Health Consultation

PALESTINE DAY CARE FACILITIES

PALESTINE, ANDERSON COUNTY, TEXAS

EPA FACILITY ID: TXN000605670

NOVEMBER 17, 2005

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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HEALTH CONSULTATION

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Prepared by:

Texas Department of State Health Services
Under Cooperative Agreement with
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Purpose

In a previous consult, the Texas Department of State Health Services (DSHS) and the Agency for Toxic Substances and Disease Registry (ATSDR) were asked by the U.S. Environmental Protection Agency (EPA) to determine the public health significance of arsenic, lead, and vanadium levels found in soil samples collected from residential yards and playgrounds near the Palestine Foundry in Palestine, Texas [1]. Specifically, EPA asked DSHS and ATSDR to determine whether the contaminants found in the soil pose a public health threat. In that consult, DSHS and ATSDR concluded that based on the environmental sampling data, under some exposure scenarios, contaminants in soil could pose a public health hazard because children may be exposed to levels of lead that could result in slight increases in blood lead [1].

The public health action plan outlined for the Palestine Foundry [1] site indicated that additional soil sampling data, particularly for day care centers and other childcare facilities, would be evaluated. In April 2005, additional soil samples collected from city property, residential areas, day care centers, and residential day care facilities were analyzed for the presence of arsenic, lead, and vanadium. The purpose of this health consultation is to evaluate the public health significance of the additional soil sampling results.

Background

Site Description and History

The area in question, a mixed industrial/residential area, is located in the southeastern portion of Palestine, Anderson County, Texas[1]. Although the exact source and extent of the contamination have not yet been determined, historically, two facilities operated in the area: the Palestine Light, Heat, and Power Company and the former George M. Dilley and Son, Founders and Machinists Shop (also known as the Palestine Foundry). Both properties are accessible to children as well as adults. The Palestine Light, Heat and Power Company site is a one-acre site that was formerly a town gas operation. The site consists of several waste piles (railroad ties, concrete blocks, and rock piles) from the adjacent railroad system on the east side of the property.

The Palestine Foundry site is north of the Palestine Light, Heat, and Power Company and east of the railroad tracks on South May Street. It was the first large industry in Palestine and operated from 1873 to 1949. Historically, several buildings and a smoke stack may have existed on the property; only two buildings currently remain in the heavily vegetated area [3]. Across S. May Street from the Palestine Foundry are residential homes. The fence along the road does not prevent access to the foundry property. The foundry office building is dilapidated and thereby poses a physical hazard. The area did not have evidence of trespassing.

Discussion

Introduction

The environmental data that DSHS used in this discussion included soil-sampling data collected by EPA in April 2005. Fifty-three (53) composite samples were collected, including 7 samples from 7 residential areas (from an area less than ½ mile west of the foundry), 33 samples from

[1] The population of Palestine, Texas is 17,598 [2].

city property (Reagan City Park, approximately ½ mile east of the Palestine Foundry), 10 samples from 8 day care centers (commercial buildings), and 3 samples from 3 residential day care facilities (resident housing used as a child care facility). Although soil samples were analyzed from a variety of depths, samples from depths of 0-1 inch are the focus of this consultation since surface soil is most important when considering the potential health hazard to children. Information provided to DSHS was presumed to have adequate quality assurance/quality control (QA/QC) with regard to data collection, chain-of-custody, laboratory procedures, and data reporting. In assessing the potential public health significance of these sample results, conservative assumptions were used to determine theoretical public health risks. The estimates used in this assessment do not apply to any specific individual or group of individuals.

Child Health Considerations

The unique vulnerabilities of children demand special attention. Critical periods exist during development, particularly during early gestation, but also throughout pregnancy, infancy, childhood, and adolescence periods when toxicants may permanently impair or alter structure and function [4]. Unique childhood vulnerabilities may be present because, at birth, many organs and body systems (including the lungs and the immune, endocrine, reproductive, and nervous systems) have not yet achieved structural or functional maturity. These organ systems continue to develop throughout childhood and adolescence.

Children may exhibit differences in absorption, metabolism, storage, and excretion of toxicants, resulting in higher biologically effective doses to target tissues. Depending on the affected media and because of behavior patterns specific to children, they may be exposed to contaminants more than adults. In an effort to account for children's unique vulnerabilities, and in accordance with ATSDR's Child Health Initiative [5] and EPA's National Agenda to Protect Children's Health from Environmental Threats [6], the potential exposure of children to the contaminants found in the soil was used as a guide in assessing the potential public health risks associated with this site.

