Health Consultation

Exposure Investigation Report

RUMPKE MEDORA LANDFILL

MEDORA, JACKSON COUNTY, INDIANA

EPA FACILITY ID: INXCRA947000

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

Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation &
Division of Regional Operations

Executive Summary

Previous limited soil sampling has shown elevated levels of metals in areas where chromium hydroxide sludge was disposed in residential areas and on agricultural fields in the Medora area of Jackson County, Indiana. This Exposure Investigation (EI) was needed to collect soil sampling data from residential properties and agricultural fields to determine if potential human exposures to elevated levels of metals are occurring. From the data collected, ATSDR can conclude that:

- Metals in sediment and water samples pose no apparent public health hazard.
- For most soil samples, metals were not elevated and pose no apparent public health hazard
- For certain sample locations, further site characterization is needed. These specific locations pose an indeterminate public health hazard.

ATSDR recommends further testing to help characterize some specific locations, and ATSDR will work with state and federal environmental agencies to help obtain this testing.

Objectives and Rationale

Previous limited soil sampling has shown elevated levels of metals in areas where chromium hydroxide sludge was disposed in residential areas and on agricultural fields in the Medora area of Jackson County, Indiana (Indiana Department of Environmental Management [IDEM], unpublished data, 2006). This EI was needed to collect soil sampling data from residential properties and agricultural fields to determine if potential exposures to elevated levels of metals are occurring. Also, sediment and water samples were collected from Guthrie Creek, which receives run-off from several properties in the Medora area and is a popular recreation area for wading and car-washing. In addition, there are reports that some people may have been using natural springs and/or pond water as a drinking water supply. Therefore, water samples were taken to determine if there is any metal contamination.

Background

ATSDR was petitioned in May 2004 by a community member concerned about the Rumpke Landfill and Gideon T property in Medora, IN. The Rumpke Landfill is an operational municipal waste landfill. The Gideon T property is an adjacent property where hazardous waste chromium hydroxide sludge was disposed of in slit trenches in the early 1980s. It is believed that the chromium waste was a result of the treatment of chromium to reduce it from the hexavalent state to the trivalent state. The source of the chromium hydroxide sludge was the former Medora Plastics factory, located in the town of Medora. The facility is also known as both: Amerace Corporation, Emconite Division of Medora, IN and ITT United Plastics Division. The factory is no longer in operation, but ITT is conducting a voluntary clean-up of lagoons at the factory under IDEM's Voluntary Remediation Program [1].

ATSDR accepted the petition and has begun conducting a public health consultation on the Rumpke Landfill and Gideon T property. During the first site visit, ATSDR staff heard reports from several community members about how metal plating sludge from the Medora Plastics factory was also disposed of in wooded areas and ravines, and land-applied to agricultural fields. Reportedly, in the early 1970s, two local residents received permission from the Indiana State Board of Health (now known as the Indiana State Department of Health) to spread the sludge in shallow furrows on their farm located northwest of the town of Medora. After the death of one of the two local residents, another party continued to contract with the plastics factory to dispose of their waste. It is reported that a custom-built 1,500 gallon mobile tank was used for land application of the sludge. Farm owners were told that the sludge was a good source of lime. In addition to lime, the sludge contained chromium and other metals such as nickel and copper.

In 1978, in order to comply with upcoming federal rules regarding disposal of hazardous waste, a proposal was submitted to construct plastic-lined lagoons on a property known as the Robertson farm as a method to dispose of the sludge. In 1979, Indiana Board of Health officials approved the proposal on an experimental basis and disposal began. Later, that approval was withdrawn, and by 1982, the Indiana Environmental Management Board (now IDEM) ordered the removal of the sludge from the lagoons and had it placed in naturally clay-lined slit trenches on property now known as the Gideon T. There is still evidence on the Robertson farm of the waste disposal, including plastic liners and trenches containing dried sludge. Other areas where sludge was disposed of have not been sampled or remediated.

Methods

Exposure Investigation Design

The chromium hydroxide sludge is visible as a blue material which was mixed in as an agricultural amendment into the soil. ATSDR attempted to collect biased samples in areas that either were alleged to have received this material, or in areas that may have received runoff from the fields where chromium hydroxide was allegedly applied. Additionally, ATSDR collected soil samples near areas where materials from the plastics factory were apparently disposed, as evidenced by linings or drums. The specific sampling areas were chosen based on information from historical records as well as information from local residents. Based on observation of materials in the field, a single sample was also analyzed for volatile organic hydrocarbons.

Environmental Sampling

Sampling Site Description

After obtaining consent, ATSDR collected surface soil and/or sediment samples from 6 private properties in the Medora area. Specific areas included farmland, play areas, and fields. Sediment samples were collected from the culvert in a right-of-way of a road and from Guthrie Creek. Water samples were collected from 3 locations. The first location was a spring house, the second was a residential water supply, which utilized pond water, and the third water sample was collected from Gutherie Creek, directly downstream of the Rumpke landfill.

Data Collection/Sampling Procedures

Soil and sediment samples were collected at a depth of approximately 0-3 inches. The selection of soil sampling locations was biased. That is, they were not be randomly selected. This approach is necessary to meet the data quality objective of determining concentrations of metals in the contaminated areas.

U.S. EPA Environmental Response Team Standard Operating Procedures (SOP) for Soil Sampling was followed for the soil and sediment sampling (ERT 2000). Water samples were collected following the US EPA's Methods for Chemical Analysis of Water and Wastes (EPA 1999).

Laboratory Analytic Procedures

Samples were analyzed for metals using the following methods:

- EPA Method 7196 (Chrome +6)
- EPA Method 6010B (Lead and other metals)
- EPA Method 8260B (Volatile organic hydrocarbons – 1 sample[a]).

Data Analysis Procedures

ATSDR utilized the guidance in Chapters 7 and 8 of the ATSDR Public Health Assessment Guidance Manual to evaluate the public health implications of the data (ATSDR 2005).

Results

a A single soil sample was analyzed for VOC's because of the nearby presence of drums which appeared to contain a viscous liquid material.

Results for sampling are shown in Table 1 (sediment), Table 2 (surface soils), and Table 3 (surface water). Specific sampling locations are not disclosed in this report to protect participant's privacy.

