Health Consultation

Colonie Site

Colonie, Albany County, NY
(Formerly National Lead Industries)

EPA Facility ID: NY0890137854

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List of Acronyms

ACHD	Albany County Health Department
AEC	Atomic Energy Commission
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
DU	depleted uranium
FUSRAP	Formerly Utilized Sites Remedial Action Program
mg/kg	Milligram per kilogram
mg/kg/day	Milligram per kilogram per day
NCRP	National Council on Radiation Protection and Measurements
NESHAP	National Emissions Standards Hazardous Air Pollutants
NL	National Lead Industries
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORNL	Oak Ridge National Laboratory
PbB	Blood lead levels
PCE	tetrachloroethene
PRG	Preliminary remediation goal
TCE	trichloroethene
TI	Teledyne Isotopes
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
USACE	US Army Corps of Engineers
USDOE	US Department of Energy
USEPA	US Environmental Protection Agency
USFDA	US Food and Drug Administration
VC	vinyl chloride
VOCs	volatile organic compounds
WHO	World Health Organization
WIC	Women, Infants and Children
µg/dL	microgram per deciliter
$\mu g/m^3$	microgram per cubic meter

Summary

Between 1958 and 1984, National Lead Industries (NL) used radioactive materials in manufacturing processes at its Colonie, NY facility. The radioactive materials consisted mostly of depleted uranium (DU). NL obtained the depleted uranium under a license from what is now the U.S. Department of Energy. NL reduced depleted uranium tetrafluoride to depleted uranium metal, with which it manufactured shielding components, ballast weights, and projectiles. In addition, from 1966 to 1972, NL processed fuel from enriched uranium for use in experimental nuclear reactors (USACE 2001b). These operations generated stack emissions, which released DU into the air. Some of the stack emissions eventually settled on residential and commercial properties and structures near the plant. Prior to 1958, the site was used as a brass and lead foundry.

At a July 11, 2001 public meeting held by the U.S. Army Corps of Engineers (USACE), several community members expressed concern about potential adverse health effects from past operations at NL's Colonie facility (referred to in this health consultation as the Colonie Site). In response to those concerns, USACE requested that the Agency for Toxic Substances and Disease Registry (ATSDR) conduct a public health evaluation of potential exposures to the community from past Colonie Site operations.

ATSDR identified three issues regarding how people were exposed or might be exposed to contamination from the Colonie Site.

1. *In the past, could people have potentially been exposed to harmful levels of DU by breathing air emissions from NL's chip burner and other onsite sources, contacting DU contaminated soil when playing or gardening, and eating fruits and vegetables grown in DU-contaminated soil?*

   Although USEPA did not have air regulations for DU while the plant was operating, for the period from 1979 to 1984 the highest stack releases of uranium exceeded USEPA's current National Emissions Standards Hazardous Air Pollutants (NESHAP) guidelines by a factor of 54,000. Based on the levels of DU found in soil, and the fact that the NL plant scaled down operations during the late 1970s and early 1980s, the earlier air emissions were probably higher than the 1979–1984 documented emissions. Therefore, DU emissions at these high levels could have increased the risk of health effects—especially kidney disease—for people living near the plant. In addition, the combination of inhaling DU and cigarette smoke could have increased risk of lung cancer. This is because the combined effect of two chemicals—DU and the cigarette smoke—is greater than their additive effects (Mabuchi et al. 1991). Although the extent to which risk was increased is unknown, ATSDR concludes that in the past, the uncharacterized emissions from the NL plant were a public health hazard to the community surrounding the Colonie Site. It is, however, important to note that when the plant stopped operating in the 1980s, the DU emissions stopped as well.

   On the other hand, contacting DU-contaminated soil when playing or gardening, or eating fruits and vegetables grown in DU-contaminated soil would not be expected to cause

illness in people. In addition, the soil removal from DU-contaminated properties during the mid-1980s would have further reduced or eliminate exposures.

2. *Were people exposed to harmful levels of lead in the past, currently, or in the future by breathing air emissions from the NL plant, contacting soil when playing or gardening, and eating fruits and vegetables grown in lead-contaminated soil?*

NL operated a foundry until 1960. While the foundry operated, no air emissions were measured at the plant. Because of the absence of any data on lead emissions in the air from NL, ATSDR cannot draw any conclusions about the health effects from breathing the lead-air emissions from the NL plant in the past. It is, however, important to note that when the foundry stopped operating in 1960, the lead emissions stopped as well.

During the 1980s the soil removal from DU-contaminated properties would likely have removed lead-contaminated soil as well, but lead contamination could remain at properties that were not cleaned up. In May 2003 NYSDOH and NYSDEC sampled soil in the Yardboro Avenue area for lead and other metals. ATSDR reviewed the data and found that the levels of lead found in these areas are not at levels that would cause adverse health effects for those who contact soil when playing or gardening and eat fruits and vegetables grown in the lead-contaminated soil.

3. *Currently and in the future, could people potentially breathe indoor air containing volatile organic compounds (VOCs) from contaminated groundwater?*

Because groundwater contamination had migrated off the Colonie Site, the USACE took two rounds of samples of indoor air from five nearby homes. The results of these samples showed no current public health impact from exposure to VOCs in the indoor air. In addition, a model that uses the highest values found in the groundwater to predict indoor air concentrations suggests that VOCs in indoor air would not be expected to reach levels that would cause health effects.

Introduction

At a July 11, 2001 public meeting held by the U.S. Army Corps of Engineers (USACE), several community members expressed concern about potential adverse health effects from past operations at the Colonie Site. In response to those concerns, USACE requested that the Agency for Toxic Substances and Disease Registry (ATSDR) conduct a public health evaluation of potential exposures to the community from past Colonie Site operations.

> **What is a public health evaluation?**
>
> A public health evaluation assesses data and information to determine whether releases of hazardous substances into the environment affect public health. Public health evaluations also identify actions needed to reduce or eliminate exposures that could cause human health effects.

During September 9–13, 2002, ATSDR conducted a site visit of the Colonie Site. The purpose of the visit was to begin collection of information necessary for conducting a public health evaluation. During the visit ATSDR staff met with local community groups and discussed community health concerns. ATSDR staff also met with representatives of the New York State Department of Health (NYSDOH), the New York State Department of Environmental Conservation (NYSDEC), Albany County Health Department (ACHD), and the New York State Department of Labor (NYSDOL). ATSDR staff toured the Colonie Site with representatives from USACE. In addition, ATSDR staff reviewed and copied many documents related to the site. ATSDR staff attended the USACE's September 12 public meeting and spoke with several members of the community about their health concerns. On November 21, 2002, ATSDR staff attended a community meeting to discuss a preliminary lead-soil sampling plan under development by the NYSDOH and the NYSDEC for properties surrounding the former NL plant.

After reviewing numerous documents and data, discussing health concerns with community members, and meeting with federal, state, and local agencies, ATSDR identified three issues regarding how people were exposed or might be exposed to contamination from the Colonie Site, as well as four community concerns. The three main exposure issues are

1. In the past, could people have potentially been exposed to harmful levels of DU by breathing air emissions from NL's chip burner and other onsite sources, by contacting soil when playing or gardening, and by eating fruits and vegetables grown in DU-contaminated soil?

2. Were people exposed to harmful levels of lead in the past, currently, or in the future by breathing air emissions from the NL plant, contacting soil when playing or gardening, and eating fruits and vegetables grown in lead-contaminated soil?

3. In the future could people potentially breathe indoor air with volatile organic compounds (VOCs) from contaminated groundwater?

The four identified community concerns are below:

1. The community is concerned that past emissions from the site have caused adverse health effects such as various types of cancer, birth defects, Down syndrome, rashes, and endometriosis.

2. A citizen is concerned that possible lead contamination in their yard could harm children and grandchildren.

3. A citizen's group is concerned that people, especially children, could have been exposed to DU in the past by playing with pellets and abandoned drums on the property.

4. A community group is concerned about exposure to DU, lead, and other possible contaminants in the surface water and sediment while swimming and wading in areas of the Patroon Creek watershed, including in and around the Patroon Reservoir and Tivoli Preserve.

Where can I find more information?

Documents related to the Colonie Site, including reports prepared by the USDOE, the USACE, and ATSDR, are available at the public repository in the William K. Sanford Town Library, 629 Albany-Shaker Road, Colonie, NY, (518) 458-9274.

Information about the Colonie Site can also be found on the Army Corps of Engineers website: http://web.ead.anl.gov/corps/colonie/back/

Residents can contact ATSDR representatives by dialing the agency's toll free number, 1-888-42ATSDR (1-888-422-8737).

Background

The 11.2-acre Colonie Site is at 1130 Central Avenue in Colonie, Albany County, New York (Figure 1). The boundary between Colonie and the city of Albany is just south of the site. The former NL property is bounded by a wooded lot on the northwest, Consolidated Rail Corporation railroad tracks on the southwest and south, commercial property on the east, Central Avenue on the northeast, and a Niagara Mohawk electrical substation on the north (USDOE 1995).

History of the Colonie Site

The Embossing Company began manufacturing wood products and toys at the site in 1923. In 1927 Magnus Metal Company purchased the property and began operating a brass foundry for manufacturing railroad parts, including brass components cast in sand molds and brass-bearing housings with surfaces of babbitt metal (an alloy of lead, copper, and antimony) (USACE 2001b).

In 1937 National Lead Industries purchased the facility and an adjacent lot which included a portion of the former Patroon Lake. NL continued operating the brass foundry—and began filling Patroon Lake with casting sand—some time before 1941. After World War II, NL began casting aluminum mainframes for airplanes. In 1958, under a license from the Atomic Energy Commission (AEC—this agency was split into the U.S. Nuclear Regulatory Commission (civilian programs) and the U.S. Department of Energy (government/military programs)), the nuclear division of NL began producing items manufactured from uranium and thorium. In 1960 NL discontinued brass foundry operations (USACE 2001b).

From 1958 to 1984 NL used radioactive materials consisting mostly of depleted uranium (DU) although between 1960 and 1972 smaller amounts of thorium and enriched uranium were also used. NL reduced depleted uranium tetrafluoride to depleted uranium metal, which was then made into shielding components, ballast weights, and projectiles. In addition, from 1966 to 1972, NL manufactured fuel from enriched uranium for experimental nuclear reactors (USACE 2001b).

Other NL processes included an electroplating operation for plating uranium with nickel and cadmium. Chemicals used included nickel sulfamate, sodium cyanide, ferric chloride, nitric acid, silicate phosphate, iridite (a chromium brightener), cadmium metal, nickel metal, boric acid, and perchloroethylene (PCE). Because there are no disposal records, little or no information is available regarding how or where most of these materials were disposed of. Nevertheless, letters from NL to the AEC indicate that in 1961 about 55 cubic yards of graphite, slag, refractory material, uranium oxide, insoluble oil, metal scrap, and combustible trash were buried in the Patroon Lake, as per NL's license. Other chemical wastes and packaged chemicals used at the site included acids, bases, degreasing agents, carbon tetrachloride, benzene, polychlorinated biphenyls (PCBs), cyanide, heavy metals, and asbestos (USACE 2001b).

