AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

BAUER DUMP & TAILINGS BLACKHAWK RESIN COMPANY
TOOELE COUNTY, UTAH
EPA FACILITY ID:
UTD980514186, UTD980635528, AND UTD980960082
JULY 25, 2006

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

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

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PUBLIC HEALTH ASSESSMENT

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EPA FACILITY ID: UTD980514186, UTD980635528, AND UTD980960082

Prepared by:

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Office of Epidemiology
Utah Department of Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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SUMMARY

The Bauer site, located approximately three miles southwest of the city of Tooele, in Tooele County, Utah, consists of three properties: Bauer Dump, Bauer Tailings, and the Blackhawk Resin Company (BRC). Bauer was an active dumping site for silver and lead ore smelting from the 1920s until 1979, when mining ceased and the town was abandoned. During the 1960s, the BRC, an adhesives manufacturing facility, discharged coal fine residue and organic solvents into diked sediment ponds in the Bauer vicinity. These operations resulted in contamination of on-site soil and water. The Tooele County Health Department (TCHD) has requested that the Environmental Epidemiology Program (EEP) of the Utah Department of Health conduct a public health assessment to determine if adverse health effects are associated with off-site migration of wind-blown dust from the Bauer site.

The Utah Department of Environmental Quality, U.S. Environmental Protection Agency, and consultants contracted by the owners of BRC have conducted investigations that indicate the presence of elevated levels of several contaminants in mine waste, tailings, off-site soil, and on-site surface water. Limited evidence indicates some contaminants have been released to groundwater.

Two completed exposure pathways by which people have been exposed to contaminants from the Bauer site include (1) ingesting or inhaling contaminated smelter waste and tailings on-site, and (2) ingesting or inhaling contaminated dust that has migrated off-site. The contaminants of concern are arsenic and lead. Exposures to high levels of lead and arsenic can cause damage to blood cells and to the gastrointestinal, kidney, reproductive, and nervous systems. Both lead and arsenic are capable of crossing the placental barrier and causing harm to the fetus. Available evidence indicates that arsenic is a human carcinogen. Based on animal studies, lead is classified as a probable human carcinogen.

Although infrequent visits to the Bauer site are not expected to pose a health hazard to adults, unrestricted access to the site could pose a health hazard due to the increased exposure to contaminants of frequent trespassers using the site for recreational activities. Children under the age of six are unlikely to gain access to the Bauer site and its vicinity. The estimated exposure doses to arsenic for on and off-site trespassers and off-site workers do not exceed the Agency for Toxic Substances and Disease Registry's (ATSDR) Minimal Risk Level (MRL); therefore, exposures to arsenic for those individuals are not expected to result in adverse non-cancer health effects. However, the MRL for lead has not been established, and exposures at any level warrant precaution. On-site physical hazards include deteriorating oxygen canisters and old, unstable buildings.

The Bauer site is currently classified as a public health hazard due to concentrations of lead in the soil and physical hazards on the site. Adult and young adult trespassers who use the site for recreation are at risk for exposure to contaminated soils and tailings, contaminated surface water, and various physical hazards that include old oxygen canisters and old, unstable buildings. Contamination from the site could also pose a health hazard for people, especially children, who live downwind of the site. Air monitoring and/or soil sampling data from downwind

communities are needed to evaluate possible exposure. In addition, the cylinders on the Bauer site may ignite if tampered with.

The EEP public health action plan, designed to reduce and prevent adverse human health effects resulting from exposure to contaminants from the Bauer site, consists of the following actions:

- EEP, in coordination with TCHD, will recommend that site owners take measures to prevent public exposure to contaminants at the site and demolish old abandoned buildings onsite to reduce safety hazards posed by the unstable buildings. Site access restrictions need to be improved by installing perimeter fencing and locked gates, signs warning of health hazards should be posted, and action should be taken to prevent off-site migration of tailings. EEP will also recommend that site owners characterize and/or properly dispose of the oxygen canisters.
- EEP, in coordination with TCHD, will inform nearby ranchers of the contaminants on-site and recommends that ranchers prevent cattle from grazing in contaminated areas. TCHD will perform water sampling of stock watering ponds.
- EEP will coordinate with UDEQ to conduct air monitoring at the nearby landfill, gravel pits, and near the Tooele Army Depot boundary. Samples will be collected in the westernmost portion near the Depot to measure the amount of tailings transported in the northwesterly direction from the Bauer site.
- EEP, in coordination with TCHD, will provide environmental health education materials to residents of Tooele Army Depot, Stockton, Tooele, and Grantsville. The materials will provide a summary of contaminants at the Bauer site, as well as outline measures to prevent lead poisoning and reduce exposure to contaminated dust.
- EEP will monitor the Utah Blood Lead Registry to identify any children living in those communities who have elevated blood lead levels to ensure adequate case management and environmental follow-up. Current ongoing monitoring of the blood registry has not detected any children with elevated blood lead levels associated with this site.
- EEP, in coordination with TCHD, will monitor the development of residential property near the site and activities on the site that could further facilitate migration of contaminants off site. To date, no development has occurred near the site that would facilitate migration of contaminants off site.

PURPOSE AND HEALTH ISSUES

The Tooele County Health Department (TCHD) has asked the Environmental Epidemiology Program (EEP) of the Utah Department of Health to determine if adverse health effects are associated with contaminants from the Bauer site [EEP 1999a]. TCHD has received complaints from residents of Grantsville who are concerned about possible adverse health effects from off-site migration of wind-blown dust from Bauer. For this public health assessment, EEP evaluated the most recent analytical results for waste, tailings, soil, sediment, and surface water samples from the Bauer site to identify any contaminants of concern. EEP identified exposure pathways and estimated exposure doses for target populations. Ultimately, this document provides conclusions on the public health issues relevant to the Bauer site and makes recommendations to protect the health of residents in the area.

BACKGROUND

Site Characterization

The former township of Bauer is in Tooele County, Utah, approximately 40 miles west of Salt Lake City (Figure 1). Bauer lies on the south side of the Tooele Valley, west of the Oquirrh Mountains, and northeast of South Mountain. It is bound on the north by the Tooele Army Depot, on the south by the Stockton Bar, on the west by agricultural land, and on the east by State Road 36. The region is characterized by sparse vegetation, a semiarid climate, and numerous round ridges and outcrops that slope westward. Bauer was established on alluvial deposits and sediments from the Quaternary epoch of Lake Bonneville. The alluvial fill is approximately 100 to 1,000 feet thick [URS 1993, URS 1993b, UDEQ 1999].

Groundwater is primarily in the alluvial deposit and sediment layers and is at a depth of 100 feet. The primary aquifer of concern is approximately 250 feet below ground surface and ranges in thickness from 3,000 to 7,000 feet. Groundwater flow is believed to be north toward the Great Salt Lake; however, more recent explorations suggest that local hydrogeological conditions may be more complex than regional groundwater data indicate. The nearest drinking water well is owned by the Tooele Army Depot and is approximately two miles north of the site. Eight additional drinking water wells are within four miles of the site. Two of those wells are owned and operated by the Tooele Army Depot, and the remainder are owned and operated by Tooele County [USGS 1999, UDWR 1999].

The annual mean precipitation is reported to be 10.47 inches per year, with a net annual precipitation of 3.43 inches. On-site precipitation infiltrates rapidly because of the high permeability of the on-site soil. Overland flow from heavy precipitation is likely to flow in a northerly direction (the gradient is less than 1%). Rush Lake is located approximately 1.5 miles up gradient (south) of the Bauer site. Soldier Creek, the primary source of drinking water for the town of Stockton, is also south of the Bauer site [URS 1993a, UDEQ 1999].

South of the Bauer town site, water emanating from the abandoned mine tunnels has formed wetlands of approximately five acres at the southeast portion of the site. The water flows from the wetlands into a ditch that flows northward, east of the tailings and west of the Bauer town site. The ditch empties into an underground pipe, which is believed to be recharging stock watering ponds a half mile northeast of Bauer [URS 1993a, URS 1993b, UDEQ 1999].

Site History

Soldiers stationed in the town of Stockton began mining lead and silver in Bauer, approximately one mile to the south of the site, in the early 1860s. By the turn of the century, the Bullion Coalition Mines Company operated the main mining shaft, the Honerine Tunnel, and had consolidated the smaller mines operated by the soldiers. Early ore yields were of such high grade that they were shipped to the smelter without the need for concentrating. In 1920, the Combined Metals Reduction Company (CMRC) purchased the mine, equipment, and buildings. Because subsequently mined ore was of a lower grade, a concentrating mill was eventually constructed, at which time tailings began being deposited on-site. CMRC operated the mine until 1979, when the mine closed and the town of Bauer was abandoned. Since then, the property has been divided, and sections have been owned by Atlantic Richfield Company (1987), Clair Bankhead and Kenneth Hansen (1988), Stockton Consolidated Mines (1989), Archie Poarch (1995 and 1999), Diamond by Ranches, L.L.C. (1996), and Lion Mountain Properties Ltd. (2004) [URS 1993a, URS 1993b, TCRO 2000, Coombs 2004].

The Bauer site, illustrated in Figure 2, is composed of three areas consisting of approximately 400 acres, and in this document, will be referred to collectively as the Bauer site. The Bauer Dump includes two dumpsites, the Laboratory and Municipal Mine Dump (LMMD) and the Oxygen Canister Dump (OCD). The LMMD site is comprised of unknown contaminants and waste quantities. The EEP is not aware of any plans to further characterize the contaminants and waste quantities at this site. A large number of spent oxygen generator canisters were deposited in the OCD and are reported to contain potassium peroxide, a chemical that can explode upon contact with air or water or can explode spontaneously. The wooden crates formerly housing the canisters have eroded and have exposed the canisters to the environment. The Bauer Tailings cover approximately 160 acres west of the former Bauer town site and is comprised of approximately 10,000,000 tons of tailings that have been carried by wind in the northwesterly direction [URS 1993a, URS 1993b, UDEQ 1999].

During the 1960s, the BRC operated on approximately 27 acres in the former Bauer town site. The facility manufactured adhesives by treating coal fine residues with benzene, toluene, and hexane. The coal fine residue was discharged into diked sediment ponds on the west side of the facility. The plant was destroyed by a fire in September 1980 and was not rebuilt. Since then, the BRC property has been owned by Hercules, Inc. (1986), Clair Bankhead and Kenneth Hansen (1995), Diamond by Ranches, L.L.C. (1996), and Cyrus Land Investment (2000) [URS 1993, URS 1993b, TCRO 2000].

Demographics and Land Use

Abandoned since 1980, no residents live in the former town of Bauer. According to the 1990 U.S. Census [USDC 1990], approximately 134 people live within a one-mile radius of the Bauer site in Stockton (Figure 3). At that time, only one child was reported to be under the age of six, and three adults were age 65 or older. According to the 2000 U.S. Census Bureau, the population of Stockton has increased to 505; of those residents, 47 are children under the age of six, and 112 are children between the ages of six and 18 [SCO 1999]. However, the town of Stockton is up gradient of Bauer, and some Stockton residences are outside the one-mile radius of the Bauer site.

Communities downwind and down gradient of the site are Tooele (three miles to the northeast) with a reported population of 22,502 in 2000, Erda (10 miles to the north-northeast) with a reported population of 2,473, and Grantsville (10 miles northwest) with a population of 6,015 [USCB 2000]. Two site-visits revealed trespassers at the site from as far away as Dugway, Utah (approximately 40 miles southwest of the site; population 2,016).

