Health Consultation

RECCHIA PROPERTY

JOHNSTON, PROVIDENCE COUNTY, RHODE ISLAND

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

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Prepared by:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation

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List of Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CREG	Cancer risk evaluation guide
DEHP	Di(2-ethylhexyl)phthalate
DHHS	Department of Health and Human Services
DNOP	Di-n-octylphthalate
EMEG	Environmental media evaluation guide
EPA	Environmental Protection Agency
EPA SSL	Environmental Protection Agency's Soil Screening Level
IARC	International Agency for Research on Cancer
kg	Kilogram
LOAEL	Lowest Observed Adverse Effect Level
mg	Milligram
MRL	Minimal risk level
NA	Not applicable
ND	Not detected
NOAEL	No Observed Adverse Effect Level
NT	Not tested
OC&I	Office of Compliance and Inspection
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
ppm	Parts per million
RfD	Reference dose
RI DEM	Rhode Island Department of Environmental Management
RI RCC	Rhode Island Resource Recovery Corporation
RMEG	Reference dose media evaluation guide

Statement of Issues

A former member of Congress in Rhode Island petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to investigate the Recchia Property in Johnston, Providence County, Rhode Island. The Recchia site was used as an unpermitted landfill. This health consultation evaluated available off-site environmental data to address public health concerns regarding respiratory problems and skin rashes in the community and whether they are associated with the fumes and gases from the landfill.

Background

Site History and Operations

The Recchia Property is located at 90 Mill Street, Johnston, RI and the property is owned by Mr. and Mrs. Robert Recchia. The site is located approximately 5 miles west/southwest of Providence, RI. The site was first discovered in July 1999 when a complaint that solid waste was being dumped on the Recchia Property was filed with the Rhode Island Department of Environmental Management (RI DEM). In January 2000, the RI DEM revealed a solid waste violation on the Recchia Property. The landfill contained construction and demolition debris (wood wastes, plastics, glass, etc.) and the estimated volume was 58,333 cubic yards [1]. Fill material also appeared to be present on the property located immediately adjacent to east/southeast of the Recchia Property. It is believed that the shredded construction and demolition debris was pushed onto the adjacent property (Cardarelli Property) before the property line was determined [2]. As a result of community complaints, RI DEM took hydrogen sulfide readings near the Recchia Property. In August 2000, a waste water collection system was installed and a clay like material (stone dust) was used to cap part of the property to prevent hydrogen sulfide odors [3]. In February 2001, a court ordered removal of the solid waste disposal on the property began. The processed construction and demolition debris was transported to the RI Resource Recovery Corporation (RI RCC) in the Town of Johnston. [4]. As of January 2003, all of the stockpiled waste on the Recchia Property was removed [5]. The environmental investigation history is summarized in Table 1.

Table 1. Summary, Environmental Investigation History for Recchia Property, RI

Date	Event/Action
01/05/2000	Inspection of Recchia Property revealed a solid waste violation. The estimated volume of waste was approximately 58,333 cubic yards.
07/28/2000	Soil and leachate samples were collected on the Recchia Property.
08/01/2000 to 08/24/2000	Hydrogen sulfide air samples were collected near the Recchia property.
08/23/2000	A petition letter was sent to ATSDR.
08/2000	A waste water collection system was installed along the toe of the east slope of the fill area to control the hydrogen sulfide odors.
08/2000	South end of the property was capped with a clay like material (stone dust) in an attempt to eliminate the hydrogen sulfide odors.
02/2001 to 12/2001	The majority of the construction and demolition debris was removed from the Recchia Property. The only waste left on the site is the construction and demolition debris under the two greenhouses.
08/2002	RI DEM Office of Compliance and Inspection (OC&I) confirmed the removal of construction and demolition debris at Cardarelli property.
06/2002 to 01/2003	The construction and demolition debris under the greenhouses was removed. The clean-up of the Recchia Property is complete.

Demographics and Land Use

Demographics

According to 2000 Census data, there are 621,602 residents in Providence County. Within that population, 6.2% are under 5 years old; 21.4% are between 5 and 19 years; 57.7% are between 20 and 64 years; and 14.6% are 65 years and older [6]. The Town of Johnston has a population of 28, 219, comprising approximately 11,192 residences. An estimated 8,499 people live within 1 square mile of the site [7]. Figure 1, Appendix A, lists additional demographic statistics.

On- Site Land Use

In the past, the Recchia Property was used as a borrow pit. In order to fill the borrow pit, Mr. and Mrs. Recchia accepted construction and demolition debris on their property. The construction and demolition waste was removed from the unpermitted landfill and currently the property is used as a hobby farm (horses, cattle and goats). Several greenhouses have always been present at the Recchia Property. The greenhouses are used to grow potted ornamental plants [8].

Discussion

Evaluation Process

ATSDR evaluates contaminants detected in environmental media at hazardous waste sites and determines whether an exposure to the contamination has public health significance. ATSDR begins this evaluation by reviewing environmental data to determine if the levels of contaminants are above health-based comparison values. Health-based comparison values are media-specific concentrations of chemicals that have been determined to be unlikely to result in adverse health effects. Refer to Appendix C for further information on health-based comparison values. Once the environmental data have been obtained and evaluated, ATSDR staff members determine whether people are exposed to the contaminants. Refer to Appendix D for further information on ATSDR's methodology.

Further evaluation focuses on identifying which chemicals and exposure situations could be a health hazard. The first step is the calculation of child and adult exposure doses, as described in Appendix G. These are compared to an appropriate health guideline for a chemical. Any exposure situation resulting in an exposure dose lower than the appropriate health guideline is eliminated from further evaluation.

Lastly, these exposure doses are evaluated in the context of known toxicological health effects levels identified in ATSDR toxicological profiles. If the chemical of concern is a carcinogen, the cancer risk is calculated using the exposure dose.

Off-Site Contamination

Air

During August, 2000, air samples were collected at various outdoor locations surrounding the Plainfield Valley Condominiums and Claiborne Pell Manor Retirement Homes which border the Rechia property. A total of 40 hydrogen sulfide air samples were collected using a Jerome meter. The Jerome meter measured hydrogen sulfide in real time. The readings ranged from 0.0001 ppm to 0.146 ppm.

Approximately half of the samples were over the comparison value (intermediate inhalation Minimum Risk Level) of 0.02 ppm. The maximum detected concentration was 0.146 ppm. The hydrogen sulfide levels exceeded the intermediate inhalation MRL (Minimum Risk Level) of 0.02 ppm for brief periods of time. Table 1B (Appendix B) summarizes the hydrogen sulfide levels detected in off-site air samples.

Soil

Off-Site surface soil samples were taken in 2000 and are shown in Table 2B (Appendix B). The samples were collected from the adjacent Cardarelli property. The samples contain the same construction and demolition debris that was on the Recchia Property. The chemicals in Table 2 were selected if the maximum value exceeded the comparison value. When looking at the maximum concentration, arsenic, chromium, copper and lead were the only metals that exceeded the corresponding comparison values. Several semi-volatile organic compounds, or PAHs, (refer to Table 2) do not have comparison values. The average concentration of Aroclor 1242 and 1248 was 0.08 ppm. The average concentrations of Aroclor 1254 and 1260 were 0.62 and 0.38 ppm respectively.

