Health Consultation

OLD TUNGSTEN MILL
(a/k/a General Instruments Site)
(a/k/a Ore Mill Site)
(a/k/a Painted Hills Natural Resources Park)

TUCSON, PIMA COUNTY, ARIZONA

SEPTEMBER 5, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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.

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Prepared By:

The Arizona Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry
U.S. Department of Health and Human Services

Purpose

This report presents an assessment of human health risks from exposure to surface soil metals in the Old Tungsten Mill, Tucson, AZ. City of Tucson officials had planned to build a park, on a parcel of land they owned west of Silverbell Road and north of Speedway Boulevard in Tucson, Pima County, Arizona. They had raised $200,000 in bond money to study what was the Old Tungsten Mill site when they found high levels of contaminants in the soil. An article ran in the *Arizona Daily Star* on 8/30/2006 describing the discovery of high concentrations of arsenic and lead in the soil of the proposed park. Citizens in neighboring areas expressed concern for their health. The Arizona Department of Health Services (ADHS), Risk Assessment & Health Consultation Program offered assistance to the city. On October 13th, 2006 City Officials asked ADHS to perform a health consultation to evaluate whether exposure to contaminants in soil pose a public health hazard, either currently or during possible future reuse of the land.

Background and Statement of Issues

This location has several identifiers; Old Tungsten Mill Site, Ore Mill Site, General Instruments Site and finally, the Painted Hills Natural Resource Park. The legal description of the Area is: SW ¼ of Section 3, Township 14 South, Range 13 East. Additionally, the site is located on the USGS 7.5-minute topographic quad map of Cat Mountain, Arizona (AZ AA:16 [NE]). In 1993 the City had a survey done of 21.4 acres which identified an historic ore mill and a house foundation which were recorded and given a designation of AA:16:376.

Records indicate that during World War II, Arthur Jacobs entered into a contract with the U.S. military to process tungsten. Tungsten is a strategic metal and is used as an alloy to “harden” other metals, used to make armor and artillery shells. The location of the actual tungsten mine from which the ore was taken is unknown. Typically an ore mill is a facility which crushes the mined material then concentrates the ore by various processes including floatation and chemical treatments. During this time period, chemicals such as mercury or cyanide were commonly used to aid in the removal of metal from the ore. There is no evidence that heating or smelting tungsten ore occurred at this site. Because there were only small amounts of slag, tailings, and other mining waste materials, this facility probably was not in operation very long (Diehl 2006).

The Old Tungsten Mill Site drains to the Anklam Wash (Diehl 2006), and is part of the Upper Santa Cruz watershed. The mill ruins are approximately 650’ from the nearest residence, 1,300’ from the Britcha Elementary School, and 1,600’ from the La Frontera Center, Inc. (residential, substance abuse treatment facility) (Appendix A). Many people use this 30 acre, parcel of land for walking and exercising dogs. Also, vandals have adorned the walls of the Mill ruins with quantities of graffiti (Diehl 2006). The city’s future plans for this site call for: walking trails, a parking area, scenic overlooks, benches, and interpretive signage.

This site is located within Congressional District, AZ-07. The demographics of this area are typical for age representation. Racial makeup is noteworthy as whites represent 66.6%, blacks 2.8%, American Indian 3%, and Other 22%. Also, of those polled 49.1% (any race) indicated that they were of Latino ethnicity. During the 2000 Census, the total population within zip code 85745 was 30,881.

Table 1. Zip code 85745 demographics (Source: 2000 Census)

Characteristic	Number	% zip code 85745	% US
Total Population (Zip Code 85745)	30,881		
Male	14,922	48.3	49.1
Female	15,959	51.7	50.9
Age			
< 5 years old	2,076	6.7	6.8
>18	23,675	76.7	74.3
>65	3,403	11.0	12.4
Race			
White	20,562	66.6	75.1
Black	876	2.8	12.3
American Indian	940	3.0	0.9
Asian	569	1.8	3.6
Latino (of any race)	15,165	49.1	12.5
Owner Occupied Housing	8085	67.6	66.2
Disability Status	4752	16.6	19.3
Labor Force	16,303	66.1	63.9

Discussion

Available Environmental Data for the Site

ADHS evaluated the available environmental sampling information for potential exposure to contaminants at the Old Tungsten Mill site. Since 2006, soil samples were taken in the former ore mill site on two separate investigation events to evaluate the extent of metal contamination. The soil samples are collected by the Kleinfelder Inc. (Kleinfelder 2006) under contract with the city of Tucson. Appendix B is a summary of all data used in this evaluation.

Environmental data are grouped into two categories (X-Ray Fluorescence instrument soil samples and laboratory soil samples). Kleinfelder used an Innov-X Systems 4000, Environmental Metals in Soil Analyzer, to conduct the X-Ray Fluorescence (XRF) survey in accordance with US Environmental Protection Agency (EPA) Method 6200. The laboratory analysis methods selected were US EPA SW-846 method 6010B and 7471A for metals.