The total population of Palestine includes 1,458 children less than five years of age and 1,396 children aged five to nine [2]. There are 12 day care, preschool, or elementary school-facilities within one mile of the Palestine Foundry and an additional 14 similar facilities within two miles of the foundry. The neighborhood just west of the Palestine Foundry has a high number of children under the age of five (up to 50% of the population), and there are 240 children under the age of seven living within the census tract that surrounds the foundry [2]. Additionally, 40% of the total population is between the ages of 15 and 44. Although data on the ratio of males and females for these age groups are not available, the total population of Palestine is 46% male and 54% female. Assuming the male to female ratio is equal across all age groups, 21.6% of the total population of Palestine is comprised of women of childbearing age [2].

Surface Soil Contaminant Evaluation

To assess the potential health risks associated with exposure to the contaminants found in the soil, measured concentrations were compared to health-based screening values. These screening values represent contaminant specific levels in the soil that are considered safe for human contact with respect to identified health endpoints. Screening values are used to determine which contaminants need further evaluation. There are screening values for non-cancer and cancer health effects.

Non-cancer screening values generally are based on ATSDR minimal risk levels (MRLs). These MRLs are developed for each route of exposure: skin absorption, ingestion, and inhalation. They also are developed for various lengths of exposure: acute (less than 14 days), intermediate (15 to 364 days), and chronic (greater than 365 days). The MRLs are then presented in ATSDR chemical-specific toxicological profiles. These profiles provide information on health effects, environmental transport, human exposure, and regulatory status. When an ATSDR MRL is not available, EPA's Reference Dose (RfD) is used. This is an estimate of daily human exposure that is unlikely to cause non-cancer adverse health effects over a lifetime of exposure. Both MRLs and RfDs are based on the assumption that there is an identifiable exposure threshold (for individuals and populations) below which there are no observable adverse health effects.

When chemical compounds have been classified as human carcinogens, probable human carcinogens, or possible human carcinogens, cancer-screening values (when available) are used to determine if these chemicals warrant a closer look. Cancer screening values are based on EPA's chemical specific cancer slope factors (CSF) and an estimated excess lifetime cancer risk of one-in-one-million persons exposed for a lifetime.

Exceeding either a non-cancer or a cancer screening value does not necessarily mean that the contaminant will cause harm; however, it does suggest that potential exposure to the contaminant warrants further consideration. Factors that influence whether exposure to a contaminant could or would result in adverse health effects include; how much of the contaminant an individual is exposed to, how often and how long they are exposed, and the manner in which the contaminant enters or contacts the body. Once exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status all may influence how well the individual absorbs, distributes, metabolizes, and excretes the contaminant. The public health significance of contaminants that exceed screening values may be assessed by reviewing and integrating relevant toxicological information with plausible exposure scenarios. When possible, for non-cancer endpoints, estimated exposures are compared to known effect levels in humans or to documented No Observed Adverse Effect Levels (NOAEL) and/or Lowest Observed Adverse Effect Levels (LOAEL) in humans or animals. Weight-of-evidence is used to determine the public health significance of the contaminants that exceed the screening values.

Soil pica behavior (ingestion of more than 1.0 gram[2] of soil per day) may occur in a sizable portion of children [7]. While an individual child may exhibit pica behavior infrequently, the behavior is not limited to a small subset of the population. It has been estimated that about 62% of children will ingest >1.0 gram of soil on 1-2 days/year. Additionally, 42% of children will ingest >5 grams of soil and 33% will ingest >10 grams of soil on 1-2 days per year. For some contaminants, periodic pica episodes potentially could result in acute intoxication [7].

[2] 1 gram is equal to 1,000 milligrams (about the same size as a pack of artificial sweetener)

Arsenic

Non–Carcinogenic Effects of Arsenic

The non-cancer screening values used for arsenic in soil [20 milligrams per kilogram (mg/kg) for children and 200 mg/kg for adults] are based on the EPA oral RfD for arsenic of 0.3 microgram per kilogram per day (µg/kg/day) [8]. The RfD was derived by dividing the identified chronic NOAEL of 0.8 µg/kg/day (obtained from human epidemiologic studies) by an uncertainty factor of three to account for the lack of data on reproductive toxicity and to account for some uncertainty as to whether the NOAEL accounts for all sensitive individuals. There is not a clear consensus among scientists regarding the oral RfD. Arguments for various values within a factor of 2-3 of the recommended RfD value have been made. The LOAEL associated with these epidemiologic studies was 14 µg/kg/day, where exposure to arsenic above this level resulted in hyperpigmentation of the skin, keratosis (patches of hardened skin), and possible vascular complications [8-10]. Standard assumptions for body weight (70 kg adult; 15 kg child) and soil ingestion (100 mg/day for an adult; 200 mg/day for a child; 5,000 mg/day for a pica child) were used to calculate the screening value. Screening values calculated using child exposure scenarios are conservative (health protective) with respect to protecting adults.

