Health Consultation

FIRST QUALITY CYLINDERS,
COMMUNITY HEALTH CONCERN

SAN ANTONIO, BEXAR COUNTY, TEXAS

EPA FACILITY ID: TXD982557217

SEPTEMBER 26, 2006

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.

HEALTH CONSULTATION

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Prepared by:

Texas Department of State Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Purpose and Statement of Issues

On April 19, 2006, the Texas Commission on Environmental Quality (TCEQ) asked the Texas Department of State Health Services (DSHS) to assist addressing health concerns from a citizen living near the First Quality Cylinders State Superfund Site. Specifically, TCEQ asked DSHS to evaluate the citizen's health concerns with respect to the soil and groundwater sampling results. (Note: Appendix A lists abbreviations and acronyms used in this report).

Background

Site Description and History

The First Quality Cylinders State Superfund Site (also known as Quality Cylinders, Incorporated; International Aircraft Cylinders, Incorporated; and Aero Chrome Services, Incorporated) is located on 1.3 acres [1] in northwest-central San Antonio, Texas [2]. The topographic high for the site is on the western side in the vicinity of a warehouse where a chromium plating process was conducted [2]. There is an approximately 25-foot elevation decline from the warehouse area to the downgradient property boundary. A shallow groundwater recovery system with a French drain, three recovery wells, and a pump system with a 6,000 gallon above-ground storage tank are contained within a slurry wall. The slurry wall generally coincides with the property line surrounding the site and isolates the shallow water bearing zone [2]. The remaining area has been paved with asphalt [1]. Off-site, local groundwater enters the site from the northwest, trends east under the site, and empties into San Pedro Creek [2]. Groundwater is not used for household purposes and all drinking water in the area comes from the City of San Antonio [2].

The site used a chromium plating process to rebuild aircraft cylinders from 1986 until it was abandoned in January 1994 [2]. In April 1988, workers renovating a plating line discovered a subsurface leakage of chromium plating solution. Two months later, a "spring" was discovered along the northeast side of the plating facility, and a French drain system was installed to collect the groundwater [2]. Approximately 200 gallons of groundwater were recovered each week from the French drain. Several months later, the water from the "spring" began to display a yellowish hue. In September 1989, a sample of this groundwater was analyzed and chromium was found at 887 mg/L [2].

In January 1992, TCEQ issued a Notice of Violation Letter to the site owner for permit violations, for the disposal of hazardous substances on-site, and for the unauthorized discharges of chromium waste waters to the public streets and potentially to nearby San Pedro Creek [2]. In March 1993, approximately 200 gallons of concentrated chromium plating wastewater was discharged at the site when a hose connection failed during the transfer of the wastewater to a temporary storage tank. Stormwater runoff samples were collected two months later due to concerns that contaminated soil from this spill was never removed from the site. Groundwater samples from monitoring wells placed around the site had total chromium levels of 13 mg/L to 79 mg/L. Additional groundwater samples collected from monitoring wells in September 1993 had hexavalent chromium levels of 75 mg/L to 80 mg/L [2]. In 1996, a slurry wall was dug completely surrounding the site. The slurry wall acts as a barrier and prevents the lateral flow of groundwater and water-borne contaminants. The French drain system is parallel to and approximately 10 feet inside the slurry wall [2].

In September 1997, TCEQ initiated immediate removal actions to dispose of on-site wastes and to repair and provide operations and maintenance of the on-site shallow groundwater recovery system for two years [2]. The Hazard Ranking System (HRS) Documentation Record was completed in August 1999 [3]. In the HRS, it was determined that the release of hazardous substances to the groundwater pathway was the major concern for the site, and that hazardous substances had been found in the subsurface soil and shallow groundwater beneath the site [3]. The site was proposed for listing on the State Superfund registry in November 1999 [1].

Access to the site is limited by a fence surrounding the property and prohibited, as stated on “no trespassing” signs. Nine industrial properties are located adjacent to the site. San Pedro Creek is approximately 300 feet southeast of the site [2].

