Health Consultation

TOOELE RAILROAD SPUR

TOOELE, TOOELE COUNTY, UTAH

EPA FACILITY ID: UT0011980278

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
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Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation 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.

HEALTH CONSULTATION

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Prepared by:

Environmental Epidemiology Program
Bureau of Epidemiology
The Utah Department of Health
Under Cooperative Agreement with the
The Agency for Toxic Substances and Disease Registry

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SUMMARY

The Tooele Railroad Spur (TRS) is located in the city of Tooele, Tooele County, Utah. The spur is approximately 10 feet wide and runs parallel along the foothills of the Oquirrh Mountains from the International Smelting and Refining (IS&R) site through the city of Tooele. The area under investigation is located within city limits: south of Elm Street to Vine Street; between 2nd Street and 7th Street; and south of Maple Street to Vine Street, between 1st and 2nd Street.

Interest in the Tooele Railroad Spur site began in January 2000, when the Tooele County Health Department (TCHD) discovered elevated levels of metals in residential soil. Subsequent sampling revealed levels of arsenic, aluminum, antimony, copper, lead, vanadium, and zinc were elevated. TCHD requested that the Environmental Epidemiology Program (EEP) of the Utah Department of Health (UDOH) conduct this health consultation to identify any public health hazards posed by the Tooele Railroad Spur.

Prior to soil remediation, the Tooele Railroad Spur was a public health hazard based on arsenic, copper, lead, and zinc concentrations in residential soil. With the exception of blood lead levels in children, no bio-monitoring data is available which can conclusively determine that exposure has occurred or is occurring. The nature of the contaminants is such that it is highly likely that exposure has occurred for residents who live near the site and for visitors to the site. Of particular concern is the potential for long-term developmental health effects on children residing on the site. The main route of exposure is via the soil pathway on-site and possibly by migration of contaminant particles off-site. Arsenic, copper, lead, and, zinc are the contaminants of concern. There is no data available to indicate surface and groundwater contamination. Off-site migration of contaminants via soil, surface water, and groundwater may potentially extend to down gradient communities, thereby increasing the affected population.

Lead is the only chemical of concern for adults. For children, arsenic and lead levels are of health concern. Levels of arsenic, copper, lead, and zinc are chemicals of concern for pica children. Based on several uncertainty factors, the estimated doses calculated for pica children are considered to be very conservative and may be much higher than the dose actually received.

Atlantic Richfield Company, under oversight from the EPA, completed remediation activities of residential properties on the TRS site in September 2005. Since the remediation work has been completed, and the contaminated soil has been removed, this site is not considered a public health hazard.

The EEP will continue to develop and provide community health education materials about health effects that may result from heavy metal exposure to contaminated soil from the spur. Information on soil dust control methods will also be provided. These materials will be made available through the TCHD.

The EEP, in coordination with TCHD, have encouraged residents of the subdivisions near the site to have their children screened for lead exposure. The EEP will continue to monitor the Utah Blood Lead Registry for children with elevated blood lead levels in areas near the site. The EEP,

in coordination with TCHD, will monitor the development of residential property near the site, and activities on the site that may further facilitate migration of contaminants off-site. The EEP will continue to coordinate site activities with the Utah Department of Environmental Quality (UDEQ), EPA, and TCHD.

PURPOSE AND HEALTH ISSUES

A preliminary analysis of soil along the Tooele Railroad Spur (TRS) by the Tooele County Health Department (TCHD) indicated that residential soils might be contaminated with high levels of arsenic, lead, and other metals. TCHD has requested that the Environmental Epidemiology Program (EEP) of the Utah Department of Health conduct this health consultation to determine any public health hazards posed by the TRS.

In this document, the most recent analytical results from soil testing were evaluated to determine the contaminants of concern at the TRS site. Exposure pathways for these contaminants are presented, along with estimations of exposure dose to target populations. Ultimately, this health consultation provides conclusions on the public health issues relevant to the TRS site and offers recommendations to protect the health of residents in the area.

BACKGROUND

Site Description and History

The TRS is located in the City of Tooele, Tooele County, Utah (Figures 1, 2). The railroad runs from the International Smelting and Refining (ISR) site and enters the city from the east, after running parallel along the foothills of the Oquirrh Mountains. The spur is roughly 10 feet wide and runs approximately 3,400 feet through the city. As the spur enters the city, it runs along a public driving range and golf course. A gravel path for the golf carts lies on top of the spur from the clubhouse to nearby the Oquirrh Hills School. To the south of the spur, in an open field, is the Tooele Youth Garden (Figure 3).

The railroad spur extends along the north side of the Oquirrh Hills School, previously used for special needs children, and a site that was previously a playground. The old playground area is approximately 20 feet higher than the spur and is connected by a steep embankment. The Oquirrh Hills School is now a “Head Start” program for 3- and 4-year-olds. The children are closely supervised when outside and are not allowed to play outside of a fenced-in area on the east side of the school.

From the Oquirrh Hills School, the spur then crosses 7^{th}, 6^{th}, 5^{th}, and 4^{th} Streets, and Broadway Avenue. Between 4^{th} Street and Broadway Avenue there is an open area that serves as a parking lot. On the west side of Broadway Avenue, the spur runs through secured Railroad Museum property, through a field, and then under East Vine Street, which is paved. New homes were constructed by the government housing authority on and around the spur between 7^{th} Street and 4^{th} Street. According to a resident of one of the new homes on 4^{th} street, no new dirt was brought in. The yards were either covered with sod or “hydro-seeded”. The resident also stated that there are many neighborhood children who like to play in the exposed area across the street. There are many nearby swing sets and other evidence supporting this claim [URS 2000, EEP 2001].

International Smelting and Refining (ISR) began operating a copper smelter in 1910, added a lead smelter in 1912, and was acquired by Anaconda Copper in 1915. Subsequently, a lead-zinc sulfide flotation mill was added to the facility in 1924, and a slag treatment plant in 1941. The site offered proximity to ore supplies, water, and the concurrently constructed Tooele Valley Railroad. In the early years of operation, tailings, slag and flue dust were produced at an annual rate of approximately 650,000 tons/year; these wastes were disposed of on-site. As ore supplies began declining, output decreased. The copper smelter was closed in 1946 and lead smelting ceased by 1972, when the complex was razed [Comp 1975, UDEQ 1997].

Site Characterization

For the purposes of this document, the site under investigation lies within the following boundaries: South of Elm Street to Vine Street; between 2nd Street and 7th Street; and South of Maple Street to Vine Street, between 1st and 2nd Street (Figure 1). This area is also defined by the census boundaries of census tract 1310, block group 4, blocks 4029 through 4035. Residents within these boundaries that have houses on, or in close proximity to, the TRS, are considered at risk of exposure to contaminated soil (Figure 2). Soil samples have been taken along the railroad spur from 1st Street to Droubay Road (Figure 3).

The spur has been paved over where it crosses the residential streets. It appears that the spur is covered with sod where it runs through the yards of residents. However, the spur is not covered with asphalt or sod where it runs through the census block 4032 (Figure 2), which contains no residents.

Drinking water for the city of Tooele is obtained from wells to the west of Tooele and springs in Middle Canyon. The nearest municipal well, located 32 miles southwest of the site and operated by the city of Tooele, supplies an unknown number of residents. Groundwater flow appears to be north or northwest, toward the Great Salt Lake [JBR 1986, E&E 1985].