The Tooele County Landfill operates roughly 100 yards east of the tailings pond and employs approximately 17 workers, 40 hours per week [D. Lore, Director, Tooele County Landfill, personal communication, 2004]. Several gravel pits also operate near the site. Two gravel pits are within a one-mile radius. Two other pits are within a two-mile radius, and three pits are within a four-mile radius. Of the two gravel pits within a mile of the Bauer site, the downwind facility employs seven workers and operates year round, five days per week [personal communication, Geneva Rock 2004]. The gravel pit upwind of the site employs approximately 20 workers, five days per week [personal communication, Jack B. Parsons Company 2004]. The Tooele Army Depot is located 2.5 miles directly north of Bauer and employs approximately 750 personnel and their families [TEAD 2004]; of these residents, approximately 15 children are under the age of 18 [personal communication, Cully 2004].

Access to the site is gained via a dirt road branching off of Bauer Road along State Road 36 in Tooele County. In the past, efforts were made to limit access by blocking the entrance with a gate and posting “No Trespassing” signs, but recent site visits revealed the gate is no longer maintained and the signs have been removed (Figure 4). When EEP staff visited the site in 1999 and 2000, there was evidence of site trespassers [EEP 1999b, EEP 2000]. The barbed wire fencing around the site has been vandalized to allow access for motorcycles and other off-road vehicles [EEP 1999b]. Evidence was found that the canisters at the OCD have been used as firearms targets [URS 1993a, URS 1993b]. Numerous site visits in 2004 revealed paintball players frequenting the area [EEP 2004a, b, c]. Conversation with the players revealed that approximately 30 – 40 paintball players visit the site each weekend, mainly in the boundaries of the old buildings. The large tailings piles near the abandoned town site (Figure 5) are “out of bounds.” An internet search on paintball at the Bauer site revealed information on a large paintball tournament held there in 1998. Workers in the area believe the abandoned mine tunnels onsite are used for drug trafficking. Shotgun shells, broken clay pigeons, and fresh graffiti were also evidence of site trespassers (Figure 6). Land around the site is used for cattle grazing [personal communication, Cline 2000].

Remediation Activities

The diked sediment ponds holding the coal fine residue from BRC eventually dried, and the residue spontaneously ignited each summer from 1982 until 1987. Access to the BRC site was unrestricted, and in 1985, two boys were severely burned when they fell into the burning residue. Hercules, Inc., the owners of BRC, began remediation activities in 1987. The remaining unburned coal residue was reportedly deposited in excavated disposal areas on-site. However, the exact location and dimensions of the area are undocumented. An approximate location of the site is presented in Figure 1. The first residue layer was deposited approximately seven feet below ground surface, followed by alternating one-foot layers of clean soil and residue. The excavated disposal areas were topped with two feet of clean fill [URS 1993b, UDEQ 1999]. The EEP does not have any verification that this was actually done, and characterization of the site for the coal residue has not been conducted. No remediation activities have been conducted for the Bauer Dump and Tailings properties and the site has since received an NFRAP designation (No Further Remedial Action) in EPA's CERCLIS program (Comprehensive Environmental Response, Compensation, and Liability Information System). The sites receive this designation because no receptors had been identified.

DISCUSSION

Nature and Extent of Contamination

In November 1979, EPA conducted a preliminary assessment of BRC but was denied access for a site visit. EPA conducted a site inspection of BRC in May 1982 and determined that the site was a potential hazardous waste site [EPA 1982].

The Division of Emergency Response and Remediation (DERR), formerly of the Utah Department of Health, conducted preliminary assessments for both the Bauer Dump and Bauer Tailings sites in March 1984. Coal residue and wastewater from BRC were deposited onto the Bauer dump site; the constituents of those wastes were unknown. A number of deteriorating oxygen canisters, which could be explosive under certain conditions, were also dumped on-site. On the tailings, vegetation was dying, presumably because of the acids produced by the original ore processing or the oxidation of the tailings. DERR recommended that a site inspection be performed, but because the immediate threat to humans was minimal, the site was given a low to medium priority [DERR 1984a, DERR 1984b].

DERR initiated a site inspection for Bauer Dump and Tailings in August 1984. In addition to providing greater detail on the site history and hydrogeology, the report contained analytical results for tailings, soil, and surface water samples collected on-site. Several heavy metals were detected in all three media analyzed, and release to air was documented through direct observations of dust clouds emanating from the site. However, quality assurance and quality control data were lacking, and the results were not validated [DERR 1984c].

An EPA Field Investigation Team conducted a site inspection for Bauer Tailings in 1985. Samples of tailings, groundwater, surface and subsurface soils were analyzed. Two monitoring wells were installed for this inspection; groundwater was encountered at a depth of 198 feet for the "up-gradient" well and at 80 feet for the "down-gradient" well. The flow direction had not been established but was likely in the northerly direction. Both up- and down-gradient samples contained elevated levels of arsenic, lead, and sulfate. Tailings and subsurface soil samples taken from depths down to 22 feet contained elevated levels of several metals, particularly arsenic and lead. Surface tailings were acidic (pH=1.29) compared to background soils (pH=7.13). To determine further actions needed, EPA recommended testing off-site groundwater and subsurface tailings, and conducting air monitoring at neighboring communities. EPA also recommended that area domestic stock owners be made aware of the potential threat posed by the tailings [EPA 1985a, b, c].

In 1986, Hercules Inc., the owners of the BRC property, contracted STS D'Appolonia to prepare a Site Exploration, Spent Coal Fire Abatement for the Blackhawk site. Six groundwater monitoring wells were installed and 12 soil samples were collected. Arsenic, lead, and several other metals were found at elevated levels in soil. Low levels of metals and organic constituents attributed to the nearby tailings were detected in groundwater samples [STS 1986].

The Emergency Response Branch of EPA visited the Bauer site in September 1988 to determine if the site was a candidate for emergency removal action. Upon examining various areas of the site, including the waste dump, tailings pile, wetlands, and a partially demolished mill facility, the EPA determined that no emergency action was necessary. However, EPA did recommend that access restrictions and signs be placed at the site to minimize usage of the property [EPA 1988].

In 1993, EPA contracted URS Consultants, Inc., to conduct a Site Inspection Prioritization to determine the data gaps for soil, surface water, groundwater, and air pathways. Data gaps included further waste characterization, extent of windblown contamination, quality of existing groundwater data, and further characterization of receptor targets. Soil samples taken from approximately 1.5 miles south of the site were analyzed and compared to soil samples taken from the mine tailings pond. Several contaminants, including arsenic, cadmium, and lead, were elevated in the off-site sample and were highly elevated in the tailings sample. The report also provided more detailed information on site geology, hydrogeology, hydrology, and meteorology in the region [URS 1993a, URS 1993b].

The Utah Department of Environmental Quality (UDEQ) performed an Expanded Site Inspection in 1995. Tailings contained elevated levels of arsenic, cadmium, and lead. Soil samples collected to the northwest of the site contained elevated levels of arsenic and lead, suggesting that tailings were being transported by wind activity. Surface and sediments samples collected from the on-site pond and ditch showed elevated levels of arsenic and lead. Groundwater sampling was not conducted in this investigation and no additional groundwater sampling has been planned [UDEQ 1999].

The 1995 UDEQ report provides the most recent analytical data for this site and is used to evaluate health hazards in this public health assessment. Tables 1 – 3 list analytical results for mine waste, tailings, soil, surface water, and sediment from the 1995 UDEQ investigation. Figure 7 illustrates the sample collection locations.

No samples were taken from the LMMD and the OCD areas of the site. It is likely that contamination exists in this area. However, it is unknown if contamination is at levels that could cause adverse health effects upon exposure.

Cattle have been reported to be grazing on the land surrounding the site. No tissue sampling of these cattle has been conducted and no tissue sampling of livestock on site has been planned. It is unlikely that people would be exposed to contaminants if they consume animal products from cattle raised in the Bauer area, therefore, tissue sampling of livestock would not be necessary.

Physical hazards at the site include the spent oxygen generator canisters that were deposited in the OCD that reportedly contain potassium peroxide, and old, unstable buildings.

Exposure Pathways Analysis

To determine whether nearby residents are exposed to contaminants at the site, the Agency for Toxic Substances and Disease Registry (ATSDR) evaluates the environmental and human components that make up a human exposure pathway. An exposure pathway consists of the following five elements (ATSDR 1992b):

(1) A source of contamination,
(2) Transport through an environmental medium,
(3) A point of exposure,
(4) A route of human exposure, and
(5) A receptor population.

ATSDR categorizes an exposure pathway as either *completed, potential, or eliminated*. In a *completed* exposure pathway, all five elements exist and indicate that exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. In a *potential* exposure pathway, at least one of the five elements has not been confirmed, but it may exist. Exposure to a contaminant may have occurred in the past, may be occurring, or may occur in the future. An exposure pathway can be *eliminated* if at least one of the five elements is missing and will never be present (ATSDR 1992b).

When an exposure pathway is identified, ATSDR comparison values (CVs) for air, soil, or drinking water are used as guidelines for selecting contaminants that require further evaluation [ATSDR 1992]. To protect the more susceptible population, CVs for children are used when available.

Because of the remoteness of the area, it is assumed that only adults and young adults would gain access to the site; thus, comparison values for adults are used for on-site contaminant exposure.

Completed Exposure Pathways

Two completed exposure pathways have been identified at the Bauer site. These exposure pathways include on- and off-site smelter waste and tailings. Exposure has occurred in the past, is currently occurring, and may occur in the future if waste is not removed or capped.

Completed Exposure Pathway: Ingestion or inhalation of on-site soil and tailings

Exposure element	Bauer Site
1) A source of contamination	former site mining activities
2) Transport through environmental medium	soil contaminated with smelting waste and mine tailings
3) A point of exposure	on-site soil and tailings piles
4) A route of human exposure	ingestion, inhalation
5) A receptor population	on-site recreational users

People have been and are currently being exposed to contaminated on-site soil and tailings (Table 4). Arsenic and lead were detected at the mine waste dump, in tailings piles, and in windblown tailings at levels that exceed ATSDR soil CVs (Table 1). The maximum concentration of arsenic, 4,900 parts per million (ppm[1]), was found in sample SC-03, the tailings spillover, located northwest of the tailings pond. The maximum concentration of lead, 15,100 ppm, was found in the tailings pile, sample SC-02. The soil CV for arsenic is 200 ppm [ATSDR 2004a], and for lead, the CV is 400 ppm (EPA action level in soil) [EPA 1998]. All contaminants detected in sample SC-07, taken from the Blackhawk site, were below the corresponding soil CVs.

People are exposed to contaminated waste and tailings through ingestion and inhalation of contaminated soil. EEP staff observed evidence of on-site recreational usage, including paintball players, off-road vehicle trespassing on the tailings pond sediments, human and animal tracks, and use of the spent oxygen canisters for firearm target practice [EEP 1999b, 2000, 2004a,b]. It is assumed that only a small number of persons trespass onto the property and that they are most likely adults and young adults. However, some of those persons might trespass on a regular basis and, thereby, increase their exposure. Exposure to on-site contaminants has occurred in the past, and because entrance into the site is insufficiently restricted, exposure will continue.

Completed Exposure Pathway: Ingestion or inhalation of off-site soil

Exposure element	Bauer Site
1) A source of contamination	former site mining activities
2) Transport through environmental medium	off-site soil contaminated by windblown tailings
3) A point of exposure	off-site soil
4) A route of human exposure	ingestion, inhalation
5) A receptor population	off-site workers and recreational users

People have been exposed to contaminated off-site soil (Table 4). Arsenic and lead were found in some soil samples at levels that exceed the soil CVs for adults (Table 2). The maximum concentration of arsenic (1,870 ppm) and lead (4,170 ppm) were found in sample SO-11, which was collected 3,500 feet north of the tailings pile and approximately 40 feet south of Tooele Army Depot. The soil CV for arsenic is 200 ppm [ATSDR 2000a]. Lead also exceeded the soil CV of 400 ppm [EPA 1998] in two samples collected up gradient of the Bauer site. Sample SO-15, collected from a residential property in the town of Stockton, contained 447 ppm and sample SO-17, collected from a gravel pit southeast of the tailings pile, contained 560 ppm. Two background samples were collected for each contaminant; arsenic was detected at 17.4 ppm and 20 ppm, and lead was detected at 92.1 ppm and 114 ppm.