A residential area is located within ½ mile northeast and upgradient of the site. In the same area, several houses are being built by the Unitarian Universalist Housing Assistance Corporation (UUHAC). In October 2000, the UUHAC submitted a Brownfields application to TCEQ [4]. Two soil samples collected from the housing site had DDE (1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene) and DDT (1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane) above health-based values; however, further sampling in the area indicated no compounds at levels above screening values [4].

Health Concerns

A concerned resident of the areas northeast of the First Quality Cylinders site claims the onset of his health problems coincided with the beginning of the UUHAC housing construction in the Spring of 2006. His illness began with vision changes followed by a sinus infection and fever. He was hospitalized for 10 days with new onset seizure disorder. Other health effects expressed by the citizen included chemical burns, skin lesions, skin peeling, vomiting, muscle aches, and renal failure. He also stated that his daughter (14 years old) was having the same symptoms as he had, delayed by about a month in time. On March 29, 2006, the citizen and his daughter moved out of their home because he believed they were being exposed to chromium and other metals from the First Quality Cylinders Site and pesticides from the UUHAC construction site. Blood and urine samples from the citizen were within the acceptable ranges for lead, arsenic, mercury, and chromium. As of June 22, 2006, they had not returned to their house, but were still experiencing adverse health effects.

Environmental Sampling

As a part of the investigation into the citizen’s health concern, TCEQ collected 32 surface soil samples from the citizen’s residence and the housing construction area in May 2006 [5,6]. Of these, 26 surface soil samples were collected from the front, side, and back yards of the citizen’s residence. Half of these samples were collected at 0-1 inch and the other half from 3-6 inches deep. The remaining 6 surface soil samples were collected from the UUHAC construction area at depths of 1-3 inches. These 32 soil samples were analyzed for total chromium, chromium(VI), and lead. An additional 9 surface soil samples were collected and analyzed for DDT, DDE, and DDD (1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane). Of these, 3 samples were collected from the citizen's residence (0-1 inches) and 6 were collected from the housing construction area (1-3 inches). Ten (10) groundwater samples also were collected from First Quality Cylinders off-site monitoring wells and analyzed for total chromium, chromium(VI), and lead [5,6].

For this consultation, DSHS relied on the information provided in the referenced documents and assumed adequate quality assurance/quality control (QA/QC) procedures were followed with regard to data collection, chain-of-custody, laboratory procedures, and data reporting.

Discussion

The presence of chemical contaminants in the environment does not always result in exposure to or contact with the chemicals. Chemicals have the potential to cause adverse health effects only when people actually come into contact with them through a complete exposure pathway. A complete exposure pathway is one in which all five elements in the pathway (a source of contamination, transport through an environmental medium, a point of exposure, a route through which the contaminant can enter the body, and a population) are present and exposure has occurred, is occurring, or will occur in the future. It is not likely that children or adults will have contact with contaminants present at the First Quality Cylinders Site because access to the site is limited by fencing and prohibited as stated on no trespassing signs. Prior to the site being fenced, trespassers used the warehouse as a shelter and evidence of that trespassing (clothing, food wrappers, and bottles) still exists. Currently, there is no evidence to suggest trespassers are still accessing the site.

To assess the potential health risks that may be associated with the contaminants found in the residential soil and groundwater, we compared each contaminant detected with its health-based assessment comparison (HAC) value for non-cancer and cancer endpoints. These screening values are guidelines that specify levels of chemicals in specific environmental media (soil, air, and water) that are considered safe for human contact with respect to identified human endpoints. Non-cancer screening values are generally based on The Agency for Toxic Substances and Disease Registry's (ATSDR's) minimal risk levels (MRLs)[1] and The Environmental Protection Agency's (EPA's) reference doses (RfDs)[2]. Both of these are based on the assumption that there is an identifiable exposure threshold (both for the individual and for populations) below which there are no observable adverse effects. Thus, MRLs and RfDs are estimates of daily exposures to contaminants that are unlikely to cause adverse non-cancer health

[1] An MRL is a contaminant specific exposure dose below those which might cause adverse health effects in the people most sensitive to such chemical-induced effects. MRLs generally are based on the most sensitive chemical-induced end point considered to be of relevance to humans.

[2] An RfD is an estimate (with a level of uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive groups) that is likely to be without appreciable risk of deleterious effects during a lifetime.

effects even if exposure occurs for a lifetime. The cancer risk evaluation guides (CREG)[3] used in this consultation are based on EPA's chemical-specific cancer slope factors (CSFs)[4].