In February 1980, because of NL's airborne releases of uranium compounds, the New York State Supreme Court issued a temporary restraining order shutting down NL operations. In May 1980, the order was amended to allow limited operations. The amended order also required the company to begin an independent investigation assessing all adverse environmental conditions in on-site soil and on the off-site vicinity properties that might have been caused by NL airborne discharges. Independent contractor Teledyne Isotopes (TI) was hired to perform a radiological survey of the NL property and surrounding properties. In 1984, again because airborne releases continued to exceed state standards, state officials again closed NL (USACE 2001b).

Soil Remediation at the Colonie Site

In 1980 TI had surveyed the neighborhood surrounding the NL plant for radioactivity. TI determined that the uranium released into the air through stack emissions had deposited on residential and commercial properties and structures. The survey showed that the majority of the contamination was north/northwest and southeast of the plant, in the direction of prevailing summer and winter winds (Teledyne Isotopes 1980).

After the 1984 closure of the NL plant, Congress authorized the U.S. Department of Energy (USDOE) to remediate the property under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The Secretary of Energy accepted an offer from NL to donate the land, buildings, and equipment to expedite the cleanup (USACE 2001b). From 1984 to 1997, USDOE managed the Colonie Site. Between 1984 and 1988, Oak Ridge National Laboratory (ORNL) performed radiological surveys of over 200 individual properties surrounding the former NL property. Of these, ORNL found that 56 vicinity properties were contaminated with concentrations of radioactive material either exceeding 35 picocuries per gram of soil (pCi/g) for uranium-238 (U-238) (when averaged over the top 2 inches of soil), or had a sample exceeding 100 pCi/g. These regulatory limits were decided for the purposes of remediation and are not based on health risk or dose. Between 1984 and 1988, 53 of the 56 vicinity properties were cleaned up by removal of DU-contaminated soil. DU typically concentrated in the upper 2 inches of soil (USDOE 1995). The waste soil was held in interim storage on the Colonie Site within an on-site building. In 1995, this material was bagged and shipped to an off-site disposal facility (USACE 2001a). A 1995 USDOE finalized Engineering Evaluation/Cost Analysis outlined the remediation of the former NL property and the remaining three vicinity properties.

By Congressional action in 1997, USACE assumed control of the Colonie Site and the responsibility for the remaining cleanup activities. USACE has remediated one of the three vicinity properties and the major portions of the Colonie Site property. USACE plans to complete the soil remediation in 2004 (USACE 2002b).

Groundwater Remediation at the Colonie Site

As a result of historical waste handling operations at the Colonie Site, volatile organic compounds were released in—and have been detected in—groundwater. USACE has conducted three separate phases of groundwater investigation at the Colonie Site. USACE completed Phase I in the winter of 1999. This work involved the initial collection of groundwater screening samples to determine whether contamination had migrated to the southern boundary of the site. The Phase II work, which involved additional groundwater screening and geophysical surveys, was completed in the summer of 2001. As part of Phase II, and to characterize more fully the underlying geology, USACE utilized a seismic survey and electrical resistance profiling techniques.

Phase III involved a variety of groundwater and soil sampling to define further the subsurface geology and the extent of groundwater contamination. As a means of defining the extent of groundwater contamination, Phase III work included the installation of additional monitoring wells located downgradient of the site along Yardboro Avenue. The groundwater contamination delineation is now complete. USACE semi-annually conducts comprehensive groundwater sampling of all monitoring wells at the site. Its sampling data will be included in the forthcoming Remedial Investigation Report.

USACE has also conducted an indoor air sampling survey for volatile organic compounds (VOCs) in properties on Yardboro Avenue that are adjacent to the site. Sampled VOCs included tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC). This survey is designed to determine whether contamination detected in off-site groundwater has impacted air quality in residences along Yardboro Avenue. Results from this survey, together with all relevant groundwater data, will be presented in the forthcoming Phase III Remedial Investigation Report.

Additional planned activities related to groundwater include a feasibility study and a human health risk assessment.

Land Use and Natural Resource Use

Because people use land and natural resources in many different ways, ATSDR examines land and natural resource uses to determine whether any of them might put people at risk for exposure. This information is important; controlling the types and frequencies of activities in contaminated areas affects exposure to contamination.

Land use around the Colonie Site is primarily residential and commercial. The site is bordered by a railway track, residences, and several businesses. Interstate 90 is to the south of the site. No plan for future land use has been developed, but one suggestion has been to use the land for a ramp to connect Central Avenue to Interstate 90.

The groundwater around the Colonie Site is not used for drinking water or for any other domestic purpose. Residents do not have private drinking water or irrigation wells; the municipal system supplies all residents of Colonie and Albany with their water. The Town of Colonie drinking water comes from the Mohawk River, the Stony Creek Reservoir, and five wells located several miles away from the Colonie Site. The City of Albany drinking water comes from the Alcove Reservoir, occasionally supplemented by the Basic Creek Reservoir. None of the water supplies for Colonie or Albany are currently affected by the groundwater contamination from the Colonie Site, nor are they likely to be affected in the future.

Downstream from the Colonie Site, the Patroon Creek watershed, including the Tivoli Preserve, is used for recreational purposes.

Demographics

ATSDR examines demographic data (i.e., information about population) to determine the number of persons potentially exposed to environmental chemicals. Demographic data is also used to determine the presence of sensitive populations, such as children (age 6 and younger), women of childbearing age (age 15–44), and the elderly (age 65 and older). Demographic data provides details on population mobility which, in turn, helps ATSDR evaluate how long residents might have been exposed to environmental contaminants.

Figure 2 summarizes demographic data for the area surrounding the Colonie Site, based on data compiled from the 2000 U.S. Census. According to the data, 10,045 persons live within 1 mile of the site property line and all are within the limits of the Town of Colonie or the City of Albany. Figure 1 also specifies the number of residents in three potentially sensitive populations for environmental exposures: children, women of childbearing age, and the elderly.

Changes in population in an area over time are also important information. Table 1 lists the population growth of Albany County, NY from 1950 to 2000.

Table 1: Population growth in Albany County, NY, 1950-2000

Year	1950	1960	1970	1980	1990	2000
Population	239,386*	272,926*	286,742*	285,909*	292,594*	294,565†
% change	-------	+14	+5	-0.2	+2	+0.6

* New York State Department of Economic Development 2000
† U.S. Census Bureau 2000

Quality Assurance and Quality Control

In preparing this health evaluation ATSDR reviewed and evaluated information provided in the referenced documents. USACE is following the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines to remediate the Colonie Site (USACE 2002b). The U.S. Environmental Protection Agency established the CERCLA process to regulate contaminated site cleanups. Documents prepared for the CERCLA program must meet specific standards for adequate quality assurance and must meet control measures for chain-of-custody procedures, laboratory procedures, and data reporting. The validity of the analyses and conclusions drawn in this evaluation are determined by the availability and reliability of the referenced information. Based on our evaluation, ATSDR has determined that the quality of environmental data available in Colonie Site-related documents prepared by USDOE and USACE is adequate to make public health decisions. Some historical data, including data collected by NL Industries and NYSDOH, lacks information relating to quality assurance and quality control. ATSDR believes, however, that the data are still adequate for use in this evaluation.

Discussion

1. In the past, could people have potentially been exposed to harmful levels of DU by breathing air emissions from NL's chip burner and other on-site sources, contacting DU-contaminated soil when playing or gardening, and eating fruits and vegetables grown in DU-contaminated soil?

Although USEPA did not have air regulations for DU while the plant was operating, the highest stack releases of uranium for the period from 1979 to 1984 exceeded USEPA's current National Emissions Standards Hazardous Air Pollutants (NESHAP) guidelines by a factor of 54,000. Based on the levels of DU found in soil, and the fact that the NL plant scaled down operations during the late 1970s and early 1980s, the earlier air emissions were probably higher than those emissions documented between 1979 and 1984. Therefore, DU emissions at these high levels could have increased the risk of health effects—especially kidney disease—for people living near the plant. In addition, the combination of inhaling DU and cigarette smoke could have increased risk of lung cancer. This is because the combined effect of two chemicals—DU and the cigarette smoke—is greater than their additive effects (Mabuchi et al. 1991). In the past, the uncharacterized emissions from the NL plant were a public health hazard to the community surrounding the NL plant.

Contacting DU-contaminated soil when playing or gardening, or when eating fruits and vegetables grown in DU-contaminated soil would not be expected to cause illness in people.

What is uranium?

Uranium is a natural and commonly occurring radioactive element. Natural uranium is actually a mixture of three types (or isotopes) of uranium: U-234, U-235, and U-238. All three isotopes behave the same chemically but have different radioactive properties (ATSDR 1999b). Radioactivity is the spontaneous emission of radiation, or energy, from the nucleus of an unstable atom. For more information about radioactivity and radiation, please see Appendix B.

What is depleted uranium (DU)?
Depleted uranium is uranium with decreased fractions of U-234 and U-235. DU is less radioactive than both enriched and natural uranium (ATSDR 1999b).

What is natural uranium?
Natural uranium is mixture of 0.01% U-234, 0.72% U-235, and 99.27% U-238, by weight. Natural uranium is more radioactive than depleted uranium and less radioactive than enriched uranium (ATSDR 1999b).

What is enriched uranium?
Enriched uranium is uranium with an increased fraction of U-234 and U-235. Enriched uranium is more radioactive than both natural and depleted uranium (ATSDR 1999b).

Depending on the percentages of U-234, U-235, and U-238, uranium can be depleted, natural, or enriched (see text box). Depleted and natural uranium are only weakly radioactive. In fact, DU is three million times less radioactive than radon (Bleise et al 2003).

What kinds of health effects are caused by uranium?

Several factors can determine whether someone will become ill from coming into contact with, or being exposed to, uranium. These include how much of the chemical gets into the body (dose), how often someone is exposed (frequency), and the length of time someone is exposed (duration). In addition, the toxicity of uranium varies with its chemical form (i.e., depleted, natural, or enriched, and water soluble or water insoluble) and with the route of exposure (i.e., eating, touching, and breathing).

The major concern for exposure to uranium is from chemical toxicity. Animal studies have shown that water-soluble forms of uranium can cause kidney problems. The only kidney effects seen in humans, however, have been from acute poisoning incidents. Studies of uranium miners and mill workers have not shown unusual rates of kidney disease (ATSDR 1999b).

Although radiation has been shown to cause cancer, no human cancer has been directly linked to natural or depleted uranium. This is because, as previously stated, natural and depleted uranium are only weakly radioactive. Studies of uranium miners, millers, and processors have shown that the main risk of developing lung cancer is associated with breathing other cancer-causing substances such as radon and cigarette smoke and not with breathing uranium (Whittemore and McMillan 1983; Polednak and Frome 1981; Scott et al 1972; Hadjimichael et al 1983; Cragle et al 1988).