Demographics and Land Use

Tooele County has experienced moderate, steady growth since the opening of the Tooele Army Depot and Dugway Proving Ground in 1942. According to the 2000 Census, the county has a population of about 40,735 residents. Affordable housing prices are drawing people to the area, many from Salt Lake County. The Federal Government (Tooele Army Depot, Dugway Proving Ground, and Deseret Chemical Depot) remains the area’s largest employer [Babitz 1996]. The City of Tooele grew from 13,887 in 1990 to 22,502 people in 2000, a 62% increase [GPHC 2002]. According to the 2000 census, there are 203 people, of these 61 are children, living on site (Figure 2).

Access to the TRS site is unrestricted along residential properties and near the school and golf course, with the exception of the Railroad Museum. Near the ISR site outside of the Tooele area, access is hindered by fencing and signs [EEP 2001].

DISCUSSION

Nature and Extent of Contamination

On May 24, 2000, the URS Operating Service, Inc. (UOS) conducted in-situ soil screening with the START Spectrace® 9000 X-Ray Fluorescence Spectrometer (XRF) for lead and arsenic at 24 locations along the spur. Five soil samples also were taken from suspected "hot spots" identified by the XRF for laboratory analysis. These samples were sent to Laucks Testing Laboratory, Inc. for Target Analyte List (TAL) Total Metals analysis on that same day. Samples from both the residential and school areas were found to have elevated levels of several metals including lead and arsenic. Previous soil sampling includes that by Delta Geotechnical Consultants in 1997 (Table 1) and by the Utah Department of Environmental Quality (UDEQ) in 2000 (Table 2). This previous sampling in 1997 and 2000 was from approximately the same residential and school areas and also showed elevated arsenic and lead levels.

Arsenic, cadmium, and lead were the main contaminants found in samples collected from tailings, slag, and soils at the ISR site [E&E 1985]. Since the Tooele Railroad Spur was used extensively in IRS operations, it was reasoned that the soil samples taken from points along the spur might also reveal these contaminants [URS 2000, EEP 2001].

Elevated levels of arsenic and lead were found in soil samples from Middle Canyon, the main watershed for the city of Tooele. There was concern about possible water contamination since the spur crosses over the mouth of the canyon. However, no evidence of contamination could be found [USDEH 1985]. The EPA has proposed further investigations of air quality, stream sediments, and groundwater [E&E 1985].

The TRS site may be contaminated by waste, tailings, and slag, consisting of accumulations of ore, concentrates, flue dust, debris, and landfill wastes generated by smelting mills. Particles of concern range in size from a grain of sand up to much larger solids.

One XRF sample was performed at the Oquirrh Hills school. This sample, sample SS-13, had a lead level of 17 ppm and 45 ppm arsenic. Based on these measurements, it was determined that soil at the school was not contaminated.

The maximum concentrations for three metals were found in soil sample TRG-ES-02, collected from the gravel road on top of the railroad grade due northeast of the Oquirrh Hills School's playground. This sample was found to contain 185 ppm arsenic, 28.6 ppm cadmium, and 5,460 ppm lead. The TRG-ES-02 sample also contained 10,800 ppm aluminum, 20.8 ppm antimony, 785 ppm copper, 17.6 ppm vanadium, and 7140 ppm zinc (Table 3). The results for the five samples analyzed at the laboratory can only be used as estimates due to the presence of interferences, and the duplicate analysis was not within the control limits. The presence and approximate concentrations of lead in the samples is reliable; however, the amount is only an estimate [URS 2000]. Additionally, while the "hot spot" sampling method may validate the need for further testing, it is indeterminate whether these five recent samples overestimate, underestimate or accurately characterize the true extent of contamination.

IHI Environmental performed additional sampling in November 2000 at four locations east of 7th Street (Table 4). Lead levels were found to be elevated with a range of 1000 ppm to 2900 ppm.

Bingham Environmental took three samples in February 2001 at locations between 1st Street and the Railroad Museum (Table 5). Two of the three samples had elevated levels of arsenic with values of 46 ppm and 49 ppm. One sample had an elevated value of lead at 510 ppm.

Anderson Engineering Company, Inc. took soil samples from the TRS in residential areas in March 2004 (Table 7) and from sites east of the TRS residences near the Oquirrh Hills School in April 2003 (Table 6). In the residential areas, several metals were found to be elevated. One residential sample had an aluminum concentration of 11,400 ppm and a vanadium concentration of 18.7 ppm. One sample had a copper value of 134 ppm. Another residential soil sample was found to have an arsenic concentration of 26.7 ppm and a lead concentration of 573 ppm. Of the samples taken near the Oquirrh Hills School, all nine samples showed elevated levels of aluminum (maximum concentration of 8,540 ppm); arsenic (maximum concentration of 195 ppm); copper (maximum concentration of 716 ppm); lead (maximum concentration of 4,010 ppm); and vanadium (maximum concentration of 15 ppm). Some of these samples also had elevated levels of antimony (one sample with 29 ppm); cadmium (maximum concentration of 20.8 ppm); and zinc (maximum concentration of 2,470 ppm).

URS Operating Service, Inc. performed sampling at seven residential locations in April 2004 (Table 8). Soil samples showed elevated levels of aluminum (maximum concentration of 9,230 ppm); arsenic (maximum concentration of 20.4 ppm); copper (maximum concentration of 117 ppm); lead (one sample with 508 ppm); and vanadium (maximum concentration of 16.7 ppm).

XRF sampling was also performed by Anderson Engineering Company, Inc. along the TRS between 7th Street and Droubay Road (Table 9) and in the Tooele Youth Garden (Table 10). The samples between 7th Street and Droubay Road had a maximum arsenic concentration of 490.8 ppm and a maximum lead concentration of 7,884.8 ppm. Maximum arsenic concentration in the Tooele Youth garden was less than 55.5 ppm and lead values were not considered elevated with a maximum concentration of 135.4 ppm. This sampling along with sampling taken east of Droubay Road demonstrated that contaminant concentrations decreased dramatically with distance from the spur.

Soil Remediation Activities

Atlantic Richfield Company, under oversight from the EPA, has completed remediation activities of residential properties on the TRS site. Soil remediation for the residential properties and the section of railroad along the school property was completed in September 2005. As part of the remediation project involving the International Smelting and Refining site, soils are being removed from contaminated locations within the city of Tooele. Soils that exceeded 580 ppm for lead or 100 ppm for arsenic are included in the removal action. These sites include residential properties on the TRS located between Broadway Avenue and 4th Street. Most of the section between 7th Street and Droubay Road will also be remediated. Removal of contaminated soils at these locations should eliminate the source of exposure to soil contaminants.

Exposure Pathways Analysis

Due to nearly unrestricted access to the TRS site in Tooele City, residents and those visiting the area were at risk of being exposed. Off-site exposure due to migration of contaminated soil may also affect both adults and children in the surrounding areas.

This section estimates exposure doses and evaluates pathways of exposure to the contaminants of concern. The implications of such exposure doses on public health are also presented.

To determine whether nearby residents and on-site visitors are exposed to contaminants related to a site, ATSDR evaluates the environmental and human components that lead to human exposure. This exposure pathways analysis consists of five elements [ATSDR 2005b]:

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* or *potential*. 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. Potential exposure pathways require that one of the five elements is missing, but may exist, and indicate that 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 2005b].