There has been no MRL or RfD established for lead; however, the EPA has set an action level of 400 mg/kg in soils and 15 µg/L in drinking water. These action levels for lead were used in place of standard screening values [7].

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.

We reviewed and integrated relevant toxicological information with plausible exposure scenarios, and used a weight-of-evidence approach to determine the public health significance of the contaminants that exceeded their respective screening values.

Public Health Implications

Lead was the only contaminant that exceeded its screening value; the EPA action levels were exceeded in soil and groundwater samples. Chromium, DDT, DDE, and DDD levels did not exceed any of the screening levels; however, a review of their toxicology is included in Appendix C since they were the contaminants with which the citizen was concerned.

Lead

Although lead is a naturally occurring element in the environment, most of the high levels of lead in the environment come from human activities [7]. Prior to the ban on the use of lead in gasoline in 1996, most of the lead released into the environment in the United States was from car exhaust. Following the ban, the amount of lead released into the air has drastically decreased [7]. Other sources of lead in the environment include burning fuel (coal or oil), industrial processes, and burning solid wastes. Lead in soils is the result of houses being painted with paint containing lead and from the settling of lead in the air from automotive exhaust when gasoline contained lead and from former smelters and other industrial activities. Elevated levels of lead are typically measured near older houses and roadways [7]. Landfills may also contain waste from lead ore mining, ammunition manufacturing, or other industrial activities such as battery production. Small particles of lead can remain in the atmosphere and travel thousands of miles. Particles that settle out onto soil stick to soil particles and may enter surface water through runoff

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[3] A CREG is an estimate of excess lifetime risk of one cancer in one million (1×10^{-6}) exposed people and an exposure period of 70 years.
[4] A CSF is the upper 95th percentile confidence limit of the slope of the dose response curve expressed as $(mg/kg/day)^{-1}$.

or remain stuck to soil for many years. Lead typically does not move into groundwater unless the water is acidic [7].

People may be exposed to lead by breathing air, drinking water, eating foods, or swallowing or touching dust or soil that contains lead [7]. Occupational exposure to lead generally occurs through inhalation of lead particles. People who work in lead smelting and refining industries, brass/bronze foundries, rubber products and plastics industries, soldering, steel welding and cutting operations, battery manufacturing plants, and lead compound manufacturing industries may be exposed to lead [7]. Other potential occupational exposures include construction workers and people who work at municipal waste incinerators, pottery and ceramics industries, radiator repair shops, and other industries that use lead solder. Additionally, families of workers may be exposed to lead when workers bring home lead dust on their work clothes [7].

Lead (in dust or chemicals) that is inhaled gets into the lungs and then quickly goes to other parts of the body via the blood [7]. Most of the lead that enters the body is ingested, but very little of the amount you swallow enters the blood and other parts of the body. Very little (6%) of lead ingested following a meal is absorbed by the body in adults, but this value increases to 60-80% in adults that had not eaten for a day [7]. A larger amount of lead that is ingested will enter the blood in children than adults. Once in the body, lead travels to soft tissues such as the liver, kidneys, lungs, brain, spleen, muscles, and heart. Several weeks later, it moves into bones and teeth. Lead that is not stored in the bones leaves the body in urine or feces [7]. In adults, most (99%) of lead that is taken into the body is eliminated within a few weeks. In children, however, only about 32% of the lead is eliminated. Accumulation of lead in body tissues (notably bone) occurs when the source of lead exposure is not removed [7].

The target organ for lead toxicity is the nervous system [7]. In adults, occupational exposure to lead has resulted in decreased performance on tests that measure functions of the nervous system. Weakness in fingers, wrists, and ankles has also been noted. Children are more vulnerable and more sensitive to lead poisoning than are adults [7]. Adverse effects of lead vary depending upon how much lead was ingested. Children whom ingest large amounts of lead (such as paint chips containing lead-based paint) may develop blood anemia, kidney damage, colic, muscle weakness, and brain damage which can kill the child [7]. Ingestion of smaller amounts of lead may result in much less severe effects on blood and brain function, and the child is likely to recover if the source of lead exposure is removed. Exposure to lead in the womb, infancy, or early childhood may result in lower birth weight, slow mental development, and lower intelligence later in childhood [7].