Discussion

By screening against default comparison values, contaminants can be selected for more detailed evaluation. However, it is important to note that in dealing with metals, several elements are found in relative abundance in the earth's crust, and will be commonly found at levels at or higher than comparison values. This is because comparison values are derived in a very conservative (health protective) manner and the process does not normally consider background levels of exposure. Comparison values do not predict toxicity, but instead, are set many tens, hundreds or even thousands of times below doses of chemicals that are known to cause health effects in either animals or humans. The degree of uncertainty determines how far below levels of known health effect that the comparison value is set. Uncertainty can arise from basically three sources:

1. extrapolating animal testing data to humans,
2. extrapolating studies of humans occupationally or accidentally exposed to people who are exposed over longer periods of their life through different routes of exposure, and/or
3. accounting for potentially sensitive individuals (elderly, children) in our populations.

ATSDR generally uses the following comparison values:

Environmental Media Evaluation Guides (EMEGs)
EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects based on ATSDR evaluation. EMEGs are based on ATSDR MRLs and conservative assumptions about exposure, such as intake rate, exposure frequency and duration, and body weight.

Cancer Risk Guides (CREGs)
CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million persons exposed during their lifetime (70 years). ATSDR's CREGs are calculated from EPA's cancer slope factors for oral exposures or unit risk values for inhalation exposures. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

Reference Dose Media Evaluation Guides (RMEGs)
ATSDR derives RMEGs from EPA's oral reference doses, which are developed based on EPA evaluations. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

Minimal Risk Levels (MRLs)
A MRL is an estimate of daily human exposure to a substance (in milligrams per kilogram per day (mg/kg/day) for oral exposures and parts per billion (ppb) or micrograms per cubic meter ($\mu g/m^3$) for inhalation exposures) that is likely to be without

noncarcinogenic health effects during a specified duration of exposure based on ATSDR evaluations.

Contaminants that exceed their respective screening values are highlighted in bold in Tables Table 1, 2, and 3. ATSDR also considered other sources of comparison values, such as EPA Region III Risk Based Comparison Values (RBC's), EPA Region IX's Preliminary Remediation Goals or Indiana's Risk Integrated System of Closure (RISC) values [2,3,4]. The public health implications of these contaminants (how likely are they to result in disease) are discussed below.

Public Health Implications

Sediment

Arsenic- Maximum detected arsenic sediment values (31 ppm) exceeded ATSDR's child EMEG of 20 ppm. However, arsenic is naturally found in soils throughout the United States at an average level of 7.2 ppm [5]. Eastern soils have average arsenic level of 4.4 ppm [5]. Two sediment samples were above the background range for soils in the region (Table 4). Given that these samples were of sediment, it is difficult to state definitively if these samples are truly above background or not. Health effects from ingesting sediments containing 31 ppm of arsenic are unlikely. First, the public is not exposed to sediments on an everyday basis. Second, bioavailability of arsenic from sediment is reduced by low solubility and inaccessibility due to the presence of secondary reaction products or insoluble matrix components [9]. Even if this location were accessible, ATSDR calculates that a 16 kilogram child could receive a maximum dose of 0.00039 mg/kg/day (Appendix A). This dose is below the no-observed-adverse-effect-level (NOAEL) of 0.0008 mg/kg/day used to calculate ATSDR's Minimal Risk Level [9]. This dose was based on a study examining hyperkeratosis and hyperpigmentation in persons who drank water that contained high levels of arsenic in Taiwan [6,7]. This NOAEL has been confirmed in studies of other populations exposed to arsenic [6].

Calcium- No ATSDR comparison values exist for calcium, which is regionally detected in soils ranging from 1,858 to 65,928 ppm. No sediment samples exceeded this range.

Iron- No ATSDR comparison values exist for iron, which is regionally detected in soils ranging from 15,000 to 65,000 ppm. EPA Region III has a Risk Based Comparison Value for soil of 23,000 ppm. A single sediment sample, taken near a roadway, exceeded both the background and the EPA RBC. Based on this location, we can not rule out anthropogenic sources of contamination from the roadway. Given the low potential for contact, this location would not constitute a health concern. Iron is an essential nutrient required by proteins involved in oxygen transport (hemoglobin) and energy metabolism (cytochromes). The Recommended Dietary Allowance (RDA) of iron ranges from 10–18 or more milligrams per day, depending on age and pregnancy status, and intakes of 25–75 milligrams per day are not expected to be harmful to healthy individuals [8,9].

Magnesium- No ATSDR comparison values exist for magnesium, which is regionally detected in soils ranging from non-detect to 10,000 ppm. All magnesium samples were within this range. EPA Region III has not published an RBC for magnesium, and Indiana has not published a RISC for magnesium.

Phosphorus- The 0.4 mg/kg comparison value is based on white phosphorus, which is used in explosives [10]. No ATSDR comparison values exist for phosphorus in its natural form. Phosphorus levels did not exceed background ranges for this region (non-detect to 1,099 ppm) Phosphorus occurs naturally in the earths crust at an average concentration of 0.12% and is present in all fertile soils [11]. Phosphorus is a macronutrient and is essential to support life. A typical adult requires approximately 0.9 grams (or 900 milligrams) per day [12].

Potassium- No ATSDR comparison values exist for potassium. Potassium levels in sediment did not exceed regional background levels (13,283 – 24,000 ppm). The Food and Nutrition Board for the National Research Council has however determined that the minimum requirement for potassium ranges from 1,600 to 2,200 milligrams per day [25]. And there is considerable evidence that increasing the amount of potassium ingested to 3,500 milligrams per day would be beneficial [25].

Silicon- No ATSDR comparison values exist for silicon, which is a natural element encountered in quartz, rock crystal, amethyst, agate, flint, jasper and opal [13]. No sediment sample exceeded the background range for silicon (Non-detect-362,350 ppm).

Sodium- No ATSDR comparison values exist for sodium. No sediment sample exceeded the background range for sodium (Non-detect-10,000 ppm). Sodium is another essential nutrient needed in large amounts every day. The Food and Nutrition Board for the National Research Council designates 120 to 500 milligrams per day as a *minimum* requirement for sodium [8]. The FDA has identified 2400 milligrams per day as a safe *upper* intake level [14]. That would be equivalent to about 6 grams of table salt. Table salt or sodium chloride is 39% sodium by weight.