To address community concerns, ADHS also reviewed information on Quality Assurance (QA)/Quality Control (QC) specifications for field data quality and laboratory data quality to verify the acceptability and adequacy of data. For example, ADHS reviewed available chain of custody sheets, project narratives, and laboratory certifications. The laboratory analysis methods and the QA/AC procedures were appropriate. In addition, ADHS made comparisons of the XRF and laboratory analysis to further understand the quality of the soil data.

Comparison of Laboratory Soil Samples and XRF Instrument Soil Samples

XRF instruments were used for the determination of element concentrations in soil and sediment for many years. US EPA has thoroughly investigated using XRF technology at Superfund sites. It is considered a fast and cost effective technology for site characterization under certain conditions. The accuracy of the XRF instrument in measuring metals is dependent on the correlation between the laboratory confirmatory analysis and field XRF analysis. According to US EPA Method 6200, the correlation coefficient for the results should be 0.7 or greater for the XRF data to be considered screening levels data; the correlation coefficient should be 0.9 or greater for the XRF data to be used in risk assessments, site characterization, and remedial alternative evaluations. ADHS decided to use the laboratory results for this evaluation based on the results of regression analysis where the correlation coefficients were less than 0.9.

Evaluation Process

ADHS provides site-specific public health recommendations on the basis of toxicologic literature, levels of environmental contaminants detected at a site compared to accepted comparison values (CVs), an evaluation of potential exposure pathways and duration of exposure, and the characteristics of the exposed population. ADHS used this approach to determine if contamination in the Old Tungsten Mill site posed a public health hazard.

Comparison values are screening tools used with environmental data relevant to the exposure pathways. CVs are conservatively developed based on the available scientific data and consideration for the most sensitive groups (e.g. children). If public exposure concentrations related to a site are below the corresponding CV, then the exposures are not considered of public health concern and no further analysis is conducted. However, while concentrations below the CV are not expected to lead to any observable adverse health effect, it should not be inferred that a concentration greater than the CV will necessarily lead to adverse health effects. Depending on site-specific environmental exposure factors (e.g. duration and amount of exposure) and individual human factors (e.g. personal habits, occupation, and/or overall health), exposure to levels above the comparison value may or may not lead to a health effect. Therefore, the CVs should not be used to predict the occurrence of adverse health effects.

ADHS used the following CVs for the screening process to identify contaminants of interest for this document:

- Arizona Residential Soil Remediation Level (ASRL)
- Reference Dose Media Evaluation Guides (RMEGs)
- Minimum Risk Levels (MRLs)

When determining what environmental guideline value to use, this health consultation followed Agency for Toxic Substances and Disease Registry's (ATSDR) general hierarchy and used professional judgment to select CVs that best apply to the site conditions.

Exposure Pathway Analysis

In evaluating this and every site, ADHS uses established methodologies for determining how people may be exposed to contamination from a site and what effects, if any, may result from exposure to those contaminants. The ways that people may come into contact with chemical contaminants (such as breathing air and drinking water) are called exposure pathways. Exposure pathways have been divided into three categories: Completed, Potential, and Eliminated. There are five elements to be considered when identifying exposure pathways: Source of Contamination, Environmental Medium through which chemicals travel, Point of Exposure, Route of Exposure, and Receptor Population. A completed exposure pathway is observed when all five elements are present. In a potential exposure pathway, one or more elements of the pathway cannot be identified, but it is possible that the element might be present or might have been present. In an eliminated exposure pathway, at least one element of the pathway is not present and either will never be present or is extremely unlikely to ever be present. Identifying an exposure pathway does not necessarily indicate the presence or concentration of potential contaminants; it is simply a way of determining the possibility of exposure as if the contaminants were present in the medium.

The former ore mill area is currently a vacant open land, along with a few residential properties. Many people use this 30 acre, parcel of land for walking and exercising dogs. Also, vandals have adorned the walls of the Mill ruins with quantities of graffiti (Diehl 2006). The City's future plans for this site call for: walking trails, a parking area, scenic overlooks, benches, and interpretive signage. The most likely human exposures in the area are occasional ingestion or infrequent dermal contact with contaminated surface soil. This exposure occurs when people have direct contact with soils in their environment. For instance, when children play outside, or when adults walk dogs, contaminated soil or dust particles cling to their hands. People can then accidentally swallow the contaminants when they put their hands on or into their mouths, as children often do. Factors that affect whether or not people have contact with contaminated soil include the amount of grass cover, weather conditions, the amount of time spent outside, and personal habits. While dermal and inhalation exposure can sometimes be a concern for soil and dust, the primary pathway of concern is ingestion. Table 2 summarizes the pathways for this site. If one or more of the exposure pathways are potential or complete, ADHS then considers whether exposure to the chemicals present may be harmful to people.