Because of the potential for lead to affect the mental and physical growth of children, the Centers for Disease Control and Prevention (CDC) has set a blood lead level of concern at 10 µg/dL [7]. Although blood lead levels have been decreasing since the ban on the use of lead in paints and gasoline, about 900,000 children (1 to 5 years old) in the United States have blood lead levels that exceed the CDC's level of concern [7].

Lead was detected in all soil and groundwater samples, and 8 soil samples and 2 groundwater samples exceeded the EPA's respective action levels for lead in soil and in drinking water

(Tables 1 and 2). Groundwater is not used for drinking water or other household purposes in this area, thus it is not likely that residents would come into contact with lead in the groundwater.

ATSDR has established guidelines to predict estimated blood lead increases due to exposure to lead in the environment [7]. These guidelines were used to assess the potential health effects associated with lead in soil. Estimated blood lead increases associated with soil ingestion are included in Table 3. Using the average concentration of lead in the soil (314 mg/kg), estimated blood lead increases are minimal (≤ 2 µg/dL). Based on the maximum concentration of lead in the soil (1,400 mg/kg), daily incidental ingestion of soil with elevated lead may result in that child's blood lead level exceeding the CDC guideline of 10 µg/dL. The highest concentrations of lead in the soil were found in the resident's front yard. The front yard has some vegetative cover which serves to reduce exposure to bare soil. Additionally, the available play area for children is limited, further reducing the potential for exposure to high concentrations of lead. Soil samples collected on the side of the house were either below the action level or just slightly elevated (less than 500 mg/kg). Soil samples collected in the backyard were all below the action level for lead. Therefore, since areas with elevated lead are not likely to be areas where children play, it is not likely that children would come into contact with levels of lead in the soil that would result in adverse health effects.

Lead is not a contaminant associated with the First Quality Cylinders Superfund site or the UUHAC housing construction site. The most likely source of lead in the soil around the home is lead-based paint on the exterior of the home; however, paint chips from the house were not analyzed for this consultation. Generally, soil samples are not collected within 5 feet of the dripline of the house and 10 feet of roadways because of the potential for peeling lead-based paints and historical deposition of lead from leaded gasoline used in cars to influence lead concentrations in the soil near older homes and roadways. Due to limited area at the front and side of the house, soil samples were collected within 5 feet of the house and the road. This home was built prior to 1978 and may be painted with lead-based paint which is a potential source for the lead contamination in soil around the home. If this is true, soil close to the house in the backyard also may have higher concentrations of lead than what was observed in the samples collected from the backyard areas (at least 5 feet from the dripline of the house). The backyard area consists of mostly bare soils; thus, it is possible that children playing outside may be exposed to lead in the soil. However, the citizen stated that he and his adolescent daughter are rarely outside.

Health Concerns

Some of the health effects expressed by the citizen do coincide with health effects known to occur due to exposure to lead, chromium, and DDT. Access to the First Quality Cylinders Site is limited and it does not appear that contamination (namely chromium) has migrated off the site into residential areas, thus the likelihood of exposure to chromium is remote. There also does not appear to be DDT, DDE, or DDD contamination in the residential housing area. Soil concentrations of these pesticides were all below screening values, thus the likelihood of exposure to DDT and its breakdown products is also low. There was elevated lead in the soil surrounding the resident's home. Young children are more vulnerable and more sensitive to lead poisoning than are older children and adults, and adverse health effects associated with lead exposure in adults is typically due to an occupational exposure. The citizen has stated that he and his daughter are rarely outside, thus they are not likely to have exposure to lead in the soil frequent enough or long enough for adverse health effects to occur due to lead. Additionally, exposure to the average concentration of lead in the soil would not likely result in adverse health effects.