At residential areas, 57% of the samples exceeded non-cancer screening values. Arsenic levels ranged from 10.1 to 47.8 mg/kg, and averaged 27.3 mg/kg. At city property collection sites, 73% of the soil samples analyzed exceeded the arsenic screening values for children; arsenic ranged from 4.3 to 85.4 mg/kg, with an average of 35 mg/kg. Arsenic levels at child care facilities were much lower. At commercial day care centers, arsenic in soil varied from 1.5 to 39.9 mg/kg, with an average of 13.8 mg/kg. Only 20% of the samples exceeded the screening values for children. At residential day care facilities, no samples exceeded the screening values. Levels of arsenic ranged from 10.5 to 13.2 mg/kg, with an average of 12 mg/kg (Tables 1-4).

Four of the seven samples collected from residential yards had arsenic levels above the screening value. A 15 kg child who regularly ingested 200 mg of soil per day from one of these yards could theoretically be exposed to arsenic at doses exceeding the RfD. It is unlikely that children living at one of these residences would be exposed to arsenic at levels above the NOAEL; thus, they would not be exposed to levels above actual known effect levels in humans (Tables 5-6).

The highest concentrations were found in the samples collected at Reagan City Park; however, children likely spend less time (frequency and duration) in the contaminated areas of the park as compared to time spent at day care facilities and the child's residence. Additionally, the city park is covered with grass; therefore, children are less likely to have direct contact with contaminated soil. Using the maximum reported concentration found in the park (a conservative assumption) a 15 kg child ingesting 200 mg of soil per day from the park, 3 days per week, and 25 weeks per year would be exposed to an average dose well below the RfD (Tables 7-8).

Two of the 10 samples collected from commercial day care centers exceeded the screening value. Assuming the types of exposures that a child might receive at a commercial day care center are similar to those received in the residential setting; children at the day care centers with soil arsenic concentrations exceeding the screening value theoretically could be exposed to arsenic at doses exceeding the RfD (Tables 9-10). It is unlikely that children attending these day care centers would be exposed to arsenic at levels above the NOAEL; thus, they would not be exposed to levels above actual known effect levels in humans.

None of the samples collected from residential day care facilities exceeded the screening value. Thus, we would not expect children attending these facilities to be exposed to arsenic at levels exceeding the RfD.

Short-Term or Sporadic Pica Behavior

The potential public health significance of acute exposure to arsenic due to pica behavior was evaluated using the scenario of a 15 kg child sporadically ingesting 5,000 mg of soil per day. For this scenario we used the highest soil arsenic level (85.4 mg/kg) found on city property and a conservative bioavailability factor (100%). The estimated daily dose of absorbed arsenic during the pica events was 28.5 µg/kg/day. This is below the acute LOAEL for serious effects (50 µg/kg/day) reported by Mizuta [11]. Using the conservative bioavailability factor of 100%, a child regularly exhibiting pica behavior would have to ingest over 8 g of soil per day to receive a dose approaching the acute LOAEL. Effects associated with this acute LOAEL include nausea, vomiting, diarrhea, occult blood in feces, gastric, and duodenal juice, and abnormal electrocardiogram [11]. This level of exposure is considered very unlikely to occur. At day care centers and residential day care facilities, the estimated daily dose of absorbed arsenic (based upon the maximum arsenic concentration in soils from these areas) during pica events was below the chronic LOAEL of 14 µg/kg/day discussed earlier. For residential areas, estimated exposure doses were 15.9 µg/kg/day.

