Letter Health Consultation

Evaluation of Chromium in Private Wells

WEST COUNTY ROAD 112
MIDLAND, MIDLAND COUNTY, TEXAS

Prepared by the
Texas Department of State Health Services

JUNE 3, 2009

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR Toll Free at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

LETTER HEALTH CONSULTATION

Evaluation of Chromium in Private Wells

WEST COUNTY ROAD 112
MIDLAND, MIDLAND COUNTY, TEXAS

Prepared By:

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

TEXAS DEPARTMENT OF STATE HEALTH SERVICES

1100 West 49th Street • Austin, Texas 78756
P.O. Box 149347 • Austin, Texas 78714-9347
1-888-963-7111 • www.dshs.state.tx.us
TDD: 1-800-735-2989

DAVID L. LAKEY, M.D.
COMMISSIONER

May 20, 2009

David W. Hastings
Special Assistant
Remediation Division
TCEQ
P.O. Box 13087
MC 225
Austin, TX 78711-3087

RE: Evaluation of Chromium in Private Wells
West County Road 112
Midland, Midland County, Texas

Dear Mr. Hastings:

On May 13, 2009, you asked the Texas Department of State Health Services (DSHS), under cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), to evaluate the potential health effects of hexavalent chromium identified in private wells in the County Road (CR) 112 community. The results of our review of the available private well data for the area are presented in this letter.

Background and Statement of Issues

On March 30, 2009, the Texas Commission on Environmental Quality (TCEQ) regional office was contacted by a member of the CR 112 community who was concerned about the yellowish color of the tap water from their private well. TCEQ sampled the well on April 8. Based on the analytical results, they installed a filtration system on April 14. As of May 14, 2009, TCEQ had sampled 50 private wells for chromium. Twenty-eight of those wells have hexavalent chromium at concentrations above the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 0.1 parts per million (ppm). The site investigation and discovery has just started in the area. The source of contamination is not known, and the groundwater contamination has not been delineated or fully characterized at this time. Additionally, well water is being further assessed to determine if chromium is the only contaminant of concern.

Based on the 2000 census, the census block associated with zip code 79706 consists of predominantly White (85.8%) residents, 31% of whom are Hispanic or Latino. Approximately 14% of the residents are below the poverty level [1].

Discussion

Environmental Sampling Data

DSHS reviewed the April-May 2009 private well sampling data for hexavalent chromium. Data ranged from below the method detection limit (0.005 ppm) to 5.41 ppm. The data were compared to the ATSDR Health Assessment Comparison (HAC) values. Further explanation of the HAC values is provided in the Appendices of this document. The average of available data (0.7 ppm) exceeded the MCL (0.1 ppm).

Pathways Analysis

Groundwater at the site is currently used for food preparation, bathing, and for commercial businesses purposes. At least one resident has used the water to fill a swimming pool. Most residents reportedly stopped drinking the well water when they noticed the change in color. Sampling data indicate that water from private wells have hexavalent chromium in excess of current drinking water standards.

Residents can be exposed to contaminants that enter the home in potable water via multiple pathways. These include direct ingestion of the water, inhalation of the contaminant due to volatilization (when the contaminant enters the air), and absorption of the contaminant through the skin during bathing or swimming. Thus, we would consider these all to be past completed exposure pathways. Currently, filtration systems on the private drinking wells have reduced contaminant concentrations to levels below analytical detection limits.

Toxicologic Evaluation

Chromium is a natural element that occurs in several different forms or valence states. The most common two forms are trivalent chromium [chromium(III) or Cr^{3+}] and hexavalent chromium [chromium(VI) or Cr^{6+}]. Trivalent chromium is required in small amounts for healthy human nutrition, but hexavalent chromium is considered toxic.

When released to the environment, chromium will settle out of air quickly and be deposited in soil or water. Once in soil or water, the form of chromium can change. The difference in the valence state can be caused by a reducing environment or organic content of soil and water.