Vanadium- Samples of sediment exceeded the *pica* comparison value. Regionally, vanadium occurs in soils ranging from 50 to 150 ppm. EPA Region III has an RBC of 78 ppm. None of the vanadium samples exceeded this level.

Soil

Arsenic – Residential soil samples exceeded ATSDR's CREG, which as previously discussed, was below background levels. ATSDR calculates that a 16 kilogram child could receive a maximum dose of 2.80×10^{-4} mg/kg/day, and for a 10 kilogram child, ATSDR calculated a dose of 4.40×10^{-4} mg/kg/day (Appendix A). These doses are below the NOAEL of 0.0008 mg/kg/day [6,7].

C12, C13, C14, C15 Hydrocarbon – These compounds were detected using EPA Method 8260B. Their identity is unknown; therefore, the toxicological implications can not be determined. Further analysis and investigation is needed to determine the identity of this material.

Calcium- No ATSDR comparison values exist for calcium, which is regionally detected in soils (Table 4). However, a single sample detected calcium slightly in excess of this range.

Chromium – Chromium was one of the main metals of interest because of the reported use of hydroxide sludge as an agricultural amendment. The assessment of chromium is dependent on what valence state (form) the chromium is in. The most common forms are chromium(0), trivalent (or chromium(III)), and hexavalent (or chromium(VI)). Chromium(III) occurs naturally in the environment and is an essential nutrient required by the human body to promote the action of insulin in body tissues so that sugar, protein, and fat can be used by the body. Chromium(VI) and chromium(0) are generally produced by industrial processes [15]**.** In general, chromium (VI) compounds are more toxic than chromium (III) compounds [15]. Most of the chromium present in the chromium hydroxide sludge is expected to be chromium (III) because chromium hydroxide's chemical formula is CrH_3O_3 [16].

Total chromium (all forms combined) was detected above background in some surface soil samples. Chromium normally ranges from 50 to 70 ppm in soil (Table 4, Figure 1). Five soil samples had chromium concentrations, ranging from 8,500-20,000 ppm, that exceeded this background range. These levels were below ATSDR's RMEG comparison value of 80,000 ppm. Specific tests for hexavelent chromium in these soils found a maximum level of only 31 ppm, which is below ATSDR's RMEG comparison value of 200 ppm. ATSDR could not locate background ranges for hexavelent chromium for this area.

Plant uptake of chromium in crops grown in this soil is not likely to produce doses of concern. Although higher concentrations of chromium have been reported in plants growing in high chromium-containing soils (e.g., soil near ore deposits or chromium-emitting industries and soil fertilized by sewage sludge) compared with plants growing in normal soils, most of the increased uptake in plants is retained in roots, and only a small fraction is translocated in the above ground part of edible plants [15].

Copper – Copper is regionally detected in soils (Table 4). Four samples exceeded the background range for copper considerably (Table 2, maximum 5,600 ppm). The IDEM residential RISC level for copper is 14,000 ppm. The EPA RBC is 3,100 ppm. The ATSDR intermediate EMEG is 500 ppm. The ATSDR EMEG is based on gastrointestinal problems seen in volunteers who were given copper over a two month period [17,18]. Gastrointestinal effects included nausea, vomiting, diarrhea, and abdominal pain [18]. However, these effects were only seen until doses approached levels nine times the dose that the ATSDR EMEG is based on [17]. Therefore, health effects are not expected from copper. Given the site's history, it is possible that this material is copper cyanide, which is used in electroplating, or some other form of copper [19]. Further analytic testing is required to make this determination.

Iron- No ATSDR comparison values exist for iron, which is regionally detected in soils ranging from 15,000 to 65,000 ppm. EPA Region III has an Risk Based Comparison Value for soil of 23,000 ppm. The maximum detected iron level was 28,000 ppm. Iron is an essential nutrient required by proteins involved in oxygen transport (hemoglobin) and energy metabolism (cytochromes). The RDA of iron ranges from 10–18 or more milligrams per day, depending on age and pregnancy status, and intakes of 25–75 milligrams per day are not expected to be harmful to healthy individuals [8,9]. Therefore, iron in these soil samples is not expected to pose a health hazard.

Magnesium- No ATSDR comparison values exist for magnesium, which is regionally detected in soils ranging from non-detect to 10,000 ppm. All soil samples were within this range. EPA Region III has not published an RBC for magnesium, and Indiana has not published a RISC value for magnesium.

Nickel - Four out of nine surface soil samples exceeded its comparison value for nickel. The maximum detection was 7,200 ppm. Pure nickel is a hard, silvery-white metal, which has properties that make it very desirable for combining with other metals to form mixtures called alloys. Soil usually contains between 5 ppm and 20 ppm of nickel in soil. One may be exposed to nickel in soil by skin contact, and children may also be exposed to nickel by eating soil. The most common adverse health effect of nickel in humans is an allergic reaction to nickel [20].

The U.S. Department of Health and Human Services (DHHS) has determined that nickel and certain nickel compounds may reasonably be anticipated to be carcinogens. The International Agency for Research on Cancer (IARC) has determined that some nickel compounds are carcinogenic to humans and that metallic nickel may possibly be carcinogenic to humans. The EPA has determined that nickel refinery dust and nickel subsulfide are human carcinogens [20].

ATSDR has not developed a chronic oral MRL, but EPA has developed a Chronic Oral Reference Dose of 0.02 mg/kg/day for non-cancerous health effects of nickel [21]. This value is 300 times lower than the highest dose that has been shown not cause adverse health effects in either animals or humans [21]. The default screening value ATSDR used, 1,000 ppm, was based on the Reference Dose, assuming daily contact with the contaminated area by small (10 kilogram) children. Since the sample locations were not located in areas where daily contact is expected to occur, ATSDR does not anticipate doses exceeding the screening levels, and health effects are not likely. However, children who are sensitive to nickel might develop allergic reactions to even a very small amount of this chemical. Further testing and identification of the specific nickel compounds should be undertaken.

Silicon- No ATSDR comparison values exist for silicon, which is a natural element encountered in quartz, rock crystal, amethyst, agate, flint, jasper and opal [22]. No soil sample exceeded the background range for silicon (Non-detect-36,235 ppm).