Table 2. Exposure pathway evaluation

Exposure Pathway Elements					Time frame	Type of exposure pathway
Source	Media	Point of exposure	Route of exposure	Potentially exposed population		
Waste piles/spill	Soil	On-site	Incidental ingestion, inhalation, skin contact	Trespassers	Past, Current	Complete
				Recreational users	Future	Complete (without remediation)

Selecting Chemicals of Interest

The investigation results indicated metals are unevenly distributed in soil with some hot spots and many non-detected concentrations at the Old Tungsten Mill site. The average concentrations of metals were computed by ProUCL using Nonparametric Kaplan-Meier Estimation Method. This provides conservative, protective evaluation but will not result in significant overestimation. The evaluation results indicated that arsenic and lead levels in the area exceeded their respective CVs (Table 3). Tungsten is kept for further evaluation since no CV is available. The evaluation of arsenic, lead and tungsten exposures are discussed below.

Table 3. Chemicals of interest in soil were identified by comparing them to their respective comparison values

Chemical	Number of Samples	Ranges of detected concentration (mg/kg)	Averaged concentration (mg/kg)	Health-based CVs[a] (mg/kg)	Type of CV	Is it a chemical of interest?
Arsenic	66	< 5 − 1,500	58.09	10	RSRL[b]	**Yes**
Barium	66	54 − 1,100	112.5	15,000	RSRL	No
Cadmium	66	< 0.5 − 43	5.81	39	RSRL	No
Chromium	66	< 2 − 110	10.57	200	RMEG[c]	No
Lead	66	9.8 − 28,000	3,064	400	RSRL	**Yes**
Selenium	66	< 5 − 68	7.7	390	RSRL	No
Silver	66	< 2.5 − 48	3.96	390	RSRL	No
Mercury	66	< 0.1 − 4	0.26	23	RSRL	No
Tungsten	66	< 5 − 6,100	413.3	NA[d]		**Yes**

a. Note that the health-based CVs refer to an average concentration. Average soil concentrations are used for screening and dose assessment because exposure to soil occurs over a large area and duration of time.
b. RSRL: Arizona Residential soil Remediation Level
c. RMEG: Reference Dose Media Evaluation Guides for children's exposure (ATSDR)
d. NA: not available

Public Health Implications

Arsenic

Arsenic is widely distributed in the earth's crust, which contains about 3.4 milligrams per kilogram (mg/kg). It is mostly found in nature as minerals, and in its elemental form only to a small extent. Typical arsenic concentrations for uncontaminated soils range from 1 to 40 mg/kg. The average arsenic concentration in Arizona soil is about 10 mg/kg.

To determine whether harmful effects might be possible, ADHS reviewed the numerous studies documenting the effects of arsenic in humans. Several factors should be considered when evaluating the potential for harm associated with arsenic in soil, include bioavailability[1], pica-like behavior in children, and carcinogenic[2] effect. Children and children with soil-pica behavior are a special concern for acute exposures because ingesting large amounts of soil could lead to significant arsenic exposure. Children who eat large amounts of soil exhibit soil-pica behavior. Soil-pica behavior is most likely in preschool children as part of their normal exploratory activities. General pica behavior is greatest in children aged 1–2 years and decreases with age.

ADHS evaluated the potential health impacts associated with exposure to current site conditions (i.e. without remediation). ADHS used the average soil arsenic concentration of 58.09 mg/kg to estimate site specific exposure for current trespassers and future recreational users. The estimated doses are compared to acute and chronic minimum risk levels (MRLs). Since no information is available on the frequency that vandals may trespass on this property, ADHS assumed that they spend 24 hours/week (i.e. ~3.4 hours/day) at this property. If the property is re-used for a recreational area, it is anticipated that people will be encouraged to use the property and increase the potential exposure to site contaminants. ADHS assumed that the general population would spend 48 hours/week (i.e. ~6.9 hours/day) at this property.

ATSDR developed a provisional acute and chronic oral MRL for arsenic of 0.005 milligrams of arsenic per kilogram of body weight per day (mg/kg/day) and 0.0003 mg/kg/ day, respectively. The MRL is an exposure level below which non-cancerous harmful effects are unlikely. The acute MRL is based on several transient (i.e. temporary) effects, including nausea, vomiting, and diarrhea. It should be noted that

- The acute MRL is 10 times below the levels that are known to cause harmful effects in humans,
- The acute MRL is based on people being exposed to arsenic dissolved in water instead of arsenic in soil — a fact that might influence how much arsenic can be absorbed, and
- The chronic MRL of 0.0003 mg/kg per day is about 46 times below the lowest observed adverse effect level[3] (LOAEL) of 0.014 mg/kg per day
- The MRL applies to non-cancerous effects only and is not used to determine whether people could develop cancer

ADHS assumes that the current trespassers on the property are older children and adults. Younger children (under 6 years old) are not likely to have contact with the contaminated soil. ADHS does not expect to see adverse health effects among younger children. Based on the assumed exposure scenario, current trespassers are not likely to experience non-cancerous harmful health effects from arsenic in soil (Table 4). For future recreational users, ADHS determined it is unlikely that adults and children undertaking general activities (e.g. walking, hiking) at the site will experience noncancerous harmful effects from arsenic in soil. However,

[1] Bioavailability is the amount of a contaminant that is absorbed into the body following skin contact, ingestion, or inhalation.