Community members have expressed concern that because they could have been exposed to DU from the NL plant they could have passed on health effects to their children and grandchildren. Only limited information is available about the genetically toxic effects of DU; however, an assessment published by the World Health Organization excluded any link between DU exposure and adverse effects present at birth (WHO 2001).

Have there been any studies of health effects from the NL plant?

In 1979, the NYSDOH and the ACHD collected urine samples from several residents near the NL plant and took several dust samples from nearby homes. The residents varied in both age (5 to 73 years) and length of years residing in their homes (3 to 50 years). The results of all the urine sampling showed no traces of uranium.

Six of these individuals were then chosen to undergo body scans to measure lung burdens of uranium. These individuals ranged in age from 5 to 62 years, and resided in their homes for 5 to 28 years. The candidates were chosen based on the following criteria: resided in areas where soil, dust, and wipe sampling showed highest uranium deposition, resided in the area for a period exceeding 2 years, covered a variety of age distribution, and spent a large portion of time at home (NYSDOH 1979). The results of the body scans showed *no measurable activity from uranium* in any of the residents.

The NYSDOH conducted two investigations looking at cancer and other health effects in the area around the NL plant. The first (1981) investigation identified four census tracts near the plant and looked at both the New York State Cancer Registry data from 1970 to 1976 and NYSDOH Office of Vital Statistics data from 1972 to 1978. NYSDOH then compared these data with data from three nearby census tracts. NYSDOH found an increased number of lung cancer cases in males 65 to 74 years old. A follow up on these lung cancer patients found that most had a history of smoking. No increased number of kidney disease deaths, spontaneous fetal deaths, or kidney cancer was detected (NYSDOH 1981).

The second (1993) NYSDOH investigation looked at the cancer incidence in five ZIP code areas in Colonie from 1978 to 1987. These data were compared with an expected cancer incidence for suburban areas in New York State (excluding New York City). The results showed an increased number of males with colon and rectal cancer and an increased number of females with cancer of the oral cavity (NYSDOH 1993). That said, however, this investigation covered a very large area with an estimated population in 1980 of 58,187 persons. Therefore, it can only provide information about the overall cancer incidence in this population; it can not provide any conclusions about the health of those who lived near the NL plant.

How much DU was released in air emissions from the NL plant?

The levels of stack emissions from the NL plant are only available for 1979–1984. Although the plant used DU beginning in 1958, ATSDR does not have emissions data for operations before 1979. ATSDR staff reviewed records at several state and local agencies while looking for this information, including NYSDEC Headquarters and Region 4 offices, NYSDOH, ACHD, and NYSDOL. ATSDR also contacted the New York State Office of the Attorney General. ATSDR found limited data for uranium stack emissions from the former NL plant during 1979–1984 (NL Industries, unpublished data, 1979–1984). Because strict environmental regulations and enforcement did not occur in the U.S. until the 1970s, it is very likely that air emissions data were not collected prior to 1979.

From the data that are available, the concentration of DU emissions ranged from not detected to 0.000000018 micro curies (µCi) per milliliter of air during 1979–1984 (NL Industries, unpublished data, 1979–1984). Based on the levels of DU found in the soil in the properties surrounding the Colonie Site, and the fact that the NL plant scaled down operations during the late 1970s and early 1980s (USDOE 1989b), it is probable that the levels of stack emissions before 1979 were higher than those found in the 1979–1984 data. In addition, the air emissions found in the data would probably not have been high enough to produce the levels of DU found in the soil of some of the adjacent properties.

It is important to note that when the NL plant was closed in 1984 the emissions stopped; it is also important to note that in the Colonie Site vicinity there is no current exposure to DU from air emissions.

What is a curie?

A curie (Ci) is the basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. It is named for Marie and Pierre Curie, who discovered radium in 1898 (NRC 2003). A micro curie, or µCi, is one millionth of a curie. A picocurie, or pCi, is one trillionth of a curie.

For reference, one gram of radium has an activity of one curie.

Did people breathe harmful levels of DU in the past?

ATSDR reviewed the 1979–1984 data and used a simple modeling program known as "COMPLY." The USEPA developed COMPLY for its guidance on National Emissions Standards Hazardous Air Pollutants (NESHAP). The model is based on the National Council on

Radiation Protection and Measurements (NCRP) Commentary Number 3, Screening Techniques for Determining Compliance with Environmental Standards. For more information about the COMPLY model, please see Appendix C.

The model showed that the highest 1979–1984 stack releases exceeded the current NESHAP guidelines by a factor of 54,000. Based on the levels of DU found in soil, and the fact that the NL plant scaled down operations during the late 1970s and early 1980s (USDOE 1989b), the earlier (pre-1979) air emissions were probably higher. ATSDR believes that the DU emissions at these high levels could have increased the risk of health effects—especially kidney disease—for people living near the plant. In addition, the combination of inhaling DU and cigarette smoke could have increased risk of lung cancer. This is because the combined effect of two chemicals—DU and the cigarette smoke—is greater than their additive effects (Mabuchi et al. 1991). Although the extent to which these risks were increased is unknown, ATSDR concludes that in the past, the uncharacterized emissions from the NL plant were a public health hazard to the community surrounding the Colonie Site.

How did DU enter the soil?

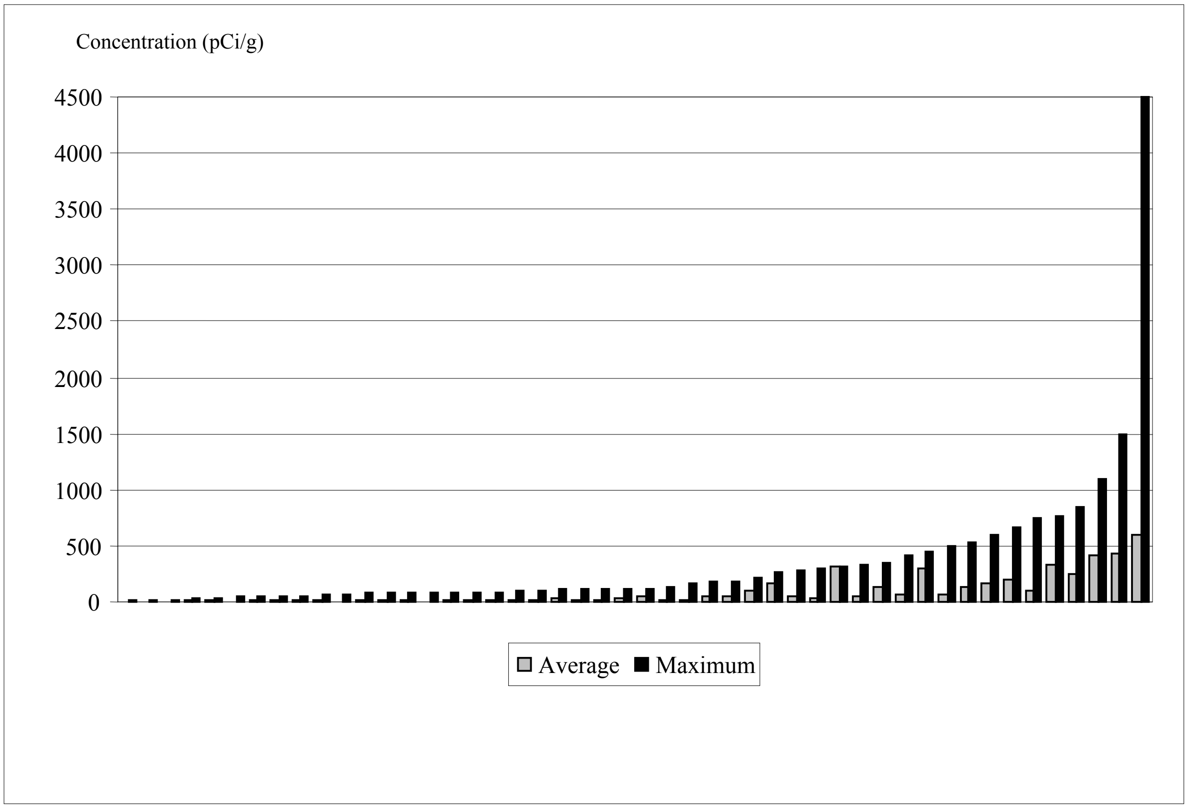
DU entered the soil from air emissions from the NL plant. In air, uranium takes on a dust-like form. Very small dust-like particles of uranium fall out of the air on surface water, on plant surfaces, and on soil, either by simple gravity or by rainfall (ATSDR 1999b).

In 1980, Teledyne Isotopes (TI) surveyed the neighborhood surrounding the NL plant for radioactivity. TI determined that the uranium released into the air through stack emissions had deposited on nearby residential and commercial properties and structures. The survey showed that the majority of the contamination was north/northwest and southeast of the plant in the direction of prevailing summer and winter winds. This area included parts of Central Avenue and Yardboro Avenue (Teledyne Isotopes 1980).

What levels of DU were found in the soil?

In 1983, ORNL performed detailed radiological surveys of the individual vicinity properties surrounding the NL plant (including private residences). These surveys were designed to locate all properties on which uranium contamination exceeded the guidelines developed by New York State and USDOE, i.e.: 1) 35 pCi/g averaged over a 10-meter by 10-meter section, or 2) 100 pCi/g in a 5-cm by 5-cm section (USDOE 1989a). These regulatory limits were decided for the purposes of remediation and are not based on health risk or dose. The agencies surveyed 219 locations. The results indicated that 56 properties required remediation (USDOE 1995). ATSDR reviewed the surveys for 48 of the 56 properties that required remediation and found that levels of DU in soil that exceeded either of the guidelines averaged 8.4 to 600 pCi/g of soil, with a maximum on one property of 4500 pCi/g of soil (Figure 3).

Figure 3: Maximum and Average DU Soil Concentrations in Vicinity Properties that Required Remediation—Colonie Site, Albany County, New York



When and how was the soil cleaned up?

Between 1984 and 1988, USDOE cleaned up 53 vicinity properties. Under its current program, USACE is cleaning up two additional properties: the town of Colonie property and the Consolidated Railroad Corporation property. Another adjacent area—the Niagara Mohawk property—requires no further remedial action for radiological contamination. The typical method of remediation for the contaminated properties involved the removal of siding, roofing materials, driveways and sidewalks, the excavation of soil, and the removal of shrubbery. After the vicinity properties were remediated, the properties were restored according to the conditions of the access agreements. This included backfilling the excavated areas with clean fill material, replacing any removed shrubbery, and restoring any altered structures (e.g., fences and pavement).

Would there have been health effects from touching DU-contaminated soil while playing or gardening?