Sodium- No ATSDR comparison values exist for sodium. One sample exceeded background range for sodium (Non-detect-10,000 ppm). Sodium is another essential nutrient needed in large amounts every day. The Food and Nutrition Board for the National Research Council designates 120 to 500 milligrams per day as a *minimum* requirement for sodium [8]. The FDA has identified 2400 milligrams per day as a safe *upper* intake level [23]. That would be equivalent to about 6 grams of table salt. Table salt or sodium chloride is 39% sodium by weight. Given this site’s history, further testing should be done on this material to assess which specific sodium compound is present (for instance, both sodium hydroxide and sodium cyanide are compounds that are used in electroplating [24].

Vanadium- Regionally, vanadium occurs in soils ranging from 50 to 150 ppm. EPA Region III has an RBC of 78 ppm. None of the vanadium samples exceeded this level.

Water

Calcium - Calcium, an essential nutrient, was detected in 3 of 3 samples. The maximum detection was 46,000 µg/l. Assuming that a person drinks 2 liters of water a day, water containing calcium at 46,000 µg/l would provide only 92 milligrams calcium/day. The Recommended Daily Allowance for calcium is 400-1200 milligrams per day, depending on age [25]. The calcium exposure from groundwater is within the RDA and well below levels expected to cause health effects.

Magnesium- No ATSDR comparison values exist for magnesium, which was detected in 3 of 3 samples. Assuming consumption of 2 liters per day, the highest concentration detected in drinking water at this site (11,000 µg/l) would provide one with only 22 milligrams of magnesium per day. The recommended daily allowance for this essential nutrient ranges from 40 to 400 milligrams [8,26].

Phosphorus - Phosphorus occurs naturally in the earths crust at an average concentration of 0.12% and is present in all fertile soils [11]. Phosphorus is a macronutrient and is essential to support life. A typical adult requires approximately 0.9 grams (or 900 milligrams) per day [27].

Potassium - Potassium, another essential nutrient, was detected in 3 out of 3 samples. The Food and Nutrition Board for the National Research Council has however determined that the minimum requirement for potassium ranges from 1,600 to 2,200 milligrams per day [8]. And there is considerable evidence that increasing the amount of potassium ingested to 3,500 milligrams per day would be beneficial [8].

Silicon- No ATSDR comparison values exist for silicon, which is a natural element encountered in quartz, rock crystal, amethyst, agate, flint, jasper and opal [28]. ATSDR could not locate other sources of comparison values for silicon in drinking water.

Sodium - Sodium was detected in 3 out of 3 samples. The maximum detection was 11,000 µg/l. Sodium is another essential nutrient needed in large amounts every day. The Food and Nutrition Board for the National Research Council designates 120 to 500 milligrams per day as a minimum requirement for sodium [8]. The FDA has identified 2400 milligrams per day as a safe upper intake level [29]. That would be equivalent to about 6 grams of table salt. (Salt or sodium chloride is 39% sodium by weight).

Limitations

Only analysis for metals and certain volatile hydrocarbons were performed. The sample analyzed for volatile hydrocarbons detected several unknown hydrocarbons, and further analysis is needed to determine the identity of the material. Furthermore, as previously discussed, the specific compounds of each metal was not analyzed for. Given the site's history, further site investigation should be conducted in areas where metals were above background to determine the specific identity of the compounds. This is because several of the metal compounds used in electroplating can be toxic, corrosive, or both.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, 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.

Conclusions

- Metals in sediment and water samples pose no apparent public health hazard.
- For most soil samples, metals were not elevated and pose no apparent public health hazard
- For certain sample locations, further site characterization is needed. These specific locations pose an indeterminate public health hazard. Particular attention should be paid to identifying unknown materials and the specific compounds of the copper, sodium and calcium.

Recommendations

- Given the site's history, further site investigation should be conducted in areas where metals were above background to determine the specific identity of the compounds.

Public Health Action Plan

ATSDR will work with the appropriate environmental agencies to make available to residents further testing in the areas of concern.

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Tables

Table 1: Sediment Results

Chemical	*# of Samples / # of Detections*	*Maximum Result (ppm)*	*Mean Result (ppm)*	*Median Result (ppm)*	*Comparison Value (ppm)/ Source*
ALUMINUM	9 / 9	6,000	4,300	4,200	100,000 iEMEG child
ANTIMONY	9 / 0	0	0	0	20 / RMEG child
ARSENIC	**9 / 9**	**31**	**12.4**	**10**	**20 / cEMEG child**
BARIUM	9 / 9	150	58.1	44	30,000 / iEMEG child
BERYLLIUM	9 / 9	1.7	0.799	0.63	100 / cEMEG child
BORON	9 / 9	3.7	2.73	2.4	500 / iEMEG child
CADMIUM	9 / 1	0.64	0.64	0.64	10 / cEMEG child
CALCIUM	**9 / 9**	**11,000**	**2630**	**1,400**	**N/A**
CHROMIUM	9 / 9	96	35.7	22	80,000 RMEG child
CHROMIUM, HEXAVALENT	9 / 7	3.8	1.56	0.76	200 / RMEG child
COBALT	9 / 9	16	11.4	11	500 / iEMEG child
COPPER	9 / 9	12	7.32	7.7	500 / iEMEG child
IRON	**9 / 9**	**83,000**	**32,200**	**29,000**	**23,000 EPA Region III RBC**
LEAD	9 / 9	20	12.4	13	400 / EPA SSL
LITHIUM	9 / 9	8.4	4.37	3.5	1,600 EPA Region III RBC
MAGNESIUM	**9 / 9**	**1,600**	**954**	**780**	**N/A**
MANGANESE	9 / 9	1,900	777	540	3,000 / RMEG child
MOLYBDENUM	9 / 1	2.5	2.5	2.5	300 / RMEG child
NICKEL	9 / 9	56	23	19	1,000 / RMEG child
PHOSPHORUS	**9 / 9**	**590**	**297**	**210**	**1 / iEMEG child**
POTASSIUM	**9 / 9**	**410**	**235**	**230**	**N/A**
SELENIUM	9 / 2	6.1	4.95	4.95	300 / cEMEG child
SILICON	**9 / 9**	**1,500**	**654**	**480**	**N/A**
SILVER	9 / 0	0	0	0	300 / RMEG child
SODIUM	**9 / 9**	**45**	**30.1**	**31**	**N/A**
STRONTIUM	9 / 9	10	4.43	3.4	4,000 / iEMEG pica
THALLIUM	9 / 0	0	0	0	5.5 / EPA Region IX PRG
TIN	9 / 2	6.1	4.3	4.3	20,000 / RMEG child
TITANIUM	**9 / 9**	**94**	**67.3**	**61**	**100,000 / EPA Region IX PRG**
VANADIUM	**9 / 9**	**60**	**30.1**	**29**	**20 / iEMEG child**
ZINC	9 / 9	380	95.9	57	20,000 / iEMEG child

