Public Health Advisory

E.C. ELECTROPLATING
(a/k/a GARFIELD CHROMIUM GROUNDWATER CONTAMINATION SITE)

GARFIELD, BERGEN COUNTY, NEW JERSEY

EPA FACILITY ID: NJD002006773

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Introduction (Statement of Purpose)

On July 21, 2010, the United States Environmental Protection Agency (EPA) advised both the New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) that they had preliminary data indicating that elevated levels (2,640,000 micrograms per square meter ($\mu g/m^2$)) of hexavalent chromium were found in a basement at a mixed use (commercial/residential) property near the E.C. Electroplating site in Garfield, New Jersey. On August 5, 2010, U.S. EPA provided ATSDR and NJDHSS with the validated data. That data provided a basis for a health consultation as well as an evaluation of the public health implications of exposures to hexavalent chromium in surface dust.[1]

ATSDR has determined that the current exposures emanating from or near the E. C. Electroplating site warrant the issuance of a Public Health Advisory. U.S. EPA found that groundwater contaminated with high levels of hexavalent chromium had entered the basements of some of the properties located above a contaminated groundwater plume. The one basement at the mixed-use property referenced above contained highly elevated levels of hexavalent chromium. Thus ATSDR and NJDHSS concluded that children and adults accessing any property basements in the area of the E.C. Electroplating site were and still are exposed to hexavalent chromium in surface dust at levels that may pose an immediate and significant threat to human health. If actions are not taken, these exposures will likely continue in the future. Note that people can be exposed to the harmful levels of hexavalent chromium by accidentally swallowing and inhaling contaminated dust.

The observed concentration of hexavalent chromium in basement dust at the mixed-use property where the maximum level was detected establishes the presence of an urgent public health hazard. In addition, while not all properties within the plume area have been evaluated, the finding of a high concentration of hexavalent chromium in basement dust at this one property is an indicator that all residences in the immediate vicinity have been, are presently, or in the future will be at risk of contamination. The degree of that contamination could pose a significant health risk to residents, whether the basement is frequently used (high-use) or lesser used (low-use).

ATSDR and NJDHSS recommend that U.S. EPA take short- and long-term measures to **dissociate** persons—whether in residential or commercial properties in the area of the contaminant plume—from hexavalent chromium exposures resulting from infiltration of contaminated groundwater into the basements of these properties. Acting on ATSDR's and NJDHSS's recommendation, U.S. EPA has already taken steps to remediate the one property where the highest levels of surface-dust hexavalent chromium were found in the basement.

Over the longer term, however, U.S. EPA should move to remediate permanently the source of the hexavalent chromium in the Garfield, NJ area groundwater-contamination plume.

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[1] The interpretation, advice, and recommendations provided in this public health advisory are based on the data and information evaluated and referenced here and in the NJDHSS health consultation prepared under cooperative agreement with ATSDR (ATSDR 2010b). The conclusions, recommendations, and public health actions in this advisory are site-specific and are not intended as generally applicable to any other situation.

In the absence of a permanent solution, all residents within that groundwater contamination plume could continue to be exposed to hexavalent chromium. And that exposure could be at levels that present an immediate and significant health threat. Until a permanent groundwater contamination solution is in place, the U.S. EPA should continue with actions to prevent hexavalent-chromium contaminated groundwater from entering any and all residences within the groundwater plume.

Background

The E.C. Electroplating site (a.k.a. Garfield Chromium Groundwater Contamination site) is located at 125 Clark Street in Garfield, Bergen County, New Jersey. The site occupies a ¾ acre (approximate) parcel in a mixed residential and commercial area of Garfield. In December 1983, approximately 3,640 gallons of chromium plating solution (chromic acid) containing 5,441 pounds of chromium were discharged from a partially below-ground storage tank. In response, five monitoring wells and one recovery well were installed to monitor groundwater and to recover discharged product. Background reports indicate that by May 1984, 1,044 gallons of product and 1,600 pounds of chromium were recovered. The tank leak and subsequent spill of chromic acid solution likely impacted the overburden and bedrock aquifers.