Child Health Considerations

In communities faced with air, water, or food contamination, children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. A child's lower body weight and higher intake rate result in a greater dose of hazardous substance per unit of body weight. Sufficient exposure levels during critical growth stages can sustain permanent damage to the developing body systems of children. Children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Children are not likely to be exposed to contaminants from the First Quality Cylinders Site because of its limited access to the public. There are a numerous physical hazards children could come into contact with if they were to trespass on the site; however, the likelihood of this occurring seems low because of the limited public access. There were several residential soil samples in which lead was elevated. Planting grass over bare soil can lower the contact children and pets may have with lead in the soil. Additionally, children should not be allowed to chew or mouth on surfaces that may be painted with lead-based paint and should wash their hands frequently, especially before eating. At the residence where lead samples were elevated, no children are known to play outside.

Conclusions

1. Total chromium, chromium(VI), DDT, DDE, and DDD were at levels below health-based screening values in soil samples collected from the citizen's residence and the UUHAC construction project. Total chromium and chromium(VI) in groundwater also were below screening values.
2. Soil samples from the UUHAC housing project contained levels of lead below the EPA action levels. Lead was elevated in soil samples collected from the citizen's residence and in groundwater collected from the off-site monitoring wells. Groundwater in the area is not used for household purposes, thus exposure to lead in the groundwater is not expected. Additionally, the citizen and his daughter spend little time outside in their yard, thus, exposure to lead in the soil is minimal. The most likely source of lead in the soil is lead-based paint used on the exterior of the house; however, paint chips from the house were not analyzed for this consultation.
3. Based upon the data presented in this consultation, there is no apparent public health hazard associated with exposure to contaminants from the First Quality Cylinders State Superfund Site or the UUHAC housing project. However, small children should not be allowed to play in areas where soil concentrations exceed the EPA action level for lead (i.e. the two front yard sampling locations).

Recommendations

Provide education to concerned citizens on ways to reduce their exposure to elevated levels of lead.

Public Health Action Plan

Actions Completed

1. Staff from DSHS and TCEQ talked with the concerned citizen about his health concerns.
2. The TCEQ sampled soil from the concerned citizen's residence and the nearby housing construction area and groundwater from off-site monitoring wells.
3. The TCEQ and DSHS independently evaluated results from the soil and groundwater sampling and chromium, lead, and DDT/DDD/DDE toxicology.
4. Educational material regarding lead toxicology and reducing exposure to lead was provided to the concerned citizen.

Actions Planned

1. The DSHS will continue to work with environmental agencies to address community concerns by providing educational materials to concerned citizens.
2. A copy of this document will be provided to the concerned citizen.

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8. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chromium. Atlanta: US Department of Health and Human Services. September 2000.

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Certification

This public health consultation on First Quality Cylinders, Community Health Concern in San Antonio, Bexar County, Texas was prepared by the Texas Department of State Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methods and procedures existing when the time the public health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

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

Team Lead, CAT, CAPEB, DHAC, ATSDR

Appendix A: Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CREG	Cancer Risk Evaluation Guide
CSF	Cancer Slope Factor
DDD	1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane
DDE	1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene
DDT	1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane
DSHS	Texas Department of State Health Services
EPA	Environmental Protection Agency
HAC	Health Assessment Comparison
HRS	Hazard Ranking System
mg	milligram
mg/kg	milligram per kilogram
mg/kg/day	milligrams per kilograms per day
mg/L	milligrams per liter
MRL	Minimal Risk Level
ND	Not Detected
QA/QC	Quality Assurance/Quality Control
RfD	Reference Dose
RMEG	Reference Dose Media Evaluation Guide
TCEQ	Texas Commission on Environmental Quality
µg	microgram
µg/dL	micrograms per deciliter
µg/L	microgram per liter
UUHAC	Unitarian Universalist Housing Assistance Corporation

Appendix B: Tables

Table 1. Concentrations of metals and pesticides in soil samples collected from the concerned citizen's residence and the UUHAC housing construction project [6].

Contaminant	Concentration Range (mg/kg)	# Detected/ # Samples Collected	# Samples that exceed HAC value	HAC value (mg/kg) [a]
Chromium (VI)	ND-7.72	2/32	0	200 (child RMEG)
Total Chromium	11.6-50.3	32/32	0	80,000 (child RMEG)
Total Lead	25.3-1,400	32/32	8	400 (EPA Action Level)
4,4'-DDD	ND	0/9	0	3 (CREG)
4,4'-DDE	ND-1.62	6/9	0	2 (CREG)
4,4'-DDT	ND-0.392	4/9	0	2 (CREG)

[a] Most conservative HAC value
RMEG – Reference Dose Media Evaluation Guide
ND – Not Detected

Table 2. Concentrations of metals in groundwater samples collected from off-site monitoring wells [6].