Although the sampling data revealed that soils south and up gradient from the site are contaminated, the soils north of the site are more severely contaminated. The maximum concentration of arsenic found in soils north of the site (down gradient) exceeded background levels by a factor of 90. In contrast, samples taken southeast of the site did not contain elevated levels of arsenic. The maximum concentration of lead found in soil north of the site exceeded background levels by a factor of 40. The lead level in soils south of the site, on the other hand,

[1]One part per million is the same as 1 ounce of salt in 31 tons of potato chips.

only exceeded background levels by a factor of 5. Those findings suggest that contaminants are being dispersed northwards because of the prevailing south winds and because of surface run-off.

People are exposed to off-site contaminated soil through ingestion and inhalation of contaminated particles. The site is subject to an extremely dry climate and does not support adequate vegetative cover and therefore, the tailings are easily blown off-site. EEP found evidence of trails used by off-road vehicles in the areas surrounding the Bauer site. The closest populations to the Bauer site are the employees at the Tooele County Landfill and Geneva Rock gravel pit, and personnel and families residing at the Tooele Army Depot. These residents and workers could be exposed to off-site contamination through dust blowing into their homes and workplaces. To date, there has been no air monitoring on- or off-site. The TCHD staff have reported that dust clouds blowing from the Bauer site are visible for a distance considerably further than the half mile where URS conducted their off-site soil sampling in 1993 [EEP 1999a]. With adequate wind velocity, residents of communities farther north of Bauer may be affected by windblown contaminants. The town of Stockton and the majority of the gravel pits are upwind and up gradient from the Bauer site. Exposure to off-site soil contaminants has occurred in the past, and because there have been no erosion control measures applied or removal of the contamination, exposure continues.

<u>*Potential Exposure Pathways*</u>

Potential Exposure Pathway: On-Site Surface Water

People could be exposed to contaminated surface water on-site (Table 4). In all surface water samples collected (Table 3), levels of arsenic exceeded the 10 parts per billion (ppb[2]) CV for drinking water [ATSDR 2000b]. The maximum concentration of arsenic found, 249 ppb, was in sample SW-02, collected from standing water found in a depression in the tailings pile. Also in sample SW-02, cadmium (97 ppb), copper (1,475 ppb), lead (1,815 ppb), and thallium (2.75 ppb) were detected at concentrations that exceeded their respective CVs of 7 ppb, 1,300 ppb, 15 ppb, and 2 ppb [ATSDR 2000a]. Except for arsenic, no other contaminant exceeded CVs in any other surface water samples.

Some co-located sediment samples collected with the surface water samples contained elevated levels of arsenic and lead (Table 3). Downstream sediment samples contained greater concentrations of contaminants than upstream samples, suggesting that surface water run-off contributes to off-site migration of contaminants. Maximum concentrations of arsenic and lead in sediment were found in sample SE-01, which was collected from sediment under standing water in a depression in the tailings pond. The corresponding surface water sample was SW-02, which contained the highest levels of arsenic and lead.

People can be exposed to contaminated surface water on-site through incidental contact or ingestion. Although unlikely, occasional recreational users might use the water for drinking or washing, especially in hot, dry weather. The water in the depression in the tailings pond seems to be seasonal or intermittent; the standing water was observed during 1995 UDEQ sampling events but was not observed during the 1996 UDEQ site visit [UDEQ 1999]. For that reason, the

[2]One part per billion is the same as one teaspoon of a chemical in 1,000,000 gallons of water.

potential of significant exposure to contaminated surface water is considered low. Nevertheless, this pathway may have existed in the past, and because no action has been taken to eliminate the source of the contamination, exposure could continue.

Potential Exposure Pathway: Ingestion of off-site surface water
Under the influence of overland flow, contaminated surface water may travel further north, thereby contaminating surface water near Tooele Army Depot, Tooele, and Grantsville. However, no surface drinking water intakes are within 15 miles downstream of the site, and runoff from the tailings would have to travel overland three miles before entering a perennial stream [UDEQ 1999]. No sampling data exists to rule out the potential exposure to ingestion of off-site surface water.

Potential Exposure Pathway: Ingestion of on- or off-site groundwater
Although no recent on-site or off-site groundwater samples have been collected, contamination of the shallow aquifer has been documented in the past [EPA 1985a,b,c & STS 1986]. Because of the site's highly permeable soils, contaminants may migrate to deeper aquifers and affect the drinking water supply in the area. In previous sampling events, arsenic and sulfate were present at elevated levels in groundwater underlying the site [EPA 1985b,c]. Groundwater monitoring wells in the vicinity of the BRC site contained low levels of metals and organic constituents [STS 1986]. Groundwater is the source for nine drinking water wells, serving approximately 2,300 people, within a four-mile radius of the Bauer site. To date, the municipal wells, which are monitored, have not shown evidence of contamination from the site [UDWR 1999]. However, as land and groundwater use change, the wells could become contaminated. Because no action has been taken to eliminate the source of the contamination, down gradient communities could be exposed to contaminants in drinking water in the future.

Potential Exposure Pathway: Consuming animal products from animals grazing on/near the site
It is unknown if the cattle reportedly grazing on the land surrounding the site have been exposed to windblown contamination. No sampling has been conducted on cattle tissue. Although unlikely, people off-site may be exposed to contamination originating at the site if they consume animal products from cattle raised in the Bauer vicinity.

Public Health Implications

To determine if the contaminants pose a public health threat, EEP estimated the exposure doses that would result when adults are exposed to those contaminants that exceed CVs (Appendix B). Exposure doses were estimated for on- and off-site recreational users and for off-site workers. For dose estimates, EEP made the following assumptions: (a) on-site recreational users are adults and young adults who visit the site four times a month for 10 years and (b) workers are at the worksite 40 hours per week and remain with the same facility for 6.6 years.

The estimated exposure doses are compared to ATSDR Minimal Risk Levels (MRLs), which are screening values used to evaluate the likelihood that non-cancer health effects might develop as a result of exposure. Exposure doses exceeding MRLs are evaluated further, and any adverse health effects expected are discussed.

Toxicological Evaluation

Arsenic and lead are the chemicals of concern for the Bauer site. Arsenic and lead are present in waste, soil, and on-site surface water at concentrations exceeding CVs. As previously discussed, ingestion of contaminated particles is the most likely exposure pathway, although inhalation of contaminated particles can also contribute to the total exposure. Because no air sampling data are available and because ingestion of surface water is unlikely, only soil ingestion is evaluated further.

Arsenic (As)

Arsenic is a naturally occurring element and is found in two forms. Inorganic arsenic is formed when arsenic is combined with oxygen, iron, and sulfur, and organic arsenic is formed when arsenic is combined with carbon and hydrogen. The inorganic form is usually more harmful than the organic form and is the form commonly found near smelter sites because it is derived from treating copper and lead ores. Both forms have no smell, and most forms have no special taste [ATSDR 2000].

Most ingested arsenic, present in contaminated water, soil, or food, quickly enters the body. Inhaled arsenic-contaminated dusts can result in arsenic settling onto the lining of the lungs, and subsequent release of the arsenic into the body. Arsenic does not readily enter the body through skin, so skin contact with arsenic is not a concern. The body usually eliminates excess arsenic through the urine [ATSDR 2000].

For arsenic, the MRL is 0.0003 mg/kg/day, the no observable adverse effect level (NOAEL) is 0.0008 mg/kg/day, and the lowest observable adverse effect level (LOAEL) is 0.014 mg/kg/day [ATSDR 2000]. MRLs, NOAELs, and LOAELs are explained in Appendix A. Exposure doses were estimated using the maximum concentration of arsenic found in on- and off-site soil at the Bauer site. Exposure doses are presented as the amount of arsenic a person will ingest (in milligrams) per kilogram of body weight per day (mg As/kg/day) and are shown in Table 5. The estimated dose for adults and young adults (ages 12 – 17) through incidental ingestion of contaminated on-site soil and tailings is 0.00003 and 0.00004 mg As/kg/day, respectively. The estimated exposure dose for adult and young adult recreational users ingesting contaminated off-site soil is 0.00001 mg As/kg/day. Nearby workers are estimated to receive an exposure dose of 0.00006 mg As/kg/day. Because the estimated doses do not exceed the MRL, NOAEL, or LOAEL, the ingestion exposures are not expected to result in non-cancer, adverse health effects.

Ingestion of large amounts of inorganic arsenic (above 60 ppm in food or water) can result in death. Ingestion of lower levels of inorganic arsenic (ranging from about 0.3 to 30 ppm in food or water) might cause irritation of the stomach and intestines, with symptoms such as pain, nausea, vomiting, and diarrhea. Other effects from swallowing arsenic might include decreased production of red and white blood cells, abnormal heart rhythm, blood-vessel damage, and impaired nerve function causing a "pins and needles" sensation in the hands and feet.

Long-term exposure to low levels of inorganic arsenic may lead to a darkening of the skin and the appearance of small “corns” or “warts” on the palms, soles, and torso. Skin changes are not considered a health concern in their own right, but a small number of corns might ultimately become skin cancer. Dermal effects are common in people exposed to arsenic through ingestion, but those effects are rare in people exposed by inhalation. Numerous studies in humans have reported dermal effects at chronic dose levels ranging from 0.01 to 0.1 mg/kg/day [ATSDR 2000].

Swallowing sufficient amounts of arsenic has also been reported to increase the risk of developing cancer in the liver, bladder, kidneys, and lungs [ATSDR 2000]. No reliable evidence has been found that indicates arsenic can injure pregnant women or their fetuses. Animal studies show that arsenic in doses of up to 1 mg/kg/day in drinking water have no significant health effects on reproduction. No studies have been conducted to assess reproductive effects after inhalation exposure to arsenic [ATSDR 2000].

The human body has the ability to change inorganic arsenic to less toxic organic forms that are more readily excreted in urine. In addition, inorganic arsenic is also directly excreted in the urine. It is estimated that by means of these two processes, more than 75% of the absorbed arsenic dose is excreted in the urine [ATSDR 2000].

Arsenic is considered a human carcinogen by the National Toxicology Program (NTP), International Association of Research on Cancer (IARC), and the EPA [ATSDR 2004a,b]. Breathing inorganic arsenic increases the risk of lung cancer. Ingesting inorganic arsenic increases the risk of cancers of the skin, liver, bladder, kidney, and lung [ATSDR 2000].

Lead

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of the environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing. Lead is used in paints, ceramic products, caulking, gasoline additives, ammunition, and many other applications. Its use has been reduced in recent years because of lead's harmful effects in humans and animals. People living near hazardous waste sites can be exposed to lead and chemicals that contain lead by breathing air, drinking water, eating foods, or swallowing or touching dust or dirt that contains lead. Once in the body, lead is mainly stored in the bones and teeth. When lead leaves the body, it is excreted in the feces [ATSDR 1999].

Lead can affect almost every organ and system in the body. The most sensitive is the central nervous system, particularly in children. Lead also damages kidneys and the reproductive system. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can also damage the male reproductive system. The connection between these effects and exposure to low levels of lead is uncertain [ATSDR 1999].