When chromium is inhaled, it enters the body through the lungs and can remain in the lungs for several years. Ingested chromium can enter the body through the digestive tract, and small amounts of chromium can enter the body through the skin. Hexavalent chromium is changed to trivalent chromium in the body, and it is usually excreted in urine within a week [2].

Hexavalent chromium compounds are more harmful than trivalent chromium compounds. Ingestion of hexavalent chromium has resulted in stomach and small intestine effects in lab animals. Anemia has also been observed. Damage to sperm and the male reproductive system have been observed in animals exposed to hexavalent chromium through ingestion.

The Interagency for Research on Cancer (IARC) has determined that hexavalent chromium compounds are carcinogenic to humans, and the National Toxicology Program (NTP) has classified hexavalent chromium compounds to be known human carcinogens. Specifically, occupational exposure to inhaled hexavalent chromium has been linked to lung cancer in workers. Chromium is not currently classified as a human carcinogen through ingestion.

Ingestion

An exposure dose was estimated using the average and highest hexavalent chromium concentrations (0.7 ppm and 5.41 ppm) from the most recent data set. This average included estimated values and one-half the method detection limit for ND values (0.005 ppm). At the site, each well presents an individual exposure scenario that has changed over time as the concentration in the well changed and as people discontinued drinking the water when they noticed a change in color. The concentration at which residents stopped drinking the water is not known, but studies have shown that voluntary ingestion is unlikely above 1 to 2 ppm because the water changes color [3]. Based on this information and information that residents stopped drinking water once they noticed a change in color, 2 ppm represents a potential upper range of chromium exposure.

An exposure dose was estimated using the following default parameters: intake rate of water for adults, two liters of water per day (2 L/day); availability factor, 1; exposure frequency, 1 to reflect daily exposure; and adult body weight, 70 kg. The calculated exposure doses (0.02 mg/kg/day and 0.06 mg/kg/day) were above the proposed Minimal Risk Level (MRL) of 0.001 mg/kg/day [2].

The MRL is based on comparison of Lowest Observed Adverse Effects Level (LOAEL) values for the following critical effects(shown in parentheses):

- 0.38 mg/kg/day (microcytic, hypochromic anemia and nonneoplastic lesions of the liver, duodenum, mesenteric lymph node, and pancreas)
- 2.4 mg/kg/day (nonneoplastic lesions of the pancreatic lymph nodes and salivary gland

The lowest LOAELs were observed for histopathological changes of the liver (chronic inflammation in female rats and histiocytic cellular infiltration in female mice), duodenum (diffuse epithelial hyperplasia in male and female mice), mesenteric lymph node (histiocytic cellular infiltration in male and female mice) and pancreas (cytoplasm cellular alteration of acinar epithelial cells in female mice), with effects occurring in all treatment groups of the study. Therefore, all effects with LOAEL values of the lowest dose tested were considered as the possible critical effect. Because the critical effects were based on LOAELs, the MRL is based on a benchmark dose (BMD) which is the result of modeling to account for non-linear effects on target organs, generally speaking. An uncertainty factor of 100 is incorporated into the MRL.

Anemia was observed in rats exposed to hexavalent chromium. No hematological effects were observed at 2.1 mg/kg/day body weight. Hematological effects were observed at the following high exposure doses:

- ≥0.77 mg/kg/day (segmented neutrophil counts)
- ≥2.1 mg/kg/day (increased BUN [blood urea nitrogen] and creatine kinase, minimal-to-mild chronic liver inflammation in males)
- ≥0.24 mg/kg/day (minimal-to-mild chronic inflammation in females)
- 5.9 mg/kg/day (decreased leukocytes, decreased total protein

Acute oral exposure doses of 0.036 mg/kg/day have been associated with dermatitis in chromium sensitive people. Exposure to 2.1 mg/kg/day over 180 days resulted in male reproductive effects in monkeys. Decreased spermatogenesis was observed in mice exposed to 15.2 mg/kg/day hexavalent chromium for 7 weeks.