Table 2. Soil Samples Above Comparison Values

Chemical	Surface Soil Maximum Concentration (ppm) Year:2000	Surface Soil Concentration Average (ppm) Year: 2000	Comparison Value (ppm)	Source
Arsenic	16.1	9.57	200 20 0.46	Chronic EMEG (adult) Chronic EMEG (child) CREG
Chromium	55.5	30.29	NA	NA
Copper	1860	434.23	10,000 1,000 40	Intermediate EMEG (adult) Intermediate EMEG (child) Intermediate EMEG (pica child)
Lead	3060	857	400	EPA SSL
Benzo(a)anthracene	57.7	26.4	0.9	EPA SSL
Benzo(a)pyrene	48.9	23.92	0.09 0.09	EPA SSL CREG
Benzo(b)fluoranthene	62.9	33.1	0.9	EPA SSL
Benzo(g,h,i)perylene	12.7	7.36	NA	NA
Benzo(k)fluoranthene	56.1	22.93	9	EPA SSL
Indeno(1,2,3-cd)pyrene	32.8	6.57	0.9	EPA SSL
Di(2-ethylhexyl)phthalate	93.9	35.78	40,000 3,000 50	Chronic EMEG (adult) Chronic EMEG (child) CREG
Aroclor 1242	0.1	0.08	NA	NA
Aroclor 1248	0.1	0.08	NA	NA
Aroclor 1254	1.77	0.62	10 1	Chronic EMEG (adult) Chronic EMEG (child)
Aroclor 1260	1.34	0.38	NA	NA

ppm = parts per million of chemical in soil. Ppm = mg (milligram) per kg (kilogram of soil)
CREG = cancer risk evaluation guide
EMEG = Environmental Media Evaluation Guide
EPA SSL = EPA Soil Screening Level
NA = Not Available

Quality Assurance and Quality Control

In preparing this public health assessment, ATSDR relies on the information provided in the referenced documents and assumes that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and conclusions drawn for this public health consultation is determined by the comprehensiveness and reliability of the referenced information. Quality assurance/quality control measures were followed with regard to sample collection.

Pathway Analysis

All of the pathways discussed in this health consultation will be from past exposures. The current and future pathways have been eliminated due to the removal of the construction and demolition debris from both the Recchia and Cardarelli properties. Table 3B (Appendix B) summarizes the eliminated exposure pathways for this site.

A completed exposure pathway for ambient air existed in the past. Residents on or near the Recchia Property were exposed to hydrogen sulfide emanating from the site. Inhalation of the gas was the primary route of exposure. The completed exposure pathway is summarized in Table 4B (Appendix B).

Several past potential exposure pathways exist for the Recchia Property (Table 5B, Appendix B). It was possible for residents to come into contact with contaminated soil from the Recchia Property. Wind may have carried contaminated soil off the Recchia Property. Area residents may have contacted the contaminated soils while gardening, playing and participating in other recreational activities. However, in September 2000, a partial clay cap was placed on the contaminated soil, which would prevent some of the contaminated soil from being blown off site. There are no fences enclosing the site; therefore, it is possible that trespassers may have come into contact with soil on the site. Skin contact, ingestion, and inhalation (of dust) would be the primary routes of exposure to the soil. Ingestion of soil usually occurs by the inadvertent consumption of soil on hands or food items, mouthing of objects, or the intentional ingestion of nonfood items (pica behavior). Leachate was found on the Recchia Property as well. It was possible for trespassers to be exposed to the leachate on the site; however, the exposure was thought to be infrequent for the 3 years before the site was cleaned up. In addition, a leachate collection system was installed in September 2000 which captured most of the leachate.

Public Health Implications

Air

Hydrogen Sulfide

Under normal conditions, hydrogen sulfide is a colorless, flammable gas. The odor is usually characterized as smelling like ‘rotten eggs’. People usually can smell hydrogen sulfide at low concentrations in air, ranging from 0.0005 to 0.3 parts per million (ppm) (0.0005-0.3 parts of hydrogen sulfide in 1 million parts of air); however, at high concentrations, a person might lose their ability to smell it. This can make hydrogen sulfide very dangerous [9]. The detection of an odor does not necessarily mean that hydrogen sulfide is present at a level that would affect a person's health. Hydrogen sulfide is released primarily as a gas and will spread in the air. Hydrogen sulfide is estimated to remain in the atmosphere for an average of 18 hours [10].

Non-carcinogenic Health Effects

Because hydrogen sulfide is a gas, inhalation is the major route of exposure, and the gas is readily absorbed in the lungs [11]. It can also be absorbed through the gastrointestinal tract and the skin. Exposure to low concentrations of hydrogen sulfide may cause irritation to the eyes, nose, or throat. It may also cause difficulty in breathing for some asthmatics. Brief exposures to high concentrations of hydrogen sulfide (greater than 500 ppm) can cause a loss of consciousness. In most cases, the person appears to regain consciousness without any other effects. However, in many individuals, there may be permanent or long-term effects such as headaches, poor attention span, poor memory, and poor motor function. No health effects have been found in humans exposed to typical environmental concentrations of hydrogen sulfide (0.00011-0.00033 ppm). Little information is available on what happens when you are exposed to hydrogen sulfide by getting it on your skin [12]. Absent any physiological effects, the odor of hydrogen sulfide alone can be annoying and affect well being.

The maximum concentration of hydrogen sulfide (0.146 ppm) exceeded the comparison value of 0.02 ppm. However, due to the wind patterns, residents were not constantly being exposed at that level. In addition, the hydrogen sulfide levels were detected at this site for a short time. As shown in Table 3, the maximum concentration of hydrogen sulfide is below levels reported to cause health effects. Due to the landfill clean-up, the exposure has been eliminated and is not a health hazard at this time.

Table 3. Human Health Effects at various hydrogen sulfide concentrations [11]

Exposure (ppm)	Effect/Observation	Reference
0.007	Odor threshold	[13]
2.01	Bronchial constriction in asthmatic individuals	[14]
3.59	Increased eye complaints	[15]
5.03 or 10.07	Increased blood lactate concentration, decreased skeletal muscle citrate synthase activity, decreased oxygen uptake	[16], [17], [18]
3.59 – 20.86	Eye irritation	[19]
20.14	Fatigue, loss of appetite, headache, irritability, poor memory, dizziness	[20]
>100.71	Olfactory paralysis	[21]
>402.87	Respiratory distress	[22]
>=503.59	Death	[23]

Carcinogenic Health Effects

Hydrogen sulfide has not been shown to cause cancer in humans, and its possible ability to cause cancer in animals has not been studied thoroughly. The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified hydrogen sulfide for carcinogenicity [12].

Soil

In this health assessment, ATSDR made the following conservative assumptions when evaluating exposures to residents:

- Persons were exposed to the average level of contaminants in the surface soil. When calculating the mean, half the method detection limit was substituted for Non Detects.

- Exposures occurred daily over a 3 year period. Illegal dumping of construction and debris started in January 2000 and the removal ended in January 2003.

Using the above assumptions (and others in Appendix G), ATSDR calculated exposure doses for children and adults resulting from ingestion with the chemicals exceeding the CV at average levels found in soil. (Appendix G contains the equations, the results, and a technical description of how exposure doses were derived.) An exposure dose is the amount of a contaminant that gets into a person's body. Exposure doses determine the possibility of harmful effects. The exposure levels were compared to health guidelines to determine if further toxicological evaluation is needed.

To evaluate potential health effects, ATSDR has developed minimum risk levels (MRLs) for contaminants commonly found at hazardous waste sites. The MRL, similar to the reference dose (RfD) of the Environmental Protection Agency (EPA), is an estimate of daily human exposure to a contaminant below which non-cancer, adverse health effects are unlikely to occur. In this health assessment, we estimated the dose of a contaminant to individual persons and compared the dose at this site with ATSDR's MRL or EPA's RfD. Any exposure dose below the appropriate MRL or RfD is unlikely to cause a non-cancer health hazard to humans. ATSDR presents the MRLs in Toxicological Profiles. These chemical-specific profiles provide information on health effects, environmental transport, human exposure, and regulatory status. To address the health impacts of contaminants at this site, we used the toxicological information in ATSDR's Toxicological Profiles for the contaminants of concern.