In May 1985, the New Jersey Department of Environmental Protection (NJDEP) allowed E.C. Electroplating to cease contaminant recovery efforts. Rather, NJDEP directed E.C. Electroplating to seal four of the groundwater wells and to continue groundwater monitoring from two on-site wells. E.C. Electroplating, however, failed to comply with this monitoring directive. In June 1993, chromium-contaminated groundwater and crystals were discovered in the basement of the nearby Garfield Fire House #3. The fire house was subsequently taken out of service. In November 1993, NJDEP and E.C. Electroplating entered into a Memorandum of Agreement to comply with regulatory investigation requirements, including full delineation of the chromium-contaminated groundwater plume (NJDEP 2002a). Between November 1994 through April 2000, four groundwater monitoring wells were installed to comply with the agreement's delineation requirements. As of April 2000, groundwater samples at one on-site monitoring well indicated maximum concentrations of total chromium and hexavalent chromium at 1,500,000 and 1,490,000 micrograms per liter (µg/L), respectively (NJDEP 2002b).

The groundwater sampling results prompted an additional, October 2000 investigation that revealed chromium-contaminated groundwater within the basement sumps of several residences and commercial properties in the immediate vicinity of the discharge site. In September 2002, the NJDEP issued a Notice of Violation to E.C. Electroplating for failing to comply with continued investigation and for failing to initiate remedial actions. The company cited financial difficulty as the reason for its inability to conduct continued remedial investigations and actions. Also in October 2002, the NJDEP requested that U.S. EPA evaluate the site.[2]

[2] In addition to E.C. Electroplating, U.S. EPA is investigating other potential sources of chromium that may have contaminated groundwater. These potential sources include a nearby tannery, a chemical plant, and another electroplating facility within the Garfield area (USEPA 2008).

In September 2007, in response to a request by U.S. EPA Region 2, NJDHSS and ATSDR completed a health consultation for the Garfield, New Jersey, E.C. Electroplating site. The September 2007 health consultation was based on limited environmental data; the health consultation, however, did recommend additional sampling to better assess potential public health threats to residents in the vicinity of the site (ATSDR 2007).

In April 2010, NJDHSS and ATSDR completed an additional site health consultation. This consultation assessed potential hexavalent chromium exposures to area residents based on U.S. EPA Region 2's 2009 sampling investigations (ATSDR 2010a). The April 2010 health consultation concluded in part that

- Because of ingestion of hexavalent chromium dust in limited-use basements, a public health hazard exists;
- If any of the basements with high levels of hexavalent chromium were used more frequently, an urgent public health hazard could exist in the future; and
- Ingestion of dust from the Roosevelt Elementary School was not expected to harm people's health.

During February and March 2010, the U.S. EPA collected dust-wipe samples from a total of 92 residential/commercial properties (USEPA 2010a). In July 2010, the U.S. EPA collected dust-wipe samples from an additional 13 residential/commercial properties (USEPA 2010b). The U.S. EPA identified these properties for evaluation based on resident survey responses and property location in relation to the contaminated groundwater plume. The purpose of the investigations was to determine whether hexavalent chromium in groundwater had affected the interior of these basements. An NJDHSS health consultation evaluated these most recent data, and that health consultation forms the basis for this public health advisory (ATSDR 2010b).

Basis for the Public Health Advisory

Concentrations of hexavalent chromium were detected in surface dust within 41 sampled basements. The detections ranged from 1 to 2,640,000 micrograms per square meter ($\mu g/m^2$). The following table summarizes the 2010 investigation dust-wipe sampling results:

Table 1: Summary of Hexavalent Chromium Concentrations in Wipe Samples

U.S. EPA Investigations: February, March, June and July 2010

Sample Locations	Number of Samples	Number of Detections	Number of Residences with Detections	Range of Detected Concentrations ($\mu g/m^2$)
105 properties	405	65	41	1 – 2,640,000

ug/m2= micrograms per meter squared.

The method for assessing the presence of a health hazard in a community is to determine whether a completed exposure pathway connects a contaminant source to a receptor population, and whether exposures to that contamination are sufficiently high to be of health concern. As described in the April 2010 Health Consultation (ATSDR 2010a), an exposure pathway was and is complete for ingestion of—and dermal contact with—surface dust containing hexavalent chromium. The recent basement data confirm the existence of this pathway for the 41 properties evaluated during the February through July 2010 investigation. Exposed persons may include children and adults occupying or working in structures identified as contaminated. In addition, anecdotal evidence suggests that residents may periodically use a broom to sweep up the yellow chromium crystals. If surface crystals are disturbed and become airborne, inhalation of hexavalent chromium becomes a potential exposure pathway. Persons exposed in this pathway may also include children and adults living or working in structures identified as contaminated.

In this health advisory, basement usage at sampled residences is characterized as either "high use" or "low use." The general assumption is that the high-use category is applied to basements that serve as an extra living space and where area usage would be intensive (e.g., for playing, sleeping, working) and on a daily basis. For the low-use category, the general assumption is that these are basements used only intermittently (e.g., for laundry or storage). Given these high-use and low-use exposure scenarios, site-specific exposure doses were calculated and compared with health guideline comparison values (CVs) as shown in Table 2.