Dermal Contact

Showering with the water was considered, and the dermal exposure dose (ED) was estimated using the following calculation:

$$ED = (C \times P \times SA \times ET \times CF)/BW$$

The concentration (C, 0.7 ppm and 2 ppm) is multiplied by the permeability coefficient (P, 0.002 cm/hr) [4], surface area (SA, 19,400 cm^2, the default values for an adult), exposure time (ET, 10 minutes a day), and a conversion factor (CF). The value is divided by the default body weight (BW, 70 kg) for an adult. The resulting dermal exposure doses are 0.0039 mg/kg/day on average and 0.01 mg/kg/day for the highest known concentration. This does not significantly increase the estimated daily dose from ingestion.

Following dermal exposure, chromium that is not absorbed into the bloodstream will remain on the skin until it is eliminated, usually by washing or other physical processes. Absorbed chromium is primarily eliminated in the urine [2]. Studies with human subjects have shown that there is very little uptake of chromium through the skin, and up to concentrations of 22 ppm, chromium does not overwhelm the reductive capacity of skin or blood [3].

Dermal exposure to very high concentrations in industrial settings and when using salves containing potassium chromate have resulted in burns and skin ulcers. In the 1920s, treatments for a skin condition (scabies) that used potassium chromate resulted in vomiting, hemolytic anemia, kidney effects, necrosis, and sloughing of the skin. In the 1930s, treatment of a skin cancer patient with ammonium dichromate resulted in destruction of the tubular epithelium [2]. The concentration of chromium in these treatments was much higher than the exposures anticipated for the site.

Animal studies have shown that application of 50 mg/kg/day of chromium (specific valence state not specified) to clipped skin for 30 days resulted in increased liver enzymes, thickening artery walls in the liver, shrunken liver cells, and changes in kidney enzymes.

Contact with chromium compounds can cause an allergic reaction, such as eczema or dermatitis, in sensitized individuals. The initial contact can cause swelling and blisters. Subsequent contact can also include thickened, scaly, and fissured skin [2]. Tests with human subjects have indicated that contact with hexavalent chromium in soil at 450 ppm would not illicit a response in non-sensitized individuals. In patch tests, 1.7% of workers tested showed sensitization to a 0.5% hexavalent chromium solution (5,000 ppm). Subjects with sensitivity were challenged with a 0.001% solution (50 ppm) and experienced increased skin thickness and blood flow. Chromate sensitivity has been observed in women who use dichromate containing detergents and bleach [2].

Inhalation

Hexavalent chromium is a human carcinogen when inhaled. The shower pathway was evaluated to determine if the dispersal of chromium in water droplets would be significant enough to cause adverse health effects. Based on studies conducted using a mannequin of average height to mimic a showering scenario and chromium concentrations as high as 11.5 ppm and using a

standard residential lifetime of 30 years and default parameters, there is no increased cancer risk from exposure to aerosolized chromium while showering [5].

Carcinogenicity

The majority of information pertaining to the carcinogenicity of hexavalent chromium is based on occupational inhalation exposure. Hexavalent chromium is classified as a human carcinogen when inhaled, but the EPA has determined that it is "not classifiable as to human carcinogenicity" by oral exposure. Recent research has indicated that laboratory rats develop oral cavity neoplasms at 516 ppm [6, 7]. In the same study, an increased incidence of small intestine neoplasms in mice were observed at 85.7 ppm in males and 172 ppm in females. Incidence of adenoma of the duodenum increased at 257.4 ppm in males and 172 ppm in females. Carcinoma of the duodenum increased at 516 ppm in females. The increased incidence of neoplasms in the small intestine of mice and uptake of Cr(VI) in rats and mice indicate that all Cr(VI) was not reduce to Cr(III) in the stomach under the conditions of this study. Non-neoplastic liver lesions were identified in animals exposed to 57.3 ppm and greater [6, 7].