EMEG = ATSDR Environmental Media Evaluation Guide (c – chronic; i – intermediate)
RMEG = Reference Media Evaluation Guide
PRG = EPA Region IX Preliminary Remediation Goal
RBC = EPA Region III Risk Based Comparison value

Table 2: Surface Soil Results

Chemical	*# of Samples/ # of Detections*	*Maximum Result (ppm)*	*Mean Result (ppm)*	*Median Result (ppm)*	*Comparison Value / Source*
1,1,1-TRICHLOROETHANE	1 / 0	0	0	0	40,000 / iEMEG pica
1,1,2,2-TETRACHLOROETHANE	1 / 0	0	0	0	4 / CREG
1,1,2-TRICHLOROETHANE	1 / 0	0	0	0	10 / CREG
1,1-DICHLOROETHANE	1 / 0	0	0	0	N / A
1,1-DICHLOROETHENE	1 / 0	0	0	0	500 / cEMEG child
1,2-DICHLOROETHANE	1 / 0	0	0	0	8 / CREG
1,2-DICHLOROETHENE, CIS-	1 / 0	0	0	0	600 / iEMEG pica
1,2-DICHLOROETHENE, TRANS-	1 / 0	0	0	0	400 / iEMEG pica
1,2-DICHLOROPROPANE	1 / 0	0	0	0	100 / iEMEG pica
1,3-DICHLOROPROPENE, CIS-	1 / 0	0	0	0	N / A
1,3-DICHLOROPROPENE, TRANS-	1 / 0	0	0	0	N / A
2-BUTANONE	1 / 0	0	0	0	30,000 / RMEG child
2-HEXANONE	1 / 0	0	0	0	N / A
ACETONE	1 / 0	0	0	0	4,000 / iEMEG pica
ALUMINUM	9 / 9	4,400	3,010	3,500	20,000 / iEMEG child
ANTIMONY	9 / 0	0	0	0	20 / RMEG child
ARSENIC	**9 / 6**	**22**	**13.7**	**12.5**	**20 / cEMEG child**
BARIUM	9 / 9	130	67.3	62	1000 / iEMEG pica
BENZENE	1 / 0	0	0	0	10 / CREG
BERYLLIUM	9 / 8	1	0.458	0.41	100 / cEMEG child
BORON	9 / 9	37	8.4	4.3	500 / iEMEG child
BROMODICHLOROMETHANE	1 / 0	0	0	0	10 / CREG
BROMOFORM	1 / 0	0	0	0	90 / CREG
BROMOMETHANE	1 / 0	0	0	0	6 / iEMEG pica
C12 HYDROCARBON	**1 / 1**	**3.2**	**3.2**	**3.2**	**See limitations**
C13 HYDROCARBON	**1 / 1**	**4.3**	**4.3**	**4.3**	**See limitations**
C14 HYDROCARBON	**1 / 1**	**2.5**	**2.5**	**2.5**	**See limitations**
C15 HYDROCARBON	**1 / 1**	**3.3**	**3.3**	**3.3**	**See limitations**
CADMIUM	9 / 2	0.63	0.49	0.49	10 / cEMEG child
CALCIUM	**9 / 9**	**67,000**	**14,100**	**2,400**	**N / A**
CARBON DISULFIDE	1 / 0	0	0	0	20 / aEMEG pica
CARBON TETRACHLORIDE	1 / 0	0	0	0	5 / CREG
CHLOROBENZENE	1 / 0	0	0	0	800 / iEMEG pica
CHLORODIBROMOMETHANE	1 / 0	0	0	0	8 / CREG
CHLOROETHANE	1 / 0	0	0	0	N / A
CHLOROFORM	1 / 0	0	0	0	200 / iEMEG pica
CHLOROMETHANE	1 / 0	0	0	0	/
CHROMIUM	**9 / 9**	**20,000**	**6,400**	**35**	**80,000 / RMEG child (exceeded background concentrations)**
CHROMIUM, HEXAVALENT	9 / 9	31	13.3	8.8	200 / RMEG child
COBALT	9 / 8	20	9.38	8.2	20 / iEMEG pica
COPPER	**9 / 9**	**5,600**	**1,630**	**16**	**500 / iEMEG child**

Chemical	*# of Samples/ # of Detections*	*Maximum Result (ppm)*	*Mean Result (ppm)*	*Median Result (ppm)*	*Comparison Value / Source*
ETHYL BENZENE	1 / 0	0	0	0	5000 / RMEG child
IRON	**9 / 9**	**28,000**	**10,900**	**9,200**	**23,000 / EPA Region III RBC**
LEAD	9 / 8	58	28	22.5	400 / EPA SSL
LITHIUM	**9 / 8**	**5**	**2.42**	**2.45**	**1,600 / EPA Region III RBC**
M & P-XYLENE	1 / 0	0	0	0	/
MAGNESIUM	**9 / 9**	**6,400**	**1,540**	**940**	**N / A**
MANGANESE	9 / 9	970	489	520	3000 / RMEG child
METHYL ISOBUTYL KETONE	1 / 0	0	0	0	N / A
METHYLENE CHLORIDE	1 / 0	0	0	0	90 / CREG
MOLYBDENUM	9 / 0	0	0	0	300 / RMEG child
NAPHTHALENE	1 / 0	0	0	0	1000 / iEMEG pica
NICKEL	**9 / 9**	**7,200**	**2,320**	**47**	**1000 / RMEG child**
O-XYLENE	1 / 0	0	0	0	N / A
PHOSPHORUS	**9 / 9**	**950**	**402**	**420**	**1 / iEMEG child**
POTASSIUM	**9 / 8**	**400**	**275**	**265**	**N / A**
SELENIUM	9 / 0	0	0	0	300 / cEMEG child
SILICON	**9 / 9**	**1,600**	**701**	**680**	**N / A**
SILVER	9 / 0	0	0	0	300 / RMEG child
SODIUM	**9 / 9**	**130,000**	**14,600**	**19**	**N / A**
STRONTIUM	9 / 9	35	12.6	6.9	30,000 / RMEG child
STYRENE	1 / 0	0	0	0	400 / iEMEG pica
TETRACHLOROETHYLENE	1 / 1	0.0003	0.0003	0.0003	100 / aEMEG pica
THALLIUM	9 / 0	0	0	0	5.5 / EPA Region III RBC
TIN	**9 / 5**	**710**	**393**	**470**	**20,000 / iEMEG child**
TITANIUM	**9 / 9**	**130**	**72.3**	**76**	**100,000 / EPA Region III RBC**
TOLUENE	1 / 1	0.00045	0.00045	0.00045	40 / iEMEG pica
TRICHLOROETHYLENE	1 / 0	0	0	0	400 / aEMEG pica
UNKNOWN HYDROCARBON	**1 / 1**	**8**	**8**	**8**	**See limitations**
VANADIUM	**9 / 9**	**24**	**13.1**	**16**	**20/ iEMEG child**
VINYL CHLORIDE	1 / 0	0	0	0	0.5 / CREG
ZINC	9 / 9	110	38.3	32	20,000 / cEMEG child