Carcinogenic Effects of Arsenic

The carcinogenic screening value for arsenic of 0.5 mg/kg is based on EPA's cancer slope factor (CSF) for skin cancer and an estimated excess lifetime cancer risk of one additional cancer in one million people exposed for 70 years. Arsenic was detected at concentrations above its carcinogenic screening value in virtually all the soil samples; however, the levels of arsenic normally found in the environment also exceed this screening value [8]. Nonetheless, people who regularly ingest soil from some of these areas could have some theoretical excess increased lifetime risk for developing cancer. Cancer risk estimates for this area range from 8.6×10^{-7} (assuming 100% bioavailability, ingestion of 50 mg/day of the maximum soil arsenic concentration at residential day care facilities of 13.2 mg/kg one day per week for 30 years) to 7.8×10^{-5} (assuming 100% bioavailability, ingestion of 100 mg/day of the maximum soil arsenic concentration at city property of 85.4 mg/kg everyday for 30 years) (Tables 11-14). These estimates indicate that chronic ingestion of soil from these areas would not be likely to significantly affect the risk of developing cancer.

Public Health Implications of Exposure to Arsenic

While it is unlikely that any specific health outcome for any one individual could be attributed to exposure to arsenic, based on these data and under some conditions, the concentrations of arsenic in the soil from this area could be considered unacceptable with respect to noncancer health effects. There is considerable controversy about assessing potential risks associated with exposure to arsenic. The RfD and CSF are based on human ecological studies that have recognized uncertainties with respect to the assignation of exposure. Such studies find it difficult to avoid errors in assigning people to specific exposure groups.

The RfD and the CSF are based on studies which involved exposure to arsenic in drinking water. The ability of the body to absorb arsenic in water likely is higher than the ability of the body to absorb arsenic in soil. In this analysis, it was assumed that the relative bioavailability of arsenic in the soil was 100%. Studies conducted for EPA at various Superfund sites have found the bioavailability of the arsenic in the soil to be less than 100%. Assuming 100% absorption is conservative with respect to protecting public health, and, to some unknown degree, over estimates risk.

Recently, EPA contracted with the College of Veterinary Medicine at the University of Missouri, Columbia (CVMUM) to assess the relative bioavailability of arsenic in soil from a site in El Paso, Texas. Using a juvenile swine model CVMUM reported the relative bioavailability of arsenic in the soil from that area to be 40% [12]. The analysis in this report suggests that the arsenic measured in the soil at four residences and two commercial day care facilities could pose a public health hazard; although this is based on the assumption that the arsenic in the soil is 100% bioavailable. The true bioavailability of the arsenic in the soil likely is less than 100%; thus, determining the true bioavailability would further refine the public health significance of the arsenic in the soil.

The mechanisms by which arsenic causes cancer are not known; however, arsenic is not believed to act directly with DNA. Since the studies used to derive the CSF are based on exposure doses much higher than those likely to be encountered at this site, it is questionable whether it is appropriate to assume linearity for the dose-response assessment for arsenic at low doses. The actual dose-response curve at low doses may be sublinear which would mean that the risk estimates in this consultation overestimate the actual risks.

Qualitatively, the cancer risk estimates derived for potential exposures at this site range from a no apparent increased lifetime risk to an insignificant increased lifetime risk of developing cancer. Liver, bladder, kidney, and lung cancer all have been associated with exposure to arsenic. While there are certainly both cases of and deaths due to these types of cancer in Palestine, Texas, it would be impossible to determine if any one of these cancers was caused by exposure to arsenic. The incidence and mortality of these cancer types in Palestine are similar to what would be expected based on state rates [1].

Lead

Lead concentrations in the 53 surface soil (0–1 inches) samples ranged from 3.7 to 1,010 mg/kg (Tables 1-4). The highest concentration, the only level measured above the Texas Commission of Environmental Quality’s (TCEQ’s) recommended soil clean-up level of 500 mg/kg, was measured in a residential area; the next highest measured concentration was 192 mg/kg. The average concentrations of lead at commercial day care centers and residential day care facilities were 28.3 and 29.2 mg/kg, respectively. None of the levels exceeded the clean-up level recommended by TCEQ. Samples from city property averaged 41.3 mg/kg, with none of the samples exceeding the TCEQ clean-up level.

Non-carcinogenic Effects of Lead

Although no threshold level for adverse health effects has been established, evidence suggests that adverse effects occur at blood lead levels at least as low as 10 μg/dL. The Centers for Disease Control and Prevention (CDC) has determined that a blood lead level greater than or equal to 10 μg/dL in children indicates excessive lead absorption and constitutes the grounds for intervention. The 10 μg/dL level is based on observations of enzymatic abnormalities in the red blood cells at blood lead levels below 25 μg/dL and observations of neurologic and cognitive dysfunction in children with blood lead levels between 10 and 15μg/dL [13-14].