Animal studies with hairless mice have indicated that ingestion of chromium in drinking water (2.5 ppm and 5 ppm) as potassium chromate and exposure to UV for 26 weeks caused increased incidence of skin tumors when compared to control groups that were either exposed to UV alone or hexavalent chromium alone [2].

Human exposure to drinking water with 20 ppm hexavalent chromium has resulted in lung and stomach cancers [2].

No studies are available regarding dermal contact and carcinogenicity. There is no cancer slope factor to assess estimated increased risk of cancer from oral or dermal exposure at this time.

Community Concerns

Based on conversations between DSHS and a resident with elevated chromium in their private well, there is concern about elevated cancers in the area. The Texas Cancer Registry has examined data from 1997 to 2006 to evaluate the occurrence of cancer in the 79706 zip code. The results of the cancer cluster investigation are as follows:

> The analysis of incidence data for zip code 79706, Midland, Texas, from January 1, 1997–December 31, 2006, found cancers of the breast, lung, colon and rectum, bladder, corpus and uterus, kidney and renal pelvis, non-Hodgkin's lymphoma, and stomach to be within expected ranges in both males and females. Prostate cancer was found to be statistically significantly less than expected among zip code 79706 residents [8].

The resident who initially reported the water problem to the TCEQ is currently suffering from gastrointestinal problems. DSHS spoke with this resident. She is not currently drinking the water, but is wondering if it might be associated with her chronic *H. pylori* infection. There is a relationship between gastrointestinal problems and chromium. These problems should be eliminated when the source of chromium is removed. There are no direct studies to link *H. pylori* to chromium exposure, but this bacteria is ubiquitous and known for active cadmium, zinc, and nickel resistance [9].

Residents had concerns about chromium in the water contributing to dermatitis. Oral intake of 0.04 mg/kg and 0.36 mg/kg as potassium dichromate was shown to exacerbate existing dermatitis in a building worker and sensitized individuals, respectively [2]. As previously discussed, exposure to chromium can lead to contact dermatitis. It generally occurs at levels much higher than the average concentration in this community. Ingesting water with 2 ppm could exacerbate existing dermatitis if chronic exposure occurs. Additionally, some people may have an allergic reaction to the chromium. This can cause contact dermatitis in sensitized people.

Residents are also concerned about plant uptake and consumption of crops. Specifically, a resident was concerned about consuming pecans that were irrigated with contaminated water. Plants grown in very highly contaminated soils, such as those near ore deposits, chromium facilities, or areas fertilized by chrome-contaminated sludge, have shown uptake of chromium into the plant. The majority of the chromium is sequestered in roots. Hexavalent chromium is actively transported into plants and is more toxic to the plant than trivalent chromium species [10]. Dicotyledonous plants transport more chromium to the shoots than monocots, whereas monocots tend to sequester chromium in the roots. A small fraction is translocated to the aboveground stems and leaves. Given that the nutritional information for pecans indicates 0 μg per serving and that the background concentration of chromium in the conterminous United States is 37 ppm in soil, it is unlikely that eating the pecans would result in adverse health effects from chromium exposure [11, 12]. However, the amount of chromium in the pecan relies on several factors. These factors include soil type, chromium concentration in water, amount of water used, and the physiology of the plant. Because of this, the only way to know for certain if the pecans are safe to eat is to test the pecans. A laboratory sample is necessary to confirm that chromium is not elevated in the pecans.

Residents have been concerned about the health of their livestock. Based on DSHS conversations with a veterinarian toxicologist at Texas A&M University, the livestock should not suffer adverse health effects from drinking the water at known concentrations. When livestock have water-related health problems, it is usually due to an unpalatable water source that results in an inadequate water supply to the animals. This is usually caused by high levels of dissolved substances [13].

