2--Evaluation of Public Health Implications

The next step in the evaluation process is to take those contaminants that are above their respective CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Separate child and adult exposure doses (or the amount of a contaminant that gets into a person's body) are calculated for site-specific scenarios, using assumptions regarding an individual's likelihood of accessing the site and contacting contamination. A brief explanation of the calculation of estimated exposure doses used in this public health assessment are presented below. Calculated exposure doses are reported in units of milligrams per kilogram per day (mg/kg/day).

Ingestion of contaminants present in drinking water

Exposure doses for ingestion of contaminants present in groundwater were calculated using the average detected concentrations of contaminants in milligrams per liter (mg/kg [mg/kg = ppm]). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated groundwater:

$$ED_w = \frac{C \times IR \times EF}{BW} * 2$$

where;

ED_w = exposure dose water (mg/kg/day)
C = contaminant concentration (mg/kg)

IR = intake rate of contaminated medium (based on default values of 2 liters/day for adults, 1 liter/day for children)
EF = exposure factor (based on frequency of exposure, exposure duration, and time of exposure). The exposure factor used for AER is 1.0 based on 24 hour day, 7 days a week, for 4 years.
BW = body weight (based on average rates: for adults, 70 kg; children, 25 kg).
* 2 = dose was multiplied by 2 to account for inhalation and dermal absorption during bathing activities.

Ingestion of contaminants present in soil

Exposure doses for ingestion of contaminants present in soil were calculated using the average detected concentrations of contaminants in milligrams per kilogram (mg/kg [mg/kg = ppm]). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated soil:

$$ED_s = \frac{C \times IR \times EF \times CF}{BW}$$

where;

ED_s = exposure dose soil (mg/kg/day)
C = contaminant concentration (mg/kg)
IR = intake rate of contaminated medium (based on default values of 100 mg/day for adults, and 200 mg/day for children.
EF = exposure factor (based on frequency of exposure, exposure duration, and time of exposure). The exposure factor used is 0.14, based on adult workers/trespassers with exposure duration of 25 years, assuming 1 day per week of exposure. The exposure factor used for children trespassers is 0.14, based on a child trespasser with exposure duration of 10 years, assuming 1 day per week of exposure.
CF = kilograms of soil per milligram of soil (10^{-6} kg/mg)
BW = body weight (based on average rates: for adults, 70 kg; children, and 25 kg)

Non-cancer Health Risks

The doses calculated for exposure to individual chemicals are then compared to an established health guideline, such as an ATSDR minimal risk level (MRL) or an EPA reference dose (RfD), in order to assess whether adverse health impacts from exposure are expected. Health guidelines are chemical-specific values that are based on available scientific literature and are considered protective of human health. Non-carcinogenic effects, unlike carcinogenic effects, are believed to have a threshold, that is, a dose below which adverse health effects will not occur. As a result, the current practice to derive health guidelines is to identify, usually from animal toxicology experiments, a no observed adverse effect level (NOAEL), which indicates that no effects are observed at a particular exposure level. This is the experimental exposure level in animals (and sometimes humans) at which no adverse toxic effect is observed. The known toxicological values are doses derived from human and animal studies that are summarized in ATSDR's *Toxicological Profiles (www.atsdr.cdc.gov/toxpro2.html).* The NOAEL is modified with an uncertainty (or safety) factor, which reflects the degree of uncertainty that exists when experimental animal data are extrapolated to the human population. The magnitude of the uncertainty factor considers various factors such as sensitive subpopulations (e.g., children, pregnant women, the elderly), extrapolation from animals to humans, and the completeness of the available data. Thus, exposure doses at or below the established health guideline are not expected to cause adverse health effects because these values are much lower (and more human health protective) than doses, which do not cause adverse health effects in laboratory animal studies.

For non-cancer health effects, the following health guidelines were used in this public health assessment:

Minimal Risk Levels (MRLs) are developed by ATSDR for contaminants commonly found at hazardous waste sites. The MRL is developed for ingestion and inhalation exposure, and for lengths of exposures: acute (less than 14 days); intermediate (between 15-364 days), and chronic (365 days or greater). ATSDR has not developed MRLs for dermal exposure (absorption through skin).

Reference Doses (RfDs) EPA developed chronic RfDs for ingestion and RfCs for inhalation as estimates of daily exposures to a substance that are likely to be without a discernable risk of deleterious effects to the general human population (including sensitive subgroups) during a lifetime of exposure.