[2] "Carcinogen" or "carcinogenic" means the potential of a contaminant to cause cancer in humans as determined by lines of evidence in accordance with a narrative classification in "Guidelines for Carcinogen Risk Assessment", EPA/630/P-03/001F, March 2005, (and no future editions), which is incorporated by reference.

[3] The lowest tested dose of a substance that has been reported to cause adverse health effects in people or animals.

children aged 1–2 years (pica-children) who eat excessive amounts of soil (> 2,500 mg/day), and who play in and ingest soil from the area with the highest arsenic levels might receive a dose exceeding the acute MRL and the dose that caused temporary harmful effects in a human study.

Table 4. Estimated arsenic intakes[4] from ingestion of arsenic-contaminated soil at the Old Tungsten Mill for current trespassers and future recreational users. The estimations are based on current site conditions (i.e. without remediation). These values are compared to acute and chronic minimum risk levels (MRLs).

Acute Exposure

Population	Soil Intake (mg/day)	Exposure Factor	Body Weight (kg)	Estimated Dose (mg/kg/day)	Acute MRL (mg/kg/day)
Current trespassers					0.005
Adult	100	1	70	0.000083	
Future recreational users					
Adult	100	1	70	0.000083	
Child	200	1	16	0.000726	
Pica-child	5,000	1	10	0.029045	

Chronic Exposure

Population	Soil Intake (mg/day)	Exposure Factor	Body Weight (kg)	Estimated Dose (mg/kg/day)	Chronic MRL (mg/kg/day)
Current trespassers					0.0003
Adult	100	0.14[5]	70	0.000006	
Future recreational users					
Adult	100	0.28[6]	70	0.000012	
Child	200	0.28	16	0.000103	
Pica-child	5,000	0.28	10	0.004138	

[4] The daily intake (ID) is estimated by: $ID = \frac{C \times SI \times BF \times EF}{BW}$, where C: arsenic concentration (mg/kg); SI: Soil Intake (kg/day); BF: Bioavailability Factor assumed to be 50%; EF: Exposure Factor; BW: Body Weight (kg).

[5] Exposure factor assumed to be 0.14 based on an exposure frequency of 24 hrs/wk for the trespassers.

[6] Exposure factor assumed to be 0.28 based on an exposure frequency of 48 hrs/wk for the general population.

The Department of Health and Human Services, the International Agency for Research on Cancer and US EPA have determined that arsenic is carcinogenic to humans. This is based on evidence from many studies of people who were exposed to arsenic-contaminated drinking water, arsenical medications, or arsenic-contaminated air in the workplace for exposure durations ranging from a few years to an entire lifetime. For the Old Tungsten Mill site, ADHS's estimation results indicated that there will be 4 additional occurrences of cancer in a population of 1,000,000 for current trespassers, and 8 additional occurrences of cancer in a population of 1,000,000 people for future recreational users due to exposure arsenic contaminated soil[7]. The estimated excess cancer risk is within US EPA's guidance range which is from 10^{-6} to 10^{-4}. The current exposure scenario increases the chances to develop cancer from 50% to 50.0004 % for a man and from 33% to 33.0004% for a woman, over a life time. The future exposure scenario increases the chance to develop cancer from 50% to 50.0008 % for a man and from 33% to 33.0008% for a woman, over a lifetime.

Lead

ADHS evaluates the public health significance of lead in soil by estimating the potential impact that it may have on the blood lead levels of potentially exposed populations. For this health consult ADHS considered potential exposure to adults and children associated with current site conditions (i.e. without remediation). ADHS assumes that current trespassers on the property are older children and adults. Younger children (under 6 years old) are not likely to have contact with the contaminated soil. Since no information is available on the frequency that vandals may trespass on this property, ADHS assumed that they spend 24 hours/week (i.e. ~3.4 hours/day) at this property. ADHS assumed that the general population would spend 48 hours/week (i.e. ~6.9 hours/day) at this property if the property is re-used for a recreational area. ADHS estimated the blood lead levels for child and adult by using ATSDR's regression analysis[8]. Table 5 shows the estimated results for current trespassers and future recreational users based on current site conditions (i.e. without remediation).

In general, lead in soil has the greatest impact on preschool-age children as they are more likely to play in dirt and place their hands and other contaminated objects in their mouths. They also are better at absorbing lead through the gastrointestinal tract than adults and are more likely to exhibit the types of nutritional deficiencies that facilitate the absorption of lead. While lead in soil also can have an impact on adults, the potential impact on adults is low compared to the potential impact on young pre-school age children.

The Centers for Disease Control and Prevention (CDC) has determined that a blood lead level 10 microgram per deciliter (µg/dL) in children indicates excessive lead absorption and constitutes the grounds for intervention. For adults, a blood level of 25 µg/dL is considered to be

[7] There is a background incidence of cancer in the general population due to everyday exposure to common materials. Nearly half of all men and one-third of all women in US population will develop cancer at some point in their life (American Cancer society 2008).