Little scientific information is available regarding how touching DU or DU-contaminated soil can affect health. Scientists do know that the skin does not easily absorb water-insoluble forms of uranium; the DU used at the NL plant was water-insoluble. Although some animal studies have found health effects such as skin irritation and dermal ulcers after exposure to different uranium compounds, a study on rats found that a 1-year exposure to uranium tetrachloride (a water-insoluble compound) did not affect the skin (Stokinger et al 1953). The alpha particle emitted by uranium will not penetrate the dead or the keratinized outer layer of the skin. Thus the concern for dermal effects from skin contact with uranium is minimal. Dermal effects were not seen in studies of uranium miners, millers, and processors. The observed skin damage reported in animals dermally exposed to excessive quantities of uranium compounds is not expected to occur in human exposures at hazardous waste sites. Such exposures, if they do occur, are expected to be at or less than the levels at which uranium miners, millers, and processors are exposed, i.e., levels at which no attributable dermal health effects were reported (ATSDR 1999b). ATSDR concludes that it would be very unlikely for people playing or gardening to absorb uranium into their bodies through the skin. Consequently, no health effects would results from touching the soil.

Concerns have been raised that children could have been playing in the soil with bare feet, arms, and legs during the summer months, thus increasing the area on their bodies that could contact contaminated soil. Because, however, the water-insoluble form of uranium is not very easily absorbed by the skin, ATSDR believes these children would not be at any higher risk of health effects.

Would there be health effects from eating DU-contaminated soil?

When people put their hands in their mouths, smoke cigarettes, or eat food after touching soil and before washing their hands, they can incidentally eat soil. Children are especially prone to this type of hand-to-mouth behavior. Some young children exhibit pica behavior by intentionally eating large amounts of soil and other non-food items Studies have shown that the water-insoluble compounds of uranium, like those used at the NL plant, are not easily absorbed by the body's gastrointestinal tract (i.e., stomach, small intestines, and colon). Many studies of animals exposed to high levels of uranium through ingestion have shown very few health effects. When incidentally ingested, uranium—especially the water-insoluble form—is not considered to be toxic (ATSDR 1999b). ATSDR reviewed the soil data from the properties surrounding the Colonie Site and calculated doses for the incidental ingestion of DU. The estimates were compared to ATSDR's minimal risk levels (MRLs). ATSDR found that adverse health effects would not be expected, even for children exhibiting pica behavior. Appendix D has information about ATSDR's calculations and assumptions for eating DU-contaminated soil.

ATSDR's Minimal Risk Levels (MRLs)

The MRL is derived from the lowest observed adverse effect level (LOAEL) identified in the scientific literature. The LOAEL is the lowest dose at which an adverse health effect has been observed. It is divided by a safety factor to protect sensitive groups and to account for the differences between humans and animals in response to exposure. MRLs are protective by design and represent doses below which non-cancer adverse health effects are not expected to occur, even from daily exposure over a lifetime. *MRLs are not thresholds for harmful health effects. A dose that exceeds the MRL indicates only the increasing potential for toxicity and that further toxicological evaluation is needed.*

Would health effects result from eating fruits and vegetables grown in DU-contaminated soil or soil contaminated with DU from air emissions?

Plants can absorb DU in the soil from the roots without absorbing it into the body of the plant.

Because of this, root vegetables such as potatoes, radishes, and beets, tend to absorb slightly more uranium than other types of plants (ATSDR 1999b). Uptake of uranium is restricted to the root system and could actually represent adsorption to the outer root membrane rather than incorporation into the interior of the root system (Sheppard et al. 1983). Washing the vegetable surfaces will remove most of this uranium; cutting away the outer membrane will essentially result in complete removal. No significant translocation of uranium from soil to the above-ground parts of plants has been observed (Van Netten and Morley 1983).

ATSDR's calculations for incidental soil ingestion found that over a 30-year period an adult eating 50 mg of soil per day and a child eating 100 mg of soil per day contaminated with 600 pCi/g of DU would not result in doses causing health effects. Similarly, contaminated dust from the air emissions landing on fruits and vegetables would not have caused health effects in people who ate those fruits and vegetables. The DU amount would have been small and, as discussed previously, ingesting small amounts of water-insoluble forms of uranium would not cause illness.

2. Were people exposed to harmful levels of lead in the past, currently, or in the future by breathing air emissions from the NL plant, contacting soil when playing or gardening, and eating fruits and vegetables grown in lead-contaminated soil?

NL operated its foundry until 1960. During this time it is very likely that no air emissions were measured at the plant. Because no data on lead emissions in the air from the plant are available, ATSDR cannot draw any conclusions about the health effects of breathing the former lead-air emissions from the NL plant. That said, however, it is important to note as well that when the foundry stopped operating in 1960, the lead emissions also stopped.

In May 2003 NYSDOH and NYSDEC sampled soil in the Yardboro Avenue area for lead and other metals. ATSDR reviewed the data and found that the levels of lead found in these areas are not at levels that would cause adverse health effects.

What kinds of health effects are caused by lead?

What is 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. It is often used in batteries, pipes, brass, solder, and paints. The amount and wide-ranging use of lead has decreased over the last several years because of the harmful neurotoxic effects of lead in people (ATSDR 1999a).

Studies on the health effects of lead are based on blood-lead levels (expressed as µg/dL or micrograms per deciliter), not the amount of lead detected in, for example, soil, air, or water. Several factors can determine whether someone will become ill from coming into contact with, or from being exposed to a chemical. These include how much of the chemical gets into the body (dose), the length of time someone is exposed (frequency), and for how long someone is exposed (duration).

Whether lead enters the body through breathing or eating, the effects are the same. In both adults and in children the main target for lead is the central nervous system. Lead exposure can cause anemia. At high levels lead can damage the kidneys and cause decreased mental capacity. In pregnant women, high levels of lead exposure can cause miscarriage. No available evidence indicates that lead causes cancer in humans (ATSDR 1999a).

Children are more sensitive to the effects of lead than are adults. Even low levels of exposure can affect a child's mental and physical growth. Children are also more vulnerable to lead exposure. If their mothers have lead in their own bodies, children can be exposed to lead in the womb. Through breast milk, nursing mothers can pass the lead in their bodies to their babies. Children are also prone to hand-to-mouth behavior, which can increase their uptake of lead (ATSDR 1999a).

Besides the former NL plant, are there other sources of lead exposure that community members should be aware of?

In 1978, the U.S. government banned lead from use in paint; lead-based paint was shown to be a major contributor to lead poisoning in children. Many of the homes in the residential areas surrounding NL were built before 1950 and could contain both interior and exterior lead paint. In addition, burning leaded gasoline was a major, albeit former source of lead emissions. Since the mid-1980s the USEPA has banned the use of lead in gasoline. Still, lead from these emissions could be present in soils near highways and major roads.

How much lead was released in air emissions from the NL plant?

As stated, NL terminated foundry operations in 1960. No information is available on the levels of air emissions of lead from NL's foundry operations; the foundry operated before many of the current air pollution control regulations were created. While searching for information about the NL plant ATSDR staff reviewed records at several state and local agencies, including NYSDEC Headquarters and Region 4 offices, NYSDOH, ACHD, and NYSDOL. ATSDR found no information about NL lead air emissions. ATSDR also reviewed many reports relating to the Colonie Site, but found little information about NL's processes that involved lead.

In the past, did people breathe harmful levels of lead?

As stated, because the NL plant operated when environmental regulations addressed only a small number of pollutants and emission sources, no information is available (e.g., stack test results, production data, and ambient air monitoring records) about what emissions were released. Therefore, ATSDR cannot draw any conclusions about the levels of lead to which people might have been exposed from air emissions.

If, however, lead was burned in a process similar to that used for DU, lead oxide would have been formed. Lead oxide is a form of lead readily absorbed by the body. If people breathed lead oxide, health effects could have included kidney disease, central nervous system effects, and impaired mental development in children.

But it is important to note again that NL closed its foundry in 1960. Thus after 1960, no hazard would have existed from the air emissions. Similarly, no current or future air emission health hazard has been detected.

How could lead have entered the soil?

As with uranium, lead could have entered the soil from air emissions from the NL plant. In air, lead exists as very small dust-like particles. These particles fall out of the air and onto—among other things—surface water, plant surfaces, and soil. Lead can also end up in the soil from the weathering and chipping of lead-based paint and from past emissions of motor vehicles burning leaded gasoline. Because lead is a heavy metal, it typically stays in the top 2 inches of soil and does not migrate (ATSDR 1999a).

What are the levels of lead in the soil surrounding the Colonie Site?

In 1992, the NYSDOH tested four locations for metals in the soil: West Highland Park, the church on Yardboro Avenue, a Kraft Road location near Alsade Supply, and a residence on Fairfield Avenue. The results showed levels at least three times below what would be of concern in an urban area. But these samples were not all from areas that would likely have had the highest level of deposition, nor were they all from properties that had high levels of DU.

During the 1980s the soil removal from DU-contaminated properties would likely have removed lead-contaminated soil as well, but lead contamination could remain at properties that were not cleaned up. In May 2003 NYSDOH and NYSDEC sampled soil for lead in areas surrounding the former NL plant. This sampling effort included locations that were remediated for uranium contamination as well as locations that did not require remediation. All of the properties sampled are within the area of DU deposition from the former NL plant. Samples taken from remediated areas were collected 3-6 inches below the ground surface. Samples from non-remediated areas were collected at 0-3 inches below the ground surface. The samples showed lead levels that are typical of urban areas.

Table 2: May 2003 Soil Sampling results for Lead in Residential Areas Near the Colonie Site

Number of sampling locations	Concentration Range (mg/kg)	Average (mg/kg)	Sample Depth (inches)
3	230-510	373	0-3
5	71-250	135	3-6

Would there be health effects from touching lead-contaminated soil while playing or gardening?

Lead can not easily get into the body through the skin (ATSDR 1999a). People can, however, incidentally ingest lead by touching lead-contaminated soil and then exhibiting hand-to-mouth behavior (see below).

Would health effects result from eating lead-contaminated soil found near the Colonie Site?

When people put their hands in their mouths, smoke cigarettes, or eat food after touching soil and before washing their hands, they can incidentally eat soil. Children are especially prone to this type of hand-to-mouth behavior. Some young children can exhibit pica behavior in which they intentionally eat large amounts of soil and other non-food items.

ATSDR considers widespread soil lead levels above 400 mg/kg to be of potential health concern for children who are likely to be exposed from their activities and who are most sensitive to the health effects of lead. Because one of the soil samples exceeded this value, ATSDR estimated lead exposure doses from incidentally eating soil from the maximum lead level found. Because there is no ATSDR MRL for lead exposure, ATSDR estimated blood lead levels based on the doses. For more information about these calculations and assumptions, please see Appendix D.