If the estimated exposure dose to an individual is less than the health guideline value, the exposure is unlikely to result in non-cancer health effects. If the calculated exposure dose is greater than the health guideline, the exposure dose is compared to known toxicological values for the particular chemical and is discussed in more detail in the text of the public health assessment. A direct comparison of site-specific exposures and doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely to occur.

It is important to consider that the methodology used to develop health guidelines does not provide any information on the presence, absence, or level of cancer risk. Therefore, a separate cancer risk evaluation is necessary for potentially cancer-causing contaminants detected at this site.

Cancer Risks

Exposure to a cancer-causing chemical, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. The estimated risk for developing cancer from exposure to contaminants associated with the site was calculated by multiplying the site-specific doses by EPA's chemical-specific cancer slope factors (CSFs) available at *www.epa.gov/iris*. This calculation estimates a theoretical excess cancer risk expressed as a proportion of the population that may be affected by a carcinogen during a lifetime of exposure. For example, an estimated risk of 1×10^{-6} predicts the probability of one additional cancer over background in a population of 1 million. An increased lifetime cancer risk is not a specified estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person may develop cancer sometime in his or her lifetime following exposure to a particular contaminant under specific exposure scenarios. For children, the theoretical excess cancer risk is not calculated for a lifetime of exposure, but from a fraction of lifetime; based on known or suspected length of exposure, or years of childhood.

Because of conservative models used to derive CSFs, using this approach provides a theoretical estimate of risk; the true or actual risk is unknown and could be as low as zero. Numerical risk estimates are generated using mathematical models applied to epidemiologic or experimental data for carcinogenic effects. The mathematical models extrapolate from higher experimental doses to lower experimental doses. Often, the experimental data represent exposures to chemicals at concentrations orders of magnitude higher than concentrations found in the environment. In addition, these models often assume that there are no thresholds to carcinogenic effects--a single molecule of a carcinogen is assumed to be able to cause cancer. The doses associated with these estimated hypothetical risks might be orders of magnitude lower that doses reported in toxicology literature to cause carcinogenic effects. As such, a low cancer risk estimate of 1×10^{-6} and below may indicate that the toxicology literature supports a finding that no excess cancer risk is likely. A cancer risk estimate greater than 1×10^{-6}, however, indicates that a careful review of toxicology literature before making conclusions about cancer risks is in order.

APPENDIX B: ATSDR Public Health Hazard Conclusion Categories

ATSDR Public Health Hazard Categories
Depending on the specific properties of the contaminant, the exposure situations, and the health status of individuals, a public health hazard may occur. Using data from public health assessments and consultations, sites are classified using one of the following public health hazard categories:

Category 1: Urgent Public Health Hazard
Sites that pose a serious risk to public health as the result of short-term exposures to hazardous substances.

Category 2: Public Health Hazard
Sites that pose a public health hazard as the result of long-term exposures to hazardous substances.

Category 3: Potential/Indeterminate Public Health Hazard
Sites for which no conclusions about public health hazard can be made because data are lacking.

Category 4: No Apparent Public Health Hazard
Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.

Category 5: No Public Health Hazard
Sites for which data indicate no current or past exposure or no potential for exposure and therefore no health hazard.

APPENDIX B: ATSDR/GDPH Glossary of Environmental Health Terms

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

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

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

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

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

Aerobic
Requiring oxygen [compare with **anaerobic**].

Ambient
Surrounding (for example, *ambient* air).

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

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

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

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

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

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

Carcinogen
A substance that causes cancer.

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

Chronic
Occurring over a long time (more than 1 year) [compare with **acute**].

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

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

Completed exposure pathway [see **exposure pathway**].

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

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

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

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

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An

"exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

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

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

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

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

EPA
United States Environmental Protection Agency.

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

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

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

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

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

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

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

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

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

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

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

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

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

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

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

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

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

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

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

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

ppb
Parts per billion.

ppm
Parts per million.

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

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

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

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might

be appropriate for each site. The five public health hazard categories are **no public health hazard, no apparent public health hazard**, **indeterminate public health hazard**, **public health hazard**, and **urgent public health hazard**.

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

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

RfD
See **reference dose**.

Risk
The probability that something will cause injury or harm.

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

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

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

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

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

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

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

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

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

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

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