In general, soil lead will have the greatest impact on the blood lead levels of preschool age children. These children are more likely to play in dirt and to place their hands and other contaminated objects in their mouths. They are better at absorbing lead through the gastrointestinal tract than adults, and they are more likely to exhibit the types of nutritional deficiencies that facilitate the absorption of lead. The predicted 95th percentile blood lead level for children that is associated with a soil lead concentration of between 400 to 500 mg/kg is approximately 10 μg/dL. In other words, a child regularly exposed to soil lead levels greater than 400 to 500 mg/kg should have no more than a 5% chance of having a blood lead level greater than 10 μg/dL as a result of that exposure.

Carcinogenic Effects of Lead

Lead and lead compounds have been classified by the National Toxicology Program as reasonably anticipated to be human carcinogens [15]. This classification is based on sufficient information from animal studies and limited information from studies in humans. Lead has been associated with an increased risk of lung, stomach, and bladder cancer in humans; however, limitations of these studies included poor exposure assessments and failure to control confounding factors (for example smoking and diet). In rats and mice, exposure to lead has been shown to cause cancer. Kidney tumors were the most common health effect in these animals. Additionally, exposure to lead compounds in rodents has been shown to increase the incidence or accelerate the appearance of kidney tumors induced by other carcinogens [15].

Public Health Implications of Exposure to Lead

In the absence of site specific information regarding the bioavailability of lead in the soil and other potential sources of exposure to lead, in Texas, a soil lead level greater than 500 mg/kg, in a residential yard, generally is regarded as requiring remediation. This is based on the increased probability that a child regularly exposed to soil at this level could have an elevated blood lead level as defined by the CDC. In this analysis, only one sample exceeded this action level and the sample was obtained from a residential area. Assuming that the concentrations of lead found in these soil samples are representative of the concentrations to which a person could be exposed, it is not likely that children will be exposed to lead concentrations high enough to result in elevated blood lead levels. Therefore, with the exception of the one residential yard, the concentrations of lead found in the soil do not pose a public health hazard as they are not likely to result in increases in children's blood lead levels.

Vanadium

ATSDR has developed an intermediate oral MRL for vanadium of 0.003 mg/kg/day derived from a NOAEL equivalent of 0.3 mg/kg/day of vanadium [16]. Based on a 15 kilogram child consuming 200 mg of the contaminated soil per day and a 70 kilogram adult consuming 100 mg of the contaminated soil per day, this translates to intermediate non-cancer screening values of 235 mg/kg for a child and 2,190 mg/kg for an adult.

Vanadium concentrations in surface soil samples collected from residential areas averaged 75.6 mg/kg, and ranged from 34 to 127 mg/kg. On city property, levels ranged from 23.8 to 328 mg/kg, with an average of 104.4 mg/kg. Vanadium in soil from child care facilities ranged from 3.2 to 58.3 mg/kg at commercial day care centers (average = 26.4 mg/kg) and from 18.7 to 29.2 mg/kg at residential day care facilities, with an average of 24.8 mg/kg (Tables 1-4).

None of the seven samples collected from residential yards exceeded either the child or adult soil screening values. Although the child screening value was exceeded in three samples obtained from city property, using the maximum reported concentration found in the park (a conservative assumption) a 15 kg child ingesting 200 mg of soil per day from the park, 3 days per week, and 25 weeks per year would be exposed to an average dose well below the RfD (Tables 15-16). None of the samples collected from commercial or residential day care facilities exceeded the screening values.

Short-Term or Sporadic Pica Behavior

To explore the potential public health significance of acute exposure to vanadium due to pica behavior at this site, the scenario of a 15 kg child sporadically ingesting 5,000 mg of soil per day is considered. At a soil vanadium concentration of 328 mg/kg (maximum vanadium concentration found on city property) and a bioavailability factor of 100%, the daily dose of absorbed vanadium during the pica events could be 0.109 mg/kg/day – below the NOAEL for vanadium (0.3 mg/kg/day). Similarly, estimated exposure doses due to pica behavior at child care facilities and in residential areas was below the NOAEL.

Carcinogenic Effects of Exposure to Vanadium

No human studies are available on the carcinogenicity of vanadium. However, no increase in tumor frequency was noted in rats and mice chronically exposed to 0.5 to 4.1 mg-vanadium/kg-body weight as vanadyl sulfate in drinking water [17]. Currently, vanadium is not classified as a human carcinogen.