Arsenic

Arsenic is an element that is widely distributed in the earth's crust. Natural levels of Arsenic in soil usually range from 1 to 40 ppm, with a mean of 5 ppm. Elemental arsenic is ordinarily a steel grey metal-like material that sometimes occurs naturally. However, arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Arsenic combined with these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic. Most inorganic and organic arsenic compounds are white or colorless powders that do not evaporate. They have no smell, and most have no special taste. Thus, you usually cannot tell if arsenic is present in your food, water, or air [24].

Non-carcinogenic Health Effects

The site-specific child and adult exposure doses calculated using the mean concentration of arsenic measured in surface soil (9.57 mg/kg) are 0.0001 and 0.00001 mg/kg/day, respectively. The level of exposure for residents does not exceed ATSDR's chronic oral MRL of 0.0003 mg/kg/day, therefore, non-carcinogenic health effects are unlikely to occur for residents exposed to the maximum level of arsenic in soil.

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs. Ingesting high levels of inorganic arsenic can result in death. Lower levels of arsenic can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet [25]. Perhaps the single most common and characteristic sign of oral exposure to inorganic arsenic is the appearance of skin ailments: hyperkeratinization (thickening) of the skin, especially on the palms and soles; formation of multiple hyperkeratinized corns or warts; and hyperpigmentation (darkening, usually a speckled pattern) of the skin with some hypopigmentation (loss of pigmentation). These effects are usually the earliest observable sign of chronic (long-term) exposure to arsenic. Direct dermal contact might cause local irritation and contact dermatitis (a rash). The effects may be mild, but they might progress to papules and vesicles in extreme cases. Organic arsenic compounds are less toxic than inorganic arsenic compounds. Exposure to high levels of some organic arsenic compounds may cause similar effects as inorganic arsenic [24].

Carcinogenic Health Effects

The International Agency for Research on Cancer (IARC) has determined that arsenic is carcinogenic to humans [26]. The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the adult exposure dose by EPA's corresponding cancer slope factor for arsenic. This is then multiplied by the fraction 3/70, because the cancer slope factor assumes a 70-year lifetime of exposure, whereas ATSDR assumes the maximum time anyone at this site could have been exposed was 3 years. There is no increased risk of cancer from arsenic at this site (approximately 8 cancer cases per 10,000,000 people exposed, or 8×10^{-7}).

Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. Total chromium concentrations in the continental U.S. soils range from 1.0 to 2,000 ppm, with a mean of 37.0 ppm. Chromium is present in the environment in several different forms. The most common forms are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds. Chromium(III) occurs naturally in the environment and is an essential nutrient. Chromium(VI) and chromium(0) are generally produced by industrial processes. The metal chromium, which is the chromium(0) form, is a steel-gray solid with a high melting point. It is used mainly for making steel and other alloys

[27]. It is not known if the chromium found on the Recchia Property is in the form of chromium III or chromium VI.

The body absorbs chromium VI more readily than it absorbs chromium III; however, once absorbed by the body, chromium VI is rapidly changed to chromium III. Chromium III is an essential nutrient. That means that it is a element needed by the body for proper functioning, but is one that is not produced by the body.

Non-carcinogenic Health Effects

The child and adult exposure doses calculated using the mean concentration of chromium measured in soil (30.29 mg/kg) are 0.0004 and 0.00004 mg/kg/day, respectively. The level of exposure for residents does not exceed EPA's chronic oral reference dose (RfD) of 0.003 mg/kg/day for Chromium (VI) or 1.5 mg/kg/day for Chromium (III), therefore, non-carcinogenic health effects are unlikely to occur for residents exposed to the mean level of chromium in soil.

Chromium(III) is an essential nutrient that helps the body use sugar, protein, and fat. Breathing high levels of chromium(VI) can cause irritation to the nose, such as runny nose, nosebleeds, and ulcers and holes in the nasal septum. Ingesting large amounts of chromium(VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium(VI) compounds can cause skin ulcers. Some people are extremely sensitive to chromium(VI) or chromium(III). Allergic reactions consisting of severe redness and swelling of the skin have been noted [27].

Carcinogenic Health Effects

According to the IARC, chromium(0) and chromium(III) are not classifiable as to their carcinogenicity; however, chromium (VI) is classified as a carcinogen to humans. Since chromium (VI) is a carcinogen through the air pathway and not oral, the risk calculation for calcium (VI) is limited to the inhalation pathway. The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the adult exposure dose by EPA's corresponding inhalation cancer slope factor for chromium (VI). This is then multiplied by the fraction 3/70, because the cancer slope factor assumes a 70-year lifetime of exposure, whereas ATSDR assumes the maximum time anyone at this site could have been exposed was 3 years. There is no apparent increased risk of cancer from chromium (VI) at this site (approximately 2 cancer cases per 100,000 people exposed, or 2×10^{-5}).

Copper

Copper is a metal that occurs naturally throughout the environment, in rocks, soil, water, and air. Its average concentration in the earth's crust is about 50 parts copper per million parts soil (ppm) or, stated another way, 50 grams of copper per 1,000,000 grams of soil. Copper also occurs naturally in all plants and animals. It is an essential element for all known living organisms including humans and other animals at low levels of intake. At much higher levels, some toxic effects can occur.

Metallic copper can be easily molded or shaped. The reddish color of this element is most commonly seen in the U.S. penny, electrical wiring, and some water pipes. It is also found in many mixtures of metals, called alloys, such as brass and bronze. Many compounds (substances formed by joining two or more elements) of copper exist. These include naturally occurring minerals as well as manufactured chemicals. The most commonly used compound of copper is copper sulfate. Many copper compounds can be recognized by their blue-green color [28].

Non-carcinogenic Health Effects

The child and adult exposure doses calculated using the mean concentration of copper measured in soil (434.23 mg/kg) are 0.005 and 0.0006 mg/kg/day, respectively. The level of exposure for residents does not exceed EPAs oral reference dose of 0.04 mg/kg/day, therefore, non-carcinogenic health effects are unlikely to occur for residents exposed to the mean level of copper in soil.

Copper is essential for good health, but high amounts can be harmful. Long-term exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea. Intentionally high intakes of copper can cause liver and kidney damage and even death [28].

Carcinogenic Health Effects

The EPA has determined that copper is not classifiable as a human carcinogenicity. ATSDR does not know whether copper can cause cancer in humans [28].

The estimated risk of developing cancer from exposure to the contaminants was not calculated because EPA does not have a cancer slope factor for copper.

Lead

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. It has no characteristic taste or smell. Metallic lead does not dissolve in water and does not burn. Lead can combine with other chemicals to form what are usually known as lead compounds or lead salts. Some lead salts dissolve in water better than others. Some natural and manufactured substances contain lead but do not look like lead in its metallic form. Some of these substances can burn—for example, organic lead compounds in some gasolines [29]. Lead has been widely used in batteries, ammunition, electronic circuitry, pipes, fuel, paint, and medical equipment. Lead use in products that frequently contact people or the environment has been greatly reduced in the past thirty years. Yet, humans have spread lead throughout the environment into air, soil, and water.

Lead exposure can be through ingestion, inhalation, or dermal exposure. Dermal exposure to lead is thought to be a minimal health risk. Inhalation of lead contaminated dust is a health threat as lead readily passes from the lungs into the blood. If consumed, differing percentages of lead will be absorbed into the blood depending on the individual’s age, types of food eaten, and the chemical form of the lead [29].