Completed Exposure Pathways

Elements of the completed exposure pathway for the Tooele Railroad Spur site are as follows:

1) Source of contamination.. contaminated fill material
2) Transport through environmental medium............................contaminated soil and dust
3) A point of exposure ....residential yards, play areas, and public access areas
4) A route of human exposure ....ingestion
5) A receptor population ....residents of Tooele on the TRS

Although few humans intentionally ingest soil, a number of studies show that most people do ingest small amounts of soil and/or dust derived from soil, mainly because of hand to mouth contact [EPA 1997]. For example, a person could be exposed to lead and arsenic in the soil, by gardening or playing in soil high in lead and arsenic, and then eating or smoking prior to washing their hands. House dust, high in lead and arsenic, might end up on dishes and in food. Table 11 shows the completed exposure pathway elements.

Comparison values (CVs) used in this discussion are meant only to screen for contaminants, which require further evaluation. Levels of exposure above these values will only cause adverse health effects if persons are actually exposed and if the exposure is at a sufficient dose for adverse effects to occur. CVs in adults were only exceeded for lead (Tables 1-10). CVs in children were exceeded for antimony, arsenic, cadmium, copper, and lead (Tables 1-10). CVs in pica children were exceeded for aluminum, arsenic, copper, vanadium, and zinc (Tables 2, 3, 5-10). The contaminants that exceeded the children and pica children comparison values (aluminum, antimony, arsenic, cadmium, copper, lead, vanadium, and zinc) were identified as the contaminants of concern.

Potential Exposure Pathways

The potential exposure pathways for the Tooele Railroad Spur site along with the missing elements that make the pathway "potential" rather than "completed" are as follows:

> The potential exposure pathway of skin contact with contaminated soil is missing element # 4, "route of human exposure," because skin does not easily absorb metals.
>
> The potential exposure pathway involving inhalation of contaminated dust is also missing element #4, "route of human exposure," because exposure through inhalation of particulates in air is estimated to be less than 0.02% of the ingested dose, making the inhalation pathway relatively insignificant.
>
> The potential exposure pathway of eating vegetables grown in contaminated soils has not been investigated. Removal of contaminated soils from residential sites will eliminate this pathway as a potential source of human exposure.

The potential exposure pathways are shown in Table 12.

With high velocity winds, the city of Tooele could be affected by off-site migration of contaminated soil. No off-site soil testing has been done. Therefore, it is considered an indeterminate public health hazard due to the lack of data. Sampling at the site has shown that contamination levels decreased dramatically with distance from the spur. Soil remediation along the site will eliminate off site migration of contaminated soil.

Public Health Implications

To determine if the contaminants pose a public health threat, the exposure doses to the chemicals of concern via the completed exposure pathways were estimated (Appendix B). For this calculation, it is assumed that those residents on and around the site were being exposed daily to contaminants. Via the soil pathway, the estimated dose for arsenic and cadmium exceeded ATSDR's Minimal Risk Levels (MRLs) for children (Table 13). The estimated dose for aluminum, antimony, arsenic, cadmium, copper, vanadium, and zinc exceeded ATSDR's MRLs for pica children (Table 13). For this reason, the toxicological effects of these chemicals of concern and that of lead were evaluated with particular emphasis on children.

Estimated doses of soil contaminants were calculated using the maximum concentration of each contaminant. The aluminum maximum value of 11,400 ppm and the vanadium value of 18.7 ppm were found in soil samples from residential areas in March 2004 (Table 7). The maximum values for antimony (29 ppm) and arsenic (195 ppm) were found in samples taken from the school section of the TRS in April 2003 (Table 6). Maximum values of cadmium (28.6 ppm), copper (785 ppm), lead (5,460 ppm), and zinc (7,140 ppm) were found in soil samples taken from both residential and school areas in May 2000 (Table 3).

There are several factors that introduce uncertainty in estimating the dose for pica children including:

- varying amounts of dirt that pica children may eat
- variations in how often children exhibit soil pica behavior
- uncertainty in the percentage of children with soil pica behavior
- length of duration of pica behavior

Therefore, the estimated doses calculated for pica children are considered to be very conservative and may be much higher than the dose actually received.

Toxicological Evaluation

Aluminum, antimony, arsenic, cadmium, copper, lead, vanadium, and zinc are the chemicals of concern for the Tooele Railroad Spur. These metals are present in the soil at concentrations that could be of potential health concern to children residing in the area. From the 2000 census, 61 children reside in the census tracts that are considered on-site as defined by this document (Figure 2). With new developments in the area, this may now underestimate the number of children potentially exposed. As discussed earlier, ingestion of contaminated soils is the most likely exposure pathway.

Aluminum

Aluminum is a naturally occurring element and is the most abundant metal in the earth's crust. Aluminum is never found as a free metal in nature but as a compound with elements such as oxygen, silicon, and fluorine [ATSDR 1999a].

Very little of aluminum that is eaten can enter the bloodstream. Most of ingested aluminum leaves the body quickly in the feces. The small amount of aluminum that does enter the bloodstream leaves in the urine. Very little aluminum can enter the body through the skin or through breathing [ATSDR 1999a].

For aluminum, the no observable adverse effect level (NOAEL) is 62 milligrams per kilogram of body weight per day (mg/kg/day) [ATSDR 1999a]. For an explanation of NOAEL, see Appendix A. As shown in Table 13, the estimated doses of aluminum for children and pica children living in the area of the TRS are 0.1 mg/kg/day and 2.9 mg/kg/day, respectively. Because the estimated doses do not exceed the NOAEL, they are not considered sufficient to lead to a significant increase in frequency or severity of adverse effects. In conclusion, an estimated dose of 0.1 mg/kg/day for children and 2.9 mg/kg/day for pica children of aluminum through ingestion of contaminated soil is not expected to cause adverse health effects.

Antimony

Antimony is a silvery white metal of medium hardness that breaks easily. Small amounts of antimony are found in the earth's crust. Antimony ores are mined and then either changed into antimony metal or combined with oxygen to form antimony oxide. Antimony oxide is a white powder that does not evaporate. Only a small amount of it will dissolve in water [ATSDR 1992a].

Antimony enters the environment during the mining and processing of its ores and in the production of antimony metal, alloys, antimony oxide, and combinations of antimony with other substances. Little or no antimony is mined in the United States. Most antimony will end up in the soil or sediment, where it attaches strongly to particles that contain iron, manganese, or aluminum [ATSDR 1992a].

The lowest observable adverse effect level (LOAEL) for antimony is 0.35 mg/kg/day [EPA 1991]. For an explanation of LOAEL, see Appendix A. The exposure dose of antimony for children is 0.0003 mg/kg/day and 0.007 mg/kg/day for pica children. Because the estimated doses do not exceed the LOAEL, they are not considered sufficient to lead to a significant increase in frequency or severity of adverse effects. In conclusion, an estimated dose of 0.0003 mg/kg/day for children and 0.007 mg/kg/day for pica children of antimony through ingestion of contaminated soil is not expected to cause adverse health effects.