Infants, children, and pregnant women should avoid exposure to lead when possible because they are particularly susceptible to its toxicity. Many children are repeatedly exposed to lead during childhood. A mother with lead in her body can expose the fetus to lead through the placenta. Fetuses exposed to lead in the womb may be born prematurely and have lower weights at birth. Exposure in the womb, in infancy, or in early childhood also may slow mental development and lower intelligence later in childhood. Evidence has been found that neurobehavioral effects may persist beyond childhood [ATSDR 1999].

Compared to adults, a greater proportion of the amount of lead swallowed by children will enter the bloodstream. Lead is stored in bones and can be released into the bloodstream when the body is stressed or when nutrition is poor, as when children refuse to eat healthy foods rich in iron and calcium [ATSDR 1999].

Unlike most contaminants, the NOAEL, LOAEL, and MRL values have not been established for lead. EPA has set soil lead contamination levels of 400 ppm for residential play areas and 1,200 ppm in bare soil of residential areas [EPA 2001]. Six of the seven on-site soil samples exceeded 400 ppm and five of the seven samples exceeded 1,200 ppm (range of 1,510 ppm to 8,920 ppm – Table 1). Three of the nine off-site samples exceeded 400 ppm (447 ppm to 4,170 ppm – Table 2); the soil sample with 447 ppm lead was taken from the nearby town of Stockton. Based on these soil samples, levels of lead both on-site and off-site may have the potential to result in adverse health effects.

Data on the health effects of lead in humans are often expressed in terms of internal exposure, or blood lead levels, rather than external exposure levels (i.e., mg/kg/day). The Centers for Disease Control and Prevention (CDC) considers blood lead levels to be elevated if greater than 10 micrograms of lead per deciliter of blood (µg/dL). This does not imply that a safe level of lead has been identified; in the last few years, several studies have been conducted and are still ongoing that suggest children may suffer neurological and developmental deficits at blood lead levels well below the current standard. While not universally accepted, these studies seem to suggest that prenatal and postnatal exposures at levels of 10-15 µg/dL are associated with low birth weight, reduced growth rate, cognitive deficits, and a reduction in neurological development as measured by IQ [ATSDR 1999]. Some studies suggest that intelligence may be affected when children have blood lead levels as low as 7 µg/dL [CDC 1997; ATSDR 1999]. Learning disabilities have been observed in children with blood lead levels exceeding 40 µg/dL [ATSDR 1999]. An estimated 890,000 U.S. children have blood lead levels equal to, or greater than, 10 µg/dL [CDC 1997]. Because it is not known what level of exposure to lead found in the environment might result in elevated blood lead levels, EEP and ATSDR recommend that any exposure to lead be avoided whenever possible.

Currently, no blood lead testing has been performed with employees at the Tooele County Landfill and Geneva Rock gravel pit, or personnel and families residing at the Tooele Army Depot. Between September 1998 and January 2004, 25 children in nearby Stockton have been tested for blood lead. Of these samples, only one was elevated with a value of 11.5 µg/dL. These are the closest populated areas to the Bauer site.

The IARC classifies lead as a 2B carcinogen, which means that it is possibly carcinogenic to humans, based on limited human evidence and less-than-sufficient evidence in animals [ATSDR 2004a,b]. EPA also classifies lead as a probable human carcinogen based on studies in rats and mice; however, the high doses used in those studies make it difficult to extrapolate the results in mice to low-level exposures to humans [ATSDR 1999].

Multiple Chemical Exposure Evaluation

The potential for the toxic effects from the chemical mixture interactions of lead and arsenic were evaluated. The health impact of exposure to chemical mixtures and the potential for combined action of chemicals may be of concern at hazardous waste sites. This evaluation included the calculation of a Hazard Index (HI) for the lead and arsenic mixture. The HI is defined as the sum of the quotients of the estimated dose of a chemical divided by its MRL or comparable value: HI = Lead Dose/MRL + Arsenic Dose/MRL. If the HI is less than 1.0, it is highly unlikely that significant additive or toxic interactions would occur. If the HI is greater than 1.0, then further evaluation is necessary [ATSDR 2005]. Since no oral MRL or RFD has been established for lead, the use of media-specific slope factors and site-specific environmental monitoring data is recommended by ATSDR to predict media-specific contributions to blood lead [ATSDR 1999]. The hazard quotient for lead is estimated by dividing the predicted blood lead level by 10 μg/dL, CDC's level of concern. The Hazard Index for the lead and arsenic mixture at this site is 0.5. Since the HI is less than 1.0, it is unlikely that significant additive interactions would occur at this site. Hazard Index calculations are presented in Appendix B.

CHILD HEALTH CONSIDERATIONS

ATSDR recognizes that the unique vulnerabilities of infants and children require special emphasis in communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from some environmental hazards. Children are more likely to be exposed to contaminants because they play outdoors, often bring food into contaminated areas, and are more likely to come into contact with dust and soil. Also, because children's bodies are still developing, children can sustain permanent damage if toxic exposures to some contaminants occur during critical growth stages.

The likelihood that children under the age of six can gain access to the Bauer site and its vicinity is low. A child's estimated exposure dose for on-site exposure has not been evaluated. However, children do live in downwind communities and could be exposed to contaminated soil and air. Fetuses can be affected indirectly through the placenta of an exposed mother. For those reasons, toxicological information about the effects of arsenic and lead on children is provided. Soil and air sampling data from downwind communities are needed to evaluate those possible exposures.

Arsenic and Children's Health

Children who are exposed to arsenic exhibit the same effects as adults; thus, all health effects due to arsenic are of potential concern in children. In particular, development of cancer has been observed in adults who were exposed to arsenic as children or young adults. Studies in animals indicate that arsenic affects development, including neural tube defects and disruption of kidney development [ATSDR 2000]. Animal studies have also shown that arsenic can cross the placental barrier and accumulate in the developing embryo. In addition, arsenic is known to be present in breast milk at low concentrations [ATSDR 2000]. A pregnant woman's infrequent exposure to arsenic at the site would not likely increase the cancer risk for her or her child, but the levels that might be present in downwind residential yards where children play have not been determined.

Lead and Children’s Health

Many children are repeatedly exposed to lead during their childhood. A mother with lead in her body can expose the fetus to lead through the placenta. After birth, the mother could continue to expose her baby to lead through breast-feeding. Children can be exposed to lead if they eat food or drink water that contains lead. Children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or on the ground. The dirt or dust on a child’s hands, toys, and other objects with which the child comes into contact may have lead particles on them. In some cases, children swallow non-food items such as paint chips, which may contain large amounts of lead, particularly in older homes with lead-based paint. Also, compared to adults, a larger proportion of the amount of lead swallowed will enter the blood in children. Lead is stored in bones and can be released into the bloodstream when the body is stressed or when nutrition is poor, as when children refuse to eat healthy foods rich in iron and calcium [ATSDR 1999].

Children are more sensitive to the effects of lead than adults. Fetuses exposed to lead in the womb (due to the mother’s high blood lead levels) may be born prematurely and have lower weights at birth. Exposure in the womb, in infancy, or in early childhood may also slow mental development and lower intelligence later in childhood. Evidence has been found that some effects may persist beyond childhood [ATSDR 1999]. Because it is not known what level of exposure to lead found in the environment might result in elevated blood lead levels, EEP and ATSDR recommend that any exposure to lead be avoided whenever possible.

CDC has determined that blood lead levels greater than 10 μg/dL in children are elevated, and some studies suggest that intelligence might be affected when levels are as low as 7 μg/dL. Blood lead levels as low as 10 μg/dL can adversely affect the behavior and development of children. Learning disabilities have been observed in children with blood levels exceeding 40 μg/dL [CDC 1991, 1997].

COMMUNITY HEALTH CONCERNS

Residents living in Grantsville have expressed concern about possible adverse health effects resulting from exposure to contaminants that are or may be present in dust emanating from the Bauer site [EEP 1999a]. Those residents have expressed concerns about increased cancer, neurological disease, and birth defect rates in their community. The EEP conducted a statistical review in 1999 of the cancers diagnosed in the Grantsville community and found that cervical cancer was significantly elevated as compared to other communities [EEP 1999c]. Exposure to heavy metals could lead to the development of respiratory and genito-urinary system cancer, but cervical cancer is not associated with heavy metal exposure. Although other types of cancer were identified, none were found to be significantly elevated.

Heavy metal exposure is associated with peripheral and central nervous system disorders. Lead, in particular, has been associated with poor child development. No air or soil samples have been collected from neighboring communities to determine whether windblown contaminants from the site have settled in communities at levels that could cause adverse health effects upon exposure.

People in those communities have not reported any specific health effects they suspect as site-related to the Tooele County Health Department [personal communication, Slade 2000].

Workers in the area have expressed concern about possible drug trafficking at the site, as well as stray bullets, and a “red dust” that covers their vehicles after a windstorm.

Public Comment Release of Public Health Assessment

On March 16, 2006, the EEP released the draft of this public health assessment for public comment. The public availability of the document was announced as a legal notice in local newspapers. The report also was available at two local repositories. Copies of the public health assessment were available for review at the Tooele County Health Department, the Tooele City Library, and through the Utah Department of Health Environmental Epidemiology Program. The public comment period for the draft PHA ended on April 8, 2006. No comments were received during the public comment period.

CONCLUSIONS

The Bauer site is currently classified as a public health hazard due to concentrations of lead in the soil and physical hazards on the site. Adult and young adult trespassers who use the site for recreation are at risk for exposure to contaminated soils and tailings, contaminated surface water, and various physical hazards that include old oxygen canisters and old, unstable buildings. Contamination from the site could also pose a health hazard for people, especially children, who live downwind of the site. Air monitoring and/or soil sampling data from downwind communities are needed to evaluate possible exposure. In addition, the cylinders on the Bauer site may ignite if tampered with.

The nearest community that could be potentially affected by off-site migration of contaminants is the Tooele Army Depot, which is approximately 2.5 miles downwind from the site. Air monitoring near the Tooele Army Depot would be useful in evaluating the potential for exposure to site-related contaminants. Windblown contaminants are not likely a concern in the town of Stockton, which is within one mile north of the site. Off-site migration of contaminants is unlikely to occur at levels sufficient to cause adverse health effects in the community of Grantsville, located approximately 10 miles from the Bauer site. Windblown contamination from the site would disperse and be diluted substantially as it traveled toward that community. A 1999 analysis of cancers in the Grantsville area concluded that although one type of cancer was found to be significantly elevated, it was a type not associated with heavy metal exposure [EEP 1999c].

The LMMD and OCD areas of the site may pose a health hazard. These dumps have not been characterized and may contain contaminants at levels that could cause adverse health effects upon exposure or might contain physical hazards that could injure people. Other physical hazards identified at the site include old, unstable buildings.

RECOMMENDATIONS

Exposure Reduction Recommendations

1. Establish erosion control measures to prevent off-site migration of contaminants.
2. Restrict site access by installing perimeter fencing and locked gates.
3. Erect signs around the perimeter of the site warning of the health hazard.
4. Inform ranchers of contaminants detected in soil and surface water.

5. Old abandoned buildings on site should be demolished to reduce the safety hazard posed by the unstable buildings to trespassers using the abandoned buildings for recreation.

Site Characterization Recommendations

1. Conduct particulate air sampling and analysis at the nearby landfill, gravel pits and the Tooele Army Depot boundary to determine the contamination levels in wind-blown dust originating at the Bauer site.
2. Characterize the Laboratory and Municipal Mine Dump (LMMD) and the Oxygen Canister Dump (OCD) for chemical contamination and physical hazards.

Health Activities Recommendations

1. Provide community health education materials to residents of Tooele Army Depot, Stockton, Tooele, and Grantsville about exposure and possible health effects from site contaminants.

PUBLIC HEALTH ACTION PLAN

The following public health action plan describes actions that UDOH and other government agencies will take at the Bauer site its vicinity. The purpose of the public health action plan is to ensure that measures are taken to reduce and prevent adverse human health effects resulting from exposure to contaminants at the Bauer site.