Non-carcinogenic Health Effects

There is no current MRL or RfD for chronic oral exposure for lead. The estimated exposure dose of 0.01 mg/kg/day and 0.001 mg/kg/day for children and adults, respectively, were below the Lowest Observed Adverse Effect Levels (LOAEL) for chronic exposure in most animals, for effects other than cancer as cited in the ATSDR Toxicological Profile for lead. However, one study by Perry et al. studied female rats for less than 18 months and observed increased systolic blood pressure with a LOAEL of 0.014 mg/kg/day [30].

The non-cancer effects of lead are well known. At high doses, lead can cause severe toxicity to the brain, referred to as encephalopathy. Lower doses have caused peripheral nervous system toxicity, kidney damage, blood disorders, hearing and vision impairment, and effects on muscle coordination. Lead also damages the heart and reproductive system. The most sensitive toxic effect of lead poisoning is believed to be impaired development of the central nervous system in children and the unborn. This effect has been measured by observing behavioral changes in children, including performance in school, as measured by decreased performance on IQ tests. These changes have been measured at very low levels of lead in the blood. No safe level of lead in blood has been established for these types of effects, although the Centers for Disease Control (CDC) level of concern is 10 micrograms of lead per deciliter (u/dl) of blood [29].

Carcinogenic Health Effects

According to IARC, lead is classified as a possible human carcinogen [26]. The estimated risk of developing cancer from exposure to the contaminants was not calculated because EPA does not have a cancer slope factor for lead. However it should be noted that the information available on the carcinogenicity of lead in occupationally exposed humans is limited in its usefulness because the lead compound(s), the route(s) of exposure, and the levels of exposure were not always reported. Furthermore, concurrent exposure to other chemical (including arsenic, particularly in lead smelters) and confounding variables, such as smoking, were often not evaluated. Therefore, the data currently available do not support an assessment of the potential carcinogenic risk of lead in humans [29].

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides [31]. The primary sources of exposure to PAHs for most of the U.S. population are inhalation of the compounds in tobacco smoke, wood smoke, and ambient air, and consumption of PAHs in foods [32]. The PAH's that were present at this site included: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene and indeno(1,2,3-c,d)pyrene.

Non-carcinogenic Health Effects

None of exposure doses calculated for PAH's at the Recchia Property exceeded the RfD of 0.3 mg/kg/day. Non-carcinogenic health effects are unlikely to occur for residents exposed to the mean level of PAHs in soil

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people. Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people [31].

No health guideline values, including MRLs, are available for the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, and indeno(1,2,3-c,d)pyrene. EPA reference doses are available, however, for the PAHs acenaphthene, anthracene, fluoranthene, fluorene and pyrene. In order to gain perspective and to assess non-cancer health effects, ATSDR will use the PAH with the highest oral reference dose, anthracene (0.3 mg/kg/day) to compare against the PAHs without a oral reference dose.

Carcinogenic Health Effects

The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the exposure dose by EPA's corresponding cancer slope factors for the respective PAHs. This is then multiplied by the fraction 3/70, because the cancer slope factor assumes a 70-year lifetime of exposure, whereas ATSDR assumes the maximum time anyone at this site could have been exposed was 3 years. When the cancer risks for all the PAHs are added together, there is no apparent increased risk of cancer expected at this site (approximately 1 cancer case per 100,000 people exposed, or 1×10^{-5}).

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens. Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer) [31].

Di(2-ethylhexyl)phthalate (DEHP)

Di(2-ethylhexyl)phthlate (DEHP) is a manufactured chemical that is commonly added to plastics to make them flexible. DEHP is a colorless liquid with almost no odor.

DEHP is present in plastic products such as wall coverings, tablecloths, floor tiles, furniture upholstery, shower curtains, garden hoses, swimming pool liners, rainwear, baby pants, dolls, some toys, shoes, automobile upholstery and tops, packaging film and sheets, sheathing for wire and cable, medical tubing, and blood storage bags [33].

Non-carcinogenic Health Effects

The site-specific child and adult exposure doses calculated using the highest concentration of DHEP measured in soil (35.78 mg/kg) are 0.0004 and 0.00005 mg/kg/day, respectively. The level of exposure for residents does not exceed ATSDR's chronic oral MRL of 0.06 mg/kg/day. Non-carcinogenic health effects are unlikely to occur for residents exposed to the maximum level of DHEP in soil.

At the levels found in the environment, DEHP is not expected to cause harmful health effects in humans. Most of what we know about the health effects of DEHP comes from studies of rats and mice given high amounts of DEHP. Harmful effects in animals generally occurred only with high amounts of DEHP or with prolonged exposures. Moreover, absorption and breakdown of DEHP in humans is different than in rats or mice, so the effects seen in rats and mice may not occur in humans. Rats that breathed DEHP in the air showed no serious harmful effects. Their lifespan and ability to reproduce were not affected. Brief oral exposure to very high levels of DEHP damaged sperm in mice. Although the effect reversed when exposure ceased, sexual maturity was delayed in the animals. High amounts of DEHP damaged the liver of rats and mice. Whether or not DEHP contributes to human kidney damage is unclear. Skin contact with products containing DEHP will probably cause no harmful effects because it cannot be absorbed easily through the skin [33].

Carcinogenic Health Effects

The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the exposure dose by EPA's corresponding cancer slope factor for DHEP. This is then multiplied by the fraction 3/70, because the cancer slope factor assumes a 70-year lifetime of exposure, whereas ATSDR assumes the maximum time anyone at this site could have been exposed was 3 years. There would be no increase risk of cancer for DHEP at this site (approximately 3 cancer cases per 100,000,000 people exposed, or 3 x 10^{-8}).

No studies have evaluated the potential for DEHP to cause cancer in humans. The Department of Health and Human Services (DHHS) has determined that DEHP may reasonably be anticipated to be a human carcinogen. EPA has determined that DEHP is a probable human carcinogen. These determinations were based entirely on liver cancer in rats and mice. The International Agency for Research on Cancer has recently changed its classification for DEHP from "possibly carcinogenic to humans" to "cannot be classified as to its carcinogenicity to humans," because of the differences in how the livers of humans and primates respond to DEHP as compared with the livers of rats and mice [34].

Polychlorinated Biphenyls (PCBs) - Aroclor 1242, Aroclor 1248, Aroclor 1254 and Aroclor 1260

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they are very persistent in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils [35].

Non-carcinogenic Health Effects

The site-specific child and adult exposure doses calculated using the mean concentration of Aroclor 1242 measured in soil (0.08 mg/kg) are 0.000001 and 0.0000001 mg/kg/day, respectively. The site-specific child and adult exposure doses calculated using the mean concentration of Aroclor 1248 measured in soil (0.08 mg/kg) are 0.000001 and 0.0000001 mg/kg/day, respectively. The site-specific child and adult exposure doses calculated using the mean concentration of Aroclor 1254 measured in soil (0.62 mg/kg) are 0.000007 and 0.0000008 mg/kg/day, respectively. The site-specific child and adult exposure doses calculated using the mean concentration of Aroclor 1260 measured in soil (0.38 mg/kg) are 0.000005 and 0.0000005 mg/kg/day, respectively. When added together, the combined PCB congeners did not exceed ATSDR's chronic oral MRL for PCBs of 0.00002 mg/kg/day. Non-carcinogenic health effects are unlikely to occur for residents exposed to the mean level of Aroclor 1242, 1248, 1254 and 1260 in soil.

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs [35].