Contaminant	Concentration Range (µg/L)	# Detected/ # Samples Collected	# Samples that exceed HAC value	HAC value (µg/L) [a]
Chromium (VI)	ND	0/10	0	30 (child RMEG)
Total Chromium	ND-62.3	5/10	0	20,000 (child RMEG)
Total Lead	0.686-43	10/10	2	15 (EPA action level)

[a] Most conservative HAC value
RMEG – Reference Dose Media Evaluation Guide
ND – Not Detected

Table 3. Estimated blood lead increases (µg/dL) due to the incidental ingestion of soil over a year of exposure. The average (314 mg/kg) and maximum (1,400 mg/kg) concentrations of lead detected in soil samples were used to estimate blood lead increases.

	Child Estimated Blood Lead Increase		Adult Estimated Blood Lead Increase	
	Average	Maximum	Average	Maximum
1 day per week	0.3	1.3	0.1	0.4
2 days per week	0.6	2.7	0.2	0.8
3 days per week	0.9	4.1	0.3	1.2
4 days per week	1.2	5.4	0.4	1.6
5 days per week	1.5	6.8	0.4	2.0
6 days per week	1.8	8.1	0.5	2.4
7 days per week	2.1	9.5	0.6	2.8

Appendix C: Other Contaminants

Lead was the only contaminant that exceeded screening values and the toxicology of lead was discussed in the Public Health Implications section of this health consultation. Because the citizen expressed concerns about chromium, DDT, DDE, and DDD, the toxicology of these contaminants is discussed here.

Chromium

Chromium is a naturally occurring element that may exist in several forms including chromium(0), trivalent (chromium(III)), and hexavalent (chromium(VI)) [8]. Chromium(III) is naturally occurring in the environment and is an essential nutrient required by the body, and an intake of 50-200 µg of chromium(III) per day is recommended for adults to promote the action of insulin in body tissues so that sugar, protein, and fat can be used by the body. Because of this, chromium(III) compounds have been used as dietary supplements and are beneficial if taken in recommended dosages [8]. Chromium(VI) and chromium(0) are generally produced by industrial processes. Chromium compounds are produced by the chemical industry and used for chrome plating [8].

Chromium enters the environment as a result of natural processes and human activities [8]. Emissions from burning coal and oil, and steel production can increase chromium(III) levels in the air while stainless steel welding, chemical manufacturing, and the use of chromium(VI) can increase the level of chromium(VI) in the air [8]. Chromium(III) and chromium(VI) are discharged to waterways from electroplating facilities and leather tanning and textile industries. The disposal of chromium, chromium waste from industry, and coal ash from electric utilities results in increases in the levels of chromium(III) and chromium(VI) in soil [8].

Chromium in the air exists as fine dust particles that settle over land and water [8]. Some chromium may dissolve in water, but most binds to dirt and other particles in the water and settles to the water bottom. Chromium in soil attaches strongly to the soil and a very small amount will dissolve in water and move deeper through the soil to groundwater [8].

People come into contact with chromium by breathing air, drinking water, or eating food containing chromium, or through direct skin contact with chromium or chromium compounds [ζ]. Chromium(III) occurs naturally in many vegetables, fruits, meat, yeast, and grain and the most likely route of exposure to chromium(III) is by eating foods that contain chromium [8]. Occupational exposures result in people being exposed to higher-than-normal levels of chromium. Chromium(VI) is absorbed by the body more easily than chromium(III), but once inside the body, chromium(VI) is converted to chromium(III) [8].

Chromium particles that are inhaled and deposited in the upper part of the lungs are likely to be coughed up and swallowed [8]. Those that are deposited deeper in the lungs are likely to remain long enough for some of the chromium to pass through the lining of the lungs and enter the bloodstream. Once in the bloodstream, chromium is distributed to all parts of the body, passes through the kidney, and is eliminated in urine within a few days. Most chromium that is ingested leaves the body through feces within a few days and never enters the bloodstream [8].