[8] ATSDR has developed an integrated exposure regression analysis which utilizes slope values from select studies to integrate all exposures from various pathways, thus providing a cumulative exposure estimate expressed as total blood lead. The general form of the model is: $PbB = \delta_S TPb_S + \delta_D TPb_D + \delta_W TPb_W + \delta_A TPb_A + \delta_F TPb_F$. Where, Pb_S: soil lead concentration; Pb_D: dust lead concentration; Pb_W: water lead concentration; Pb_A: air lead concentration; Pb_F: food lead concentration; T: relative time spent; δ: the respective slope factor for specific media.

"elevated." While there is no clear relationship between soil lead and blood lead applicable to all sites, a number of models have been developed to estimate the potential impact that lead in soil could have on different populations.

Table 5. Estimated blood lead concentrations and contribution of environmental lead to blood lead for current trespassers and future recreational users. The estimations are based on current site conditions (i.e. without remediation).

Current Trespassers: Adult

Media	Concentration		Relative Time Spent	Slope Factor		Blood Lead (µg/dL)	
						Low	High
Air	0.2	µg/m^3	1	2.57 ± 0.12	(µg/dL)/(µg pb/m^3)	0.49	0.54
Water	4	µg/L	1	0.06	(µg/dL)/(µg pb/L)	0.24	0.24
Diet	5	µg/day	1	0.034	(µg/dL)/(µg pb/day)	0.17	0.17
Soil	3,064	mg/kg	0.14	0.001– 0.003	(µg/dL)/(µg pb/kg)	0.429	1.287
Dust	70	mg/kg	1	0.0086 – 0.0096	(µg/dL)/(µg pb/kg)	0.602	0.672
Predicted range of blood lead						*1.93*	*2.91*

Future Recreational Users: Adult

Media	Concentration		Relative Time Spent	Slope Factor		Blood Lead (µg/dL)	
						Low	High
Air	0.2	µg/m^3	1	2.57 ± 0.12	(µg/dL)/(µg pb/m^3)	0.49	0.54
Water	4	µg/L	1	0.06	(µg/dL)/(µg pb/L)	0.24	0.24
Diet	5	µg/day	1	0.034	(µg/dL)/(µg pb/day)	0.17	0.17
Soil	3,064	mg/kg	0.29	0.001– 0.003	(µg/dL)/(µg pb/kg)	0.889	2.666
Dust	70	mg/kg	1	0.0086 – 0.0096	(µg/dL)/(µg pb/kg)	0.602	0.672
Predicted range of blood lead						*2.39*	*4.29*

Future Recreational Users: Child

Media	Concentration		Relative Time Spent	Slope Factor		Blood Lead (µg/dL)	
						Low	High
Air	0.2	µg/m^3	1	1.92 ± 1.8	(µg/dL)/(µg pb/m^3)	0.024	0.744
Water	4	µg/L	1	0.26	(µg/dL)/(µg pb/L)	1.04	1.04
Diet	5	µg/day	1	0.24	(µg/dL)/(µg pb/day)	1.2	1.2
Soil	3,064	mg/kg	0.29	0.0068 ± 0.00291	(µg/dL)/(µg pb/kg)	3.4565	8.6279
Dust	70	mg/kg	1	0.00718 ± 0.0027	(µg/dL)/(µg pb/kg)	0.3136	0.6916
Predicted range of blood lead						*6.03*	*12.3*

Based on the assumed exposure scenario, the predicted results indicated that current trespassers are not likely to have elevated blood lead levels. If this property is reused as a recreational area without remediation, adults undertaking general activities (e.g. walking, hiking) at the site will not experience harmful health effects from lead in soil. However, the contaminated soil (without remediation) could present a health hazard to children. There are many potential sources of children's exposure to lead, directly contact to contaminated soil from this site could add to the existing body burden children may already have from other sources.

Tungsten

Little is known about the toxicity of tungsten compounds. Keith et al. (2007) provides a comprehensive review of tungsten compound and its relevance to the public health. Limited study results implicate reproductive, developmental and neurological effects as endpoints of concern following oral exposure to tungsten. Acute toxicity does not appear to be a particular toxicological concern based on high values of LD_{50} (240~11,300 mg/kg/day). LD_{50} literally is the dose required to kill 50% of the population. Determining the LD_{50} is a method used by toxicologists to understand the toxicity of a chemical. Animal studies show long term exposure to tungsten may have effects on body weight. These studies were used to derive non-observed adverse effects levels (NOAEL) of 0.75 mg/kg/day and 8,256 mg/kg/day for chronic and intermediate exposure, respectively. The estimated daily exposure doses (Table 6) are small compared to the available NOAELs. Tungsten has not been classified for carcinogenic effect by the US Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), or the US EPA. No evidence exists to suggest that tungsten, at the levels detected at the Old Tungsten Mill site, pose any hazard to human health.

Table 6. Estimate daily intake[9] from ingestion of tungsten-contaminated soil at the Old Tungsten Mill for current trespassers and future recreational users. The estimations are based on current site conditions (i.e. without remediation).