The public health action plan consists of the following:

- EEP, in coordination with TCHD, will recommend that site owners take measures to prevent public exposure to contaminants at the site and demolish old abandoned buildings onsite to reduce safety hazards posed by the unstable buildings. Site access restrictions need to be improved by installing perimeter fencing and locked gates, signs warning of health hazards should be posted, and action should be taken to prevent off-site migration of tailings. EEP will also recommend that site owners characterize and/or properly dispose of the oxygen canisters.
- EEP, in coordination with TCHD, will inform nearby ranchers of the contaminants on-site and recommend that cattle should not be grazed in contaminated areas on or near the site. TCHD will perform water sampling of stock watering ponds.
- EEP, in coordination with UDEQ, will perform air monitoring at the nearby landfill, gravel pits, and near the Tooele Army Depot boundary. Samples will be collected in the westernmost portion near the Depot to measure the amount of contamination in wind-blown dust transported in the northwesterly direction from the Bauer site.
- EEP, in coordination with TCHD, will provide environmental health education materials to residents of Tooele Army Depot, Stockton, Tooele, and Grantsville. The materials will provide a summary of contaminants at the Bauer site, as well as outline measures to prevent lead poisoning and reduce exposure to contaminated dust.
- EEP will monitor the Utah Blood Lead Registry to identify any children living in those communities who have elevated blood lead levels to ensure adequate case management and environmental follow-up. Current ongoing monitoring of the blood registry has not detected any children with elevated blood lead levels associated with this site.

- EEP, in coordination with TCHD, will monitor the development of residential property near the site and activities on the site that could further facilitate migration of contaminants off site. To date, no development has occurred near the site that would facilitate migration of contaminants off site.

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CERTIFICATION

This Bauer Dump and Tailing Public Health Assessment was prepared by the Utah Department of 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 health assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

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

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Team Lead, CAT, SPAB, DHAC, ATSDR

FIGURES AND TABLES

Figure 1. Map of Tooele Valley, Tooele County, Utah

Depicts the Location of the Bauer CERCLIS Site in Relationship to Surrounding Communities.

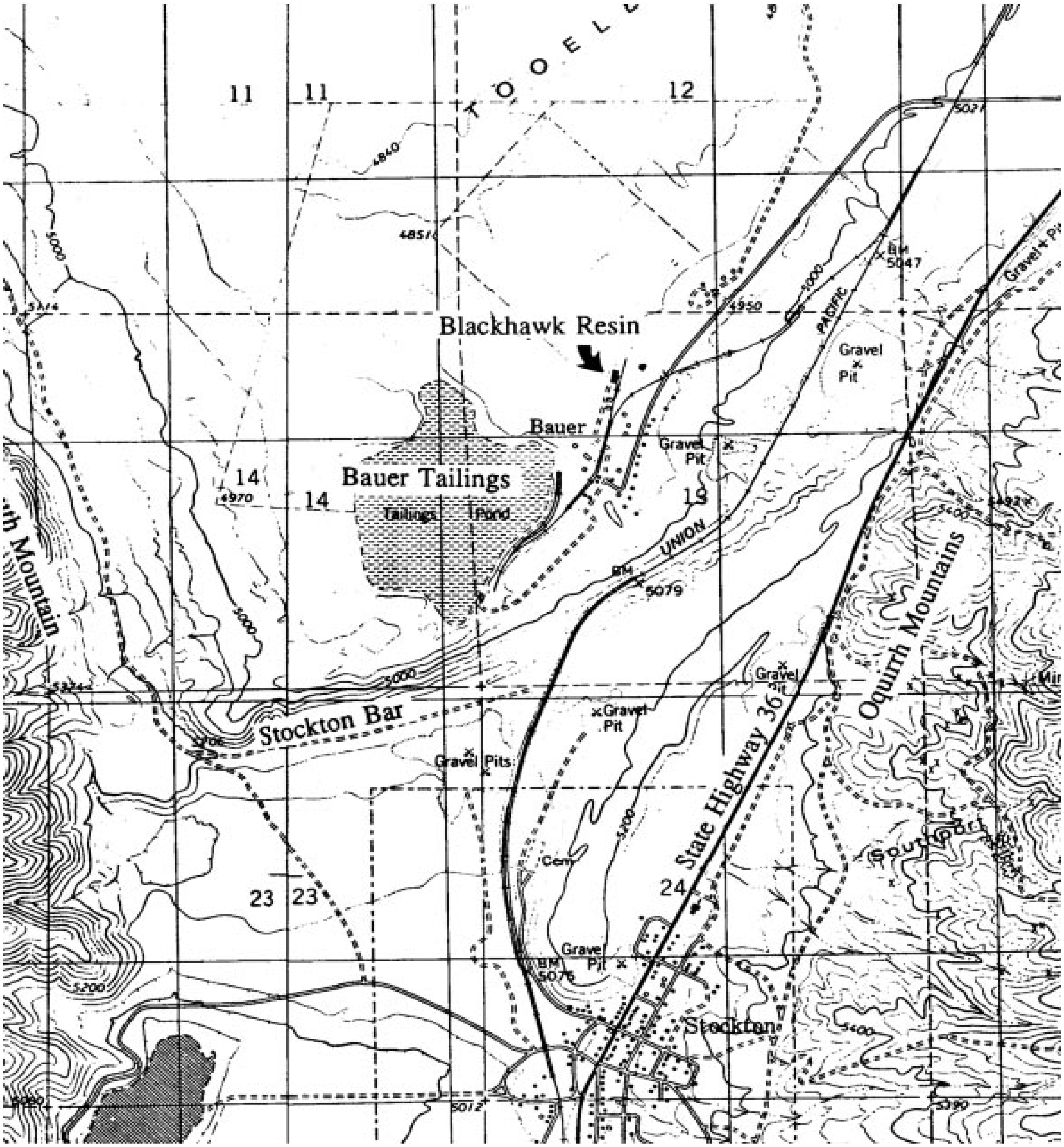

Figure 2. Map of Bauer, Tooele County, Utah
Depicts the Township, Tailings Pond and Dump Sites.

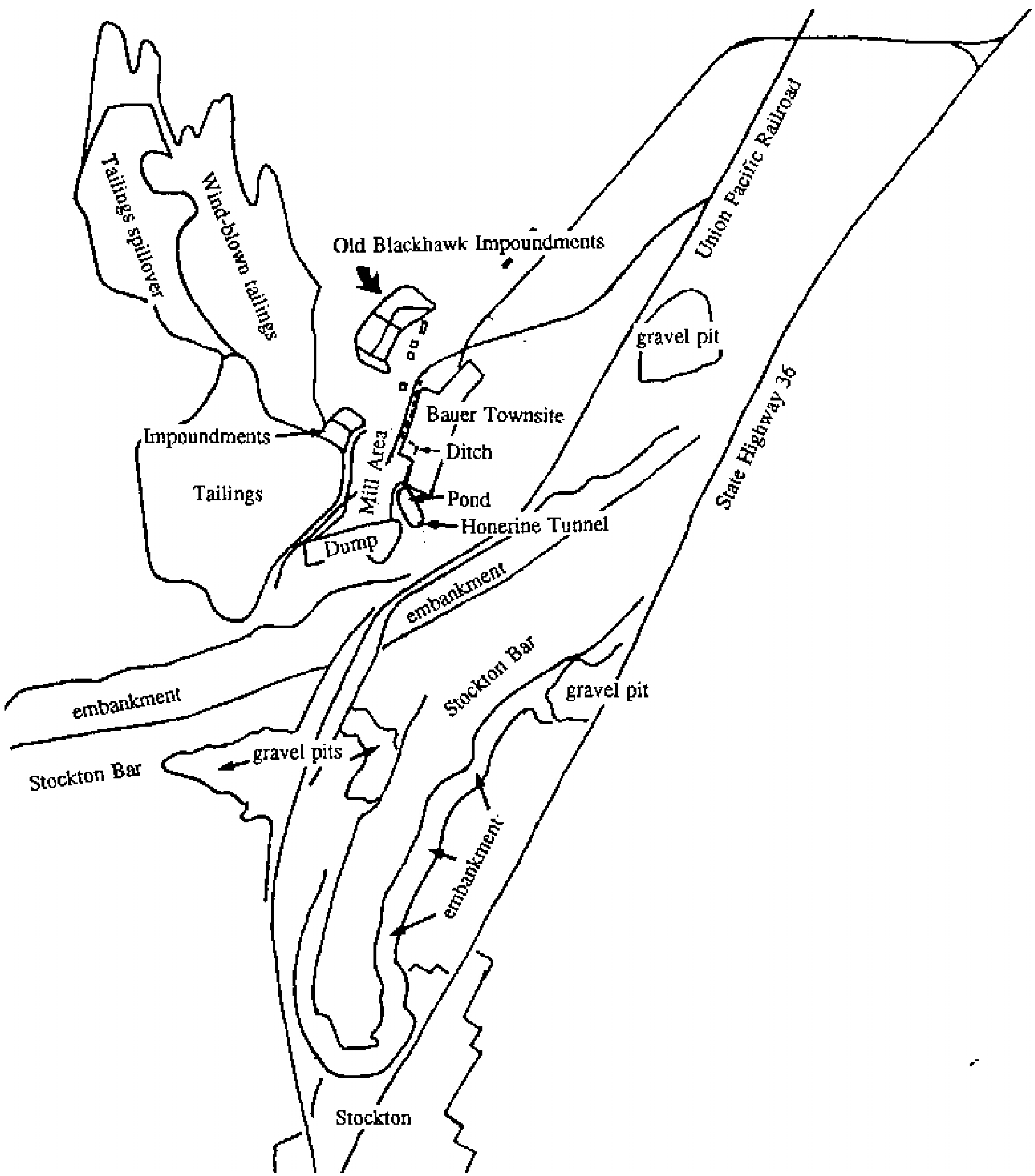

Figure 3. Demographics Introductory Map.