It is important to note, however, that lead-contaminated soil covered by grass and other vegetation is less likely to be accessible for incidental ingestion and is not considered a completed exposure pathway. Also, people— especially children—do not spend all of their time in the same location and would be exposed to an average of the concentrations rather than the highest concentration. Therefore, areas of soil with lead levels above 400 mg/kg will not necessarily cause health effects.

Because one of the samples exceeded the screening value of 400 mg/kg, ATSDR calculated the estimated blood lead levels from incidentally ingesting soil with 373 mg/kg of lead, the average of the surface soil samples. Epidemiological studies have identified harmful effects of lead in children at blood lead levels at least as low as 10 µg/dL. Based on these studies, the Centers for Disease Control and Prevention (CDC) recommends that action be taken for blood lead levels of 10 µg/dL or higher. The estimated levels for lead in the soil near the Colonie Site—1.8 µg/dL for children and 0.2 µg/dL for adults—are well below CDC's recommended action level of 10 µg/dL. The estimated blood lead level for a pica child is 15 µg/dL. This estimate, however, is very protective and assumes that the concentrations sampled are accessible to children—i.e., bare soil rather than grass cover. Therefore, ATSDR believes that children—even pica children—will not have health effects from incidentally ingesting lead-contaminated soil.

If people are concerned about current or future exposure to lead in the soil, they can take precautions by washing their hands after touching soil and before eating or smoking. They can also make sure children do not put soiled hands in their mouths.

CDC recommends that states develop a plan to find children who could be exposed to lead and have their blood tested for lead. CDC makes basic recommendations for states to follow, including testing all children at ages 1 and 2. Children who are 3 to 6 years old should be tested if they have never been tested for lead previously and they receive services from public assistance programs such as Medicaid or the Supplemental Food Program for Women, Infants and Children (WIC). Also, children should be tested if they live in a building, or frequently visit a house built before 1950, if they visit a home (house or apartment) built before 1978 (when lead was removed from paint) that has been recently remodeled, or if they have a brother, sister, or playmate who has had lead poisoning (ATSDR 1999a).

The NYSDOH Childhood Lead Poisoning Prevention Program follows CDC guidelines. ATSDR recommends that parents concerned about their children's exposure to lead follow these guidelines and have their children's blood-lead levels tested by their health care provider.

Would health effects result from eating fruits and vegetables grown in lead-contaminated soil or contaminated with lead from air emissions?

When dust containing lead falls onto crops, that lead can end up on plants. If people eat the dirt and dust on the surface of those crops they can be exposed to lead. To reduce this type of exposure, washing and peeling fruits and vegetables is a good precautionary measure (WHO 2000). Again, this would have been of most concern prior to 1960 when the lead foundry was operational.

Lead also can be taken up by edible plants grown in lead-contaminated soil. The roots typically absorb the lead. But the availability of lead to plants in soil is limited because lead strongly adsorbs to the soil's organic matter. ATSDR reviewed the U.S. Food and Drug Administration's (USFDA) Total Diet Study results and found that lead in fruits and vegetables of the American food supply typically ranges from non-detect to 12 mg/kg (USFDA 2000). Another study reported that lettuce grown in soil with less than 400 mg/kg of lead and radishes grown in soil with less than 800 mg/kg of lead had lead levels equal to or less than those found in the USFDA's report (Nwosu et al 1995). Based on these studies and the lead levels found in the soil near the Colonie Site, ATSDR believes that edible plants grown in the lead-contaminated soil would not have absorbed significant amounts of lead. Therefore, eating these plants would not have caused health effects.

3. Currently and in the future, could people potentially breathe indoor air with volatile organic compounds (VOCs) from contaminated groundwater?

Because groundwater contamination had migrated off site, USACE took two rounds of indoor air samples from five homes near the Colonie Site. The results showed no current public health impact from exposure to VOCs in the indoor air. In addition, a model used to predict indoor air concentrations from the highest values found in groundwater suggests that VOCs in indoor air would not be expected to reach levels that would cause health effects.

How did the groundwater become contaminated and where is the contamination now?

Spills and releases of VOCs at the former NL plant saturated the soils and seeped into underground water (groundwater). The contamination is in the groundwater under the southern portion of the site and has migrated off site, under Yardboro Avenue.

Can I be exposed to VOCs if I live in an area near the groundwater plumes?

Under some conditions, VOCs can travel upward from the groundwater, through the soil, and into the air of subsurface spaces. For example, vapors can seep into basements through cracks in the foundation or around the sump pump. If VOCs had reached indoor spaces of houses, residents living in the housing units could come into contact with them by breathing air containing these compounds.

What are VOCs?

Volatile organic compounds, or VOCs, are a group of chemicals having similar physical properties. VOCs readily evaporate or volatilize into gases when exposed to air. Chemicals in this group include trichloroethene (TCE), dichloroethene (DCE), tetrachloroethene (PCE), benzene, methylene chloride, and vinyl chloride and in general may be used as dry-cleaning solution, additives in fuels, or as solvents to dissolve grease or other compounds.

Exposure to VOCs at high levels can affect the central nervous system, resulting in fatigue, dizziness, headache, and nausea. Liver and kidney damage has been seen in animals exposed to very high levels of VOCs. Although VOCs such as TCE and PCE have not been shown to cause cancer in people, some animals have developed cancer from exposed to these chemicals.

In July and August of 2002, USACE sampled the indoor air of five residences adjacent to the Colonie Site to determine if VOCs from the contaminated groundwater had affected the indoor air quality of those homes (Table 2). Eight-hour samples were taken from the basements, where the highest levels would be expected. All windows in the basements were closed. Contaminants sampled were tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and cis-1,2-dichloroethene (cis-1,2-DCE). Although PCE was detected at very low levels in the ambient air of all the homes none of the other VOCs were detected. Because contaminant concentrations in indoor air can potentially be higher during the winter months, in January 2003 USACE again sampled the five homes (Table 2). Eight-hour samples were collected from the basements, where the highest levels would be expected. Again, all windows in the basements were closed. The heating systems remained operational during the sampling period. A level of 12 micrograms of PCE per cubic meter of air (µg/m^3) was found in the basement of one residence during this sampling round. The basement in this particular residence has a dirt floor—this makes it easier for VOCs to enter than if the home had a concrete floor.

ATSDR compared the values from the two sampling rounds to USEPA Region 9's preliminary remediation goals (PRGs) and to ATSDR's comparison values. The PRGs are risk-based concentrations derived from standardized equations combining exposure information assumptions with USEPA toxicity data. They are used for site screening and as initial cleanup goals, if applicable. The PRG's role in site screening is to help identify areas, contaminants, and conditions that do not require further federal attention at a particular site; PRGs are not de facto cleanup standards. Chemical concentrations above their PRGs would not automatically trigger a response action. That said, however, exceeding a PRG suggests that further evaluation of the potential risks posed by site contaminants is appropriate.

By contrast, ATSDR's comparison values do not represent thresholds of toxicity. They are strictly screening values used to facilitate the initial selection of site-specific chemical substances for further evaluation of potential health effects. After the chemicals exceeding the screening values have been identified, they must be individually scrutinized in more detail to determine whether, under site-specific conditions, they represent a realistic threat to human health. Although concentrations at or below ATSDR's comparison values could reasonably be considered safe, it does not automatically follow that any concentration above a comparison value will necessarily produce toxic effects. Comparison values are intentionally designed to be orders of magnitude lower than the corresponding no-effect levels determined in laboratory experiments.

Two of the samples from the January 2003 sampling round exceeded the USEPA Region 9 PRG for TCE. One sample from the January 2003 sampling round and one and the July/August sampling round exceeded the PRG for PCE. In addition, TCE, which was not detected in many of the samples, had detection limits above the PRG. Still, none of the samples measured during either sampling round exceeded ATSDR's comparison values.

Table 2: Residential VOC indoor air sampling conducted by USACE*

July/August 2002 Sampling Round							
Compound	**Location 1**	**Location 2**	**Location 3**	**Location 4**	**Location 5**	**USEPA Region 9 PRGs for ambient air† (µg/m³)**	**ATSDR's comparison values for air‡ (µg/m³)**
PCE	0.45	0.31	1.0	0.23	0.29	0.67	300
TCE	ND (0.19)	ND (0.19)	ND (0.18)	ND (0.24)	ND (0.19)	0.017	500
cis-1,2-DCE	ND (0.14)	ND (0.14)	ND (0.14)	ND (0.14)	ND (0.14)	37	NA
VC	ND (0.044)	ND (0.044)	ND (0.044)	ND (0.045)	ND (0.044)	0.11	0.1
January 2003 Sampling Round							
Compound	**Location 1**	**Location 2**	**Location 3**	**Location 4**	**Location 5**	**USEPA Region 9 PRGs for ambient air† (µg/m³)**	**ATSDR's comparison values for air (µg/m³)**
PCE	12	0.52	0.44	0.29	0.2	0.67	300
TCE	0.22	ND (0.17)	ND (0.15)	ND (0.17)	0.58	0.017	500
cis-1,2-DCE	0.21	ND (0.12)	ND (0.11)	ND (0.13)	0.48	37	NA
VC	ND (0.04)	ND (0.04)	ND (0.036)	ND (0.041)	0.057	0.11	0.1

* USACE, unpublished data, 2003. All results are in µg/m³. Values in parentheses are the detection limits. Values in bold exceed the USEPA Region 3 risk based concentration.
† USEPA 2002
‡ PCE – chronic environmental media evaluation guide (EMEG); TCE – intermediate EMEG; VC – cancer risk evaluation guide (CREG); NA – not applicable.

Because some VOC samples exceeded the USEPA Region 9 PRGs, ATSDR looked at toxicological information for PCE and TCE to determine whether people exposed at these levels could become ill. The values reported in these studies for PCE and TCE exposure are substantially higher than those found in the indoor air of homes on Yardboro Avenue. For more information about the information in these toxicological studies, please see Appendix E.

ATSDR does not believe that there is currently any public health impact from VOCs in indoor air from groundwater contamination. Health effects are not likely in the future, either; USACE is currently evaluating the groundwater and a feasibility study/proposed plan will be issued in late 2003 or early 2004. This will reduce the chance that higher VOC levels will migrate toward the Yardboro Avenue homes. In addition, the public will haven an opportunity to comment on this plan.

My home was not sampled. How do I know I won't get sick from VOCs in the indoor air?

ATSDR applied a simple vapor intrusion model—the Johnson and Ettinger model—to 1) predict indoor air concentrations based on the maximum groundwater concentrations (located on site), 2) predict indoor air concentrations based on the groundwater concentrations near the Yardboro Avenue homes, and 3) predict indoor air concentrations based on the sub-foundation soil gas samples taken during the July/August 2002 sampling round. The groundwater levels used in the model were at least a factor of 10 greater than levels found in groundwater monitoring wells near Yardboro Avenue. Based on the results of this model, VOCs in indoor air would not be expected to reach levels that would cause health effects. For more information about this model and the results, please see Appendix F.

What is being done about the groundwater contamination?