Carcinogenic Health Effects

The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the exposure dose by EPA's corresponding cancer slope factor for PCBs. This is then multiplied by the fraction 3/70, because the cancer slope factor assumes a 70-year lifetime of exposure, whereas ATSDR assumes the maximum time anyone at this site could have been exposed was 3 years. There would be no increase risk of cancer for PCBs at this site (approximately 9 cancer cases per 1,000,000,000 people exposed, or 9×10^{-9} for Aroclor 1242 and 1248 , approximately 7 cancer cases per 100,000,000 people exposed or 7×10^{-8} for Aroclor 1254 and approximately 8 cancer cases per 100,000,000 people exposed or 8×10^{-8} for Aroclor 1260).

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. The EPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans [35].

Community Health Concerns

Residents of Plainfield Valley Condominiums, Claiborne Pell Manor Retirement Homes and single family dwellings, all located near the Recchia Property, have experienced many symptoms that they believe are associated with the gases and vapors from the landfill. Some of these symptoms include: eye irritation, respiratory tract irritation, nausea, vomiting and diarrhea. The residents began noticing the symptoms around May 2000 and they attribute them to the hydrogen sulfide [36]. The residents have also noticed skin rashes that appear on children after they play at the Plainfield Valley Condominiums playground [37]. Some of the residents complained of the stress associated with the odors and the fact that their living arrangements were disrupted due to the odors. They were also concerned about whether their health would be impacted by the short and long-term exposure to the odors [38].

In addition, one resident reported that “bubbles” appeared on his skin after he had contact with his dog which had waded in the leachate from the Recchia Property. The dog also developed “bubbles” at the same time as the owner [35]. The chemicals detected in the leachate included barium, cadmium, chromium, copper, lead, mercury, nickel and zinc. However, these chemicals are no longer present since the leachate was cleaned up along with the construction and demolition debris.

ATSDR has no reliable information about the possible health effects in humans who are exposed to barium by breathing or by direct skin contact. However, barium is not expected to cross the intact skin because of the high polarity of the forms in which it is most commonly encountered [39]. Skin contact with cadmium is not known to affect the health of people or animals because virtually no cadmium can enter the body through the skin under normal circumstances (i.e., without exposure to very high concentrations for long times or exposure to skin that was not damaged) [40]. Skin contact with certain chromium(VI) compounds can cause skin ulcers. Some people are extremely sensitive to chromium(VI) or chromium(III). Allergic reactions consisting of severe redness and swelling of the skin have been noted. Exposure to chromium(III) is less likely than exposure to chromium(VI) to cause skin rashes in chromium-sensitive people [27]. No studies were located regarding dermal effects in humans or animals following dermal exposure to copper or inorganic lead [28], [29]. Excluding reports of contact dermatitis, limited information was obtained regarding the dermal effects of inorganic mercury. However, it was found that short-term exposure to high levels of metallic mercury vapors may cause skin rashes [41]. The most common harmful health effect of nickel in humans is an allergic reaction to nickel. Approximately 10-15% of the population is sensitive to nickel. A person can become sensitive to nickel when jewelry or other things containing nickel are in direct contact with the skin. Wearing earrings containing nickel in pierced ears may also sensitize a person to nickel. Once a person is sensitized to nickel, further contact with the metal will produce a reaction. The most common reaction is a skin rash at the site of contact. In some sensitized people, dermatitis (a type of skin rash) may develop in an area of the skin that is away from the site of contact. For example, hand eczema (another type of skin rash) is fairly common among people sensitized to nickel [42]. Putting low levels of certain zinc compounds, such as zinc acetate and zinc chloride, on the skin of rabbits, guinea pigs, and mice caused skin irritation. Skin irritation from exposure to these chemicals would probably occur in humans [43].

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 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 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.

ATSDR evaluated exposures using these child health considerations and determined that no adverse health effects would be expected for children exposed to the levels of chemicals detected in soil at Recchia Property. Children were exposed to varying levels of hydrogen sulfide. Children are likely to be exposed to hydrogen sulfide in the same manner as adults, except for adults at work. However, because hydrogen sulfide is heavier than air and because children are shorter than adults, children sometimes are exposed to more hydrogen sulfide than adults. Health problems in children who have been exposed to hydrogen sulfide have not been studied much. Exposed children probably will experience effects similar to those experienced by exposed adults [9]. However, as mentioned before, children were not constantly being exposed to the same levels of hydrogen sulfide in the air due to wind patterns. The exposure time of the hydrogen sulfide was of short duration and the levels are below those reported to cause health effects. Taking all this into consideration, it is determined that no adverse health effects are likely for children exposed to levels of hydrogen sulfide in the air surrounding the site.

Conclusions

ATSDR requires that one of five conclusion categories be used to summarize findings of a health consultation. A category is selected from site-specific conditions such as the degree of public health hazard based on the presence and duration of human exposure, contaminant concentration, the nature of toxic effects associated with site-related contaminants, presence of physical hazards, and community health concerns. (refer to Appendix F)

1. ATSDR considers this site to pose **no public health hazard** in the present and in the future**.** The construction and demolition debris that was illegally dumped on the Recchia Property was removed in January 2003. There is no current or future exposure.

2. Based on the data, ATSDR has determined that in the past there was **no apparent public health hazard** associated with exposures to soil and air on or near the Recchia Property. This determination was based on environmental sampling and calculated exposure doses

for the chemicals. Non-cancer and cancer health effects were evaluated for children and adults. Based on the exposure doses, results indicated that there was no health risk to the community.

Recommendations

ATSDR has no recommendations.

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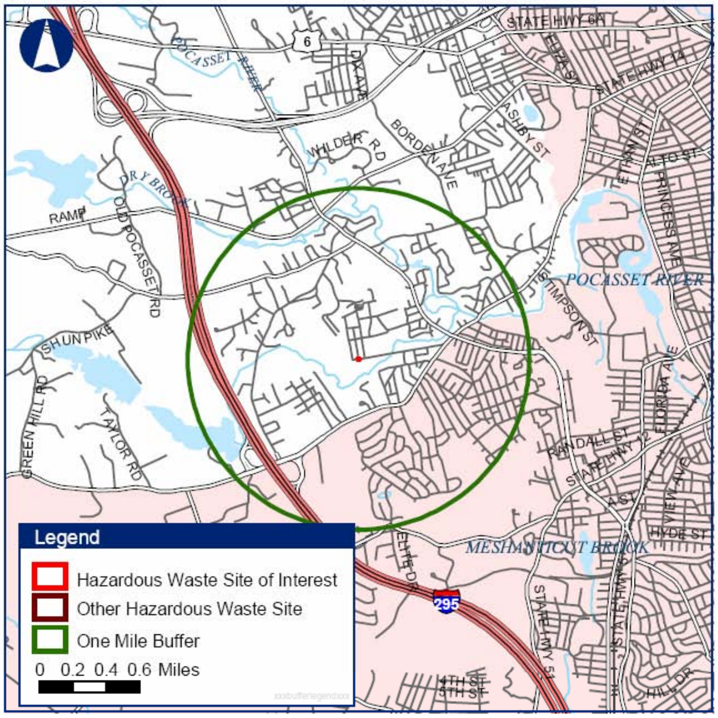
Appendix A. Figures

Figure 1. Site Introductory Map

Recchia Property
Johnston, RI
EPA Facility ID: UNAVAILABLE

ATSDR AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY CDC



Base Map Source: Geographic Data Technology (DYNAMAP 2000), August 2002
Site Boundary Data Source: ATSDR Public Health GIS Program, August 2002
Coordinate System (All Panels): NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