U.S. EPA data verify that contaminated groundwater can infiltrate into basements. That contaminated groundwater can then leave behind a high-level residue of hexavalent chromium in surface dust and crystals. The maximum concentration of hexavalent chromium detected in surface dust was 2,640,000 $\mu g/m^2$ in the mixed-use, low-use basement identified by U.S. EPA (see Photographs 1 and 2 below). This detected hexavalent chromium value was used to evaluate exposure scenarios for both high- and low-use basements for properties within the immediate vicinity of the E.C. Electroplating site. Because the basements of properties in the immediate vicinity of this property fall within varying degrees of both high- and low-use scenarios, we used the maximum concentration.

Environmental sampling can only show contaminant concentration at a point in time. Resident actions such as cleaning can influence sampling results in ways that could lead to an underestimation of actual exposures and risks. Furthermore, high concentrations may recur following new water infiltration events. In this area of Garfield NJ, water infiltration events are common. Therefore, all properties in the vicinity of the E.C. Electroplating site are considered at risk of similar concentrations in basement surface dusts. Conservatively estimated, 15 to 20 unsampled properties are within in the immediate vicinity of that part of the groundwater plume area exhibiting the highest concentrations of hexavalent chromium in groundwater.

Photograph 1: Photo taken by U.S. EPA Region 2 On Scene Coordinator of basement where maximum detection of hexavalent chromium occurred. The yellow staining indicates chromium precipitate.

Photograph 2: Another photo taken by U.S. EPA Region2 OSC of adjoining room in basement where maximum detection of hexavalent chromium occurred. This area of the basement has a couch (bottom of photo), air conditioner, and paneling.

Public Health Implications of Completed Exposure Pathways

Appendix A contains the site-specific exposure assumptions (USEPA 1997; 2003; 2008) used to calculate exposure doses to child and adult residents and to adult employees. Appendix A also contains a statement regarding the uncertainty introduced by the assumptions used in calculating the non-cancer dose from incidental ingestion of surface dust from the formula used in the U.S. EPA World Trade Center Indoor Environment Assessment study (USEPA 2003).

Noncancer Health Effects—Incidental Ingestion of Surface Dust

Exposure dose estimates were calculated using the exposure assumptions outlined in the April 2010 health consultation. For this evaluation, we used the maximum concentration of hexavalent chromium detected in surface dust at 2,640,000 $\mu g/m^2$ the mixed-use, low-use basement target property. That concentration was then used to construct exposure scenarios for both high- and low-use basements for properties within the immediate vicinity of the target property. We used the maximum concentration because the basements of properties in the immediate vicinity of this property and the groundwater "hot-spot" area fall within high or low usage. Moreover, U.S. EPA data verify that contaminated groundwater can infiltrate into basements and leave behind very high levels of hexavalent chromium residue in surface dust. As stated, environmental sampling can only show the concentration of a contaminant at a point in time, and resident actions such as cleaning can influence sampling results. These conditions, then, could lead to an underestimation of actual exposures and risks. Furthermore, following new water infiltration events, high concentrations may recur. In support of this assumption, the three residences, previously evaluated in the April 2010 health consultation, within the groundwater "hot-spot" plume area showed that concentrations of hexavalent chromium in surface dust had created conditions in which exposure doses could exceed the margin of safety represented by the chronic and intermediate health CVs. Additionally and as discussed further in this document, the most recent U.S. EPA sampling results show that exposure doses for one of these three properties also exceeded the chronic, intermediate, and acute lowest-observed-adverse-effect levels (LOAELs) based on recent animal studies. From a public health standpoint, exceeding the LOAEL is important—it represents a level at which harmful (adverse) health effects have been seen in either animals or humans.

Low-Use Basements

Hexavalent Chromium. The intermediate oral ATSDR Minimal Risk Level (MRL) for hexavalent chromium is 0.005 milligrams of contaminant per kilogram of body weight per day (mg/kg/day). That MRL is based on the health effect of microcytic, hypochromic anemia in male rats intermediately exposed to sodium dichromate dihydrate in drinking water for 22 days to 6 months. An uncertainty factor of 100 and the Benchmark Dose Level $(BMDL)_{2sd}$ of 0.52 mg/kg/day were used to calculate the intermediate oral MRL (ATSDR 2008; NTP 2008). The chronic oral MRL for hexavalent chromium of 0.001 mg/kg/day is based on the health effect of diffuse epithelial hyperplasia of the duodenum observed in male and female mice chronically exposed to sodium dichromate dihydrate in drinking water for 1 to 2 years. The chronic oral MRL was calculated using an uncertainty factor of 100 and the $BMDL_{10}$ of 0.09 mg/kg/day (ATSDR 2008; NTP 2008).