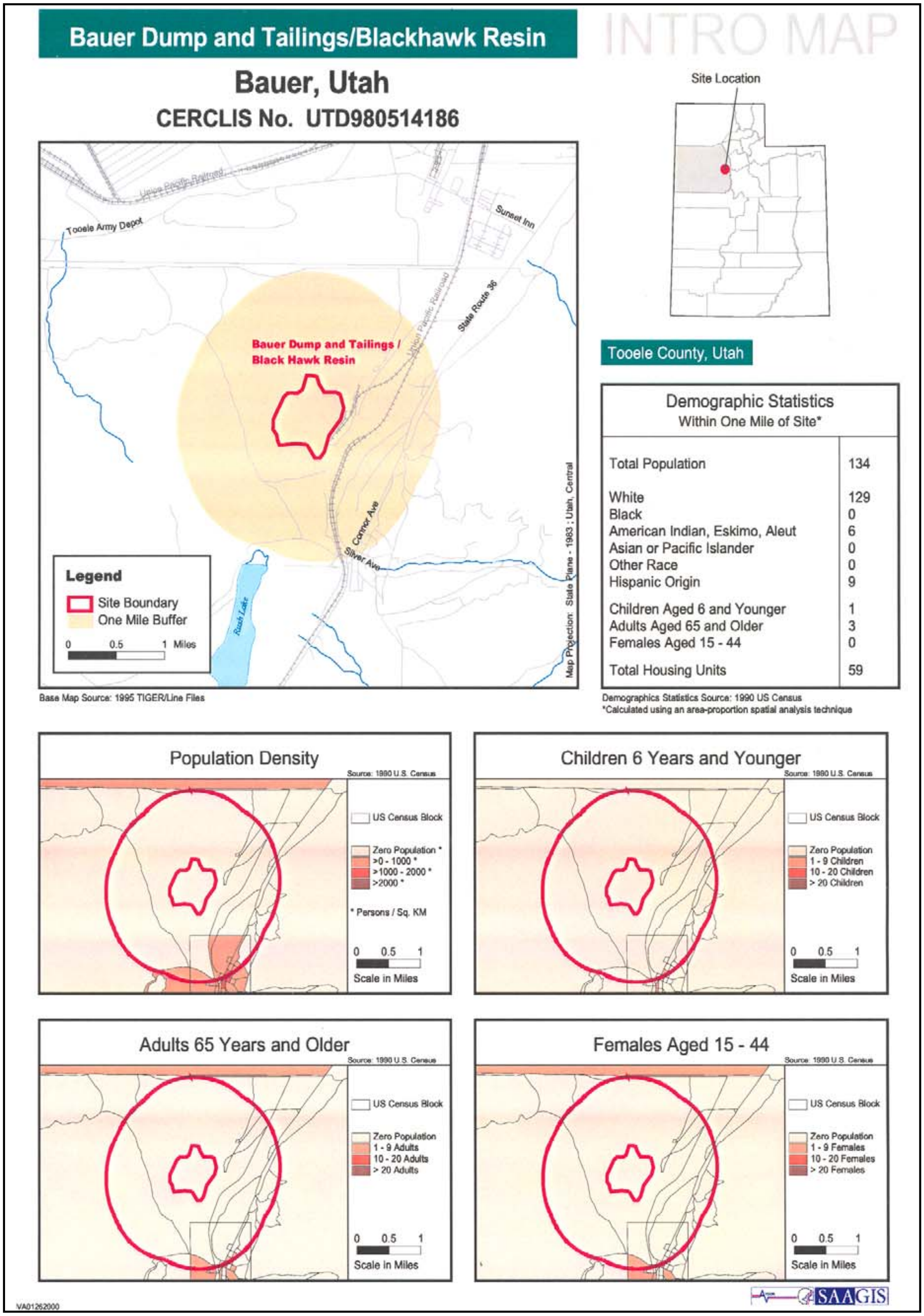

Figure 4. Open gate near Bauer site entrance.

Figure 5. Tailings near the abandoned Bauer town site.

Figure 6. Evidence of site trespassers at the Bauer site

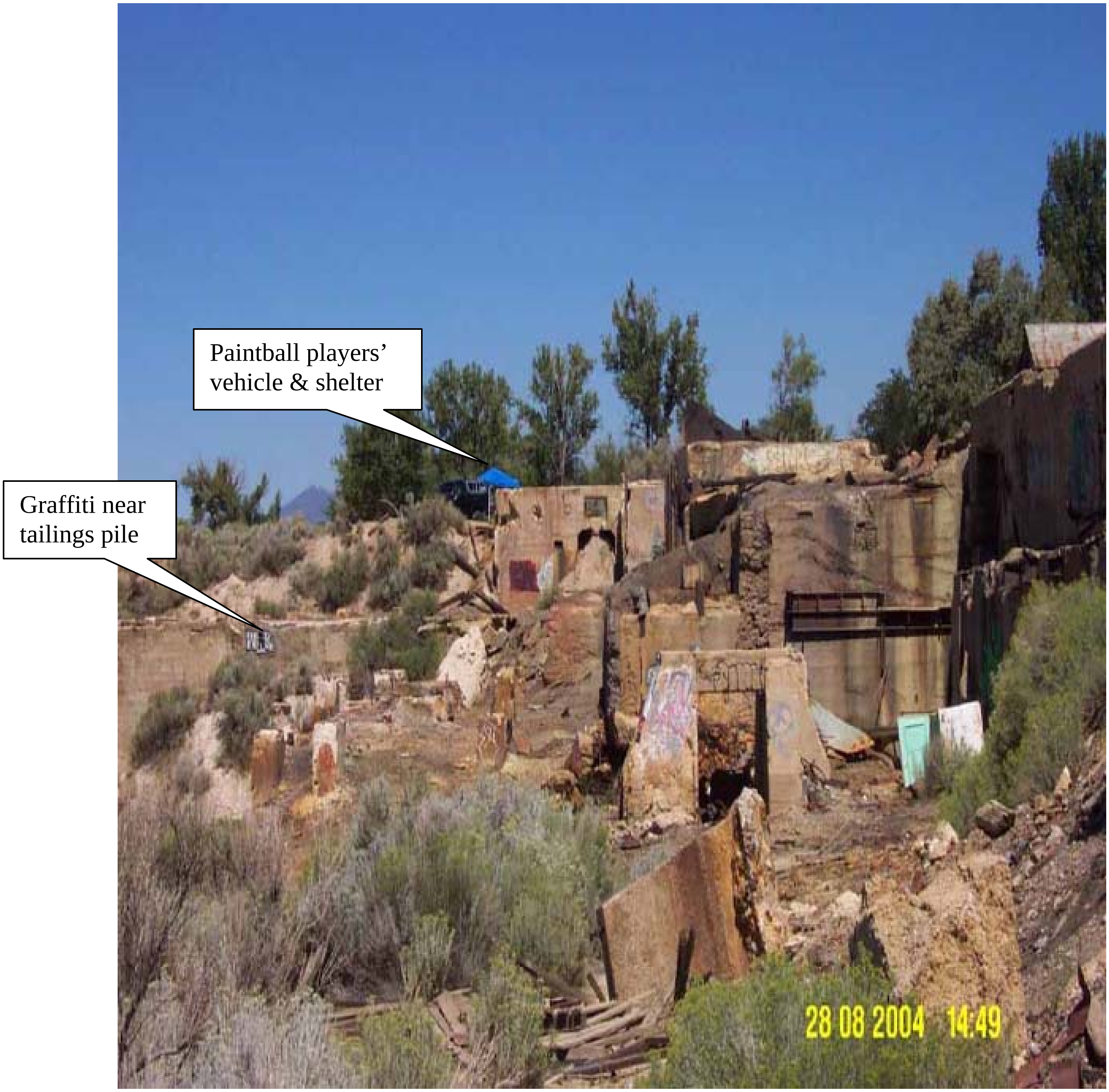

Figure 7. Map depicts locations of Source, Soil, Surface Water, and Sediments Samples.

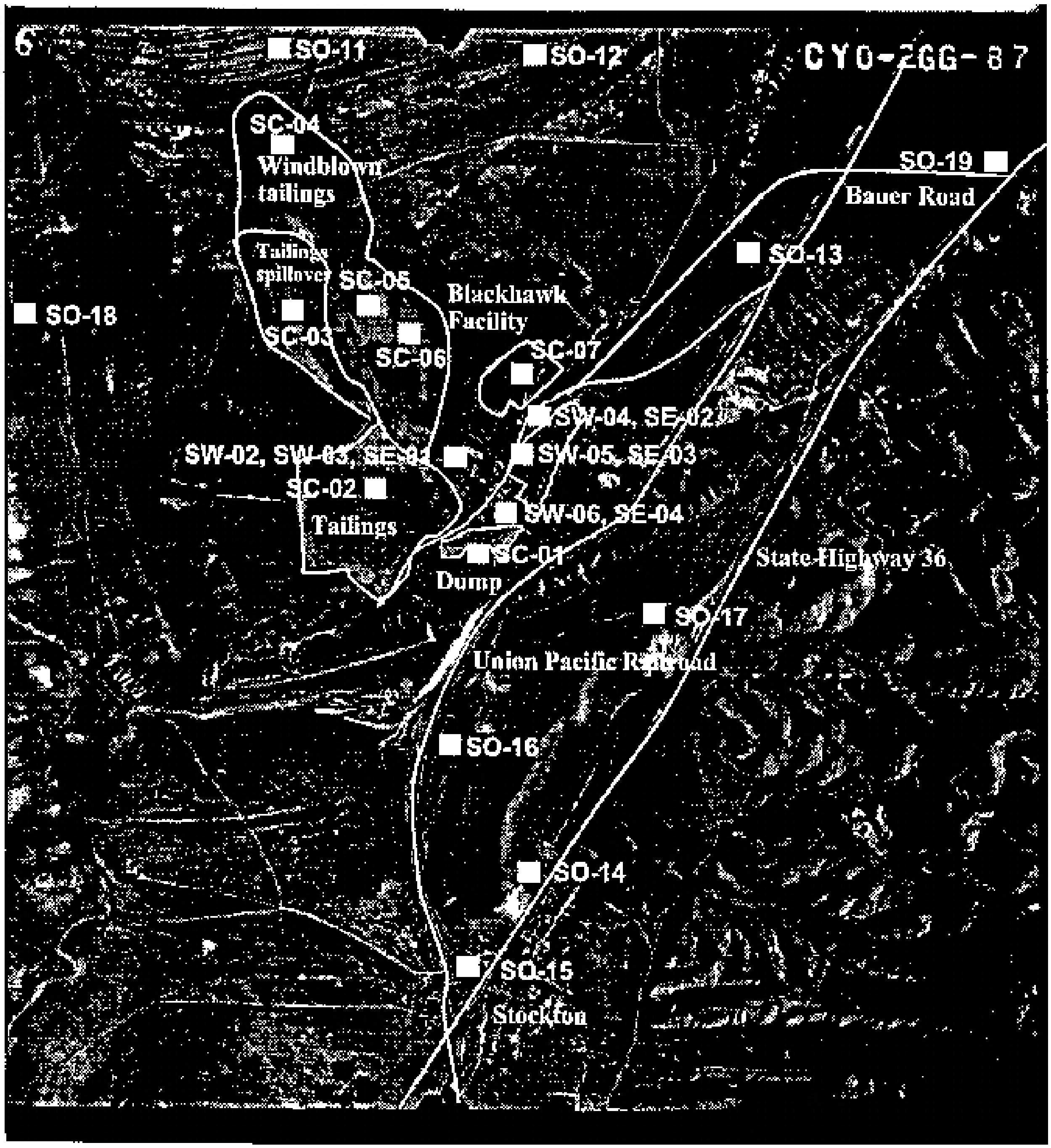

Table 1. Analytical Results for Waste and Tailings Samples

Contaminant	**ATSDR Soil Comparison Values[*] (CVs)**		**Sample Locations**						
			SC-01	*SC-02*	*SC-03*	*SC-04*	*SC-05*	*SC-06*	*SC-07*
	CV for Adults (ppm)	CV Source	Mine Waste Dump	Tailings Pile	Tailings Spillover	Windblown Tailings			Blackhawk Site
			(ppm)	*(ppm)*	*(ppm)*	*(ppm)*			*(ppm)*
Aluminum	1,000,000	EMEG	2,760	627	6,120	2,760	3,500	2,940	5,690
Arsenic	200	EMEG	**792**	**1,880**	**4,900**	**2,920**	**1,000**	**1,680**	62.9
Barium	50,000	RMEG	140	66.1	90.9	104	71.7	82.6	127
Beryllium	1,000	RMEG	0.44	0.25	1.4	0.63	0.88	0.45	0.42
Cadmium	100	EMEG	9	9.9	97.6	69.1	29.9	44.5	1.2
Copper	10,000	EMEG	393	90.9	309	254	298	289	21.1
Lead	400[†]	EPA	**1,070**	**1,510**	**6,100**	**8,920**	**2,640**	**3,170**	164
Manganese	40,000	RMEG	314	546	10,400	4,810	5,850	6,450	238
Mercury	70[‡]	RMEG	0.3	U	0.32	0.35	0.14	0.07	0.12
Nickel	10,000	RMEG	28.9	29.4	39.4	28	18.8	25.6	U
Selenium	4,000	EMEG	U	U	2.2	10.1	U	U	U
Silver	4,000	RMEG	20.1	29.7	32.7	49.8	30.6	39.4	U
Vanadium	2,000	EMEG	U	U	20	9	3.3	U	9.3
Zinc	200,000	EMEG	1,120	664	11,500	8,380	4,150	5,380	263

Entries in **bold** indicate contaminant concentrations that exceed soil comparison values.
ppm: parts per million
EMEG: Environmental Media Evaluation Guide
RMEG: Reference Dose Media Evaluation Guide
EPA: Environmental Protection Agency
U = undetected
[*] See Appendix A.
[†]EPA Lead Soil Hazard Standards: 1,200 ppm average lead in bare soil in residential areas with the exception of play areas which should not exceed 400 ppm lead in bare soil [EPA 2001].
[‡]Mercury comparison values calculated from an EPA Reference Dose for methylmercury [EPA 1998]. See Appendix B for calculations. Source: UDEQ 1999

Table 2. Analytical Results for Off-site Soil Samples.