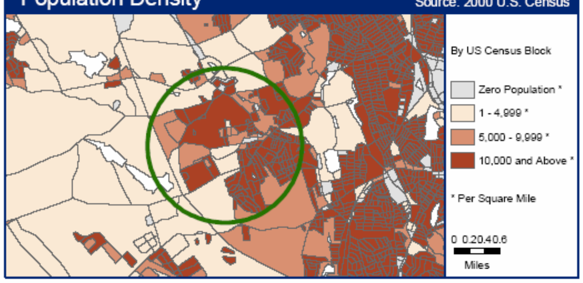
Site Location: Providence County, RI

Demographic Statistics
Within One Mile of Site*

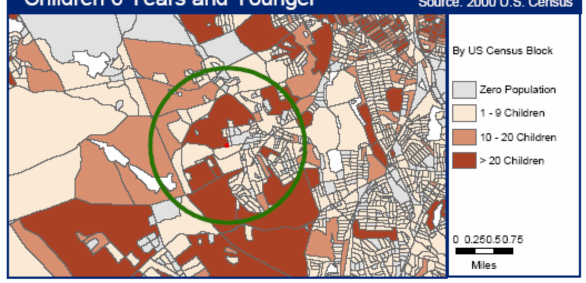
Total Population	8,499
White Alone	8,202
Black Alone	42
Am. Indian & Alaska Native Alone	11
Asian Alone	91
Native Hawaiian & Other Pacific Islander Alone	5
Some Other Race Alone	74
Two or More Races	74
Hispanic or Latino**	158
Children Aged 6 and Younger	607
Adults Aged 65 and Older	1,918
Females Aged 15 to 44	1,643
Total Housing Units	3,694

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.

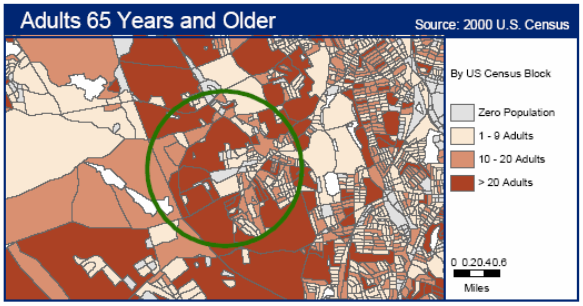
Population Density
Source: 2000 U.S. Census



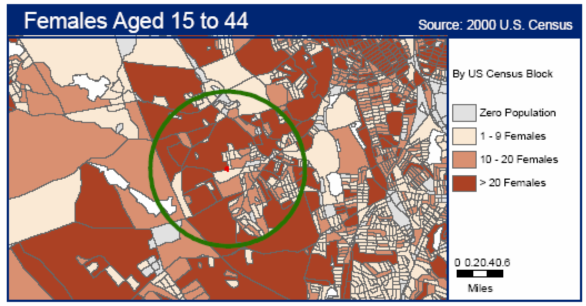
Children 6 Years and Younger
Source: 2000 U.S. Census



Adults 65 Years and Older
Source: 2000 U.S. Census



Females Aged 15 to 44
Source: 2000 U.S. Census



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Appendix B. Tables

Table 1B. Off-Site Air data (Hydrogen Sulfide)

Chemical	Number of Readings	Range (ppm)	Comparison Value (ppm)	Source
Hydrogen sulfide	40	0.0001 – 0.146	0.02	Intermediate MRL
Note: one sample was out of calibration range EMEG Environmental Media Evaluation Guide ppm parts per billion				

Table 2B. Off-Site Soil Data

Chemical	Surface Soil Concentration Range (ppm) Year: 2000	Comparison Value (ppm)	Source
TOTAL METALS			
Arsenic	ND-16.10	200 20 0.46	Chronic EMEG (adult) Chronic EMEG (child) CREG
Barium	ND-606	50,000 4,000	Chronic RMEG (adult) Chronic RMEG (child)
Cadmium	ND-4.15	100 10	Chronic EMEG (adult) Chronic EMEG (child)
Chromium	5.54-55.5	NA	NA
Copper	3.05-1860	10,000 1,000 40	Intermediate EMEG (adult) Intermediate EMEG (child) Intermediate EMEG (pica child)
Lead	12.3-3060	400	EPA SSL
Mercury	ND-1.88	23	EPA SSL
Molybdenum	ND-9.26	4,000 300	Chronic RMEG (adult) Chronic RMEG (child)
Nickel	ND-81	10,000 1,000	Chronic RMEG (adult) Chronic RMEG (child)
Silver	ND-2.63	4,000 300	Chronic RMEG (adult) Chronic RMEG (child)
Zinc	28.8-7070	200,000 20,000	Chronic EMEG (adult) Chronic EMEG (child)
SEMI-VOLATILE ORGANIC COMPOUNDS			
Anthracene	ND-28.3	200,000 20,000	Chronic RMEG (adult) Chronic RMEG (child)
Benzo(a)anthracene	ND-57.7	0.9	EPA SSL
Benzo(a)pyrene	ND-48.9	0.09 0.09	EPA SSL CREG
Benzo(b)fluoranthene	ND-62.9	0.9	EPA SSL
Benzo(g,h,i)perylene	ND-12.7	NA	NA

Benzo(k)fluoranthene	ND-56.1	9	EPA SSL
Indeno(1,2,3-cd)pyrene	ND-32.8	0.9	EPA SSL
Di(2-ethylhexyl)phthalate	ND-93.9	40,000 3,000 50	Chronic EMEG (adult) Chronic EMEG (child) CREG
Butylbenzylphthalate	ND-249	100,000 10,000	Chronic RMEG (adult) Chronic RMEG (child)
Chrysene	ND-54.3	88	EPA SSL
Di-n-octylphthalate	ND-116	300,000 20,000 800	Intermediate EMEG (adult) Intermediate EMEG (child) Intermediate EMEG (pica child)
Fluoranthene	3.43-318	30,000 2,000	Chronic RMEG (adult) Chronic RMEG (child)
Phenanthrene	ND-93.3	7,800	EPA SSL
Pyrene	ND-121	20,000 2,000	Chronic RMEG (adult) Chronic RMEG (child)
PCBs			
Aroclor 1016	ND	50 4	Chronic RMEG (adult) Chronic RMEG (child)
Aroclor 1242	ND	NA	NA
Aroclor 1248	ND	NA	NA
Aroclor 1254	0.49-1.77	10 1	Chronic EMEG (adult) Chronic EMEG (child)
Aroclor 1260	ND-1.34	NA	NA

CREG Cancer Risk Evaluation Guide
EMEG Environmental Media Evaluation Guide
EPA SSL Environmental Protection Agency's Soil Screening Level
NA Not applicable
ppm parts per million
RMEG Reference Dose Media Evaluation Guide

Table 3B. Eliminated Exposure Pathways

Pathway Name:	Source	Medium	Exposure Point	Exposure Route	Receptor Population	Time of Exposure	Exposure Activities
Ambient Air	Recchia Property landfill	Air	On or near the site	Inhalation	Area Residents	Current, Future	Breathing
Surface Soil	Recchia Property landfill	Soil	On or near the site	Ingestion Inhalation Dermal	Area Residents, Trespassing	Current, Future	Contacting contaminated soil
Subsurface Soil	Recchia Property landfill	Soil	On or near the site	Ingestion Inhalation Dermal	Area Residents, Trespassing	Current, Future	Contacting contaminated soil
Leachate	Recchia Property landfill	Leachate	On site	Ingestion Dermal	Trespassing	Current, Future	Contacting contaminated leachate