Given the maximum concentration of hexavalent chromium detected in surface dusts, the exposure dose calculated for children (1–6 years) at 0.54 mg/kg/day, children (1–18 years) at 0.31 mg/kg/day and adults at 0.25 mg/kg/day significantly exceeded the margin of safety represented by the ATSDR intermediate and chronic MRLs of 0.005 and 0.001 mg/kg/day, respectively (see Table 2 below). They also met or exceeded effect levels shown in animal studies, as detailed below.

Compared with toxicological studies, the calculated exposure doses based on the maximum hexavalent concentration in surface dust

- Exceed the lowest-observed-adverse-effect level (LOAEL) of 0.38 mg/kg/day in female mice and are near the LOAELs of 0.77 and 1.4 mg/kg/day in male rats and female mice for intermediate exposures known to cause hematological effects (NTP 2008);

- Exceed the LOAEL of 0.38 mg/kg/day for chronic exposures known to cause gastrointestinal and hepatic effects in male and female mice (NTP 2008); and

- Exceed the benchmark dose level ($BMDL_{10}$) of 0.09 mg/kg/day for chronic exposures known to cause diffuse epithelial hyperplasia of the duodenum observed in male and female mice (NTP 2008).

We cite the three intermediate LOAELs to provide the range of exposure doses wherein health effects were observed for the specific intermediate exposure period. The LOAELs are based on 2008 studies conducted by the National Toxicology Program (NTP). These studies examined the health effects of oral exposures in mice and rats intermediately exposed to sodium dichromate dihydrate in drinking water. The three intermediate LOAELs identified in these studies are also based on hematological effects observed for the following: 0.38 mg/kg/day for female mice after a 22-day exposure; 0.77 mg/kg/day for male rats after 22-day and 6-month exposures; and 1.4 mg/kg/day for female mice after a 6-month exposure (NTP 2008). Thus for the property in which the maximum observed concentration of hexavalent chromium in dust was detected, noncancer adverse health effects could occur in children and adults who have accessed this low-use basement. This conclusion may also apply to other properties with high-use-basements in the vicinity of and with contamination levels similar to the contaminated low-use basement property described above that exhibited the highest concentration of hexavalent chromium detected in basement dust.

High-Use Basements

Hexavalent Chromium. Using the maximum observed concentration of hexavalent chromium, the estimated exposure dose calculated for children (1–6 years) at 4.3 mg/kg/day, children (1–18 years) at 2.2 mg/kg/day and adults at 1.7 mg/kg/day significantly exceeded the margin of safety established by the ATSDR intermediate and chronic MRLs of 0.005 and 0.001 mg/kg/day, respectively (see Table 2 below). The exposure dose also exceeded effect levels shown in animal studies as detailed below.

Table 2: Comparison of Ingested Exposure Dose to Hexavalent Chromium (Cr^{+6}) in Surface Dust with Health Guideline Comparison Values (CVs) for Noncancer Health Effects

Exposure Scenario	Exposure Point Concentration[c] (micrograms per square meter ($\mu g/m^2$))	Exposure Dose (milligrams per kilogram per day (mg/kg/day))			Health Guideline CVs (mg/kg/day)		National Toxicology Program Study LOAELs (NTP 2008)[f] (mg/kg/day)		LOAEL Exceeded
		Child (1–6 yrs)	Child (1–18 yrs)	Adult	ATSDR MRL[d]	USEPA RFD[e]	Acute	Intermediate Range	
Low Usage Residential Basements Cr^{+6} [a]	2,640,000	0.54	0.31	0.25	0.005 (I)	0.003	2.8	0.38–1.4	Yes
High Usage Residential Basements Cr^{+6} [b]	2,640,000	4.3	2.2	1.7	0.001 (C)				Yes

Cr^{+6}= Hexavalent chromium

(a) Low Usage Exposure Assumptions (source USEPA 1997, 2003):

1 - 2.5 hours per day (hrs/day), 2–5 days/week –(i.e., unfinished basements, laundry use)

Exposure Duration: 18 years (child), 30 yrs (adult)

Body Weight: Child - 16.5 kilogram (kg) (1–6 years), 34 kg (7–12 yrs) and 58 kg (13–18 years); Adult - 70 kg

(b) High Usage Exposure Assumptions (source USEPA 1997; 2003):

365 days/year - i.e. living space

Exposure Duration: 6 and 18 yrs (child), 30 yrs (adult)

Body Weight: Child - 16.5 kg (1–6 yrs), 34 kg (7–12 yrs) and 58 kg (13–18 yrs); Adult - 70 kg

(c) Exposure Point Concentrations (micrograms per square meter) derived using Pro UCL Version 4.00.02 (USEPA 2007).