Public Health Implications of Exposure to Vanadium

Using the maximum reported concentration found in the park (a conservative assumption) a 15 kg child ingesting 200 mg of soil per day from the park, 3 days per week, and 25 weeks per year would be exposed to an average dose well below the RfD. Determining the public health implications of vanadium in soil is difficult. The toxic effects of vanadium are greater when vanadium is inhaled as compared to when it is taken orally [16]. Protein and other trace elements in the diet may have an affect on its toxicity and the toxic effects also may vary by species. Humans who have been exposed to relatively large doses for up to five months only reported minor complaints at the higher doses; whereas, in animals numerous effects such as weight loss, dehydration, depressed growth, cardiac irregularities, and loss of renal function have been reported [16]. Whether vanadium is essential to the diet is controversial. There is in vivo evidence that vanadium may be needed for normal iodine and/or thyroid function and other evidence that it may have some effect on glucose metabolism. Although a variety of inconsistent deficiency symptoms have been reported in animals, no specific function for vanadium has been identified for humans [16]. Based on available information the vanadium in the soil poses no apparent public health hazard.

Conclusions

In some instances, human exposure to contaminated soil may be occurring currently, and may have occurred in the past. Based on the conservative assumptions used in this consultation, these exposures are not expected to result in adverse health effects. Therefore, we have concluded that the site poses no apparent public health hazard; however, there are selected residences and daycare facilities that deserve further attention.

Recommendations

1. The four residences and two day care centers with arsenic levels above the screening values and the one residence with the elevated soil lead level should be reevaluated. Any children living in the household with the elevated soil lead level should have their blood lead levels determined. As a general precaution, all children below 6 years of age should have their blood tested for lead content.
2. Provide education on ways that residents can reduce their exposure to elevated levels of contaminants.

Public Health Action Plan

Actions Completed

1. Residents were notified by EPA of the soil test results for their individual properties.
2. Soil samples at several childcare facilities were collected by EPA.
3. Texas DSHS Environmental and Injury Epidemiology and Toxicology Branch (EIET) provided local physicians with educational material regarding environmental exposure and recommended childhood blood lead testing according to CDC guidelines.
4. Texas DSHS EIET Branch evaluated additional soil sampling data from day care and other childcare facilities.

Actions Planned

1. Texas DSHS Cancer Epidemiology and Surveillance Branch will update the analysis for zip code 75801, Palestine, Texas when the 2001 incidence data for the area are considered more than 90% complete.
2. Texas DSHS EIET Branch will provide education to residents and child care facilities on ways to reduce exposure to contaminants in areas in where elevated levels of contaminants in the soil are found.

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Certification

This Palestine Day Care public health consultation was prepared by the Texas Department of State Health Services (DSHS) 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 public health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, CAT, SPAB, DHAC, ATSDR

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

Team Lead, CAT, SPAB, DHAC, ATSDR

Appendices

Appendix A: Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CSF	Cancer Slope Factor
CVMUM	College of Veterinary Medicine at the University of Missouri
DSHS	Texas Department of State Health Services
EIET	Environmental and Injury Epidemiology and Toxicology
EPA	Environmental Protection Agency
kg	kilogram
LOAEL	Lowest Observable Adverse Effects Level
mg	milligram
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
µg/dL	microgram per deciliter
µg/kg/day	microgram per kilogram per day
MRL	Minimal Risk Level
NOAEL	No Observable Adverse Effects Level
QA/QC	Quality Assurance/Quality Control
RfD	Reference Dose

Appendix B: Tables of Exposure Estimates and Related Information

Table 1. City property soil samples (0-1 in, 33 samples).

	Arsenic	Lead	Vanadium
Concentration range (mg/kg)	4.3-85.4	9-111	23.8-328
Number of samples (%) exceeding screening values for children	24 (73%)	0	3 (9%)

Table 2. Residential soil samples (0-1 in, 7 samples).

	Arsenic	Lead	Vanadium
Concentration range (mg/kg)	10.1-47.8	50.9-1010	34-127
Number of samples (%) exceeding screening values for children	4 (57%)	1 (14%)	0

Table 3. Day Care soil samples (0-1 in, 10 samples).

	Arsenic	Lead	Vanadium
Concentration range (mg/kg)	1.5-39.9	3.7-96.1	3.2-58.3
Number of samples (%) exceeding screening values for children	2 (20%)	0	0

Table 4. Residential Day Care soil samples (0-1 in, 3 samples).