Table 4B. Completed Exposure Pathways

Pathway Name:	Source	Medium	Exposure Point	Exposure Route	Receptor Population	Time of Exposure	Exposure Activities
Ambient Air	Recchia Property landfill	Air	On or near the site	Inhalation	Area Residents	Past	Breathing

Table 5B. Potential Exposure Pathways

Pathway Name:	Source	Medium	Exposure Point	Exposure Route	Receptor Population	Time of Exposure	Exposure Activities
Surface Soil	Recchia Property landfill	Soil	On or near the site	Ingestion Inhalation Dermal	Area Residents, Trespassing	Past	Contacting contaminated soil
Subsurface Soil	Recchia Property landfill	Soil	On or near the site	Ingestion Inhalation Dermal	Area Residents, Trespassing	Past	Contacting contaminated soil
Leachate	Recchia Property landfill	Leachate	On site	Ingestion Inhalation Dermal	Trespassing	Past	Contacting contaminated leachate

Appendix C. Comparison Values

ATSDR comparison values are media-specific concentrations considered safe under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific “contaminants of concern.” The latter term should not be misinterpreted as an implication of “hazard.” As ATSDR uses the phrase, a “contaminant of concern” is a chemical substance detected at the site in question and selected by the health assessor for further evaluation of potential health effects. Generally, a chemical is selected as a “contaminant of concern” because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR’s comparison values.

It must however be emphasized that comparison values are not thresholds of toxicity. Although concentrations at or below the relevant comparison value can reasonably be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. The principal purpose behind protective health-based standards and guidelines is to enable health professionals to recognize and to resolve potential public health hazards before they become actual public health consequences. For that reason, ATSDR’s comparison values are typically designed to be 1 to 3 orders of magnitude (or 10 to 1,000 times) lower than the corresponding no-effect levels (or lowest-effect levels) on which they are based. The probability that such effects will actually occur depends not on environmental concentrations alone. Rather, the probability depends on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

Listed and described below are the various comparison values that ATSDR uses to select chemicals for further evaluation, as well as other non-ATSDR values that are sometimes used to put environmental concentrations into a meaningful frame of reference.

CREG	Cancer Risk Evaluation Guides
EMEG	Environmental Media Evaluation Guides
EPA SSL	EPA Soil Screening Level
MRL	Minimal Risk Level
RfD	Reference Dose
RMEG	Reference Dose Media Evaluation Guide

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors, or cancer potency factors, using default values for exposure rates.

Environmental Media Evaluation Guides (EMEGs) are concentrations that are calculated from ATSDR minimal risk levels by factoring in default body weights and ingestion rates.
EPA Soil Screening Levels (SSL) are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (#14 days), intermediate (15–364 days), and chronic (∃365 days) exposures. MRLs are published in ATSDR Toxicological Profiles for specific chemicals.

Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRL, EPA's RfD is a dose expressed in mg/kg/day

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

Appendix D. ATSDR Methodology

The Agency for Toxic Substances and Disease Registry (ATSDR) addresses the question of whether exposure to contaminants at the maximum concentrations detected would result in adverse health effects. While the relative toxicity of a chemical is important, the human body's response to a chemical exposure is determined by several additional factors, among which are

- the dose (how much) of the chemical to which the person was exposed,

- the amount of time the person was exposed (how long), and

- the way the person was exposed (through breathing, eating, drinking, or direct contact with something containing the chemical).

Lifestyle factors (for example, occupation, and personal habits) have a major affect on the likelihood, magnitude, and duration of exposure. Individual characteristics such as age, sex, nutritional status, overall health, and genetic constitution affect how a human body absorbs, distributes, metabolizes, and eliminates a contaminant. A unique combination of all these factors will determine the individual's physiologic response to a chemical contaminant and any adverse health effects the individual may suffer as a result of the chemical exposure.

ATSDR evaluates contaminants detected in environmental media at a site and determines whether an exposure to them has public health significance. ATSDR begins this evaluation by gathering reports that contain relevant environmental data for the site. These data are reviewed to determine whether contaminant levels are above health-based comparison values. Health-based comparison values are estimates of the daily human exposure to a substance that are not likely to result in adverse health effects over a specified duration of exposure. These values are developed for specific media (such as air and water) and for specific durations of exposure (such as acute and chronic).

Comparison values represent conservative levels of safety and not thresholds of toxicity. Thus, although concentrations at or below a comparison value may reasonably be considered safe, concentrations above a comparison value will not necessarily be harmful. Comparison values are intentionally designed to be much lower, usually by orders of magnitude, than the corresponding no-effect levels (or lowest-effect levels) determined in laboratory studies to ensure that even the most sensitive populations (such as children or the elderly) are protected.

To determine whether people are being exposed to contaminants or whether they were exposed in the past or will be exposed in the future, ATSDR examines the path between a contaminant and a person or group of people who could be exposed. Completed exposure pathways have five required elements. ATSDR evaluates each possible pathway at a site to determine whether all five factors exist and people are being exposed, were exposed, or may be exposed in the future. These five factors or elements must exist for a person to be exposed to a contaminant:

(1) a source of contamination
(2) transport through an environmental medium
(3) a point of exposure
(4) a route of human exposure, and
(5) an exposed population.

ATSDR classifies exposure pathways in one of the following three categories.

- *Completed Exposure Pathway*. ATSDR calls a pathway "complete" if it is certain that people are exposed (or were exposed or will be exposed) to contaminated media. Completed pathways require that the five elements exist and indicate that exposure to the contaminant has occurred, is occurring, or will occur.

- *Potential Exposure Pathway.* Potential pathways are those in which at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring, or could occur in the future.

- *Eliminated Exposure Pathway*. In an eliminated exposure pathway, at least one of the five elements is missing and will never be present. From a human health perspective, pathways can be eliminated from further consideration if ATSDR is able to show that (1) an environmental medium is not contaminated or that (2) no one is exposed to contaminated media.

Appendix E. Glossary

Acute Exposure: Exposure to a chemical for a duration of 14 days or less.

Cancer Risk Evaluation Guides (CREGs): Estimated contaminant concentrations in water, soil, or air that would be expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors.

Chronic Exposure: Exposure to a chemical for 365 days or more.

Detection limit: the minimum concentrations that must be accurately and precisely measured by the laboratory and/or specified in the quality assurance plan.

Dose: the amount of a contaminant that is absorbed or deposited in the body of an exposed organism for an increment of time. Total dose is the sum of doses received by a person from a contaminant in a given interval resulting from interaction with all environmental media that contain the contaminant. Units of dose and total dose (mass) are often converted to units of mass per volume of physiological fluid or mass of tissue.

Environmental Media Evaluation Guides (EMEGs): Concentrations of a contaminant in water, soil, or air unlikely to produce any appreciable risk of adverse, non-cancer effects over a specified duration of exposure. EMEGs are derived from ATSDR minimal risk levels by factoring in default body weights and ingestion rates. ATSDR computes separate EMEGs for acute (<- 14 days, intermediate (15-364 days), and chronic (>- 365 days) exposures.

EPA SSL: risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data.

Exposure (biology): an event that occurs when there is contact at a boundary between a human being and the environment with a contaminant of a specific concentration for an interval of time; the units of exposure are concentration multiplied by time.

Intermediate Exposure: Exposure to a chemical for a duration of 15-364 days.

Leachate: a solution obtained by leaching. Leachate from a sanitary landfill is a mineralized liquid with a high content of organic and inorganic substances. Any liquid, including any suspended components in the liquid, that has percolated through or drained from hazardous waste.