As discussed in the Background section of this health evaluation, USACE is developing a Remedial Investigation Report for the groundwater. Sampling in off-site monitoring wells indicates groundwater contaminated at low levels had migrated off site. Currently, USACE is developing a feasibility study to evaluate alternatives to clean up this contaminated groundwater. A variety of techniques are available to remove or destroy groundwater contaminants to ensure that human health and the environment is protected. Alternatives include using naturally occurring bacteria to degrade the contaminants, injecting other chemicals into the ground to destroy the VOCs, and extracting and treating the groundwater.

In addition, USACE has begun a health risk assessment to evaluate both the human health and ecological impacts of groundwater contaminants from the Colonie Site. A health risk assessment characterizes the nature and magnitude of risks to public health from exposure to hazardous substances, pollutants, or contaminants released from specific sites; it is used to support the selection of a site-specific remedial measure. The human health risk assessment will consider on-site and off-site land use scenarios. The on-site scenario will assume potential future residential development of the site, with a variety of exposure pathways evaluated. The off-site scenario will evaluate vapor intrusion from VOCs from shallow groundwater aquifer exposure.

Community Health Concerns

During site visits and telephone conversations with community members, ATSDR identified five community concerns related to the Colonie Site. These are discussed below.

1. **Community members are concerned that past emissions from the site have caused adverse health effects such as various types of cancer, birth defects, Down syndrome, rashes, and endometriosis.**

ATSDR reviewed the available scientific information about the health effects associated with both uranium and lead. Based on this information and the data available for the Colonie Site, ATSDR concludes that the levels of DU from the NL plant could have increased the risk of health effects in the community surrounding the plant. Although, as discussed previously, the extent to which these risks were increased is unknown. The uranium used at the plant, however, was water-insoluble and would not have been easily absorbed by the body. In addition, many studies of uranium miners, millers, and processors showed no damage to skin after touching uranium. No currently available studies show a link between uranium and birth defects, Down syndrome, or endometriosis.

In both adults and in children the main targets for lead are the central nervous system and the kidney. There is no evidence that lead will cause cancer in humans. No currently available studies show a link between lead and birth defects, Down syndrome, or endometriosis.

Community members have also expressed concern that because they were exposed to contaminants from the NL plant, they could have passed on health effects to their children and grandchildren. Unborn children can be exposed to lead through their mothers. But DU and lead are not known to cause any kinds of genetic effects and there is no evidence that health effects would be passed on to children and grandchildren in this way. There is also no evidence from animal studies that lead or DU cause malformation of a developing embryo or fetus.

2. **A citizen is concerned that possible lead contamination in their yard could harm children and grandchildren.**

In May 2003 NYSDOH and NYSDEC sampled soil in the Yardboro Avenue area for lead and other metals. ATSDR reviewed the data and found that the levels of lead found in these areas are not at levels that would cause adverse health effects. For more information about lead contamination in soil, please see the previous discussion section on lead in this document.

Lead paint is a major contributor to lead poisoning in children. Through hand-to-mouth behavior children can eat the sweet-tasting lead paint chips, or eat they can lead paint dust. Many of the homes in the residential areas surrounding NL were built before 1950 and could contain both interior and exterior lead paint.

CDC recommends that states develop a plan to find children who could be exposed to lead and have their blood tested for lead. They make basic recommendations for states to follow, including testing all children at ages 1 and 2. Children who are 3 to 6 years old should be tested if they have never previously been tested for lead. Children should also be tested if they receive services from public assistance programs such as Medicaid or the Supplemental Food Program for WIC, if they live in a building or frequently visit a building built before 1950, if they visit a home (house or apartment) built before 1978 that has been recently remodeled, or if they have a brother, sister, or playmate who has had lead poisoning (ATSDR 1999a).

The NYSDOH Childhood Lead Poisoning Prevention Program follows CDC guidelines. Similarly, ATSDR recommends that parents concerned about their children's exposure to lead follow these guidelines and have their children's blood lead levels tested by their health care provider.

3. A citizen's group is concerned that people, especially children, could have been exposed to DU in the past by playing with pellets and abandoned drums on the property.

As discussed in previous sections, the DU used at the NL plant was water-insoluble. Touching or incidentally eating it would not have made people sick. No information is available concerning the contents of any drums on the property while NL was in operation.

4. A community group is concerned about exposure to DU, lead, and other possible contaminants in the surface water and sediment while swimming and wading in areas of the Patroon Creek watershed, including in and around the Patroon Reservoir and Tivoli Preserve.

The Patroon Creek watershed is located in an industrial area and is subject to contamination from several point and non-point sources of pollution. Although not classified by New York State for primary contact recreation, it is reported that some parts of the Patroon Creek and Patroon Reservoir have been used for many years for swimming and wading by people living nearby.

A local university researcher collected sediment cores and samples from the Patroon Reservoir, which is a little more than ½ mile downstream from the Colonie Site and the MerCo state superfund site. Uranium, lead, cadmium, and mercury were found in the core sample taken from below the sediment surface (Arnason and Fletcher 2003). The maximum levels of these contaminants are shown in Table 3, below.

Table 3: Maximum concentrations in sediments from the Patroon Creek Reservoir*

Compound	Maximum concentration (mg/kg)	Depth of maximum concentration† (m)	USEPA Region 9 PRGs for residential soil‡ (mg/kg)
Uranium	320	1.7	16
Lead	3600	1.9	400
Cadmium	25	1.5	37
Mercury	13	0.8	23

* Arnason and Fletcher 2003
† Depths are approximate
‡ USEPA 2002; concentration for uranium is for soluble uranium compounds; value for lead is from the USEPA Region 9 Preliminary Remediation Goals, USEPA 2002

Although the maximum concentrations for uranium and lead exceed the USEPA Region 9 PRGs, it is important to note that the PRGs are health-protective concentrations for residential soil; they are not applicable to sediments under approximately 2.5 meters of water. The maximum concentrations were found in samples approximately 0.8 to 1.9 meters (or 2.6 to 6.2 feet) below the sediment/water interface. This means that although the levels of contaminants are high, people cannot presently encounter these contaminants in the sediment. In addition, researchers have found no evidence of sediments resuspended from the bottom of the Patroon Reservoir (Arnason and Fletcher 2003). This means that the contaminants will not be resuspended in the water and do not currently pose a health risk. It is important to remember, however, that the Patroon Creek watershed is located in an industrial area and is subject to contamination from several point and non-point pollution sources.

Past contamination levels in the water and in the sediment are unknown. Because the Patroon Creek watershed was in an industrialized area with few environmental safeguards, the levels of contamination were probably high. The USACE is currently developing a plan for sampling sediments in the unnamed tributary leaving the Colonie Site and parts of Patroon Creek.

ATSDR's Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health. ATSDR is committed to evaluating children's sensitivities at areas such as the Colonie Site.

ATSDR has attempted to identify populations of children in the vicinity of the Colonie Site and any public health hazards threatening these children. Some 710 children aged 6 and younger live within a 1-mile radius of the Colonie Site. All calculations, health guidelines, and comparison values consider the sensitivities of children.

The calculations for exposure to DU in the soil discussed in the text were also performed for children. ATSDR concluded that no adverse health effects are expected to occur in children who contact DU-contaminated soil when playing or gardening, or when eating fruits and vegetables grown in DU-contaminated soil.

The calculations for exposure to lead in the soil discussed in the text were also performed for children. ATSDR concluded that no adverse health effects are expected to occur in children who contact lead-contaminated soil when playing or gardening, or when eating fruits and vegetables grown in lead-contaminated soil.

Children can also be exposed to lead from paint by eating sweet-tasting lead paint chips or, through hand-to-mouth behavior, by eating lead paint dust. ATSDR recommends that parents concerned about their children's exposure to lead follow established guidelines and have their children's blood lead levels tested by their health care provider.

Conclusions

Please see Appendix A (ATSDR glossary of terms) for definitions of ATSDR's conclusion categories.

1. Although USEPA did not have air regulations for DU while the plant was operating, the highest stack releases of uranium for the 1979–1984 period exceeded USEPA's current NESHAP guidelines by a factor of 54,000. Based on the levels of DU found in soil, and the fact that the NL plant scaled down operations during the late 1970s and early 1980s (USDOE 1989b), the earlier air emissions were probably higher than those documented between 1979 and 1984. ATSDR believes that the DU emissions at these high levels could have increased the risk of health effects—especially kidney disease—for people living near the plant. In addition, the combination of inhaling DU and cigarette smoke could have increased risk of lung cancer. This is because the combined effect of two chemicals—DU and the cigarette smoke—is greater than their additive effects (Mabuchi et al. 1991). Although how much the risk was increased is unknown, ATSDR concludes that in the past, the uncharacterized emissions from the NL plant were a **public health hazard** to the community surrounding the plant. On the other hand, contacting DU-contaminated soil when playing or gardening, or when eating fruits and vegetables grown in DU-contaminated soil, probably would not have caused people to become sick. ATSDR's conclusion category for this exposure is **no apparent public health hazard**.

2. NL operated a foundry until 1960. During this time no air emissions were measured at the plant. Because of the lack of data on lead-air emissions from the plant, ATSDR's conclusion category for breathing lead from air emissions at NL is an **indeterminate public health hazard**. That said, however, it is important to note that when the foundry stopped operations the lead emissions also stopped.

   In May 2003 NYSDOH and NYSDEC sampled soil in the Yardboro Avenue area for lead and other metals. ATSDR reviewed the data and found that the lead in these areas is not at levels that would cause adverse health effects. Based on this data, contacting lead-contaminated soil and incidental ingestion of lead-contaminated soil is **no apparent public health hazard**.

3. Because groundwater contamination had migrated off site, USACE took two rounds of VOC-indoor samples from five homes near the Colonie Site. ATSDR compared these results to reference values and used a screening level model to predict indoor air concentrations from the highest values found in the groundwater plume for homes not sampled. The results of these samples and the results from the model showed VOCs in indoor air would not be expected to reach levels that would cause health effects. ATSDR's conclusion category for this exposure is **no apparent public health hazard**.

Recommendations

ATSDR recommends that parents concerned about their children's exposure to lead have their children's blood-lead levels tested by their health care provider. This includes following CDC's recommendations for testing children who live in houses built before 1950.

Public Health Action Plan

Completed Actions

1. Between 1984 and 1988 USDOE cleaned up 53 of the 56 DU-contaminated vicinity properties.

2. USACE has sampled for VOCs in the indoor air in five homes adjacent to the Colonie Site.

3. ATSDR participated in the November 21, 2002 NYSDOH/NYSDEC public meeting discussing the lead-soil sampling plan for properties surrounding the former NL plant.

4. On May 1, 2003 NYSDOH and NYSDEC conducted soil sampling for lead in areas around the Colonie Site.

Ongoing Actions

1. USACE is continuing to remediate the soil at the Colonie Site. Over 90,000 tons of soil has been cleaned up and the estimated completion date for the overall soil cleanup is 2004.