Population	Soil Intake (mg/day)	Exposure Factor	Body Weight (kg)	Estimated Dose (mg/kg/day)	NOAEL (mg/kg/day)
Current trespassers					0.75
Adult	100	0.14[10]	70	0.0001	
Future recreational users					
Adult	100	0.28[11]	70	0.0002	
Child	200	0.28	16	0.0015	
Pica-child	5,000	0.28	10	0.0589	

[9] The daily intake (ID) is estimated by: $ID = \frac{C \times SI \times BF \times EF}{BW}$, where C: tungsten concentration (mg/kg); SI: Soil Intake (kg/day); BF: Bioavailability Factor assumed to be 100%; EF: Exposure Factor; BW: Body Weight (kg).

[10] Exposure factor assumed to be 0.14 based on an exposure frequency of 24 hrs/wk for the trespassers.

[11] Exposure factor assumed to be 0.28 based on an exposure frequency of 48 hrs/wk for the general population.

Child Health Considerations

ADHS considers children in its evaluations of all exposures, and we use health guidelines that are protective of children. In general, ADHS assumes that children are more susceptible to chemical exposures than are adults. For the site-specific exposure scenarios, ADHS considered that children can be exposed to arsenic, lead and tungsten in soil when they play in the former ore mill site, if the property is reused as a recreational area without remediation. ADHS has taken into account that children are at a greater risk for exposure than are adolescents or adults because the normal behavior of children might result in higher rates of ingestion of contaminated soil and dust. Children might also receive a higher dose of contaminants because they have lower body weights than do adults. Some children might eat soil excessively (called soil-pica behavior) and therefore have a higher exposure dose to contaminants in soil. ADHS has considered these factors in the development of its conclusions for this site. The CVs used in this health consultation are developed to be protective of susceptible populations such as children.

Conclusions

Current Trespassers:

Based on the available information, ADHS concludes that this site poses **no apparent public health hazard** to current trespassers. It is assumed that the current trespassers on the property are older children and adults. Younger children (under 6 years old) are not likely to have contact with the contaminated soil. General activities will not produce exposures that pose an acute or chronic public health hazards to current trespassers.

Future Recreational Users:

Without remediation, arsenic, lead and tungsten exposures from walking or exercising at the Old Tungsten Mill site are not expected to result in non-cancerous harmful health effects among adults. No significant increase in cancer would be expected for the people recreating for long periods in the area.

Future redevelopment of the property as a recreational park area is likely to encourage access to the property, particular to young children who may be at a greater risk for exposure to site contaminants. Without remediation, these conditions will pose a **future public health hazard** to children and pica children:

- Pica children could get acute arsenic toxicity from a one-time exposure at soil hot spots.
- Lead concentrations in surface soil at the site could present a health concern to children who frequently play in the high concentration areas.

Recommendations

ADHS recommended/supported the city of Tucson to

- Restrict access to the site before remediation activities are completed
- Remediate the site before it is reused as a recreational park
- Apply for a Brownfield Cleanup Grant to clean-up the site

Public Health Action Plan

Completed:

- The city of Tucson moved quickly to restrict access to this site by constructing a 2-acre, perimeter fence around the mill ruins.
- The city of Tucson has fenced all areas identified as having lead contaminated soil exceeding the State's Residential Soil Remediation Levels.
- ADHS submitted a letter of support for the city of Tucson's grant application. The city of Tucson received a Brownfields Cleanup Grant from the US EPA to clean-up the site.

Future:

- The ADHS will continue to review and evaluate data provided for this site.
- The ADHS will attend public meetings, make presentations, develop handout literature, and engage in other actions to notify the property owners in the area of the findings of this health consultation.
- The ADHS will post this report on the ADHS website.
- The city will perform the cleanup (remediation activities) under the Arizona Department of Environmental Quality, Voluntary Remediation Program. Once the site is remediated (cleaned-up), the property is intended to be redeveloped as a Natural Resource Park.

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Preparers of Report

Arizona Department of Health Services, Office of Environmental Health

Alan Croft, MPH, Health Risk Assessor

Hsin-I Lin, ScD, Health Risk Assessor

Diane Eckles, Office Chief, Principal Investigator

ATSDR Technical Project Officer

Charisse Walcott

Division of Health Assessment and Consultation

Cooperative Agreement and Program Evaluation Branch

Cooperative Agreement Team

ATSDR Regional Representative

Gwen Eng

Office of Regional Operations, Region IX

Office of the Assistant Administrator

Certification

This Old Tungsten Mill Site, Health Consultation was prepared by the Arizona Department of Health Services under cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures existing at the time the exposure investigation report were begun.