$\mu g/m^2$= micrograms per square meter

mg/kg= milligrams per kilogram

MRL= ATSDR Minimal Risk Level

(d) ATSDR's Minimal Risk Level (I = Intermediate 15–365 days; C= Chronic > 364 days)

RFD= EPA Reference Dose

(e) USEPA's Chronic Reference Dose

(f) National Toxicology Program. (NTP) 2008. NTP technical report on the toxicology and carcinogenesis studies of sodium dichromate dihydrate (CAS No. 7789-12-0) in F344/N rats and B6C3F1 mice (drinking water studies). Washington, DC: National Toxicology Program. NTP TR 546. August 13, 2008.

LOAEL= Lowest observed adverse effect level

Compared with toxicological studies, the calculated exposure doses based on the maximum hexavalent concentration in surface dust

- Exceeded the LOAEL of 2.8 mg/kg/day for acute exposures known to cause hematological effects in male rats (NTP 2008**);**
- Exceeded all intermediate and chronic LOAELs (0.38 to 1.4 mg/kg/day) and the chronic $BMDL_{10}$ of 0.09 mg/kg/day described in the preceding *Low Use Basement* scenario.

Therefore, in basements considered as high use and at the maximum observed concentration of hexavalent chromium in dust, noncancer adverse health effects are likely to occur in children and adults exposed to such hexavalent chromium-contaminated dust. This conclusion applies to all properties with high-use basements in the vicinity of the low-use basement property with the highest concentration of hexavalent chromium detected in basement dust, if those basements have similar contamination levels.

Cancer Health Effects—Incidental Ingestion of Surface Dust

The United States Department of Health and Human Services (US DHHS), the U.S. EPA, the U.S. DHSS, National Toxicology Program (NTP) and the International Agency for Research on Cancer have determined that regarding inhalation exposure, the cancer class of hexavalent chromium is listed as a known human carcinogen.

Regarding oral exposure, the NTP has recently completed a 2-year study in which reliable evidence supported the conclusion that ingestion of hexavalent chromium-contaminated drinking water caused malignant tumors in mice and rats. A 2-year study on laboratory animals is considered the primary method to determine the potential for human hazard. Regulatory agencies have used NTP rodent studies to promulgate regulations to protect human health and in the hazard identification process for risk assessment (NTP 2008).

The cancer risk was evaluated for incidental ingestion of surface dust contaminated with hexavalent chromium based on the location-specific exposure scenarios used to assess noncancer health effects. Appendix A contains the site-specific exposure assumptions for the cancer risk calculations.

Low-Use Basements

For the property in which the maximum observed concentration of hexavalent chromium in dust was detected, the lifetime excess cancer risks (LECRs) were approximately 4 in 100 for children and adults who have accessed and who might continue to access this low-use basement. This is considered an increased risk of cancer when compared with the background risk of all or specific cancers, and it is of significant concern (see Table 3 below). ATSDR considers as insignificant estimated cancer risks of less than one additional cancer case among one million persons exposed (expressed as 1 in 1,000,000). This conclusion also applies to similarly contaminated properties with low-use basements in the vicinity of that property described above that exhibited the highest concentration of hexavalent chromium detected in basement dust.

High-Use Basements

Using the maximum observed concentration of hexavalent chromium in dusts, the theoretical LECRs for children and adults were approximately 3 in 10, which is considered an increased risk of cancer and is of significant concern (see Table 3 below). This conclusion may also apply to other properties with high-use-basements in the vicinity of and with contamination levels similar to the previously referenced, contaminated low-use basement property. That is, the low-use basement that exhibited the highest concentration of hexavalent chromium detected in basement dust.