2. USACE has begun a health risk assessment to evaluate both the human health and the ecological impacts of groundwater contaminants from the Colonie Site.

3. USACE is developing a plan for sampling sediments in the unnamed tributary leaving the Colonie Site and for sampling parts of Patroon Creek.

Planned Actions

USACE will develop a feasibility study evaluating the remediation alternatives for VOCs in groundwater.

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Figures

Figure 1: Regional Setting of the Colonie Site

Figure 2: Colonie Site Demographics

Appendices

A. ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (USEPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community.

CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by USEPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to USEPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might

be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An USEPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

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B. Glossary of Radiation Terms

What is radioactivity?

Radioactivity is the spontaneous emission of radiation from the nucleus of an unstable atom. Atoms are the smallest units of an element that have the same properties as the element. All matter is made up of atoms. Atoms are made up of protons and neutrons (found in the nucleus of the atom) and electrons. The number of protons in an atom of a particular element is always the same, but the number of neutrons can vary. Whether an atom is unstable, or radioactive, is determined by the ratio of neutrons to protons. Isotopes are forms of the same element with different numbers of neutrons. To name the isotope, the number of protons and neutrons in the atom are added. For example, an atom of cobalt that has 27 protons and 33 neutrons is called cobalt-60. Cobalt-60 is radioactive and is therefore called a radioisotope, or a radionuclide.

Where does radioactivity come from?

All elements heavier than bismuth (which contains 83 protons) are naturally radioactive. Lighter elements, such as carbon-14, tritium, and potassium-40, are radioactive because of natural processes in the environment. Everyone is exposed to naturally occurring radiation from space and from radioactive materials in the ground. Scientists can also create radionuclides of most elements. For example, scientists create radionuclides to use as tracers to help measure the flow of materials in sick people or in the environment. Radioactive or not, the way a substance moves in people or through the environment depends on its chemical properties. Some radioactive materials can travel through the air as particles or gases; some can enter soil, water, plants, and animals. Most of the radiation that people are exposed to in the air is radon, an alpha emitter that results from decaying uranium-238, which is found to varying degrees in all soil and rocks.

What is radiation?

Radiation, a form of energy, can be ionizing or non-ionizing. Ionizing radiation occurs as alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles able to produce ions, or charges. Non-ionizing radiation includes radio waves, microwaves, visible light, infrared light, and ultraviolet light.

What are alpha particles, beta particles, and gamma radiation?

Alpha particles are positively charged particles made up of two protons and two neutrons. They can travel only a few inches (centimeters) in air. The particles lose their energy quickly and do not penetrate the skin surface if exposure is external. Alpha particles can enter the body through a cut in the skin, by ingestion, or inhalation. Once inside the body, alpha-emitting radioactive substances can be harmful. Uranium-238 and plutonium-239 are sources of alpha radiation.
Beta particles, or beta radiation, are made of fast-moving particles that can be either positively or negatively charged. A negatively charged beta particle is an electron, and a positively charged one is a positron. Beta particles are easily stopped by a thin sheet of metal or plastic. Beta radiation can penetrate a few millimeters in human tissue before losing all of its energy. Large amounts of beta radiation can cause skin burns, and beta emitters can be harmful if they enter the

body from ingestion or inhalation. Iodine-131, phosphorus-32, and strontium-90 are sources of beta radiation.

Gamma rays, or gamma radiation, occur as high-energy, short-wavelength electromagnetic radiation, or packets of energy emitted from the nucleus, or core, of an atom. Gamma radiation often accompanies alpha and beta emissions, and always accompanies fission, or splitting of atoms. Unlike alpha and beta particles, gamma rays are very penetrating and are best stopped, or shielded against, by dense materials such as lead. Gamma rays are like x-rays, but more energetic. Gamma rays emitted from a nearby source can enter the body without ingestion or inhalation. That said, the energy (and the dose that can be deposited) drops rapidly with distance from the source of radiation. The dose received by a person 1 meter (just over a yard) from a source is 0.01% of the dose that would be received 1 centimeter (just under ½ inch) from the source. If enough gamma rays pass through the body, they can damage cells. Cesium-137 is a source of gamma radiation.

What is worldwide fallout?

Fallout is the term given to radioactive particles that fall from the atmosphere and settle on the Earth's surface. Radionuclides enter the atmosphere worldwide from atmospheric testing of nuclear weapons and accidents at weapons production facilities. Accidents involving weapons transport, satellite reentry, and nuclear reactors have also released some radionuclides, though in much smaller amounts. Scientists track radionuclide levels in our environment that have resulted from fallout. The information collected to date suggests that the levels are very low and that exposure to these low levels is not likely to increase an individual's chances of developing health effects such as cancer.

Source: Schlein B, editor. 1992. The health physics and radiological health handbook. Silver Spring, MD: Scinta, Inc.

C. USEPA's COMPLY Model

Background

In 1985, EPA asked the National Council on Radiation Protection and Measurements (NCRP) to develop simple screening methods for assessing compliance with the Clean Air Act by users of small quantities of radionuclides. NCRP published these procedures in 1986 and 1989 in Commentary No. 3 (NCRP89). USEPA's COMPLY model was developed based on the procedures in Commentary No. 3.

Regulatory Context

The COMPLY computer program may be used to demonstrate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPS) in 40 CFR 61, Subpart I and H.

Application Niche

COMPLY calculates the effective dose equivalent (ede) from radionuclides released from stacks and vents. Atmospheric concentrations are estimated using a Gaussian plume model and equations that account for building wake effects.

Strengths and Limitations

The COMPLY computer program includes four levels of complexity. A user can demonstrate compliance at any level. Level 1 requests the least amount of information, however "worst case" assumptions are used in the dose estimate. Level 4 requests the most information and uses site specific data instead of assuming the worst. Because of the limited information about the operations at NL, ATSDR used level 1 in this screening, thereby estimating a worst case scenario.

The values estimated by this screening model are strictly for comparison with environmental standards and are not intended to represent actual doses to real people.

Source: USEPA 2002

D. Exposure Evaluation Methodology and Assumptions for DU and Lead in Soil

This appendix details the assumptions and calculations that ATSDR used to estimate potential exposure levels from the consumption of soil contaminated with DU and lead. To be protective and account for the uncertainty surrounding how representative the exposure factors are for the residents near the Colonie Site, ATSDR used health-protective assumptions to estimate the reasonable maximum exposure level. These estimates are a daily exposure dose in milligrams of contaminant per kilogram body weight (mg/kg/day). And because lead is typically compared based on a concentration in blood, the estimates for lead doses were further converted to correspond to micrograms of lead per deciliter of blood. All of these calculations are intentionally protective and likely overestimate the amount of chemical exposure from ingesting soil.

Estimating DU exposure doses from ingesting soil

The highest average of DU in soil from a vicinity property, 600 pCi/g, was used to calculate the exposure doses for children, children who exhibit pica behavior, and adults—including pregnant women and the elderly. This value was converted to 1500 mg/kg based on the activity of DU, where 150 pCi equals 0.38 mg.

The amount of soil each group would ingest was intentionally overestimated. Table D-1 lists additional assumptions used in the calculations**.** Pica children were evaluated for acute rather than long-term exposures because pica behavior generally involves ingestion of a large amount of soil during single day rather than smaller amounts over a longer period of time (Calabrese 1997).

The following equation was used in calculating the exposure doses:

$$\textit{Dose (mg/kg/day)} = \frac{C \times IR \times EF \times ED \times AR}{BW \times AT \times AD}$$

Table D-1: DU Exposure Dose Assumptions for Soil

Parameter		**Child with pica behavior**	**Child**	**Adult**
Chemical Concentration	C	1500 mg/kg	1500 mg/kg	1500 mg/kg
Ingestion Rate	IR	500 mg/day	100 mg/day	50 mg/day
Exposure Frequency	EF	1 day	224* days/year	224* days/year
Exposure Duration	ED	1 day	9 years	30 years
Absorption fraction†	AF	0.02	0.02	0.02
Body Weight	BW	10 kg	25 kg	70 kg
Averaging Time	AT	1 day	365 days/year	365 days/year
Averaging Duration	AD	ED	ED	ED

* Excludes winter months
†ICRP 1995

Table D-2 lists the calculated non-cancer effects doses for DU exposure from incidentally ingesting soil for children, children with pica behavior, and adults.

Table D-2: Estimated DU Exposure Dose Levels from Incidentally Ingesting Soil			
Dose (mg/kg/day)			**MRL (mg/kg/day)**
Child	**Child with pica behavior**	**Adult**	
$7.4x10^{-5}$	$1.5x10^{-3}$	$1.3x10^{-5}$	$2x10^{-3}$

ATSDR compared these estimated exposure doses with ATSDR's MRL for oral exposure to uranium. This MRL is based on the chemical non-cancerous health effects of uranium rather than the radiological effects. MRLs for radiological exposure were not calculated because:

- no data are available for use in calculating radiological MRLs for any duration because no radiological effects were identified in any of the available studies that used natural uranium as a test material;
- the MRLs for chemical effects would adequately protect against the possible radiotoxicity of natural and depleted uranium because radiological effects are not expected to occur, based on the low specific activities of these isotopic mixtures and the current toxicity data in humans and animals;
- the studies that reported potential radiological effects (severe pulmonary fibrosis, friable blood vessels) used highly enriched uranium in a single inhalation exposure
- the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has considered that limits for natural (and depleted) uranium in food and drinking water (the most important sources of human exposure) should be based on the chemical toxicity rather than on a hypothetical radiological toxicity, which has not been observed in either humans or animals (ATSDR 1999b).

In addition, no acute- or chronic-duration oral MRLs were developed for uranium because of a lack of suitable data. ATSDR used the intermediate duration MRL (15-364 days) to compare the estimated exposure doses. The exposure to DU contaminated soil near the Colonie Site was most likely for longer than 364 days. ATSDR believes, however, that because the assumptions used in the calculations are very protective and the estimated exposure doses are all below the intermediate-duration MRL people, including children, are not at risk of adverse health effects from ingesting DU contaminated soil.

Estimating lead exposure doses and blood lead levels from ingesting soil

The average value of lead in soil from the residential properties, 373 mg/kg, was used to calculate the exposure doses for children, children who exhibit pica behavior, and adults—including pregnant women and the elderly. The amount of soil each group would ingest was intentionally overestimated. Table D-3 lists additional assumptions used in the calculations**.** Pica children were evaluated for acute rather than long-term exposures because pica behavior generally involves ingestion of a large amount of soil during single day rather than smaller amounts over a longer period of time (Calabrese 1997).