	Arsenic	Lead	Vanadium
Concentration range (mg/kg)	10.5-13.2	10.1-54.7	18.7-29.2
Number of samples (%) exceeding screening values for children	0	0	0

Table 5. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of arsenic in residential areas (47.8 mg/kg, assumes 100% bioavailability) throughout the year (52 weeks). Bold numbers represent exposure doses that exceed the arsenic reference dose (0.3 µg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for arsenic (0.8 µg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (µg/kg/day)						
100	0.045	0.091	0.136	0.182	0.227	0.272	**0.319**
150	0.068	0.136	0.204	0.272	**0.340**	**0.409**	**0.478**
200	0.091	0.182	0.272	**0.363**	**0.454**	**0.545**	**0.637**
250	0.113	0.227	**0.340**	**0.454**	**0.567**	**0.681**	**0.797**
300	0.136	0.272	**0.409**	**0.545**	**0.681**	**0.817**	**0.956**

Table 6. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of arsenic in residential areas (47.8 mg/kg, assumes 100% bioavailability) for 25 weeks out of the year. Bold numbers represent exposure doses that exceed the arsenic reference dose (0.3 µg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for arsenic (0.8 µg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (µg/kg/day)						
100	0.022	0.044	0.065	0.087	0.109	0.131	0.153
150	0.033	0.065	0.098	0.131	0.164	0.196	0.229
200	0.044	0.087	0.131	0.175	0.218	0.262	**0.306**
250	0.055	0.109	0.164	0.218	0.273	**0.327**	**0.382**
300	0.065	0.131	0.196	0.262	**0.327**	**0.393**	**0.458**

Table 7. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of arsenic on city property (85.4 mg/kg, assumes 100% bioavailability) throughout the year (52 weeks). Bold numbers represent exposure doses that exceed the arsenic reference dose (0.3 µg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for arsenic (0.8 µg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (µg/kg/day)						
100	0.081	0.162	0.243	**0.324**	**0.406**	**0.487**	**0.569**
150	0.122	0.243	**0.365**	**0.487**	**0.608**	**0.730**	**0.854**
200	0.162	**0.324**	**0.487**	**0.649**	**0.811**	**0.973**	**1.139**
250	0.203	**0.406**	**0.608**	**0.811**	**1.014**	**1.217**	**1.423**
300	0.243	**0.487**	**0.730**	**0.973**	**1.217**	**1.460**	**1.708**

Table 8. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of arsenic on city property (85.4 mg/kg, assumes 100% bioavailability) for 25 weeks out of the year. Bold numbers represent exposure doses that exceed the arsenic reference dose (0.3 µg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for arsenic (0.8 µg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (µg/kg/day)						
100	0.039	0.078	0.117	0.156	0.195	0.234	0.273
150	0.058	0.117	0.175	0.234	0.292	**0.351**	**0.409**
200	0.078	0.156	0.234	**0.312**	**0.390**	**0.468**	**0.546**
250	0.097	0.195	0.292	**0.390**	**0.487**	**0.585**	**0.682**
300	0.117	0.234	**0.351**	**0.468**	**0.585**	**0.702**	**0.819**

Table 9. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of arsenic at commercial day care centers (39.9 mg/kg, assumes 100% bioavailability) throughout the year (52 weeks). Bold numbers represent exposure doses that exceed the arsenic reference dose (0.3 µg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for arsenic (0.8 µg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (µg/kg/day)						
100	0.038	0.076	0.114	0.152	0.189	0.227	0.266
150	0.057	0.114	0.171	0.227	0.284	**0.341**	**0.399**
200	0.076	0.152	0.227	**0.303**	**0.379**	**0.455**	**0.532**
250	0.095	0.189	0.284	**0.379**	**0.474**	**0.568**	**0.665**
300	0.114	0.227	**0.341**	**0.455**	**0.568**	**0.682**	**0.798**

Table 10. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of arsenic at commercial day care centers (39.9 mg/kg, assumes 100% bioavailability) for 25 weeks out of the year. Bold numbers represent exposure doses that exceed the arsenic reference dose (0.3 µg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for arsenic (0.8 µg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (µg/kg/day)						
100	0.018	0.036	0.055	0.073	0.091	0.109	0.128
150	0.027	0.055	0.082	0.109	0.137	0.164	0.191
200	0.036	0.073	0.109	0.146	0.182	0.219	0.255
250	0.046	0.091	0.137	0.182	0.228	0.273	**0.319**
300	0.055	0.109	0.164	0.219	0.273	**0.328**	**0.383**

Table 11. Estimated lifetime cancer risk estimates for arsenic. (Maximum reported concentration of arsenic on city property, 85.4 mg/kg, assumes 100% bioavailability).