EMEG = ATSDR Environmental Media Evaluation Guide (c – chronic; i – intermediate)
RMEG = Reference Media Evaluation Guide
PRG = EPA Region IX Preliminary Remediation Goal
RBC = EPA Region III Risk Based Comparison value

Table 3: Surface Water Results

Chemical	*# of Samples/ # of Detections*	*Maximum Result (µg/l)*	*Mean Result (µg/l)*	*Median Result (µg/l)*	*Comparison Value / Source*
ALUMINUM	3 / 2	1800	1550	1550	20,000 / iEMEG child
ANTIMONY	3 / 0	0	0	0	4 / RMEG child
ARSENIC	3 / 0	0	0	0	0.02 / CREG
BARIUM	3 / 3	76	47.7	41	6,000 / cEMEG child
BERYLLIUM	3 / 0	0	0	0	20 / cEMEG child
BORON	3 / 2	35	28.5	28.5	100 / iEMEG child
CADMIUM	3 / 0	0	0	0	2 / cEMEG child
CALCIUM	**3 / 3**	**46,000**	**33,300**	**29,000**	**N/A**
CHROMIUM	3 / 1	3.6	3.6	3.6	100 / MCL
CHROMIUM, HEXAVALENT	3 / 2	27	24.5	24.5	30 / RMEG child
COBALT	3 / 0	0	0	0	100 iEMEG child
COPPER	3 / 2	17	13.4	13.4	1,300 / MCLG
IRON	3 / 3	4900	2210	1600	11,000 RBC
LEAD	3 / 0	0	0	0	15 / EPA Action Level
LITHIUM	3 / 2	3.7	3.45	3.45	730 EPA Region III RBC
MAGNESIUM	**3 / 3**	**11,000**	**9,100**	**9,500**	**N/A**
MANGANESE	3 / 3	260	148	120	300 / LTHA
MOLYBDENUM	3 / 1	10	10	10	40 / LTHA
NICKEL	3 / 0	0	0	0	100 / LTHA
PHOSPHORUS	**3 / 3**	**210**	**123**	**84**	**0.1 / LTHA**
POTASSIUM	**3 / 3**	**4200**	**2930**	**3100**	**N/A**
SELENIUM	3 / 0	0	0	0	50 / cEMEG child
SILICON	**3 / 3**	**8,300**	**5,570**	**4,900**	**N/A**
SILVER	3 / 0	0	0	0	50 / RMEG child
SODIUM	**3 / 3**	**11,000**	**8,900**	**9,700**	**N/A**
STRONTIUM	3 / 3	96	81	89	4000 / LTHA
THALLIUM	3 / 0	0	0	0	0.5 / LTHA
TIN	3 / 0	0	0	0	2.6 EPA Region III RBC
TITANIUM	3 / 2	34	32	32	150,000 EPA Region III RBC
VANADIUM	3 / 0	0	0	0	10 iEMEG child
ZINC	3 / 3	88	35.7	9.6	3000 / cEMEG child

EMEG = ATSDR Environmental Media Evaluation Guide (c – chronic; i – intermediate)
RMEG = Reference Media Evaluation Guide
PRG = EPA Region IX Preliminary Remediation Goal
RBC = EPA Region III Risk Based Comparison value
LTHA = EPA Lifetime Health Advisory Level
MCL = Maximum Contaminant Level (Public drinking water supplies)
MCLG = Maximum Contaminant Level Goal (Public drinking water supplies)

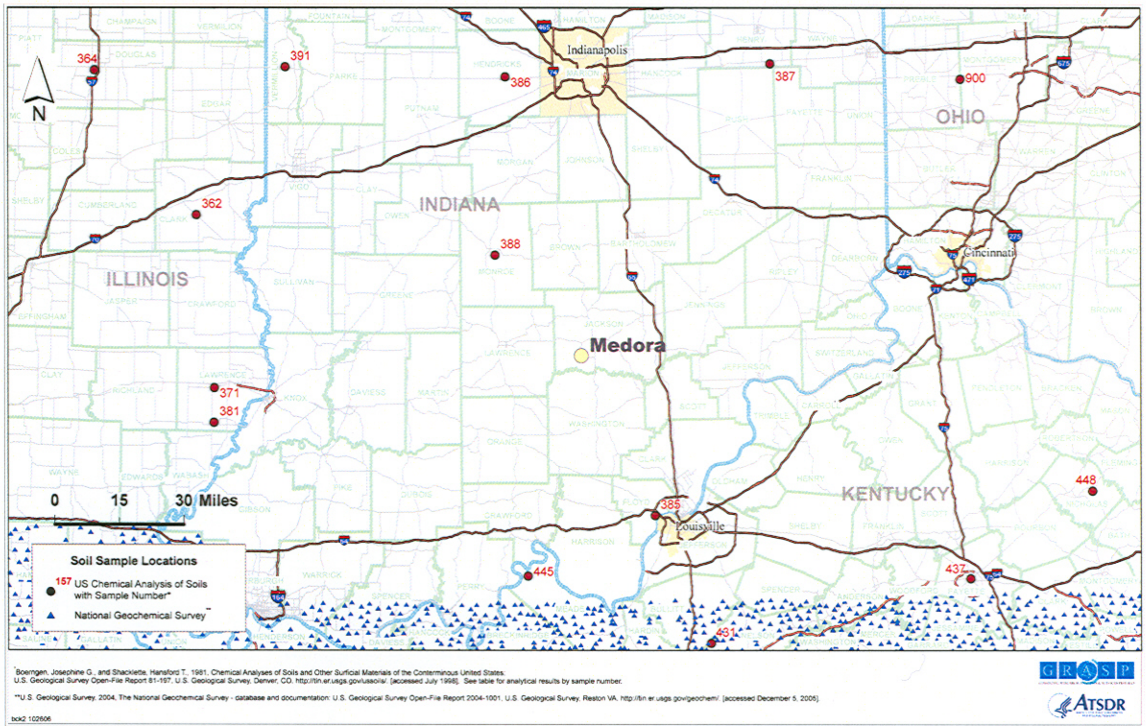
Table 4: Background levels of Metals in Medora region