Contaminant	**ATSDR Soil Comparison Values[*] (CVs)** CV for Adults (ppm)	CV Source	**Sample Locations** *SO-11* N of Tailings Pile *(ppm)*	*SO-12* E/NE of Tailings Pile *(ppm)*	*SO-13* NE near Bauer Rd. *(ppm)*	*SO-14* Stockton *(ppm)*	*SO-15* Stockton *(ppm)*	*SO-16* Stockton *(ppm)*	*SO-17* Gravel Pit SE of Tailings Pile *(ppm)*	*SO-18* Background *(ppm)*	*SO-19* Background *(ppm)*
Aluminum	1,000,000	EMEG	6,560	13,300	9,460	4,630	7,700	6,830	10,200	6,880	7,800
Arsenic	200	EMEG	**1,870**	**1,070**	42.5	25.1	33	14.6	49	20	17.4
Barium	50,000	RMEG	235	2,171	1,169	88.6	144	73.3	136	110	122
Beryllium	1,000	RMEG	0.76	0.825	0.55	0.272	0.047	0.35	0.56	0.44	0.54
Cadmium	100	EMEG	35.8	2.6	1.56	1.9	1.5	U	2.5	0.88	0.88
Copper	10,000	EMEG	165	31.7	34.4	33.6	41.1	14.5	55.6	30.8	42.8
Lead	400[†]	EPA	**4,170**	227	190	241	**447**	72.2	**560**	92.1	114
Manganese	40,000	RMEG	4,320	716	366	286	313	240	559	337	371
Mercury	70[‡]	RMEG	0.19	U	U	U	0.17	U	U	U	U
Nickel	10,000	RMEG	24.1	17.8	14.8	U	14.2	U	17.1	14.4	U
Selenium	4,000	EMEG	U	U	0.4	U	U	U	U	U	U
Silver	4,000	RMEG	23	2.7	109	1.9	2.2	U	2.3	U	U
Vanadium	2,000	EMEG	5	14	13	5.8	11	9.2	15.2	10.8	10.8
Zinc	200,000	EMEG	4,300	288	161	202	256	67.8	181	87.9	115

Entries in **bold** indicate contaminant concentrations that exceed soil comparison values.
ppm: parts per million
EMEG: Environmental Media Evaluation Guide
RMEG: Reference Dose Media Evaluation Guide
EPA: Environmental Protection Agency
U = undetected
[*] See Appendix A.
[†]EPA Lead Soil Hazard Standards: 1,200 ppm average lead in bare soil in residential areas with the exception of play areas which should not exceed 400 ppm lead in bare soil [EPA 2001].
[‡]Mercury comparison values calculated from an EPA Reference Dose for methylmercury [EPA 1998]. See Appendix B for calculations. Source: UDEQ 1999

Table 3. Analytical Results for Surface Water and Co-Located Sediment Samples.

Contaminant	**ATSDR Comparison Values[*] (CVs)**			**Sample Locations**			
	Non Cancer CV			SW-02/03 (SE-01)	SW-04 (SE-02)	SW-05 (SE-03)	SW-06 (SE-04)
	Drinking Water CV for Adults (ppb)	Soil CV for Adults (ppm)	CV Source	NE of tailings pile	On-site ditch	On-site pond	Outflow of Honerine Tunnel
				ppb and (ppm)	*ppb and (ppm)*	*ppb and (ppm)*	*ppb and (ppm)*
Aluminum	70,000	1,000,000	EMEG	3,690 (2120)	101 (2,970)	113 (2,930)	130 (6,710)
Antimony	10	n/a	RMEG	U (139)	U (95.5)	U (R)	U (R)
Arsenic	10	200	EMEG	**249 (7,050)**	**20.5 (1,430)**	**15.3 (680)**	**17.7** (12.3)
Barium	2,000	50,000	RMEG	27 (147)	27.1 (120)	26.6 (129)	26.4 (71.1)
Beryllium	70	1,000	RMEG	U (0.3)	U (0.31)	U (0.27)	U (0.34)
Cadmium	7	100	EMEG	**97** (11.4)	U (38.4)	U (17.4)	U (6.1)
Chromium	100	n/a	MCL	U (U)	U (U)	U (U)	U (U)
Copper	1,300	10,000	MCL	**1475** (3530)	U (385)	U (178)	U (22)
Lead	15[‡]	400[§]	EPA	**1815 (64,000)**	13.9 **(15,500)**	1.1 **(9,730)**	1.2 **(422)**
Manganese	2,000	40,000	RMEG	858 (78.2)	11.4 (365)	12.8 (1,290)	60.4 (129)
Nickel	700	10,000	RMEG	31.5 (1.1)	U (17.8)	U (20.3)	U (U)
Selenium	200	4,000	EMEG	U (2.8)	U (U)	U (2)	U (0.64)
Silver	200	4,000	RMEG	9.4 (210)	U (58.4)	U (12.9)	U (2.2)
Thallium	2	n/a	MCL	**2.75** (4.7)	U (5.6)	U (4.8)	U (1.7)
Vanadium	100	2,000	EMEG	U (U)	U (2.3)	U (1.4)	U (9.1)
Zinc	10,000	200,000	EMEG	9,015 (4,470)	83.1 (4,920)	92.3 (3,710)	146 (729)

Entries in **bold** indicate contaminant concentrations that exceed soil comparison values.
Values in parentheses () are results for co-located sediment samples in ppm.
ppb: parts per billion
ppm: parts per million
EMEG: Environmental Media Evaluation Guide
RMEG: Reference Dose Media Evaluation Guide
CL: Maximum Contaminant Level
EPA: Environmental Protection Agency
U = undetected
[*] See Appendix A.
[†] Values given are mean of results from duplicate samples.
[‡] EPA Action Level From EPA Current Drinking Water Standards [EPA 2004].
[§] EPA Lead Soil Hazard Standards: 1,200 ppm average lead in bare soil in residential areas with the exception of play areas which should not exceed 400 ppm lead in bare soil [EPA 2001].

Table 4. Completed and Potential Exposure Pathways.

Pathway Classification	Pathway Name	Exposure Pathway Elements: *Source*	*Environmental Medium*	*Point of Exposure*	*Route of Exposure*	*Receptor Populations*	Time Frame	Contaminant(s)
Completed	On-site Waste and Tailings	Bauer Dump and Tailings	Surface Soil	On-site waste dumps, tailings piles, and windblown tailings	Ingestion, Inhalation	On-site Recreational Users	Past Present Future	Arsenic Lead
	Off-site Soil	Bauer Dump and Tailings	Surface Soil	Off-site Soil	Ingestion, Inhalation	Off-site Recreational Users, Off-site Workers	Past Present Future	Arsenic Lead
Potential	On-site Surface Water	Bauer Dump and Tailings	On-site Surface Water	On-site Surface Water	Ingestion	On-site Recreational Users	Past Present Future	Arsenic Lead Cadmium Copper Thallium
	Off-site Surface Water	Bauer Dump and Tailings	Off-site Surface Water	Off-site Surface Water	Ingestion	Off-site Recreational Users, Off-Site Workers, Residents in Nearby Communities	Past Present Future	Arsenic Lead Cadmium Copper Thallium
	Groundwater	Bauer Dump and Tailings	Groundwater	Water Wells	Ingestion	Residents in Nearby Communities	Future	Arsenic Lead Cadmium Copper Thallium
	Consuming Animal Products	Bauer Dump & Tailings	Animal products	Consuming products from animals gazing on-site	Ingestion	Consumers	Past Present Future	Arsenic Lead Cadmium Copper Thallium

Table 5. Exposure Dose Estimates: Ingestion of Soil On- and Off-Site.

Pathway	Contaminant	Maximum Contaminant Level (mg/kg)	Target	Estimated Exposure Dose (mg/kg/day)	Health Guideline (mg/kg/day)	Exceeds Guideline?	Source of Guideline
On-site Soil and Tailings	Arsenic	4,900	Adults	0.00003	0.0003	**No**	[ATSDR 2004a]
			Young Adults*	0.00004			
	Lead	15,100	Adults	0.00009	n/a	n/a	n/a
			Young Adults	0.0001			
Off-site Soils	Arsenic	1,870	Adults	0.00001	0.0003	**No**	[ATSDR 2004a]
			Young Adults	0.00001			
			Workers	0.00006			
	Lead	4,170	Adults	0.00002	n/a	n/a	n/a
			Young Adults	0.00003			
			Workers	0.0001			

n/a = not available
* Young adults are considered to be between the ages of 12 and 17 and weigh 50 kilograms.

Appendix A: Acronyms & Terms Defined

Background Level — The amount of a chemical that occurs naturally in a specific environment.

Cancer Classes — Each health organizations has a separate method of cancer classification:

<u>Environmental Protection Agency (EPA) (Based on 1986 cancer assessment guidelines):</u>

A	=	Human Carcinogen.
B1	=	Probable Human Carcinogen (based on limited human and sufficient animal studies).
B2	=	Probable Human Carcinogen (based on inadequate human and sufficient animal studies).
C	=	Possible Human Carcinogen (no human studies and limited animal studies).
D	=	unlikely to be a Human Carcinogen
E	=	Evidence of noncarcinogenicity in humans

<u>Environmental Protection Agency (EPA) (Based on 2003 cancer assessment guidelines):</u>

CA	=	Carcinogenic to humans
LI	=	Likely human carcinogen (cancer potential established; but limited human data)
SU	=	Suggestive evidence (human or animal data suggestive)
IN	=	Inadequate (data inadequate to assess)
NO	=	Robust data indicate no human carcinogen.

<u>International Agency for Research on Cancer (IARC)</u>

1	=	Carcinogenic to Humans (sufficient human evidence).
2A	=	Probably Carcinogenic to Humans (limited human evidence; sufficient evidence in animals).
2B	=	Possibly Carcinogenic to Humans (limited human evidence; less than sufficient evidence in animals).
3	=	Not Classifiable
4	=	Probably Not Carcinogenic to Humans

<u>National Toxicology Program (NTP)</u>

1	=	Known Human Carcinogen
2	=	Reasonably anticipated to be a carcinogen
3	=	Not Classified

Comparison Values

CVs; Health-based and media-specific concentrations that are used to select environmental contaminants for further evaluation in public health assessments. These values are not valid for other types of media, nor do concentrations above these values indicate that a health risk actually exists (agency that developed the value is in parenthesis for the examples below):

Examples of Comparison Values for non-cancer health effects

EMEG-c = Environmental Media Evaluation Guide for chronic (more than 365 days) exposure (ATSDR).

EMEG-i = Environmental Media Evaluation Guide for intermediate exposure (ATSDR).

EMEG-u = Environmental Media Evaluation Guide - unpublished.

RMEG = Reference Dose Media Evaluation Guide (ATSDR).