In general, chromium(VI) is more toxic than chromium(III) [8]. Occupational exposure to chromium(VI) through inhalation results in irritation to the nose, such as runny nose, sneezing, itching, nosebleeds, ulcers, and holes in the nasal septum. High levels of chromium in the work place have caused asthma attacks in people who are allergic to chromium. Inhalation of chromium(III) dose not cause irritation to the nose or mouth in most people [8]. Ingestion of small amounts of chromium(VI) will not hurt most people; however, ingestion of larger amounts has caused stomach upsets and ulcers, convulsions, kidney and liver damage, and death. Skin ulcers have also resulted in workers handling liquids or solids containing chromium(VI) [8]. Exposure to chromium(0) is not currently believed to cause a serious health risk. Long-term exposure to chromium(VI) has been associated with lung cancer in workers exposed to levels in air that were 100 to 1,000 times higher than those found in the natural environment, and chromium(VI) is a known human carcinogen [8].

All soil and groundwater samples were below the detection limit, or, if detected, below the screening value for both chromium(VI) and total chromium (Table 1 and 2). Thus, it is not likely that adverse health effects will occur due to exposure to levels of these contaminants in the soil or groundwater.

DDT, DDE, and DDD

The pesticide DDT was widely used in the United States for insect control until it was banned in 1972 [9]. It was very effective in killing crop insects, as well as those pests that carry diseases such as malaria. The use of DDT is allowed in some countries for the control of malaria, but may only be used in the United States during a public health emergency. The breakdown products of DDT are DDE and DDD [9].

The presence of DDT, DDE, and DDD in the environment is a result of past use [9]. Before it was banned, DDT entered the air, water, and soil during its production and use. Today, DDT and its breakdown products are present at many waste sites, and releases from these sites might continue to contaminant the environment. Most DDT breaks down slowly into DDE and DDD, and these products may exist in soil for a long time, potentially for hundreds of years [9]. They stick strongly to soil, and therefore generally remain in the surface layers of soil. This allows them to be carried into surface waters in runoff, and they may evaporate from soil and water and be deposited on surface water or soil. This cycling allows DDT, DDE, and DDD to be carried long distances, and they have been found in areas (such as in the Artic and Antarctic regions) far from where they were used [9]. In surface water, DDT settles and binds to sediment. Very little (if any) of these contaminants will seep into the ground and get into groundwater. Animals (especially fish and marine mammals) accumulate DDT in their adipose tissues, and DDT levels may be thousands of times higher than in the water they live [9].

In the United States, people come into contact with DDT, DDE, and DDD mainly by eating foods containing small amounts of these compounds [9]. Plants take up these compounds from the soil, and humans and other animals are then exposed by eating these plants. Similarly, fish take up DDT from contaminated water and from ingesting sediment; humans and other animals who eat these fish can be exposed to DDT. In humans, these chemicals are stored in fatty tissues and leave the body very slowly [9]. Exposure to large amounts (grams) of DDT in food over a short time period affects the nervous system, including excitability, tremors, and seizures as well as sweating, headache, nausea, vomiting, and dizziness. Once exposure stops, these effects also stop. Small daily doses (up to 35 mg per day) for 18 months resulted in no adverse health effects [9]. Long-term exposure to small amounts (less than 20 mg per day) of DDT may result in some minor changes in the levels of liver enzymes in the body, while long-term exposure to moderate amounts (20-50 mg/kg/day) may affect the liver. Reproduction also may be affected with short-term exposure to DDT and its metabolites. It has been determined that DDT and its metabolites are carcinogens, and may cause liver cancer [9].

All soil samples were below the detection limit, or, if detected, below screening values for DDT, DDE, and DDD (Table 1), thus it is not likely that adverse health effects will occur from exposure to these contaminants in the soil. The maximum concentrations of DDT and DDE and the cancer slope factor for these contaminants were used to assess the risk of developing cancer. The lifetime excess risk of developing cancer due to DDT and DDE in the soil were 8×10^{-8} and 3×10^{-7}, respectively. Qualitatively, we would interpret this as no increased risk for developing cancer.