Arsenic

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. Organic arsenic is formed when arsenic is combined with carbon and hydrogen. The inorganic form is usually more harmful than the organic form. Inorganic arsenic is derived from treating copper and lead ores. Both forms have no smell, and most have no special taste. Thus, one cannot usually tell if arsenic is present in food, water, or air [ATSDR 2000].

Most of the arsenic ingested from contaminated water, soil, or food quickly enters into the body. Inhalation of arsenic contaminated dusts can result in contaminated dust particles settling onto the lining of the lungs, and subsequent entry of arsenic into the body. Exposure through the skin is not sufficient enough to be a concern. The body usually eliminates arsenic through the urine [ATSDR 2000].

For arsenic, the NOAEL is 0.0004 milligrams per kilogram of body weight per day (mg/kg/day) and the LOAEL is 0.001 mg/kg/day [ATSDR 2000]. As shown in Table 13, the estimated dose of arsenic for children living in the area of the TRS is 0.002 mg/kg/day and 0.05 mg/kg/day for pica children. Because the estimated dose exceeds the LOAEL for both children and pica children, the current levels of arsenic in the soil at the Tooele Railroad Site may lead to an increase in frequency or severity of adverse effects. No air sampling data are available to determine the exposure to inhaled arsenic particles.

The single most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. This includes a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. While these skin changes are not considered to be a health concern in their own right, a small number of the corns may ultimately develop into skin cancer [ATSDR 2000].

The ingestion of arsenic has also been reported to increase the risk of cancer in the liver, bladder, kidney, and lung. The National Toxicology Program (NTP), International Agency for Research on Cancer (IARC), and Environmental Protection Agency (EPA) have determined that arsenic is a human carcinogen [ATSDR 2000]. The estimated lifetime cancer risk from arsenic exposure for adults is 1×10^{-4}, 3×10^{-4} for children, and 6×10^{-3} and for pica children. This means that if 100,000 people were exposed to arsenic in soil at the concentrations, frequencies, and exposure durations assumed in the calculations for cancer risk, there would be a theoretical increase of 10 (for adults), 30 (for children), and 600 (for pica children) cancers above the number of cancers that would normally be expected to occur in the population of 100,000. Background rates of cancer in the United States are one in two or three [NCI 2001]. This means that in a population of 100,000, background numbers of cancer cases would be approximately 33,000 to 50,000. Arsenic exposures could result in a theoretical increase of 20 (for adults), 30 (for children), and 600 (for pica children) cancer cases above the background number of 33,000 to 50,000 cancer cases. This represents a relatively low increased cancer risk for children and adults. For pica children, arsenic exposure could lead to an increase of 1%-2% over background cancer cases.

Cadmium

Cadmium is an element that occurs naturally in the earth’s crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). All soils and rocks, including coal and mineral fertilizers, have some cadmium in them. Most cadmium used in this country is extracted during the production of other metals such as zinc, lead, or copper. Cadmium has no definite taste or odor [ATSDR 1999b].

Cadmium can enter the body from food, water, or inhaled particles. Very little cadmium enters through the skin. The body rapidly takes in about one-quarter of the cadmium inhaled, and about one-twentieth of the cadmium ingested. Cadmium that enters the body stays in the liver and kidneys. Cadmium leaves the body slowly, in urine and feces [ATSDR 1999b].

Cadmium has no known beneficial health effects. Eating lower levels of cadmium over a long period of time leads to a build-up of cadmium in the kidneys, which leads to kidney disease [ATSDR 1999b].

Ingestion and inhalation studies with cadmium in humans and animals are inconclusive. Some studies show that inhaling cadmium causes lung cancer while other studies show that eating or drinking cadmium does not cause cancer. For these reasons, the NTP, the IARC, and the EPA have determined that cadmium is a probable human carcinogen [ATSDR 1999b].

Chronic exposure studies in humans indicate that the NOAEL is 0.0021 mg/kg/day and the LOAEL is 0.0078 mg/kg/day [ATSDR 1999b]. As shown in Table 13, the estimated dose for children in Tooele is 0.0003 mg/kg/day and for pica children is 0.007 mg/kg/day. Because the estimated dose for children is less than the NOAEL and LOAEL and less than the LOAEL for pica children, adverse health effects are not expected as a result of cadmium exposure through ingestion. No air sampling data are available to determine the exposure resulting from inhaled cadmium particles.

Copper

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and, at low levels, air. Copper also occurs naturally in all plants and animals. It is an essential element for all known living organisms including humans and other animals at low levels of intake. At much higher levels, toxic effects can occur [ATSDR 2004a].

Copper rapidly enters the bloodstream and is distributed throughout the body after ingestion. Certain substances in foods eaten with copper can affect the amount of copper that enters the bloodstream from the gastrointestinal tract. The human body is very good at blocking high levels of copper from entering the bloodstream. Copper leaves the body in feces and urine, mostly in feces. It takes several days for copper to leave the body. Generally, the amount of copper in the body remains constant (the amount that enters the body equals the amount that leaves) [ATSDR 2004].

Copper is essential for good health. However, exposure to higher doses can be harmful. Long-term exposure to copper dust can irritate the nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea. If water that contains higher than normal levels of copper is ingested, it may cause nausea, vomiting, stomach cramps, or diarrhea. Intentionally high intakes of copper can cause liver and kidney damage and even death. EPA does not classify copper as a human carcinogen because there are no adequate human or animal cancer studies [ATSDR 2004].

Intermediate duration exposure studies in humans indicate that the NOAEL is 0.042 mg/kg/day and the LOAEL is 0.091 mg/kg/day [ATSDR 2004]. As shown in Table 13, the estimated dose for children in Tooele is 0.008 mg/kg/day and for pica children is 0.2 mg/kg/day. Because the estimated dose for children is less than the NOAEL and LOAEL, adverse health effects are not expected as a result of copper exposure through ingestion. However, both the NOAEL and LOAEL values are exceeded for pica children. Children with soil eating behavior are therefore at increased risk for showing adverse health effects due to the ingestion of copper in the soil at the Tooele Railroad Site.

Lead

Lead occurs naturally in the environment; however, most of the lead dispersed throughout the environment comes from human usage. 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 until it is excreted in the feces [ATSDR 1999c].

Lead can affect almost every organ and system in the body. Unlike most contaminants, the NOAEL, LOAEL, and MRL values have not been established for lead. Studies of lead exposure in humans do not generally correlate exposure levels (mg/kg/day) to health effects, but rather absorbed dose (concentration of lead in blood) to effects. At high levels, greater than 40 micrograms per deciliter of blood (40 μg/dL), lead exposure in adults may cause decreased reaction time, weakness in fingers, wrists, or ankles, memory loss, and anemia. Lead exposure may also damage the kidneys and the reproductive system [ATSDR 1999c].

Children are particularly sensitive to the toxic affects of lead, and, for this reason, this topic is further addressed in the Child Health Initiative section of this health assessment. Although some forms of lead have been demonstrated to be carcinogenic, there is insufficient evidence to clearly determine the carcinogenicity of lead in humans [ATSDR 1999c].

Vanadium

Vanadium is a natural element in the earth. It is a white to gray metal, often found as crystals. It has no particular odor. Vanadium occurs naturally in fuel oils and coal. In the environment it is usually combined with other elements such as oxygen, sodium, sulfur, or chloride. When rocks and soil containing vanadium are broken down into dusts by wind and rain, vanadium can get into the air, groundwater, surface water, or soil. It does not dissolve well in water, but the water can carry it, much as particles of sand might be carried [ATSDR 1992b].