Charisse Walcott

Technical Project Officer

CAT, CAPEB, DHAC, ATSDR

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

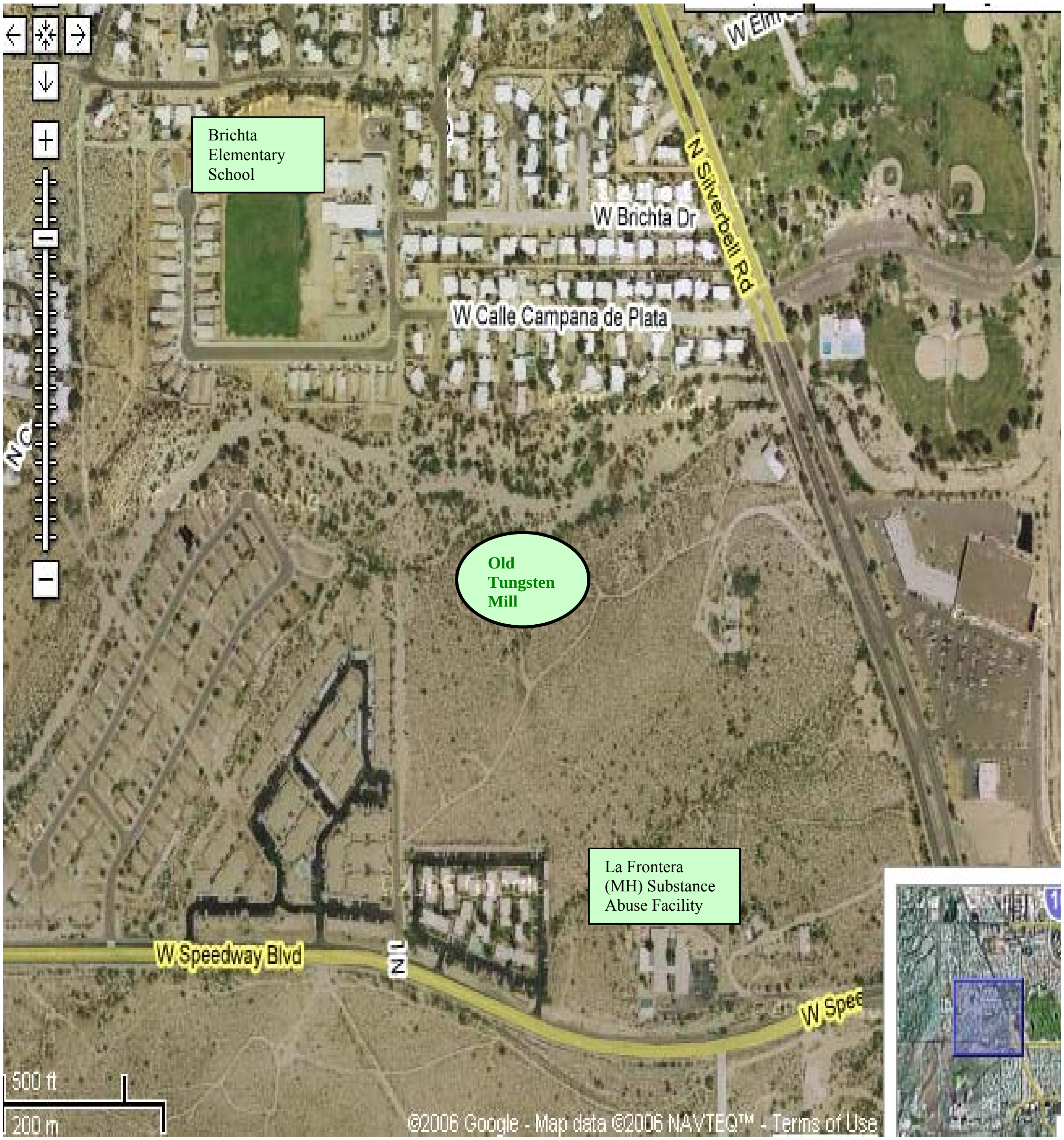
Alan Yarbrough

Team Leader-Cooperative agreement Program

CAT, CAPEB, DHAC, ATSDR

APPENDIX A

Old Tungsten Mill Site (A.K.A. "General Instrument")
Source: Google Maps



Appendix B

Summary of laboratory soil sample results in milligrams per kilogram (mg/kg) for the Old Tungsten Mill Site