Lowest Observed Adverse Effect Level (LOAEL): The lowest exposure level of a chemical in a study, or group of studies, that produces statistically or biologically significant increase(s) in frequency or severity of adverse health effects between the exposed and control populations.

Minimal Risk Level (MRL): Estimate of daily human exposure to a hazardous substance that is likely to be without an appreciable risk of adverse noncancer health effects over a specified route and duration of exposure.

No Observed Adverse Effect Level (NOAEL): The dose of a chemical at which there were no statistically or biologically significant increases in frequency or severity of adverse health effects seen between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Parts per million (ppm): a common basis of reporting water analysis. One part per million (ppm) equals 1 pound per million pounds of water; 17.1 equals one grain per U. S. gallon; 14.3 equals one grain per Imperial gallon.

Quality assurance: a planned system of activities (program) whose purpose is to provide assurance of the reliability and defensibility of the data.

Quality control: a routine application of procedures for controlling the monitoring process. QC is the responsibility of all those performing hands-on operations in the field and in the laboratory.

Appendix F. ATSDR's Levels of Public Health Hazard

CATEGORY A: URGENT PUBLIC HEALTH HAZARD

This category is used for sites where short-term exposures (<1 year) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily meant that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards, such as open mine shafts, poorly stored or maintained flammable/explosive substances, or medical devices, which, if ruptured, could release radioactive materials.

CATEGORY B: PUBLIC HEALTH HAZARD

This category is used for sites that pose a public health hazard because of the existence of long-term exposure (>1 year) to hazardous substances or conditions that could result in adverse health effects.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical hazards, such as open mine shafts, poorly stored or maintained flammable/explosive substances, or medical devices, which, if ruptured, could release radioactive materials.

CATEGORY C: INDETERMINATE PUBLIC HEALTH HAZARD

This category indicates that a professional judgment on the level of health hazard cannot be made because information critical to such decision is lacking.

Criteria:

This category is used for sites for which available critical data are insufficient with regard to the extent of exposure and/or toxicological properties at estimated exposure levels. The health assessor must determine, using professional judgment, the "criticality" of such data and the likelihood that the data can and will be obtained in a timely manner. Where some data- even limited data- are available, health assessors should to the extent possible select other hazard categories and support their decision with a clear narrative that explains the limits of the data and the rationale for the decision.

CATEGORY D: NO APPARENT PUBLIC HEALTH HAZARD

This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Available relevant information indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in adverse impact on human health.

CATEGORY E: NO PUBLIC HEALTH HAZARD

This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.

Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are occurring, and none are likely to occur in the future.

* *Examples include environmental, demographic, health outcome, exposure, toxicological, medical, or epidemiologic data, as well as community health concerns information.*

Appendix G. Exposure Dose Calculations and Results for the Recchia Property

When chemical concentrations at the site exceed the established comparison values, it is necessary for a more thorough evaluation of the chemical to be conducted. In order to evaluate the potential for human exposure to contaminants present at the site and potential health effects from site-specific activities, ATSDR estimates human exposure to the site contaminant from different environmental media by calculating exposure doses. A brief discussion of the calculations and assumptions is presented below.

Soil Pathway (Ingestion)

The ATSDR exposure dose formula used for the soil pathway is:

$$ED = \frac{C \times IR \times EF \times 10^{-6}}{BW}$$

where:

ED	exposure dose in milligrams per kilogram per day (mg/kg/day)
C	maximum concentration of contaminant in soil (mg/kg)
IR	ingestion rate (mg/day)
EF	exposure factor, days of exposure divided by 365 (unitless)
10^{-6}	conversion factor (kg/mg)
BW	body weight in kilogram (kg)

Assumptions used were based on default values and/or professional judgment. The soil ingestion rate for adults was assumed to be 100 mg/day and 200 mg/day for children. For average body weight, 70 kg and 16 kg was used for adults and children, respectively. The exposure factor was 0.95 because residents were assumed to be exposed for 350 days per year (350/365), assuming the resident was not home for a total of two weeks per year. The doses derived from this calculation, along with the applicable health guideline, are presented in Table 8 below.

Table G1. Adult and Child Ingestion Exposure Doses Calculated for Soil

Chemical	Surface Soil Concentration mean (mg/kg)	Child Dose (mg/kg/day)	Adult Dose (mg/kg/day)	Health Guideline (mg/kg/day) and source
Arsenic	9.57	0.0001	0.00001	0.0003 – Oral MRL
Chromium	30.29	0.0004	0.00004	1.5 – Oral RfD (III) 0.003 – Oral RfD (VI)
Copper	434.23	0.005	0.0006	0.04 – Oral RfD
Lead	857	0.01	0.001	none
Benzo(a)anthracene	26.4	0.0003	0.00004	0.3*
Benzo(a)pyrene	23.92	0.0003	0.00003	0.3*
Benzo(b)fluoranthene	33.1	0.0004	0.00004	0.3*
Benzo(g,h,i)perylene	7.36	0.00009	0.00001	0.3*
Benzo(k)fluoranthene	22.93	0.0003	0.00003	0.3*
Indeno(1,2,3-cd) pyrene	6.57	0.00008	0.000009	0.3*
Di(2-ethylhexyl)phthalate	35.78	0.0004	0.00005	0.06 – Oral MRL
Aroclor 1242	0.08	0.000001	0.0000001	0.00002 – Oral MRL
Aroclor 1248	0.08	0.000001	0.0000001	0.00002 – Oral MRL
Aroclor1254	0.62	0.000007	0.0000008	0.00002 – Oral MRL
Aroclor 1260	0.38	0.000005	0.0000005	0.00002 – Oral MRL
* the RfD for Anthracene was used as a health guideline				

No health guideline values, including MRLs, are available for the PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, and indeno(1,2,3-c,d)pyrene. EPA reference doses are available, however, for the PAHs acenaphthene, anthracene, fluoranthene, fluorene and pyrene. In order to gain perspective and to assess non-cancer health effects, ATSDR will use the PAH with the highest oral reference dose, anthracene (0.3 mg/kg/day) to compare against the PAHs without a oral reference dose.

Excess cancer risk is estimated by multiplying the adult exposure dose by the cancer slope factor. This is then multiplied by the fraction 3/70, because the cancer slope factor assumes a 70-year lifetime of exposure, whereas ATSDR assumes the maximum time anyone at this site could have been exposed was 3 years. Table 9 below presents the results of this calculation for the contaminants of concern in soil.

Table 9. Excess Cancer Risk Calculations for Soil

Contaminant	Adult Dose (mg/kg/day)	Oral Cancer slope factor $1/(mg/kg/day)^{-1}$	Excess cancer risk
Arsenic	0.00001	1.5	$8.28x10^{-7}$
Chromium	0.00004	none	
Copper	0.0006	none	
Lead	0.001	none	
Benzo(a)anthracene	0.00004	0.73	$1.1x10^{-6}$
Benzo(a)pyrene	0.00003	7.3	$9.95x10^{-6}$
Benzo(b)fluoranthene	0.00004	0.73	$1.4x10^{-6}$
Benzo(g,h,i)perylene	0.00001	none	
Benzo(k)fluouranthene	0.00003	0.073	$9.5x10^{-8}$
Indeno(1,2,3-cd) Pyrene	0.000009	0.73	$2.7x10^{-7}$
Di(2-ethylhexyl)phthalate	0.00005	0.014	$2.9x10^{-8}$
Aroclor 1242	0.0000001	2	$9.1x10^{-9}$
Aroclor 1248	0.0000001	2	$9.1x10^{-9}$
Aroclor 1254	0.0000008	2	$7.1x10^{-8}$
Aroclor 1260	0.0000005	2	$4.3x10^{-8}$