Table 3: Calculated Lifetime Excess Cancer Risk Based on Ingestion Exposures to Hexavalent Chromium (Cr^{+6}) in Surface Dust

Exposure Scenario	Exposure Point Concentration[(c)] (micrograms per square meter ($\mu g/m^2$))	Exposure Duration (years)	Exposed Population	CSF[(d)] [(milligrams per kilogram per day)$^{-1}$ (mg/kg/day)$^{-1}$]	Lifetime Excess Cancer Risk (LECR)
Low Usage Residential Basements Cr^{+6} (a)	2,640,000	30	Adult	0.5	4.1E-02
		18	Child		3.4E-02
High Usage Residential Basements Cr^{+6} (b)	2,640,000	30	Adult		3.0E-01
		18	Child		2.8E-01

Cr^{+6}= Hexavalent chromium

(a) Low Usage Exposure Assumptions (source USEPA 1997; 2003):

1 - 2.5 hours/day, - days/week - i.e. unfinished basements, laundry use, adults only

Exposure Duration: 18 years (child), 30 years (adult); Averaging Time 70 years

Body Weight: Child - 16.5 kg (1–6 years), 34 kg (7–12 years) and 58 kg (13–18 years); Adult - 70 kg

(b) High Usage Exposure Assumptions (source USEPA 1997; 2003):

365 days/year - i.e. living space

Exposure Duration: 18 years (child), 30 years (adult); Averaging Time 70 years

Body Weight: Child - 16.5 kg (1–6 years), 34 kg (7–12 years) and 58 kg (13–18 years); Adult - 70 kg

(c) Exposure Point Concentrations (micrograms per square meter) derived using Pro UCL Version 4.00.02 (USEPA 2007).

$\mu g/m^2$= micrograms per square meter

(d) Source: NJDEP, 2009

Inhalation Exposure Evaluation

No hexavalent chromium air sampling data are available for the basement where the highest levels of hexavalent chromium were found. Nonetheless, the potential remains for exposure to hexavalent chromium via inhalation if the dust/crystals are disturbed and become airborne. No data are available to conclude whether the inhalation of hexavalent chromium could affect people's health in the mixed-use, low-use basement where the highest level of hexavalent chromium was found. That said, ATSDR has established an intermediate inhalation MRL for hexavalent chromium particles of 0.0003 milligrams per cubic meter of air. The most common health problem in workers exposed to chromium involves the respiratory tract. Health effects include irritation of the lining of the nose, runny nose, and breathing problems (e.g., asthma, cough, shortness of breath, wheezing) inhalation of hexavalent chromium has been shown to cause lung cancer in workers.

Dermal Exposure Evaluation

No known environmental comparison value relates dermal exposures to hexavalent chromium in surface dust. Hexavalent chromium, however, is a known skin irritant and can cause skin ulcers. But the health risks via the dermal pathway are uncertain; they were not evaluated quantitatively in the September 2010 health consultation on which this public health advisory is based.

Conclusions

ATSDR has determined that the current exposures warrant the issuance of a Public Health Advisory. ATSDR and NJDHSS conclude that children and adults accessing basements of properties in the area of the E.C. Electroplating site area were, are, and will continue to be exposed to hexavalent chromium at levels that may pose an immediate and significant threat to their health. People can be exposed to the harmful levels of hexavalent chromium by inhaling and by accidentally swallowing contaminated dust. The observed concentration of hexavalent chromium in basement dust at the mixed-use, low-use property where the maximum level was detected indicates the presence of an urgent public health hazard.

Data for the basement area of one of the properties sampled indicated hexavalent chromium was present in dust at high concentrations due to contaminated groundwater entering the basement area. Not all properties within the groundwater plume area have been evaluated. But finding a high concentration of hexavalent chromium in basement dust at one property is an indicator that all residences in this immediate vicinity have been, are presently, or will be at risk of contamination. And that contamination could be at levels that pose a significant health threat to residents. Note that this conclusion applies to all affected residences, whether their basements are high- or low-use areas.

As long as groundwater remains contaminated with high levels of hexavalent chromium, that contaminated groundwater may continue to infiltrate into the basements of residences, as demonstrated by current U.S. EPA data. Children and adults will therefore continue to be at risk of exposure to levels of hexavalent chromium posing an immediate and significant threat to

human health. This risk affects all residents at properties within the immediate vicinity of the mixed-use, low-use property with the maximum hexavalent chromium concentration in basement surface dust.

Using the concentration of hexavalent chromium detected in basement surface dust, the risk of noncancer health effects from ingestion exposures is significantly elevated above a reasonable margin of safety for children and adults. The theoretical lifetime oral excess cancer risk is calculated as 4 in 100 for low-use basements and 3 in 10 for high-use basements, but note that both are considered an increased cancer risk and both are of significant concern.

Data are unavailable for the inhalation pathway. ATSDR cannot therefore reach a conclusion regarding the health effects of inhaling hexavalent chromium particulates in air. Anecdotal evidence suggests, however, that residents may periodically use a broom to sweep up the yellow chromium crystals. If surface crystals are thus disturbed and become airborne, inhalation of hexavalent chromium is a potential exposure pathway. This is of particular concern given that hexavalent chromium is considered a known human carcinogen via inhalation.