The NOAEL for vanadium is 0.3 mg/kg/day [ATSDR 1992b]. The exposure dose of vanadium for children is 0.0002 and 0.005 for pica children. Because the estimated doses do not exceed the NOAEL, they are not considered sufficient to lead to a significant increase in frequency or severity of adverse effects. In conclusion, an estimated dose of 0.0002 mg/kg/day for children and 0.005 mg/kg/day for pica children of vanadium through ingestion of contaminated soil is not expected to cause adverse health effects.

Zinc

Zinc is one of the most common elements in the earth's crust. Zinc is found in the air, soil, and water and is present in all foods. In its pure elemental (or metallic) form, zinc is a bluish-white, shiny metal. Zinc can also combine with other elements, such as chlorine, oxygen, and sulfur, to form zinc compounds. Zinc compounds that may be found at hazardous waste sites are zinc chloride, zinc oxide, zinc sulfate, and zinc sulfide. Most zinc ore found naturally in the environment is in the form of zinc sulfide. Zinc compounds are widely used in industry. Zinc compounds are used by the drug industry as ingredients in some common products, such as vitamin supplements, sun blocks, diaper rash ointments, deodorants, athlete's foot preparations, acne and poison ivy preparations, and antidandruff shampoos [ATSDR 2003].

Taking too much zinc into the body through food, water, or dietary supplements can affect health. The levels of zinc that produce adverse health effects are much higher than the Recommended Dietary Allowances (RDAs) for zinc of 11 mg/day for men and 8 mg/day for women. If large doses of zinc (10-15 times higher than the RDA) are taken by mouth even for a short time, stomach cramps, nausea, and vomiting may occur. Ingesting high levels of zinc for several months may cause anemia, damage the pancreas, and decrease levels of high-density lipoprotein (HDL) cholesterol [ATSDR 2003].

Consuming too little zinc is at least as important a health problem as consuming too much zinc. Without enough zinc in the diet, people may experience loss of appetite, decreased sense of taste and smell, decreased immune function, slow wound healing, and skin sores. Too little zinc in the diet may also cause poorly developed sex organs and retarded growth in young men. If a pregnant woman does not get enough zinc, her babies may have birth defects [ATSDR 2003].

The lowest observable adverse effect level (LOAEL) for zinc is 0.83 mg/kg/day [ATSDR 2003]. The exposure dose of zinc for children is 0.07 mg/kg/day and 2 mg/kg/day for pica children. Because the estimated dose does not exceed the LOAEL for children, it is not considered sufficient to lead to a significant increase in frequency or severity of adverse effects. The LOAEL is exceeded for pica children. In conclusion, an estimated dose of 0.07 mg/kg/day for children and 2 mg/kg/day for pica children of zinc through ingestion of contaminated soil is not expected to cause adverse health effects for children but may cause adverse health effects in children that have pica behavior.

Multiple Chemical Exposure Evaluation

The potential for the toxic effects from the chemical mixture interactions of the contaminants found at the TRS 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) that included all of the contaminants. The HI is defined as the sum of the quotients of the estimated dose of a chemical divided by its MRL or comparable value. 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, further evaluation is necessary [ATSDR 2005b]. 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 1999c]. The hazard quotient for lead is estimated by dividing the predicted blood lead level by 10 µg/dL, CDC's level of concern. Using exposure doses for children, the Hazard Index for the mixture of aluminum, antimony, arsenic, cadmium, copper, lead, vanadium, and zinc at this site is 13.1.

Since the HI for the chemical mixture at this site is greater than 1.0, the estimated doses for each individual chemical were then compared to their NOAELs or comparable values. Doses of chemicals that are less than one-tenth of their respective NOAELs are unlikely to contribute to significant additive or interactive effects with other chemicals in the mixture. Aluminum, antimony, vanadium, and zinc all had exposure doses less than one-tenth of their respective NOAEL values and no further evaluation was performed for these chemicals. Arsenic, cadmium, copper, and lead were then considered for possible additive interactions.

Following the strategy recommended by ATSDR's Guidance Manual for the Assessment of Joint Toxic Action of Chemical Mixtures [ATSDR 2004b], two Interaction Profiles were referenced for the health effects of mixtures containing arsenic, cadmium, copper, and lead [ATSDR 2004c, 2004d]. With respect to neurological effects, lead may have an additive effect on the toxicity of arsenic; arsenic and cadmium may have an additive effect on lead; and copper may have a less than additive effect on lead; and all other interactions were considered indeterminate. Cadmium and lead may have additive effects on each other for testicular toxicity. The chemicals of this mixture should have no impact on the toxicities of other chemicals with respect to cardiovascular, hepatic, and dermal effects. These chemicals are considered to have less than additive effects for the renal and hematological systems. Cadmium, copper, and lead have no apparent effects on the carcinogenicity of arsenic.

CHILD HEALTH INITIATIVE

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 increased risk than adults from 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 occur during critical growth stages. Children's health was considered as part of this health consultation.

Aluminum and Children's Health

Children with kidney problems who were given aluminum in their medical treatments developed bone diseases. Other health effects of aluminum on children have not been studied. It is not known whether aluminum affects children differently than adults, or what the long-term effects might be in adults when exposed as children. Large amounts of aluminum have been shown to be harmful to unborn and developing animals because it can cause delays in skeletal and neurological development. Aluminum has been shown to cause lower birth weights in some animals [ATSDR 1999a]. At the TRS, the estimated dose for children is 0.1 mg/kg/day and 2.9 mg/kg/day for pica children, levels that are not expected to cause adverse health effects.

Antimony and Children's Health

The health effects in children from exposure to toxic levels of antimony are expected to be similar to the effects seen in adults [ATSDR 1992a]. An estimated dose of 0.0003 mg/kg/day for children and 0.007 mg/kg/day for pica children of antimony through ingestion of contaminated soil is not expected to cause adverse health effects.

Arsenic and Children's Health

Arsenic crosses the placenta and is found in breast milk. As a result, fetuses and nursing infants may be exposed to arsenic. Animals exposed to arsenic show developmental damage, including

AUTHORS

D. Jason Scholl, Ph.D., Toxicologist
Health Hazard Assessment Manager
Environmental Epidemiology Program
Office of Epidemiology
Utah Department of Health

Designated Reviewer

R. Wayne Ball, Ph.D., D.A.B.T., Toxicologist
Environmental Epidemiology Program Manager
Office of Epidemiology
Utah Department of Health

