Health Consultation

DUPONT POMPTON LAKES WORKS SITE
ANALYSIS OF THE VAPOR INTRUSION PATHWAY IN THE POMPTON LAKES NEIGHBORHOOD IMPACTED BY THE DUPONT GROUNDWATER CONTAMINATION

POMPTON LAKES, PASSAIC COUNTY, NEW JERSEY

EPA FACILITY ID: NJD980771604

Prepared by the
New Jersey Department of Health and Senior Services

December 7, 2009

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

Health Consultation: A Note of Explanation

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

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

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Summary

Introduction

In June 2008, the New Jersey Department of Environmental Protection (NJDEP) asked the New Jersey Department of Health and Senior Services (NJDHSS) to evaluate the potential health impacts to Pompton Lakes residents exposed to volatile organic compounds in indoor residential air. E. I. Du Pont, Pompton Lakes Works operations resulted in significant contamination of groundwater both on and off site with chlorinated solvents. Volatile organic compounds that are present in the groundwater can enter residential indoor air via a process known as vapor intrusion.

Through a Cooperative Agreement with the ATSDR, the NJDHSS prepared a Health Consultation (HC) for the Pompton Lakes site.

Agency for Toxic Substances and Disease Registry (ATSDR) and New Jersey Department of Health and Senior Services's (NJDHSS) top priority is to ensure that the community around the site has the best information possible to safeguard its health.

Conclusions

The NJDHSS and ATSDR have reached the following five conclusions in this health consultation on the Pompton Lakes site:

Conclusion 1

NJDHSS and ATSDR conclude that current and future exposures to plume-related contaminants in indoor air at residences where properly functioning mitigation systems have been installed will not occur, and therefore will not harm people's health.

Basis for Conclusion

The exposure pathway has been interrupted for these residences due to the installation of the vapor mitigation systems.

Next Steps

It is essential that New Jersey Department of Environmental Protection ensures that DuPont installs and maintains the mitigation systems correctly, in addition to the groundwater remedial action currently underway (see Conclusion 2).

Conclusion 2	*NJDHSS and ATSDR conclude that current and future exposures to plume-related contaminants in indoor air at residence where mitigation systems have <u>not</u> been installed may harm people's health.*
Basis for Conclusion	People may be exposed by inhaling indoor air contaminated by VOCs while spending time in the basement. Although the levels of chemicals detected in indoor air from the groundwater plume may result in low increased risk for cancer, these indoor air concentrations only provide a snapshot estimate, i.e., concentration levels at a single point in time. Additionally, if the variables that affect vapor intrusion (such as temperature, wind, moisture, integrity of basements) were to change, there is potential for the elevated sub-slab soil gas to be released into residential indoor air at levels that may harm people's health.
Next Steps	It is recommended that all residences impacted by the groundwater plume get the mitigation system installed. In addition, to the extent feasible, the groundwater plume should be remediated to eliminate the vapor intrusion pathway.
Conclusion 3	*NJDHSS and ATSDR cannot conclude if past exposures to plume-related contaminants in indoor air at residences located south of the DuPont facility may have harmed people's health.*
Basis for Conclusion	Although there were not any plume-related contaminants that would potentially result in non-cancer health effects, it is unknown if past levels of these contaminants were higher in the residences since the indoor air concentrations only provide an estimate of concentration levels at a single point in time. For cancer health effects, lifetime excess cancer risks were estimated to be low in comparison to the background risk of cancer. This conclusion is based on current plume conditions; the extent of past plume contamination is unknown and could have been higher.
Next Steps	Based on the information currently available, it is recommended that all residences impacted by the groundwater plume get the mitigation system installed.

Conclusion 4	*NJDHSS and ATSDR conclude that current and future exposures to non-plume related contaminants in indoor air at residences located south of the DuPont are not expected to harm people's health.*
Basis for Conclusion	Although the most likely average concentrations of non-plume related contaminants of concern were above their respective health guideline comparison values, the likelihood of potential non-cancer adverse health effects is low. For cancer health effects, lifetime excess cancer risks were calculated to be a very low increase in cancer compared to background cancer rates.
Next Steps	Residents with elevated levels of non-plume related contaminants can choose to identify the sources of the chemicals in indoor air and take steps to reduce or eliminate exposures.
Conclusion 5	*NJDHSS and ATSDR cannot conclude if past exposures to non-plume related contaminants in indoor air at residences south of the DuPont facility could have harmed people's health.*
Basis for Conclusion	It is unknown what past levels of these contaminants were in the residences, especially since consumer products are the most likely source for the indoor air levels of these contaminants.
Next Steps	Residents with elevated levels of non-plume related contaminants can choose to identify the sources of the chemicals in indoor air and take steps to reduce or eliminate exposures.
For More Information	Copies of this report were made available to concerned residents in the vicinity of the site via the township library and the internet. Questions about this health consultation should be directed to the NJDHSS at (609) 584-5367.