Contaminant	*Average Concentration (range), ppm*
Aluminum	48,461 (ND-484,615,385)
Arsenic	9.43 (4.8-15)
Calcium	6,592.77 (1,858 - 65,927,692)
Chromium	57.69 (50-70)
Copper	20.08 (10-30)
Iron	25,000 (15,000-65,000)
Potassium	17,236 (13,283-24,000)
Lithium	28.54 (15-57)
Magnesium	4,192.3 (ND-10,000)
Nickel	15.77 (5-20)
Silicon	8,122 (ND – 36,235)
Sodium	7,000 (0-10,000)
Phosphorus	277.7 (0-1,099)
Titanium	3,784.62 (2,000-7,200)
Vanadium	77.69 (50-150)

ND: Non-detect

Figures

Figure 1: US Chemical Analysis of Soils locations



Appendix A – Dose Calculations

Arsenic Sediment Dose Calculation

Soil Ingestion Exposure Dose Equation:ED = (C x IR x EF x BF x CF) / BW

** *Equation and all default values are taken from ATSDR's Public Health Assessment Guidance Manual.*

Exposure Dose Calculator will automatically convert units to standard units.

Contaminant: ARSENIC | CAS No: 007440382 | Mol Wt.: 74.92 g/mol

C = Contaminant Concentration: 31 mg/kg | Value Source: Maximum

IR = Intake Rate of Contaminated Soil:
- Calculate Rate Based on Amount of Soil Ingested Per Da[y]: mg/day
- Use Standard Intake Rate: 200 mg/day - Child average

EF = Exposure Factor (unitless): 1

BF = Bioavailability Factor (unitless): 1

CF = Conversion Factor (10**-6 kg/mg) 1.0E-6

Optional: enter a health guideline value to use in calculating a margin of exposu[re]

Margin of Exposure:

BW = Body Weight: 16 kg -OR- Population Group: CHILDREN AGES 1-6 16 kg

RESULTS

ED = Exposure Dose: 3.90E-04 (mg/kg/day)

Daily Intake: 0.0062 mg/day

Notes

Cancer Risk (Optional) CR = ED * Oral Slope Factor * (Exposure Years / 7[0])

Exposure Duration (in years): 6 | 5.00E-05

ATSDR Health Guidelines

Chronic Oral MRL: 0.0003 mg/kg/day | Intermediate Oral MRL: mg/kg/day | Acute Oral MRL: 0.005 mg/kg/day

EPA Health Guidelines

Oral RfD: 0.0003 mg/kg/day | Oral Slope Factor: 1.5 (mg/kg/day) -¹ | RfD Soil: mg/kg/day

Health Guideline Comments

The acute oral MRL is considered provisional because it is based on a serious LOAEL.

ATSDR Comparison Values

Hierarchy Level 1 CVs*		Hierarchy Level 2 CVs*		Additional CVs*	
Chronic EMEG Child:	20 ppm	Intermediate EMEG Child:	ppm	Acute EMEG Pica Child:	10 ppm
Chronic EMEG Adult:	200 ppm	Intermediate EMEG Adult:	ppm	Intermediate EMEG Pica Child:	ppm
CREG:	0.5 ppm	Chronic RMEG Child:	20 ppm	ATSDR Soil Action Level:	ppm
		Chronic RMEG Adult:	200 ppm		

Cancer Classes

DHHS (NTP): 1 - Known to be carcinogenic

IARC: 1 - Carcinogenic to humans

EPA: A - Human carcinogen

Soil Comments

The CREG for arsenic in soil (0.5 ppm) is below background levels, so the recommended soil CV is 20 ppm.

Alternate CVs - See Welcome page regarding use of these values.

	Value	Last Download:
EPA Region III RBC (residential soil):	0.43 mg/kg	11/21/2005
EPA Region III SSL (soil, for groundwater migration, DAF 1):	0.0013 mg/kg	12/1/2005
EPA Region III SSL (soil, forgroundwater migration, DAF 20):	0.026 mg/kg	12/1/2005
EPA Region IX PRG (residential soil):	0.39 mg/kg	12/1/2005
EPA Region IX CAL-Modified PRG (residential soil):	mg/kg	
EPA Region IX SSL (soil, for groundwater migration, DAF 1):	1 mg/kg	12/1/2005
EPA Region IX SSL (soil, forgroundwater migration, DAF 20):	29 mg/kg	12/1/2005

12/13/2006 2:02 pm | MEDORA_ARSENIC_CHILD | TopHat Toxicological Profile and Health Assessment ToolKit

Arsenic Soil Dose Calculation (child)

Soil Ingestion Exposure Dose Equation:ED = (C x IR x EF x BF x CF) / BW

** Equation and all default values are taken from ATSDR's Public Health Assessment Guidance Manual.

Exposure Dose Calculator will automatically convert units to standard units.