CERTIFICATION

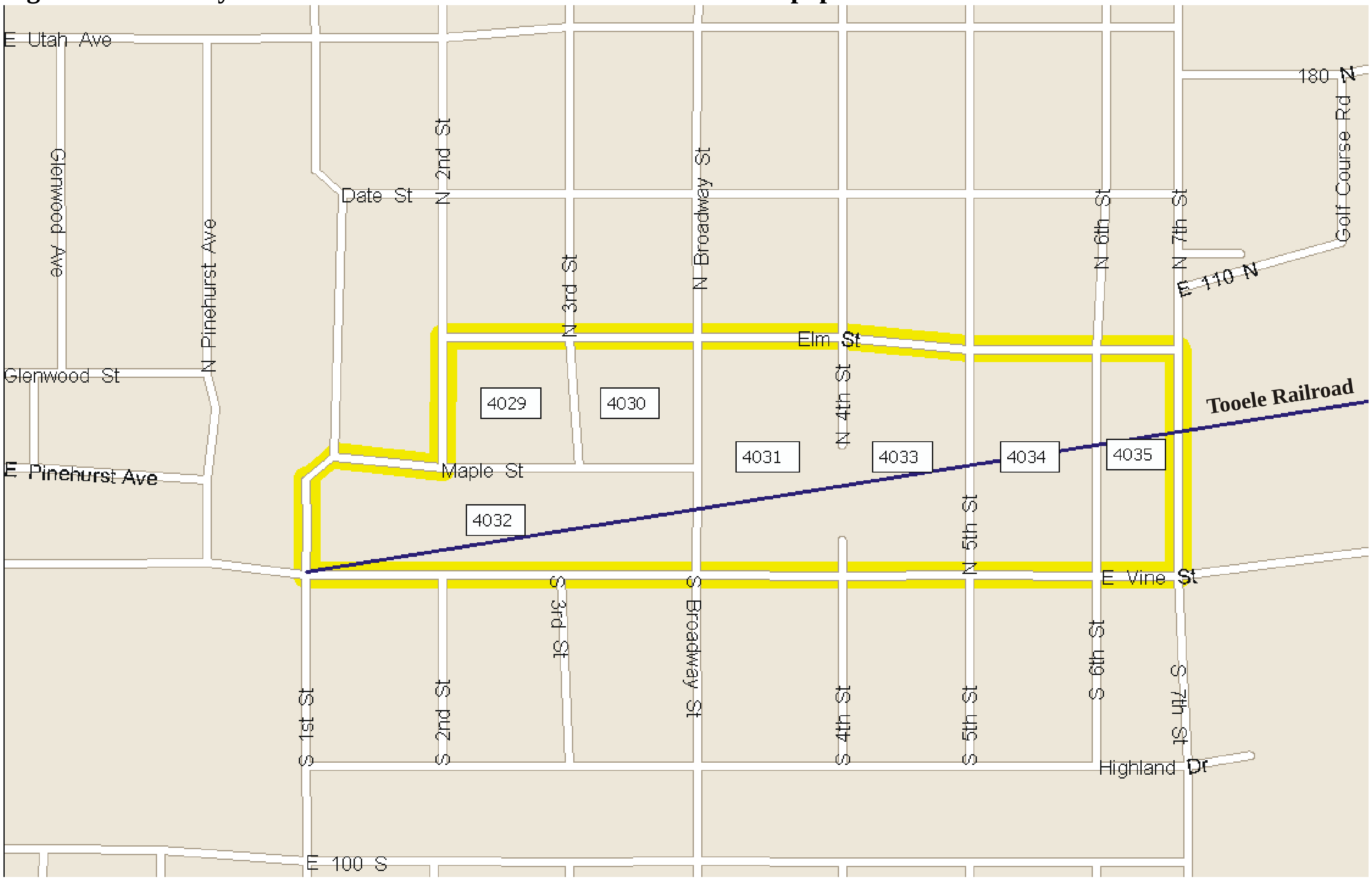
This Tooele Railroad Spur Health Consultation was prepared by the State of Utah Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial Review was completed by Cooperative Agreement partner.

Charisse Walcott
Technical Project Officer
Division of Health Assessment and Consultation
ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Alan Yarbrough
Chief, State Programs Section
Division of Health Assessment and Consultation
ATSDR

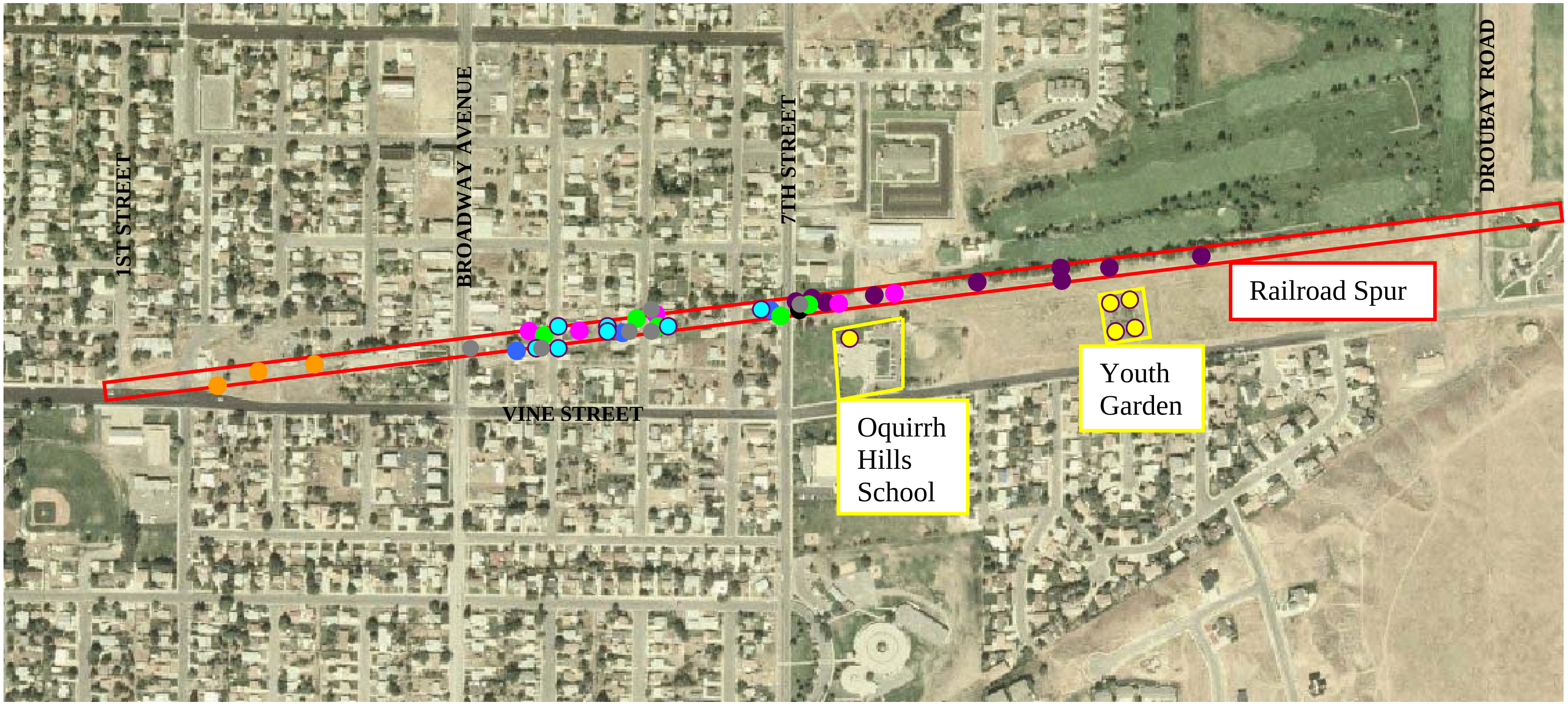
Figure 2. Boundary of on-site census blocks with 2000 census block populations.