Sample ID	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver	Mercury	Tungsten
S1	41	94	19	5.3	6600	< 5	2.6	0.4	680
S2	120	92	19	7.3	15000	< 5	4.1	0.24	670
S3	56	130	7.3	2.9	1900	< 5	< 2.5	0.25	680
S4	130	76	43	17	28000	< 5	3.7	0.52	850
S5	1500	110	6.4	6.8	8300	< 5	48	4	< 50
S6	64	86	10	20	6100	< 25	< 12	0.14	600
S7	37	80	4.4	13	6200	< 25	< 12	0.19	580
S8	63	100	6.7	25	6000	< 25	< 12	0.34	1000
S9	91	160	21	42	13000	48	16	0.71	4200
S10	65	110	14	20	7900	< 25	< 12	0.43	1200
S11	53	150	3.8	12	2100	< 25	< 12	< 0.1	1100
S12	58	100	17	19	4000	< 25	< 12	0.23	2100
S13	140	130	16	34	4100	< 25	< 12	0.23	640
S14	70	90	41	23	14000	< 25	< 12	0.25	740
S15	< 25	280	< 2.5	11	< 25	< 25	< 12	< 0.1	< 50
S16	37	260	4.5	34	1900	68	< 12	< 0.1	6100
S17	< 25	120	6.6	11	160	< 25	< 12	< 0.1	480
S18	< 25	92	< 2.5	11	160	< 25	< 12	< 0.1	100
S19	< 5	82	< 0.5	2.5	74	< 5	< 2.5	< 0.1	180
S20	< 5	82	2.4	2.6	190	< 5	< 2.5	< 0.1	340
S21	< 5	97	< 0.5	2.4	36	< 5	< 2.5	< 0.1	5
S22	< 5	120	0.95	2.7	260	< 5	< 2.5	< 0.1	600
S23	< 5	150	< 0.5	2.1	16	< 5	< 2.5	< 0.1	< 5
S24	< 5	63	< 0.5	< 2	12	< 5	< 2.5	< 0.1	< 5
S25	< 5	85	0.76	2.8	190	< 5	< 2.5	< 0.1	86
S26	12	150	3.9	3.1	1600	< 5	< 2.5	< 0.1	200
S27	< 5	78	0.5	3.1	110	< 5	< 2.5	< 0.1	48
S28	< 5	93	1.1	3.3	120	< 5	< 2.5	< 0.1	280
S29	< 5	260	8.7	2.4	3800	< 5	< 2.5	0.2	400
S30	150	110	6.7	2.6	2300	< 5	8	0.23	430
S31	120	82	9	< 2	3200	< 5	6.4	0.85	410
S32	< 5	70	0.79	< 2	270	< 5	< 2.5	< 0.1	18

Sample ID	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver	Mercury	Tungsten
S33	< 5	86	< 0.5	< 2	70	< 5	< 2.5	< 0.1	6.2
S34	56	150	2.6	2.7	620	< 5	< 2.5	0.12	140
S35	< 5	320	11	3.3	1100	< 5	< 2.5	0.14	680
S36	32	86	12	4.5	4400	< 5	< 2.5	< 0.1	640
S37	< 5	54	2.2	2.6	790	< 5	< 2.5	0.18	220
S38	130	150	24	15	13000	< 5	3.8	0.3	240
S39	450	85	12	18	10000	< 5	16	0.94	80
S40	82	97	8.8	16	9900	< 5	< 2.5	< 0.1	240
S41	< 5	99	< 0.5	8.6	16	< 5	< 2.5	< 0.1	< 5
S42	< 5	87	0.81	5.6	45	< 5	< 2.5	< 0.1	150
S43	< 5	88	< 0.5	8.6	110	< 5	< 2.5	< 0.1	< 5
S44	< 5	120	< 0.5	7.6	15	< 5	< 2.5	< 0.1	< 5
S45	7.6	140	< 0.5	7.6	15	7.1	< 2.5	< 0.1	< 5
S46	< 5	96	< 0.5	7.9	33	< 5	< 2.5	< 0.1	< 5
S47	< 5	1100	12	110	22000	< 5	4.3	0.66	< 5
S48	< 5	680	6.2	52	1500	< 5	< 2.5	0.52	< 5
S49	< 5	85	1.1	11	210	< 5	< 2.5	< 0.1	21
S50	6	170	< 0.5	3.6	10	< 5	< 2.5	< 0.1	< 5
S51	5.8	130	< 0.5	3.8	9.8	< 5	< 2.5	< 0.1	< 5
S52	11	210	< 0.5	5.4	19	6.6	< 2.5	< 0.1	< 5
S53	6.2	220	< 0.5	5	9.8	6.1	< 2.5	< 0.1	< 5
S54	< 5	82	< 0.5	< 2	13	< 5	< 2.5	< 0.1	< 5
S55	< 5	110	< 0.5	8.4	23	< 5	< 2.5	< 0.1	< 5
S56	< 5	74	< 0.5	2.6	16	< 5	< 2.5	< 0.1	< 5
S57	< 5	59	< 0.5	< 2	11	< 5	< 2.5	< 0.1	< 5
S58	< 5	92	< 0.5	< 2	16	< 5	< 2.5	< 0.1	< 5
S59	< 5	86	< 0.5	< 2	19	< 5	< 2.5	< 0.1	< 5
S60	< 5	94	< 0.5	< 2	16	< 5	< 2.5	< 0.1	< 5
S61	< 5	100	< 0.5	< 2	21	< 5	< 2.5	< 0.1	< 5
S62	< 5	91	0.62	6	200	< 5	< 2.5	< 0.1	< 5
S63	< 5	82	< 0.5	5.2	110	< 5	< 2.5	< 0.1	< 5
S64	< 5	54	< 0.5	7.2	250	< 5	< 2.5	< 0.1	< 5
S65	< 5	74	< 0.5	< 2	25	< 5	< 2.5	< 0.1	< 5
S66	< 5	82	< 0.5	< 2	15	< 5	< 2.5	< 0.1	< 5