Contaminant: ARSENIC CAS No: 007440382 Mol Wt.: 74.92 g/mol

C = Contaminant Concentration: 31 mg/kg Value Source: Maximum

IR = Intake Rate of Contaminated Soil:
- Calculate Rate Based on Amount of Soil Ingested Per Day: mg/day
- Use Standard Intake Rate: 200 mg/day - Child average

EF = Exposure Factor (unitless): 1

BF = Bioavailability Factor (unitless): 1

CF = Conversion Factor (10**-6 kg/mg): 1.0E-6

BW = Body Weight: 16 kg -OR- Population Group: CHILDREN AGES 1-6 16 kg

Optional: enter a health guideline value to use in calculating a margin of exposure:

Margin of Exposure:

RESULTS

ED = Exposure Dose: 3.90E-04 (mg/kg/day)

Daily Intake: 0.0062 mg/day

Cancer Risk (Optional) CR = ED * Oral Slope Factor * (Exposure Years / 70)

Exposure Duration (in years): 6 5.00E-05

Notes:

ATSDR Health Guidelines

Chronic Oral MRL: 0.0003 mg/kg/day Intermediate Oral MRL: mg/kg/day Acute Oral MRL: 0.005 mg/kg/day

EPA Health Guidelines

Oral RfD: 0.0003 mg/kg/day Oral Slope Factor: 1.5 (mg/kg/day) -1 RfD Soil: mg/kg/day

Health Guideline Comments

The acute oral MRL is considered provisional because it is based on a serious LOAEL.

ATSDR Comparison Values

Hierarchy Level 1 CVs*		Hierarchy Level 2 CVs*		Additional CVs*	
Chronic EMEG Child:	20 ppm	Intermediate EMEG Child:	ppm	Acute EMEG Pica Child:	10 ppm
Chronic EMEG Adult:	200 ppm	Intermediate EMEG Adult:	ppm	Intermediate EMEG Pica Child:	ppm
CREG:	0.5 ppm	Chronic RMEG Child:	20 ppm	ATSDR Soil Action Level:	ppm
		Chronic RMEG Adult:	200 ppm		

Cancer Classes

DHHS (NTP): 1 - Known to be carcinogenic
IARC: 1 - Carcinogenic to humans
EPA: A - Human carcinogen

Soil Comments

The CREG for arsenic in soil (0.5 ppm) is below background levels, so the recommended soil CV is 20 ppm.

Alternate CVs - See Welcome page regarding use of these values.

	Value	Last Download:
EPA Region III RBC (residential soil):	0.43 mg/kg	11/21/2005
EPA Region III SSL (soil, for groundwater migration, DAF 1):	0.0013 mg/kg	12/1/2005
EPA Region III SSL (soil, forgroundwater migration, DAF 20):	0.026 mg/kg	12/1/2005
EPA Region IX PRG (residential soil):	0.39 mg/kg	12/1/2005
EPA Region IX CAL-Modified PRG (residential soil):	mg/kg	
EPA Region IX SSL (soil, for groundwater migration, DAF 1):	1 mg/kg	12/1/2005
EPA Region IX SSL (soil, forgroundwater migration, DAF 20):	29 mg/kg	12/1/2005

12/13/2006 2:02 pm MEDORA_ARSENIC_CHILD TopHat Toxicological Profile and Health Assessment ToolKit

Arsenic Soil Calculation (Infant)

Soil Ingestion Exposure Dose Equation:ED = (C x IR x EF x BF x CF) / BW

*** Equation and all default values are taken from ATSDR's Public Health Assessment Guidance Manual.*

Exposure Dose Calculator will automatically convert units to standard units.

Contaminant: ARSENIC | CAS No: 007440382 | Mol Wt.: 74.92 g/mol

C = Contaminant Concentration: 22 mg/kg | Value Source: Maximum

IR = Intake Rate of Contaminated Soil:
- Calculate Rate Based on Amount of Soil Ingested Per Day: mg/day
- Use Standard Intake Rate: 200 mg/day - Child average

EF = Exposure Factor (unitless): 1

BF = Bioavailability Factor (unitless): 1

CF = Conversion Factor (10**-6 kg/mg): 1.0E-6

BW = Body Weight: 10 kg -OR- Population Group: INFANTS 10 kg

Optional: enter a health guideline value to use in calculating a margin of exposure:

Margin of Exposure:

RESULTS

ED = Exposure Dose: 4.40E-04 (mg/kg/day)

Daily Intake: 0.0044 mg/day

Cancer Risk (Optional) CR = ED * Oral Slope Factor * (Exposure Years / 70)

Exposure Duration (in years): 1

Notes

ATSDR Health Guidelines

Chronic Oral MRL:	0.0003 mg/kg/day	Intermediate Oral MRL:	mg/kg/day	Acute Oral MRL:	0.005 mg/kg/day

EPA Health Guidelines

Oral RfD:	0.0003 mg/kg/day	Oral Slope Factor:	1.5 (mg/kg/day) -1	RfD Soil:	mg/kg/day

Health Guideline Comments

The acute oral MRL is considered provisional because it is based on a serious LOAEL.

ATSDR Comparison Values

Hierarchy Level 1 CVs*

Chronic EMEG Child:	20 ppm
Chronic EMEG Adult:	200 ppm
CREG:	0.5 ppm

Hierarchy Level 2 CVs*

Intermediate EMEG Child:	ppm
Intermediate EMEG Adult:	ppm
Chronic RMEG Child:	20 ppm
Chronic RMEG Adult:	200 ppm

Additional CVs*

Acute EMEG Pica Child:	10 ppm
Intermediate EMEG Pica Child:	ppm
ATSDR Soil Action Level:	ppm

Cancer Classes

DHHS (NTP): 1 - Known to be carcinogenic
IARC: 1 - Carcinogenic to humans
EPA: A - Human carcinogen

Soil Comments

The CREG for arsenic in soil (0.5 ppm) is below background levels, so the recommended soil CV is 20 ppm.

Alternate CVs - See Welcome page regarding use of these values.

		Last Download:
EPA Region III RBC (residential soil):	0.43 mg/kg	11/21/2005
EPA Region III SSL (soil, for groundwater migration, DAF 1):	0.0013 mg/kg	12/1/2005
EPA Region III SSL (soil, forgroundwater migration, DAF 20):	0.026 mg/kg	12/1/2005
EPA Region IX PRG (residential soil):	0.39 mg/kg	12/1/2005
EPA Region IX CAL-Modified PRG (residential soil):	mg/kg	
EPA Region IX SSL (soil, for groundwater migration, DAF 1):	1 mg/kg	12/1/2005
EPA Region IX SSL (soil, forgroundwater migration, DAF 20):	29 mg/kg	12/1/2005

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