Additionally, residents have been concerned about the potential for health effects if they eat products from the animals. Absorbed chromium is carried throughout the body in the blood, eventually being distributed to all tissues. Overall uptake of chromium (based on human studies) would be relatively low (less than 10%), and the majority would be converted to trivalent chromium and eliminated. The highest concentrations can be found in the blood, liver, lung, spleen, kidney, and heart [2]. Based on this information and assuming similar assimilation in livestock, the past exposure to organ meat may have increased the overall oral dose in individuals. It is unlikely that consuming muscle tissue would greatly increase the exposure dose. Chromium is eliminated in urine and feces relatively quickly (within days); thus products from farm animals should be safe to eat. The only way to definitively determine if the meat contains chromium would be to have it laboratory analyzed.

Conclusions

DSHS concludes that ingesting hexavalent chromium for more than one year at the West County Road 112 site could have harmed people's health in the past.

Since the contamination was identified, TCEQ and its contractors have mobilized to the area to conduct sampling of private wells and to install filtration systems on wells. Because of their intervention and assuming that the filtration systems are maintained, DSHS concludes that currently, drinking or bathing with water from wells with elevated chromium and filtration systems is not expected to harm people's health.

Recommendations

The TCEQ should continue to identify wells with elevated hexavalent chromium and install filtration systems on affected wells. The filtration systems will require ongoing maintenance until an alternative water supply can be identified and made available. Residents with health concerns should talk to their personal physicians and let them know about the chromium concentrations in their private wells.

Public Health Action Plan

DSHS staff plan to attend the TCEQ's May 28, 2009 public meeting to distribute information about the potential health effects from exposure to chromium. DSHS will also continue to work with the TCEQ to insure the protection of public health.

Please contact me at 1-800-588-1248 if you have any questions about these findings.

Sincerely,

Michelle N. Bost, MS, CHMM
Environmental Specialist

Appendices

Appendix A – Health Assessment Comparison (HAC) Values

To simplify the health assessment process, ATSDR, EPA, Oak Ridge National Laboratories (ORNL), and some of the individual states have compiled lists of chemical substances that have been evaluated in a consistent, scientific manner in order to derive toxicant doses (health guidelines) and/or toxicant concentrations (environmental guidelines), exposures to which, are confidently felt to be without significant risk of adverse health effects, even in sensitive sub-populations.

Health Guidelines

Health guidelines are derived from the toxicologic or epidemiologic literature with many uncertainty or safety factors applied to insure that they are amply protective of human health. They are generally derived for specific routes of exposure (e.g., inhalation, oral ingestion, or dermal absorption) and are expressed in terms of dose, with units of milligrams per kilogram per day (mg/kg/day).

Media-specific HAC values for non-cancer health effects under oral exposure routes are generally based on ATSDR's chronic oral minimal risk levels (MRLs) or EPA's oral reference doses (RfDs). Chronic oral MRLs and RfDs are based on the assumption that there is an identifiable exposure dose (with units of mg/kg/day) for individuals, including sensitive subpopulations (such as pregnant women, infants, children, the elderly, or individuals who are immunosuppressed), that is likely to be without appreciable risk for non-cancer health effects over a specified duration of exposure.

Environmental Guidelines

Environmental guidelines for specific media (e.g., air, soil/sediment, food, drinking water, etc.) are often derived from health guidelines after making certain assumptions about 1) the average quantities of the specific media that a person may assimilate into the body per day (i.e., inhale, eat, absorb through the skin, or drink) and 2) the person's average body weight during the exposure period. Environmental guidelines are expressed as chemical concentrations in a specific medium with units such as micrograms per cubic meter ($\mu g/m^3$), milligrams per kilogram (mg/kg), micrograms per liter (µg/L), parts per million (ppm), or parts per billion (ppb). If these values are based on ATSDR's oral MRLs, they are known as environmental media evaluation guides (EMEGs); if they are based on EPA's RfDs, they are called reference dose media evaluation guides (RMEGs).