Block 4029 = 8 of 22 residents under age of 18
Block 4031 = 4 of 42 residents under age of 18
Block 4033 = 17 of 49 residents under age of 18
Block 4035 = 9 of 26 residents under age of 18

Block 4030 = 7 of 21 residents under age of 18
Block 4032 = 0 of 0 residents under age of 18
Block 4034 = 16 of 43 residents under age of 18
Total on-site = 61 of 203 residents under age of 18

Figure 3. Soil Sampling Locations Along the Tooele Railroad Spur



- Delta Geotechnical - October 1997
- Tooele County Health Dept. - January 2000
- URS Operating Services - May 2000
- IHI Environmental - November 2000
- Bingham Environmental - February 2001
- Anderson Engineering - April 2003
- Anderson Engineering – March 2004
- URS Operating Services – April 2004
- XRF samples away from the TRS

Table 4. Comparison Values and Analytical Results for November 2000 Soil Samples from East of 7th Street.

	ATSDR Comparison Values (CV)						Sampling Locations			
	Non-Cancer CV				Cancer CV		CS-1	CS-2	CS-3	CS-4
	Adult	Child	Pica Child	CV Source	CREG	Class*				
Contaminant	ppm				ppm		ppm			
Lead	400†			EPA	NA	B2	**1500**	**2900**	**1000**	**2600**

IHI Environmental conducted this study in November 2000 at the TRS.
Bold entries indicate contaminant concentrations exceeding soil comparison values.
* See Appendix A.
† From EPA 540-F-98-030 [EPA 1998].

Table 6. Comparison Values and Analytical Results for April 2003 Soil Samples from along School Property Golf Course (between 7th Street and Droubay Road).

Contaminant	ATSDR Comparison Values (CV)						Sampling Locations								
	Non-Cancer CV				Cancer CV		TVRR -1	TVRR -2	TVRR -3	TVRR -5DN	TVRR -9AN	TVRR 12AN	TVRR 12AS	TVRR 14AS	TVRR 18AS
	Adult	Child	Pica Child	CV Source	CREG	Class*									
	ppm				ppm		ppm								
Aluminum	1000000	500000	4000	EMEG-i	NA	3	**5160**	**5290**	**4390**	**5200**	**7300**	**8540**	**6960**	**6370**	**7340**
Antimony	300	20	NA	RMEG	NA	D	12.1	11.2	**29**	8.59	1.51	4.01	16.8	14.4	16
Arsenic	200	20	10	EMEG	0.5	A	**101**	**90.3**	**193**	**59.7**	**25.2**	**48.9**	**143**	**195**	**129**
Cadmium	100	10	NA	EMEG	NA	B1	**14.6**	**10.8**	**20.8**	7.42	2.93	9.1	**19.9**	**20.2**	**17.3**
Copper	7000	500	20	EMEG-i	NA	D	**357**	**405**	**657**	**291**	**87.5**	**240**	**716**	**645**	**669**
Lead	400†			EPA	NA	B2	**2880**	**2000**	**3860**	**1370**	**408**	**1180**	**3210**	**4010**	**2570**
Vanadium	2000	200	6	EMEG-i	NA	3	**9.81**	**11.4**	**11**	**10.3**	**13.7**	**14.8**	**13.1**	**12**	**15**
Zinc	200000	20000	600	EMEG-i	NA	D	**1740**	**1090**	**2470**	**714**	315	**817**	**1830**	**2080**	**1740**

Anderson Engineering Company, Inc. conducted this study in April 2003 at the TRS.
Other contaminants measured but were below Comparison Values were: barium, beryllium, calcium, chromium, cobalt, iron, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, and thallium.
Bold entries indicate contaminant concentrations exceeding soil comparison values.
* See Appendix A.
† From EPA 540-F-98-030 [EPA 1998].

Table 7. Comparison Values and Analytical Results for March 2004 Soil Samples from Residential Area between Broadway and 7th Street.

	ATSDR Comparison Values (CV)						Sampling Locations					
	Non-Cancer CV				Cancer CV		TVRR -1-4	TVRR -3-1	TVRR -5-1	TVRR -7-2	TVRR -9-4	TVRR -12-3
	Adult	Child	Pica Child	CV Source	CREG	Class*						
Contaminant	ppm				ppm		ppm					
Aluminum	1000000	500000	4000	EMEG-i	NA	3	**7640**	**9650**	**9710**	**11400**	**10400**	**8670**
Arsenic	200	20	10	EMEG	0.5	A	**11.7**	**26.7**	**14.7**	8.71	8.94	7.71
Copper	7000	500	20	EMEG-i	NA	D	**134**	**123**	**64.9**	**38.6**	**32.6**	**26.6**
Lead	400†			EPA	NA	B2	259	**573**	303	111	73.5	51.3
Vanadium	2000	200	6	EMEG-i	NA	3	**13.1**	**17.4**	**17.6**	**18.7**	**16.7**	**15.2**

Anderson Engineering Company, Inc. conducted this study in March 2004 at the TRS.
Other contaminants measured but were below Comparison Values were: antimony, barium, beryllium, cadmium, calcium, chromium, cobalt,, iron, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, and zinc.
Bold entries indicate contaminant concentrations exceeding soil comparison values.
* See Appendix A.
† From EPA 540-F-98-030 [EPA 1998].

Table 8. Comparison Values and Analytical Results for April 2004 Soil Samples from Residential Area between Broadway and 7th Street.

	ATSDR Comparison Values (CV)						Sampling Locations						
	Non-Cancer CV				Cancer CV		North Lot	#3	#4	#5	#6	#9	#13
	Adult	Child	Pica Child	CV Source	CREG	Class*							
Contaminant	ppm				ppm		ppm						
Aluminum	1000000	500000	4000	EMEG-i	NA	3	**4260**	**9230**	**9210**	**6430**	**6390**	3970	**6170**
Arsenic	200	20	10	EMEG	0.5	A	9.8	**20.4**	8.2	**10.9**	**10.2**	5.9	7.9
Copper	7000	500	20	EMEG-i	NA	D	**52.5**	**117**	**70.8**	**56.6**	**31.1**	14.4	**48**
Lead	400†			EPA	NA	B2	172	**508**	83	280	108	42.2	158
Vanadium	2000	200	6	EMEG-i	NA	3	**10.4**	**15.9**	**16.7**	**12.4**	**13**	**9.3**	**12.6**

URS Operating Services, Inc. conducted this study in April 2004 at the TRS.
Other contaminants measured but were below Comparison Values were: antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, iron, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, and zinc.
Bold entries indicate contaminant concentrations exceeding soil comparison values.
* See Appendix A.
† From EPA 540-F-98-030 [EPA 1998].

Table 11. Completed Exposure Pathways.