The amount of exposure to hexavalent chromium and consequent health risk depends in part on the degree to which residents access this contaminated area and the activities they conduct therein. Under both the high- and low-use scenarios, however, these risks remain very high. And these risks are considered present for all residents at properties within the immediate vicinity of that property with the maximum hexavalent chromium concentration.

Recommendations

ATSDR and NJDHSS recommend that U.S. EPA take short- and long-term measures to **dissociate** persons (either in residential or commercial properties), who live, work, or both in the contaminant plume area. This dissociation would be from hexavalent chromium exposures due to the infiltration of contaminated ground water into the basements of these properties. Acting on ATSDR's and NJDHSSs' recommendation, U.S. EPA has already taken immediate steps to remediate the property with the highest levels of hexavalent chromium in basement surface dust.

Additionally, U.S. EPA should advise residents in the immediate vicinity of the property showing the highest contaminant levels not to use their basements as they otherwise might use them until after completion of an environmental assessment to determine the presence of a health hazard. Residents should be advised to contact U.S. EPA if they observe signs of hexavalent chromium contamination (e.g., yellow dust or crystals) in the basements of their homes.

In the long term, U.S. EPA should take steps to remove permanently the source of hexavalent chromium contamination in the Garfield, NJ area groundwater. Until completion of such permanent solution, all residents within the contaminant plume may continue to be exposed to hexavalent chromium at levels that present an immediate and significant threat to their health. And until completion of that permanent solution, U.S. EPA should continue to implement actions to clean basements where hexavalent chromium is at levels of health concern. U.S. EPA should also continue to prevent groundwater contaminated with hexavalent chromium from entering any residence within the groundwater plume.

With regard to worker safety, a site-specific health and safety plan should be implemented during any remedial activities to ensure such worker safety.

Public Health Action Plan

The public health actions taken by the ATSDR and NJDHSS are as follows:

1. The ATSDR and NJDHSS have worked with U.S. EPA to review information and relevant data and thereafter to evaluate the potential health implications for exposures to hexavalent chromium detected in surface dust at residences within the hexavalent chromium groundwater plume associated with the E.C. Electroplating site.
2. Two health consultations were completed by the ATSDR and NJDHSS in September 2007 and April 2010, respectively (ATSDR 2007; ATSDR 2010a).
3. In September 2008, the NJDHSS attended a public meeting hosted by U.S. EPA to discuss site investigations planned for the residential area within the affected groundwater plume area.
4. In May 2010, the NJDHSS and ATSDR held a public meeting to discuss the April 2010, E C Electroplating site Health Consultation findings and recommendations.
5. In September 2010 (ATSDR 2010b), the NJDHSS, under cooperative agreement with ATSDR, issued a health consultation that evaluated the most recent data and that provided the basis for this public health advisory.

The public health actions planned by the ATSDR and NJDHSS are as follows:

1. By issuing this Public Health Advisory, ATSDR calls on U.S. EPA to implement short- and long-term actions necessary to prevent exposures of affected residents to hexavalent chromium and to address the source of hexavalent chromium in groundwater. Short-term actions include

    - Continued assessment of properties in areas with high levels of hexavalent chromium groundwater contamination,
    - Outreach to residents and community members to inform U.S. EPA of any wet basements, chromium blooms (e.g. yellow dust or crystals) or other evidence of suspected site-related contamination, and
    - Continued monitoring of previously remediated properties to evaluate possible recontamination.

    Concurrently, in the long-term, U.S. EPA should develop options for addressing the contaminated groundwater plume, with an emphasis on remediating the area of highest groundwater contamination as soon as possible.

2. NJDHSS will advise area health care providers, particularly pediatricians and family practitioners, of this report's findings. NJDHSS will make available materials on hexavalent chromium, including the ATSDR Case Study in Environmental Medicine—

Chromium Toxicity and the chromium ToxFAQ. NJDHSS will also provide copies of the report to the New Jersey Poison Information and Education System for health care provider reference and information.

3. NJDHSS will provide additional community health education to advise residents to limit activities in chromium-contaminated basements. Also, NJDHSS will encourage residents who see yellow deposits in dust or on their floors or walls to contact U.S. EPA.
4. ATSDR is committed to review of additional data or to respond to additional requests involving the E.C. Electroplating site as necessary.