The following equation was used in calculating the exposure doses:

$$\text{Dose (mg/kg/day)} = \frac{C \times IR \times EF \times ED \times AR}{BW \times AT \times AD}$$

Table D-3: Lead Exposure Dose Assumptions for Soil

Parameter		Child with pica behavior	Child	Adult
Chemical Concentration	C	373 mg/kg	373 mg/kg	373 mg/kg
Ingestion Rate	IR	500 mg/day	100 mg/day	50 mg/day
Exposure Frequency	EF	1 day	224* days/year	224* days/year
Exposure Duration	ED	1 day	9 years	30 years
Absorption fraction†	AF	0.5	0.5	0.5
Body Weight	BW	10 kg	25 kg	70 kg
Averaging Time	AT	1 day	365 days/year	365 days/year
Averaging Duration	AD	ED	ED	ED

* Excludes winter months
†ATSDR 1999

Table D-4 lists the calculated exposure doses for lead exposure from incidentally ingesting soil and the corresponding estimated blood lead levels for children, children with pica behavior, and adults. The relationship between lead ingestion and blood lead levels in children and adults has been estimated to be 0.16 and 0.04 µg Pb/dL blood per µg Pb/day ingested (USEPA 1986).

Table D-4: Estimated Lead Exposure Doses and Estimated PbB Levels from Ingestion Soil

Estimated lead exposure (mg/kg/day)			Estimated PbB levels (µg Pb/dL blood)			CDC's recommended action level (µg Pb/dL blood)
Child	Child with pica behavior	Adult	Child	Child with pica behavior	Adult	
4.6×10^{-4}	9.3×10^{-3}	8.2×10^{-5}	1.8	15	0.2	10

MRLs for lead have not been developed because a clear threshold for some of the more sensitive effects in humans has not been identified. In addition, there is a wide body of literature about lead in the blood (PbB) and deriving an MRL would overlook this significant information. Epidemiological studies have identified harmful effects of lead in children at blood lead levels at least as low as 10 µg/dL. Because 10 µg/dL is the lower level of the range at which effects are now identified, CDC recommends that primary prevention activities, community wide environmental interventions, and nutritional and educational campaigns should be directed at reducing children's blood lead levels at least to below 10 µg/dL (CDC 1991). ATSDR believes that because the assumptions used in the calculations are very protective and the estimated exposure doses are all below CDC's action level for blood lead levels, people, including children, are not at risk of adverse health effects from ingesting lead contaminated soil.

E. Toxicological Studies of PCE and TCE

PCE

PCE is an animal carcinogen. In long-term animal studies (1.5–2.0 years), massive doses of PCE administered by inhalation at levels of 500,000–1,000,000 $\mu g/m^3$ have produced liver cancer in mice, but not in rats. In other animal studies in which PCE was administered by inhalation at levels of 1,000,000–2,000,000 $\mu g/m^3$, PCE has also caused a statistically insignificant increase in kidney tumors in male, but not female rats (ATSDR 1993). Recent re-evaluations of these studies by various government agencies and by independent scientists indicate that the tumors observed in these animals were probably due to species-specific mechanisms that exhibit thresholds at near-toxic levels (Green and Trevor 1990a; Green et al 1990b; Goodman et al 1991; Borghoff and Lagard 1993). That is to say, the induction of cancers in mice and rats by PCE required doses in excess of anything humans might reasonably be expected to encounter. The experiments also involved certain elements of rodent biology that are not likely to be shared by humans. The implication is that the cancers observed in laboratory animals at very high doses of PCE have little or no relevance for human risk evaluation at environmental levels of exposure orders of magnitude lower. In fact, a number of epidemiological studies of men and women exposed occupationally to PCE have not identified an increased risk of cancer (ATSDR 1993).

The known human health effects of PCE have usually been the result of occupational exposure to high concentrations, primarily by inhalation. In studies of long-term, or chronic, occupational exposures to PCE, health effects were reported at concentrations of 67,000 $\mu g/m^3$, 100,000 $\mu g/m^3$, and 150,000 $\mu g/m^3$ (Franchini et al 1983; Mutti et al 1992; Vyskocil et al. 1990). Other studies did not find any health effects in workers exposed to PCE at levels of 130,000 $\mu g/m^3$ (Cai et al 1991; Lauwerys et al 1983).

TCE

Various types of cancer have appeared in animals treated with TCE orally and by inhalation (ATSDR 1997). The positive animal studies are, however, plagued by a number of problems. These include 1) high rates of mortality due to high dose toxicity, 2) the use of TCE containing epoxide stabilizers that could themselves cause cancer, 3) high, strain-specific, background rates of specific cancers, and 4) species-specific mechanisms (peroxisome proliferation, α-2μ-globulin accumulation, activation of TCE-glutathione conjugates) that do not occur in humans and thus have no relevance to human risk assessment. The findings from epidemiological studies of workers exposed by inhalation have been largely negative and provide no clear evidence that TCE causes cancer in humans (ATSDR 1997).

Workers chronically exposed to TCE at levels between 200,000 $\mu g/m^3$ and 900,000 $\mu g/m^3$ reported symptoms of sleepiness, dizziness, headache, and nausea, but no nerve disorders (El Ghawabi et al. 1973). Nerve activity was normal in workers occupationally exposed to TCE levels of about 120,000 $\mu g/m^3$ (Nagaya et al. 1990).

F. Johnson and Ettinger Indoor Air Model (1991)

VOC air modeling

The contaminated groundwater under the southern portion of the site has migrated off site, under Yardboro Avenue. The majority of the contaminants in the groundwater plumes are volatile organic compounds having the ability to volatilize into vapor. This vapor can, in turn, move from the groundwater, through soil, and eventually seep into basements and affect indoor air. Indoor air sampling was performed in a few houses near the groundwater plume from the Colonie Site. ATSDR applied the Johnson and Ettinger model to estimate indoor air concentrations for homes that were not sampled.

Modeling approach

Rather than simulating the many complex factors that affect how toxic chemicals disperse in air, ATSDR evaluated a simple and overestimated exposure situation, formulating the modeling scenario as *What would be the predicted indoor air concentration of a VOC contaminant for a house located directly above a groundwater plume with a VOC concentration equal to the highest level measured at the Colonie Site?* This scenario provides an extreme, upper-bound estimate of what the actual ambient air concentrations might be. Groundwater sampling data from the Colonie Site was used in the Johnson and Ettinger indoor air model to estimate indoor air concentrations in residences near the groundwater plume. The maximum value for each VOC is much higher than the groundwater contamination near any of the homes.

In addition, ATSDR entered the sub-foundation soil gas concentrations measured in the July/August 2002 sampling round into the model.

Limitations of the Johnson and Ettinger Model

The Johnson and Ettinger model is a first-tier screening tool that is based on several assumptions. As a result, it has limitations:

- The model does not consider the effects of multiple contaminants.
- Its calculations do not account for preferential vapor pathways due to soil fractures, vegetation root pathways, or the effects of a gravel layer beneath the floor slab.
- The groundwater model does not account for the rise and fall of the water table due to aquifer discharge and recharge.
- The model also assumes that all vapors will enter the building, implying a constant pressure field is generated between the interior spaces and the soil surface.
- It neglects periods of near zero pressure differential.
- Soil properties in the area of contamination are assumed to be identical to those in the area above the contamination.

All but the most sensitive parameters have been set to either an upper bound value or the median value. As a result, the model is very protective when predicting indoor air concentrations.

Validation of model

Some researchers have compared their measured results to those predicted by the Johnson and Ettinger model. These comparisons found that the model can effectively predict indoor air concentrations. But they also stressed the importance of collecting the proper site-specific information to identify appropriate values of the input parameters (Fisher et al 1996, Fitzpatrick and Fitzgerald 1996).

Air model results

For predicting indoor air concentrations in homes near the plume from the Colonie Site, ATSDR entered the maximum groundwater concentrations for each VOC into the Johnson and Ettinger model. Predicted concentrations were then compared to the USEPA Region 9's PRG and ATSDR's comparison value for that compound. Based on this strategy, ATSDR found that only the TCE air concentration exceeded the PRG, and none of the contaminants exceeded ATSDR's comparison values (Table F-1).

Table F-1: Predicted indoor air concentrations from maximum groundwater concentrations

Compound	Maximum groundwater concentration* (µg/L)	Predicted indoor air concentration† ($\mu g/m^3$)	USEPA Region 9 PRGs for ambient air‡ ($\mu g/m^3$)	ATSDR's comparison values for air‡ (ug/m^3)
PCE	490	0.175	0.67	300
TCE	190	0.577	0.017	500
cis-1,2-DCE	440	0.203	37	NA
VC	11	0.0503	0.11	0.1

* USACE 2002
† The indoor air concentration that would be expected from the maximum groundwater concentration.
‡ USEPA 2002

ATSDR then entered the groundwater concentrations near Yardboro Avenue for each VOC into the Johnson and Ettinger model. Predicted concentrations were then compared to the USEPA Region 9's PRG and ATSDR's comparison value for that compound. Based on this analysis, ATSDR found that none of the air concentrations exceeded the references (Table F-2).

Table F-2: Predicted indoor air concentrations from groundwater concentrations near Yardboro Avenue				
Compound	**Groundwater concentration* (µg/L)**	**Predicted indoor air concentration† (µg/m³)**	**USEPA Region 9 PRGs for ambient air‡ (µg/m³)**	**ATSDR's comparison values for air‡ (ug/m³)**
PCE	41	0.0147	0.67	300
TCE	3	0.00912	0.017	500
cis-1,2-DCE	ND (0.5)	0.00023	37	NA
VC	ND (0.5)	0.00229	0.11	0.1

* USACE 2002; Note: the detection limits (in parentheses) were used for the cis-1,2-DCE and VC calculations.
† The indoor air concentration that would be expected from the groundwater concentration near Yardboro Avenue.
‡ USEPA 2002

Sub-foundation soil gas concentrations were collected during the USACE's July/August 2002 sampling round. ATSDR entered the maximum soil gas concentration measured for each VOC into the Johnson and Ettinger model and a predicted indoor air concentration was calculated. The predicted concentrations were then compared to the USEPA Region 9's PRG and ATSDR's comparison value for that compound. Based on this strategy, ATSDR found that none of the air concentrations exceeded reference values and thus were not at levels that could cause adverse health effects (Table F-3).

Table F-3: Predicted indoor air concentrations from soil gas concentrations				
Compound	**Soil gas concentration* (µg/L)**	**Predicted indoor air concentration† (µg/m³)**	**USEPA Region 9 PRGs for ambient air‡ (µg/m³)**	**ATSDR's comparison values for air‡ (ug/m³)**
PCE	120	0.0013	0.67	300
TCE	63	0.00069	0.017	500
cis-1,2-DCE	ND (0.83)	0.0000091	37	NA
VC	ND (0.27)	0.0000031	0.11	0.1

* USACE, unpublished data, 2003. Note: the detection limits (in parentheses) were used for the cis-1,2-DCE and VC calculations.
† The indoor air concentration that would be expected from the highest sub foundation soil gas concentration sampled.
‡ USEPA 2002