For airborne contaminants, ATSDR health assessors frequently use ATSDR's inhalation minimal risk levels (inhalation MRLs) or EPA's inhalation reference concentrations (RfCs). Inhalation MRLs and RfCs are all based on the assumption that there is an identifiable exposure concentration in air [with units of micrograms per cubic meter ($\mu g/m^3$) or parts per billion by volume (ppbv)] for individuals, including sensitive subpopulations (such as pregnant women, infants, children, the elderly, or individuals who are immunosuppressed), that is likely to be without appreciable risk for non-cancer health effects over a specified duration of exposure. Since it is already in the form of a concentration in a particular medium, the inhalation MRL is also called the EMEG for air exposures.

These environmental guidelines are frequently referred to as "screening values" or "comparison values" since the contaminant concentrations measured at a Superfund or other hazardous waste site are frequently "compared" to their respective environmental guidelines in order to screen for

those substances that require a more in-depth evaluation. Since comparison values are health-based (i.e., derived so as to be protective of public health) and they are frequently employed in conducting public health assessments, they are frequently referred to as health assessment comparison values or HAC values.

Other HAC value names have been coined by the various EPA Regions or other state or federal agencies including EPA Regional Screening Levels (RSLs), EPA's health effects assessment summary tables (HEAST) "dose-response values" (DRVs), California's "reference exposure levels" (RELs), and Texas Commission on Environmental Quality's "effects screening levels" (ESLs). These values are occasionally used when there are no published MRLs, RfDs, or RfCs for a given contaminant.

HAC values for non-cancer effects (specifically ATSDR's oral and/or inhalation MRLs) may be available for up to three different exposure durations: acute (14 days or less), intermediate (15 to 365 days), or chronic (366 days or more). As yet, EPA calculates RfD or RfC HAC values only for chronic exposure durations.

HACs for Cancer Effects

When a substance has been identified as a carcinogen, the lowest available HAC value usually proves to be the cancer risk evaluation guide (CREG). For oral exposures, the CREG (with units of mg/kg or ppm) is based on EPA's chemical-specific cancer slope factor (CSF) (also referred to as oral slope factor or OSF) and represents the concentration that would result in a daily exposure dose (in mg/kg/day) that would produce a theoretical lifetime cancer risk of 1×10^{-6} (one additional cancer case in one million people exposed over a 70 year lifetime).

For inhalation exposures, the CREG (in $\mu g/m^3$) is based on the EPA's inhalation unit risk (IUR) value and is calculated as CREG = $10^{-6} \div$ IUR. The inhalation CREG represents the ambient air concentration that, if inhaled continuously over a lifetime, would produce a theoretical excess lifetime cancer risk of 1×10^{-6} (one additional cancer case in one million people exposed over a 70 year lifetime).

Imputed or Derived HAC Values

The science of environmental health and toxicology is still developing, and sometimes, scientific information on the health effects of a particular substance of concern is not available. In these cases, ATSDR scientists will occasionally look to a structurally similar compound, for which health effects data are available, and assume that similar health effects can reasonably be anticipated on the basis of their similar structures and properties. Occasionally, some of the contaminants of concern may have been evaluated for one exposure route (e.g., the oral route) but not for another route of concern (e.g., the inhalation route) at a particular NPL site or other location with potential air emissions. In these cases ATSDR scientists may do what is called a route-to-route extrapolation and calculate the inhalation RfD, which represents the air concentration (in $\mu g/m^3$) that would deliver the same dose (in mg/kg/day) to an individual as the published oral RfD for the substance. This calculation involves making certain assumptions about the individual's inhalation daily volume (in m^3/day), which represents the total volume of air inhaled in an average day, the individual's body weight (in kg), a similarity in the oral and inhalation absorption fraction, and – once the contaminant has been absorbed into the bloodstream – that it behaves similarly whether it came through the GI tract or the lungs. Because of all the assumptions, route-to-route extrapolations are employed only when there are

no available HAC values for one of the likely routes of exposure at the site.