	Days per Week of Exposure						
	1	2	3	4	5	6	7
Soil Ingestion Rate (mg/day)	Excess Lifetime Cancer Risk Estimates						
50	5.6E-06	1.1E-05	1.7E-05	2.2E-05	2.8E-05	3.4E-05	3.9E-05
75	8.4E-06	1.7E-05	2.5E-05	3.4E-05	4.2E-05	5.0E-05	5.9E-05
100	1.1E-05	2.2E-05	3.4E-05	4.5E-05	5.6E-05	6.7E-05	7.8E-05

Table 12. Estimated lifetime cancer risk estimates for arsenic. (Maximum reported concentration of arsenic in residential areas, 47.8 mg/kg, assumes 100% bioavailability).

	Days per Week of Exposure						
	1	2	3	4	5	6	7
Soil Ingestion Rate (mg/day)	Excess Lifetime Cancer Risk Estimates						
50	3.1E-06	6.3E-06	9.4E-06	1.3E-05	1.6E-05	1.9E-05	2.2E-05
75	4.7E-06	9.4E-06	1.4E-05	1.9E-05	2.3E-05	2.8E-05	3.3E-05
100	6.3E-06	1.3E-05	1.9E-05	2.5E-05	3.1E-05	3.8E-05	4.4E-05

Table 13. Estimated lifetime cancer risk estimates for arsenic. (Maximum reported concentration of arsenic at day care centers, 39.9 mg/kg, assumes 100% bioavailability).

	Days per Week of Exposure						
	1	2	3	4	5	6	7
Soil Ingestion Rate (mg/day)	Excess Lifetime Cancer Risk Estimates						
50	2.6E-06	5.2E-06	7.8E-06	1.0E-05	1.3E-05	1.6E-05	1.8E-05
75	3.9E-06	7.8E-06	1.2E-05	1.6E-05	2.0E-05	2.3E-05	2.7E-05
100	5.2E-06	1.0E-05	1.6E-05	2.1E-05	2.6E-05	3.1E-05	3.7E-05

Table 14. Estimated lifetime cancer risk estimates for arsenic. (Maximum reported concentration of arsenic at residential day care facilities, 13.2 mg/kg, assumes 100% bioavailability).

	Days per Week of Exposure						
	1	2	3	4	5	6	7
Soil Ingestion Rate (mg/day)	Excess Lifetime Cancer Risk Estimates						
50	8.6E-07	1.7E-06	2.6E-06	3.5E-06	4.3E-06	5.2E-06	6.1E-06
75	1.3E-06	2.6E-06	3.9E-06	5.2E-06	6.5E-06	7.8E-06	9.1E-06
100	1.7E-06	3.5E-06	5.2E-06	6.9E-06	8.6E-06	1.0E-05	1.2E-05

Table 15. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of vanadium on city property (328 mg/kg, assumes 100% bioavailability) throughout the year (52 weeks). Bold numbers represent exposures that exceed the vanadium MRL (0.003 mg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for vanadium (0.3 mg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (mg/kg/day)						
100	0.00031	0.00062	0.00093	0.00125	0.00156	0.00187	0.00219
150	0.00047	0.00093	0.00140	0.00187	0.00234	0.00280	**0.00328**
200	0.00062	0.00125	0.00187	0.00249	**0.00312**	**0.00374**	**0.00437**
250	0.00078	0.00156	0.00234	**0.00312**	**0.00389**	**0.00467**	**0.00547**
300	0.00093	0.00187	0.00280	**0.00374**	**0.00467**	**0.00561**	**0.00656**

Table 16. Estimated exposure doses for various exposure scenarios for children exposed to the maximum reported concentration of vanadium on city property (328 mg/kg, assumes 100% bioavailability) for 25 weeks out of the year. Bold numbers represent exposures that exceed the vanadium MRL (0.003 mg/kg/day) and shaded areas represent exposure doses that exceed the NOAEL for vanadium (0.3 mg/kg/day).

	Days per week of exposure at MAXIMUM reported concentration						
	1	2	3	4	5	6	7
soil ingestion rate (mg/day)	Exposure Dose (mg/kg/day)						
100	0.00015	0.00030	0.00045	0.00060	0.00075	0.00090	0.00105
150	0.00022	0.00045	0.00067	0.00090	0.00112	0.00135	0.00157
200	0.00030	0.00060	0.00090	0.00120	0.00150	0.00180	0.00210
250	0.00037	0.00075	0.00112	0.00150	0.00187	0.00225	0.00262
300	0.00045	0.00090	0.00135	0.00180	0.00225	0.00270	**0.00315**