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Appendix A. Noncancer Exposure Assumptions

Exposures are based on incidental ingestion of surface dust contaminated with hexavalent chromium during use of residential basement areas. Noncancer exposure doses were calculated using the following formula obtained from the U.S. EPA World Trade Center Indoor Environment Assessment study (USEPA 2003):

$$\textit{Exposure Dose (mg/kg/day)} = \frac{[(ET_{hard} \times FTSS_{hard} \times CSL_{hard}) + (ET_{soft} \times FTSS_{soft} \times CSL_{soft})] \times SA \times FQ \times SE}{BW}$$

where mg/kg/day = milligrams of contaminant per kilogram of body weight per day and;

ET = Exposure Time (hr/day) for hard and soft (carpeted) surfaces;
FTSS = Fractions Transferred from Surface to Skin (unitless)
$FTSS_{hard}$ = 50%, $FTSS_{soft}$ = 10%;
CSL = Contaminant Surface Load (mg/cm^2);
SA = Surface Area (cm^2/event);
FQ = Frequency of hand-to-mouth events (events/hr);
SE = Saliva Extraction Factor at 50% (unitless); and,
BW = Body Weight (kg)

Note: The above formula requires multiple assumptions in estimating exposures to surfaces which add uncertainty to estimating exposure doses. Factors such as surface loading and transfers to skin are likely to be highly variable as they have not been well studied. Variability of these factors may be influenced by characteristics of different surfaces, activity patterns related to surface contact, and surface cleaning techniques and frequency (USEPA 2003). In following the USEPA World Trade Center Indoor Environment Assessment study, this assessment used input parameters to define reasonably the maximum exposures for both high and low use basement areas.

General Exposure Assumptions

Exposure Setting	Exposed Population	Surface Area (mouthing area)	Hand-to-Mouth Contacts (events/hour)
Resident	Child (1 through 6 years)	15 to 25 cm^2 (Age Adjusted)	9.5 (Age Adjusted)
	Child (1 through 18 years)	15 to 45 cm^2 (Age Adjusted)	2 to 9.5 (Age Adjusted)
	Child/Adult (1 to 31 years)	15 to 45 cm^2 (Age Adjusted)	1 to 9.5 (Age Adjusted)
Resident/Employee	Adult	45 cm^2	1

cm^2= centimeter squared

Location Specific Assumptions: Low Usage Scenario for Basements

Exposed Population	Body Weight	Exposure Time [(e)]	Number of Years Exposed
Child [(a)] (1 through 6 years)	12 to 23 kg (Age Adjusted)	1 hour/day 5 days/week	6
Child [(b)] (7 through 12 years)	26 to 53 kg (Age Adjusted)	1 hour/day 2 days/week	
Child [(c)] (13 through 18 years)	56 to 70 kg (Age Adjusted)	2.5 hours/day 5 days/week	
Adult [(d)]	12 to 70 kg (Age Adjusted)	2.5 hours/day 5 days/week	30

(a) Child spends less than half the time that an adult does in basement.

(b) School-aged child exposed only during weekend period.

(c) Assumes child 13 to 18 years takes on laundry duties.

(d) Worst-case scenario: child exposed through and into adulthood in residence.

(e) Low Usage Assumption (i.e. unfinished basements, laundry use, storage)

kg= kilogram

Location Specific Assumptions: High Usage Scenario for Basements

Exposed Population	Body Weight	Exposure Time	Number of Years Exposed
Child (1 through 6 years)	12 to 23 kg (Age Adjusted)	12 hours/day 365 days/year [(b)]	6
Child (1 through 18 years)	12 to 70 kg (Age Adjusted)		18
Child/Adult (1 to 31 years) [(a)]	12 to 70 kg (Age Adjusted)		30

(a) Worst-case scenario: child exposed through and into adulthood in residence

High Usage Assumption (i.e. living space, actively used area) at 12 hours/day

kg= kilogram

Cancer Exposure Assumptions

Cancer exposure doses were calculated using the noncancer exposure dose and adjusting for the following formula:

$$\textit{Cancer Exposure Dose (mg/kg/day)} = \textit{Noncancer Exposure Dose} \times \frac{ED}{AT}$$

Where ED = exposure duration representing the location-specific scenario (years);

and AT = averaging time (years).

The LECR for adults was calculated by multiplying the cancer exposure dose by the cancer slope factor (CSF). The CSF is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(mg/kg/day)^{-1}$.

The CSF regarding ingestion exposure was obtained from the NJDEP. The NJDEP derived a CSF of 0.5 $(mg\ hexavalent\ chromium/Kg/day)^{-1}$ using chronic bioassay data of male mice from the 2008 NTP study and U.S. EPA cancer assessment guidelines (NJDEP 2009).