Use of HAC Values

When assessing the potential public health significance of the environmental sampling data collected at a contaminated site, the first step is to identify the various plausible site-specific pathways and routes of exposure based on the media that is contaminated (e.g., dust, soil, sediment, sludge, ambient air, groundwater, drinking water, food product, etc.). Once this is done, maximum values for measured contaminant concentrations are generally compared to the most conservative (i.e., lowest) published HAC value for each contaminant. If the maximum contaminant concentration is below the screening HAC value, then the contaminant is eliminated from further consideration, but if the maximum concentration exceeds the screening HAC, the contaminant is identified as requiring additional evaluation. However, since the screening HAC value is almost always based on a chronic exposure duration (or even a lifetime exposure duration, in the case of comparisons with CREG values) and the maximum contaminant concentration represents a single point in time (which would translate to an acute duration exposure), one cannot conclude that a single exceedance (or even several exceedances) of a HAC value constitutes evidence of a public health hazard. That conclusion can be reached only after it has been determined that peak concentrations are exceeding acute-exposure-duration HAC values, intermediate-term average concentrations are exceeding intermediate-exposure-duration HAC values, or long-term average concentrations are exceeding chronic-exposure-duration HAC values.

References

1. United States Census Bureau. Information for 79706 accessed May 14, 2009. Available at: http://factfinder.census.gov

2. Agency for Toxic Substances and Disease Registry. Toxicological profile for chromium, draft for public comment, comment period ending February 26, 2009. Atlanta: ATSDR, September 2008

3. Paustenbach, D, et al. 2003. Human health risk and exposure assessment of chromium(VI) in tap water. J Toxicol and Environ Health. Vol 66:1295-1339.

4. United State Environmental Protection Agency. 2001. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. http://www.epa.gov/oswer/riskassessment/ragse/pdf/org04_01.xls

5. Finley, BL, et al. 1996. Assessment of airborne hexavalent chromium in the home following use of contaminated tap water. J Exp Anal and Environ Epi. Vol 6(2):229-245.

6. Stout, MD, et al. 2009. Hexavalent chromium is carcinogenic to F344/N rats and B6C3F1 mice after chronic oral exposure. Environ Health Perspect 117(5):716-722.

7. National Toxicology Program. 2008. Toxicology and carcinogenesis studies of sodium dichromate dihydrate (CAS No 7789-12-0) in F334/N rats and B6C3F$_1$ mice (drinking water studies) TR 546. Research Triangle Park, NC:National Toxicology Program.

8. Texas Department of State Health Services, Texas Cancer Registry. Summary of Investigation into the Occurrence of Cancer, Zip Code 79706, Midland, Midland/Glasscock County, Texas, 1997–2006. Austin, DSHS April 29, 2009.

9. Stahler, FN, et al. 2006. The novel *Helicobacter pylori* CznABC metal efflux pump is required for cadmium, zinc, and nickel resistance, urease modulation, and gastric colonization. Infection and Immunity. Vol. 74(7):3845-3852.

10. Amarillo National Research Center for Plutonium. 1998. Literature review: phytoaccumulation of chromium, uranium, and plutonium in plant systems. ANCRP-1998-3. Amarillo, Texas.

11. Dlife. Detailed nutritional analysis for pecans. Accessed May 26, 2009 from http://www.dlife.com/diabetes/diabetic-recipes/chopped-pecans/f4577.html. Data provided by ESHA Research.

12 Shacklette H and J Boerngen. 1984. Element concentrations in soilsand other surficial materials of the conterminous United States. Washington: US Government Printing Office. US Geological Survey Professional Paper 1270. http://pubs.er.usgs.gov/pubs/pp/pp1270.

13. AgriLife Extension. Texas A&M System. Water quality: its relationship to livestock. L-

2374, 6-98. Available at: http://lubbock.tamu.edu/irrigate/documents/2074410-L2374.pdf

CERTIFICATION

This Letter Health Consultation was prepared by the Texas Department of State Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedure existing at the time the health consultation was initiated.

Jeff Kellam
Technical Project Officer
Division of Health Assessment and Consultation (DHAC)
ATSDR

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

Alan Yarbrough
Cooperative Agreement Team Leader, DHAC, ATSDR