NPDWR = National Primary Drinking Water Regulations (EPA) accessed on web at: www.epa.gov/safewater/mcl.html

LTHA = Lifetime health advisory for drinking water (EPA).

Example of a Comparison Value for cancer health effects

CREG = Cancer Risk Evaluation Guide for $1x10^{-6}$ excess cancer risk (ATSDR)

Completed Exposure Pathway

A way in which people can be exposed to a contaminant associated with a site. An exposure pathway is a description of the way a chemical moves from a source to where people can come into contact with it. A completed exposure pathway has all of the 5 following elements:

1) A source of contamination
2) Transport through environmental medium
3) A point of exposure
4) A route of human exposure
5) An exposed population

CREG

Cancer Risk Evaluation Guides are based on a contaminant concentration estimated to increase the cancer risk in a population by one individual in one million people over a lifetime exposure.

EMEG

Environmental Media Evaluation Guides are media-specific comparison values used to select contaminants of interest at hazardous waste sites. EMEGs are derived from Minimal Risk Levels (MRLs), developed by the Agency for Toxic Substances and Disease Registry (ATSDR), and are an estimate of human exposure to a compound that is not expected to cause noncancerous health effects at that level for a specified period. They are intended to protect the most sensitive individuals (i.e. children). MRLs are guidelines and are not used to predict adverse

	health affects. MRLs do not take into account carcinogenic effects, chemical interactions, or multiple routes of exposure.
EMEG-c	**Environmental Media Evaluation Guides** for chronic exposures (see entry for "EMEG" and for "Comparison Values").
EMEG-i	**Environmental Media Evaluation Guides** for intermediate exposures (see entry for "EMEG" and for "Comparison Values").
EMEG-u	**Environmental Media Evaluation Guides** that are unpublished are designated with an asterisk by the authors of this health assessment and used only in the absence of published comparison values and are calculated using equations outlined in Appendix B.
EPA	The **U.S**. **Environmental Protection Agency** is the federal agency that develops and enforces environmental laws to protect the environmental and public health
Exposure Dose	At some sites, the existing conditions may result in exposures that differ from those used to derive Comparison Values such as the EMEG. In these situations, the health assessor can calculate site-specific exposures more accurately using an exposure dose. The exposure dose can then be compared to the appropriate toxicity values (MRL, RfC, RfD).
Health-Based Comparison Values	see "Comparison Value" entry.
ICP	Inductively Coupled Plasma.
LOAEL	The **Lowest Observable Adverse Effect Level** (LOAEL) is the lowest exposure level of a chemical that produces significant increases in frequency or severity of adverse effects.
LTHA	**Lifetime Health Advisory** for drinking water from EPA.
MCL	A **Maximum Contaminant Level** is an enforceable standard calculated by the United States Environmental Protection Agency. The MCL is the highest level of a contaminant that is allowed in drinking water.
MRL	A **Minimal Risk Level** (MRL) is defined as an estimate of daily human exposure to a chemical that is likely to be without an appreciable risk of deleterious non-cancer health effects over a specified duration of exposure. Thus, MRLs provide a measure of the toxicity of a chemical.

NOAEL

The **No Observable Adverse Effect Level** (NOAEL) is the exposure level of chemical that produces no significant increases in frequency or severity of adverse effects. Effects may be produced at this dose, but they are not considered to be adverse.

NPDWR

National Primary Drinking Water Regulations are legally enforceable standards that apply to public water systems. Primary standards are available on the web at: http://www.epa.gov/safewater/mcl.html

NPL site

The National Priorities List (NPL) is a list published by EPA ranking all the Superfund sites. Superfund is the common name for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a federal law enacted in 1980. This law was preauthorized in 1986 as the Superfund Amendments and Reauthorization Act. CERCLA enables EPA to respond to hazardous waste sites that threaten public health and the environment. A site must be added to the NPL site list before remediation can begin under Superfund.

Potential Exposure Pathway

A possible way in which people can be exposed to a contaminant associated with a site. An Exposure pathway is a description of the way a chemical moves from a source to where people can come into contact with it. A potential exposure pathway has 4 of the 5 following elements:

1) a source of contamination
2) transport through environmental medium
3) a point of exposure
4) a route of human exposure
5) a receptor population

PRG

Preliminary Remediation Goals. Used for EPA Planning Purposes only.

Public Health Hazard

The category ATSDR assigns to sites that pose a health hazard to the public as the result of long-term exposures to hazardous substances. See “Public Health Hazard Categories”

Public Health Hazard Categories

Categories defined by ATSDR and used in public health assessments that assess if people could be harmed by conditions present at a site. One of the following categories is assigned to each site:

Category A: Urgent Public Health Hazard
Category B: Public Health Hazard
Category C: Indeterminate Public Health Hazard
Category D: No Apparent Public Health Hazard
Category E: No Public Health Hazard

RMEG **Reference Dose Media Evaluation Guides** are media-specific comparison values used to select contaminants of interest at hazardous waste sites. RMEGs are derived from reference doses (RfDs), developed by the U.S. Environmental Protection Agency (EPA), and are an estimate of human exposure to a compound that is not expected to cause noncancerous health effects at that level for a specified period. They are intended to protect the most sensitive individuals (i.e. children). RfDs are guidelines and are not used to predict adverse health affects. RfDs do not take into account carcinogenic effects, chemical interactions, or multiple routes of exposure.

Appendix B: Calculations

Estimating Exposure Dose (ED) [ATSDR 1992]

The formula used to calculate ED is given as follows:

$$ED = (C \times IR \times EF \times CF) / BW$$

Where:

C = Contaminant level (mg/kg)
IR = Soil ingestion rate (mg soil/day)
= 100 mg soil/day for an adult / young adult
= 200 mg soil/day for a child
= 5,000 mg soil/day for a pica child
EF = Exposure factor (unitless, see below for calculation)
CF = Conversion factor (10^{-6})
BW = Body weight (kg)
= 70 kg for an adult
= 50 kg for a young adult (age 12-17)
= 10 kg for a child

Calculating Exposure Factor (EF) [ATSDR 1992]

$$EF = (F \times E_D) / T$$

Where:

F = frequency of exposure
E_D = exposure duration (years)
T = time of exposure (days)

<u>On-site adult/young adult exposure</u>:
In estimating EF for on-site adult recreational users, it is assumed an adult/young adult visits the site for 6 hours per week, for 9 months of the year, for 10 years, and lives for 70 years*.

F = 6hrs/24hrs = 0.25 day/week x 4.33 weeks/month = 1.08 days/month x 9 months/year = 9.74 days/year
E_D= 10 years
T = 70 years x 365 days/year = 25,550 days
EF = 0.004

Receptor	days/week	weeks/month	months/year	E_D (years)	T (days)	EF (unitless)
Adult/young adult	0.25	4.33	9	10	25,550	**0.004**

* Because the exposure factor is being derived for a carcinogen, the time period during which the dose is averaged may be a 70-years life-time [ATSDR 1992]

Therefore, to calculate the exposure dose (ED) for adult/young adult exposure to on-site soil:

$$ED = (C \times IR \times EF \times CF) / BW$$

For Arsenic: ED_{adult} = (4,900 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 70kg
= **0.00003 mg Arsenic/kg/day**
$ED_{young\ adult}$ = (4,900 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 50 kg
= **0.00004 mg Arsenic/kg/day**
For Lead: ED_{adult} = (15,100 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 70kg
= **0.00009 mg Lead/kg/day**
$ED_{young\ adult}$ = (15,100 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 50 kg
= **0.0001 mg Lead/kg/day**

Off-site adult/young adult recreational users and adult workers:
Off-site adults/young adults: As above, for off-site adult/young adult recreational users, it is assumed an adult/young adult visits the site for 6 hours per week, for 9 months of the year, for 10 years, and lives 70 years. Therefore, the **EF = 0.004.**

To calculate the exposure dose (ED) for adult/young adult exposure to off-site soil:

$$ED = (C \times IR \times EF \times CF) / BW$$

For Arsenic: ED_{adult} = (1,870 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 70kg
= **0.00001 mg Arsenic/kg/day**
$ED_{young\ adult}$ = (1,870 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 50 kg
= **0.00001 mg/Arsenic/kg/day**
For Lead: ED_{adult} = (4,170 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 70kg
= **0.00002 mg Lead/kg/day**
$ED_{young\ adult}$ = (4,170 mg/kg x 100 mg soil/day x 0.004 x 10^{-6}) / 50 kg
= **0.00003 mg Lead/kg/day**

Off-site Workers: Workers at the gravel pit operations generally follow a 5 day, 8 hour work schedule and are at work 50 weeks per year. It is assumed that workers remain with the same facility for 6.6 years, the median occupational tenure for the working population, and that the worker lives for 70 years.

F = 8 hours/day x 5 days/week = 40 hours/week x 1 day/24 hours = 1.67 days x 50 weeks/year
E_D= 6.6 years the median occupational tenure for the working population
T = 70 years x 365 days/year = 22,550 days
EF = 0.022

Receptor	days/week	weeks/year	E_D (years)	T (days)	EF (unitless)
Workers	1.67	50	6.6	25,550	**0.022**

To calculate the exposure dose (ED) for worker exposure to off-site soil:

$$ED = (C \times IR \times EF \times CF) / BW$$

For Arsenic: $ED_{worker} = (1{,}870 \text{ mg/kg} \times 100 \text{ mg soil/day} \times 0.022 \times 10^{-6}) / 70\text{kg}$
= **0.00006 mg Arsenic/kg/day**

For Lead: $ED_{worker} = (4{,}170 \text{ mg/kg} \times 100 \text{ mg soil/day} \times 0.022 \times 10^{-6}) / 70\text{kg}$
= **0.0001 mg Lead/kg/day**

Comparison Value Calculations for Soil [ATSDR 1992]**:**

EMEG = MRL x (BW)/IR

RMEG = R_fD x (BW)/IR

CREG = $10E^{-6}$ x (BW)/[IR x(OSF)]

Where:

EMEG = Environmental Media Evaluation Guide (ppm)
MRL = Minimal Risk Level (mg/kg/day)
RMEG = Reference Dose Media Evaluation Guide
R_fD = Reference Dose
CREG = Cancer Risk Evaluation Guide for 1×10^{-6} excess cancer risk
OSF = Oral Slope Factor
BW = Body Weight (kg)
= 70 kg for an adult
= 50 kg for a young adult (ages 12 – 17)
= 10 kg for a child
IR = Soil Ingestion rate (mg soil/day)
= 100 mg soil/day for an adult / young adult
= 200 mg soil/day for a child
= 5,000 mg soil/day for a pica child

Mercury in soil

$R_fD = 1E^{-4}$ (ppm)/day

Of the mercury compounds, "methylmercury is the compound of greatest concern for human health" [EPA 1998].

$RMEG_{adult} = R_fD$ (BW)/IR
= 1×10^{-4} mg methylmercury/kg/day (70 kg)/100 mg soil/day)
= 7×10^{-5} (mg methylmercury/day)/(mg soil/day)
= 70 (mg methylmercury/day)/(kg soil/day)

Chemical Mixture Interaction Calculations

Lead Hazard Quotient = $\frac{\text{slope factor} \times \text{soil lead concentration} \times \text{relative time spent on site}}{\text{CDC blood level of concern}}$

$= \frac{0.0068\ \mu\text{g./dL per mg/kg} \times 15{,}100 \text{ mg lead/kg} \times 0.0357}{10\ \mu\text{g/dL}}$

= 0.367

$$\text{Arsenic Hazard Quotient} = \text{Arsenic Dose/MRL} = \frac{0.00004 \text{ mg/kg/day}}{0.0003 \text{ mg/kg/day}} = 0.133$$

$$\text{HI} = 0.367 + 0.133 = 0.5$$