Pathway Name	Exposure Pathway Elements					Time Frame	Chemical(s)
	Source	Environmental Medium	Point of Exposure	Route of Exposure	Receptor Populations		
On-site soil	TRS	Surface soil	On-Site soil	Ingestion	On-site Adult Residents	Past Present Future	Lead
On-site soil	TRS	Surface soil	On-Site soil	Ingestion	On-site Children Residents	Past Present Future	Arsenic, Cadmium, Lead
On-site soil	TRS	Surface soil	On-Site soil	Ingestion	On-site Pica Children Residents	Past Present Future	Aluminum, Antimony, Arsenic, Cadmium, Copper, Lead, Vanadium, Zinc

Table 12. Potential Exposure Pathways

Pathway Name	Exposure Pathway Elements					Time Frame	Chemical(s)
	Source	Environmental Medium	Point of Exposure	Route of Exposure	Receptor Populations		
Soil	TRS	Surface soil	Soil	Skin	Residents and Visitors	Past Present Future	Aluminum, Antimony, Arsenic, Cadmium, Copper, Lead, Vanadium, Zinc
Dust	TRS	Airborne Particulates	Air	Inhalation	Residents and Visitors	Past Present Future	Aluminum, Antimony, Arsenic, Cadmium, Copper, Lead, Vanadium, Zinc
Food	TRS	Vegetables Grown in Contaminated Soil	Food	Ingestion	Residents and Visitors	Past Present Future	Aluminum, Antimony, Arsenic, Cadmium, Copper, Lead, Vanadium, Zinc

APPENDICES

APPENDIX A: ACRONYMS & TERMS DEFINED

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

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

Environmental Protection Agency (EPA) (Based on 1986 cancer assessment guidelines):

A	=	Classified as a Human Carcinogen
B1	=	Classified as Probable Human Carcinogen (based on limited human and sufficient animal studies)
B2	=	Classified as Probable Human Carcinogen (based on inadequate human and sufficient animal studies)
C	=	Classified as Possible human carcinogen (no human studies and limited animal studies)
D	=	Not classifiable as to human carcinogenicity
E	=	Evidence of noncarcinogenicity in humans
UR	=	Under review (not in IRIS)

Environmental Protection Agency (EPA) (Based on 1999 cancer assessment guidelines):

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 cancer hazard

International Agency for Research on Cancer(IARC):

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

National Toxicology Program (NTP):

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

Soil Comparison Values Soil-specific concentrations that are used in this consultation to select environmental contaminates for further evaluation. These values are not valid for other types of media, nor do actual soil concentrations above these values indicate that a health risk actually exists (11).

Examples of Soil Comparison Values

EMEG = Environmental Media Evaluation Guide.
I-EMEG = Intermediate Environmental Media Evaluation Guide.
RMEG = Reference Dose Media Evaluation Guide.
CREG = Cancer Risk Evaluation Guide for $1x10^{-6}$ excess cancer risk.

Completed Exposure Pathway

The 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 concern 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 supposed 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.

RMEG

Reference Dose Media Evaluation Guides are media-specific comparison values used to select contaminants of concern based on EPA's RfDs for each contaminant when default values for body weight and intake rates are taken into account.

EPA
The U.S. Environmental Protection Agency (EPA) is the federal agency that develops and enforces environmental laws to protect the environmental and public health.

LOAEL
The Lowest Observable Adverse Effect Level (LOAEL) is the lowest exposure of a chemical that produces significant increases in frequency or severity of adverse effects.

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 adverse.

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) an exposed population

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: Urgent Public Health Hazard Public Health Hazard Indeterminant Public Health Hazard No Apparent Health Hazard No Public Health Hazard
ppm	parts per million.

APPENDIX B: CALCULATIONS

Estimating Exposure Dose (ED) [ATSDR 2005b]:

The formula used to calculate ED is given as follows:

ED = { C x IR x EF) / BW }

where C = Contaminant level (mg/kg (or ppm))

IR = Soil Ingestion rate (kg soil/day)
= 0.0001 kg soil/day for an adult
= 0.0002 kg soil/day for a child
= 0.005 kg soil/day for a pica child

EF = Exposure Factor (see below for calculation)

BW = Body Weight (kg)
= 70 kg for an adult
= 16 kg for a child

Calculating Exposure Factor (EF) [ATSDR 2005b]:

EF = { (#days/week) x (#weeks/year) x (ED) / (ET) x (365days/year) }

(A) In estimating EF for adults on-site, it is assumed an adult is on-site daily for 30 years and lives for 70 years (11).

On-site adult exposure :

Weekdays:
Hours at work per day = 8
Hours at home per day = 16
work days / week = 5
hours at home during working days = 80

Weekends:
Hours at home per day = 24
days per weekend = 2
hours at home – weekend = 48

Total hours at home during a 7 day week = 80 + 48 = 128

Converted to number of days at home during a 7 day week (128/24) = 5.33

Adult	Days/wk	Wks/Yr	exposure duration (years)	exposure time (years)	Exposure Factor (EF)
Noncancer	5.33	52	30	30	0.759
Cancer	5.33	52	30	70	0.325

Then use EF and substitute it into the ED equation given above to estimate the exposure dose to a given contaminant.

(B) In estimating EF for children on-site, an EF for children are calculated as follows:

Weekdays:
Hours at school per day = 8
Hours at home per day = 16
school days / week = 5
hours at home - 1 week of school =80

Weekends:
Hours at home per day = 24
days per weekend = 2

hours at home during weekend = 48

Total hours at home - a 7 day week = 80 + 48 = 128

Since the academic year lasts 9 months, that is equivalent to 3/4 of a full calendar year or 39 weeks.
During the academic year, children are at home for 128 x 39 = 4992 hours = 208 days.

During the summer months, children may be home 24 hours per day for the remaining 13 weeks; therefore, children are at home for 24hrs/day x 7 days/wk x 13wks = 2184 hours = 91 days.
The total number of days / year that children are home is 208 + 91 = 299
Therefore children are at home 299 days in 52 weeks = 299/52 = 5.75 days/wk.

Child	Days/wk	Wks/Yr	exposure duration (years)	exposure time (years)	Exposure Factor (EF)
Noncancer	5.75	52	6	6	0.819
Cancer	5.75	52	6	70	0.070

Comparison Value Calculations for Soil [ATSDR 2005b]:

$$EMEG = MRL(BW)/IR$$
$$RMEG = RfD(BW)/IR$$
$$CREG = 1\times10^{-6}(BW)/IR(OSF)$$

where,

EMEG	=	Environmental Media Evaluation Guide (ppm)
MRL	=	Minimal Risk Level (ppm/day)
RMEG	=	Reference Dose Media Evaluation Guide
RfD	=	Reference Dose
CREG	=	Cancer Risk Evaluation Guide for $1x10^{-6}$ excess cancer risk
OSF	=	Oral Slope Factor
BW	=	Body Weight (kg)
	=	70 kg for an adult
	=	16 kg for a child
IR	=	Soil Ingestion rate (mg soil/day)
	=	0.0001 kg soil/day for an adult
	=	0.0002 kg soil/day for a child
	=	0.005 kg soil/day for a pica child

Calculating Cancer Risk [ATSDR 2005b]:

Theoretical Cancer Risk = Dose x OSF

Chemical Mixture Interaction Calculations

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

$= \frac{0.0068\ \mu g/dL \text{ per mg/kg x } 5{,}460 \text{ mg lead/kg x } 0.82}{10\ \mu g/dL}$

= 3.04

Aluminum, Antimony, Arsenic, Cadmium, Copper, Vanadium, Zinc
Hazard Quotient = Dose/MRL

Hazard Index = Sum of all Hazard Quotients
= 0.05 (Al) + 0.75 (An) + 6.67 (As) + 1.50 (Cd) + 0.80 (Cu) + 3.04 (Pb) + 0.07 (V) + 0.23 (Zn)
= 13.11