Statement of Issues

In June 2008, the New Jersey Department of Health and Senior Services (NJDHSS) was asked by the New Jersey Department of Environmental Protection (NJDEP) to evaluate the potential health impacts to the community posed by the detection of elevated levels of volatile organic compounds (also known as VOCs) in indoor residential air in Pompton Lakes, Passaic County. The indoor air contamination may be due to a groundwater plume that has migrated from the E. I. DuPont Pompton Lakes Works site. This health consultation provides the results of that evaluation, which was conducted through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

Background

Site Description

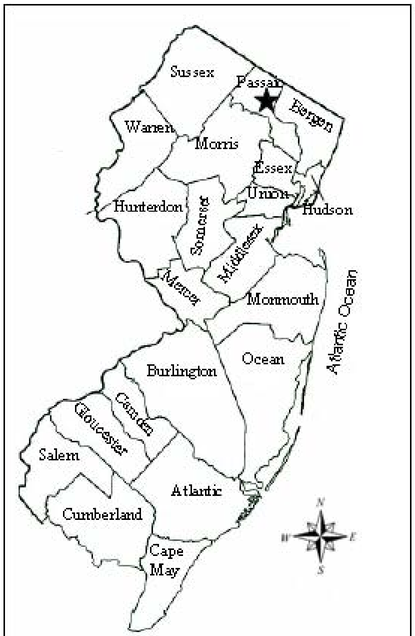


Figure 1: Location of Pompton Lakes site

E. I. DuPont, Pompton Lakes Works (PLW), located at 2000 Cannonball Road, was an explosives manufacturing plant operation that had been in operation since 1886. The site occupies approximately 630 acres of land in Pompton Lakes and Wanaque. Two parallel valleys (Wanaque River and Acid Brook) run through the site north to south. DuPont acquired the site in 1902 and operations ceased at the site in 1994. During this time, PLW produced black powder, smokeless powder, blasting caps, bullets, grenades and lead azide. Waste management practices resulted in significant contamination of surface water, soil and sediment, and groundwater both on and off site and included lead salts, mercury compounds, chlorinated solvents and detonated blasting caps. The primary contaminants in the soil and sediments are lead and mercury. The contaminants in the groundwater are chlorinated volatile organics, such as tetrachloroethylene, trichloroethylene, cis 1,2-dichloroethylene, and vinyl chloride (ATSDR 1994). Groundwater contamination migrated off-site from the eastern valley facility towards Pompton Lake.

Site Geology and Hydrogeology

In the off-site area, the direction of groundwater flow in the shallow zone is toward the southeast towards Pompton Lake. The depth to groundwater varies seasonally and spatially from approximately 5 to 21 feet below ground surface (Corporate Remediation Group, 2008). Pompton Lakes residents receive their water supply from three municipal groundwater wells. The closest is half a mile southwest of PLW near the southern border of Twin Lake; the other two are located three quarters of a mile and a mile and a half south and southwest of Acid Brook, respectively. Twenty-six private wells were identified south of PLW and sampling began in 1985. Two residences with contaminated wells were connected to the municipal water supply in 1985, and by 1989, all residences with private wells identified in the Pompton Lakes community, whether contaminated or not, were connected to the municipal water supply (ATSDR 1994). Three municipal wells, located approximately one half mile, three quarters of a mile, and a mile and a half south of the Acid Brook Area, are tested routinely for bacteria, VOCs, heavy metals, pesticides, and herbicides. It is reported that water quality met all state and federal standards (ATSDR 1994).

There are four main surface water bodies in Pompton Lake: Acid Brook, Wanaque River, Pequannok River, and Pompton Lake. The lake lies 2000 feet southeast of PLW, with residential areas in between. Acid Brook empties into the western end of the lake at the lake's widest point. Health advisories were issued for Acid Brook, Wanaque River, and Pompton Lake jointly by DuPont and the Borough of Pompton Lakes in 1990 (ATSDR 1994).

Site Investigations

Environmental (groundwater) investigations began for this area in 1984, when DuPont reportedly suspected that a plume of contaminated groundwater may have migrated off site. In October 1985, DuPont sampled private wells of nearby residences and connected two residences that had been using private wells for drinking water to the municipal water system later that same year. By 1989, all homes with private wells in the area adjacent to the facility were connected to the municipal water utility. In May 1990, DuPont discovered other off-site contamination, primarily heavy metals, in the soil and sediments along Acid Brook and the Wanaque River (ATSDR 1994).

In 1998, DuPont installed a system along the southeast boundary line to pump contaminated groundwater and to treat it (Corporate Remediation Group, 2008). After treatment, the water is discharged back to the ground. The groundwater is being monitored to assess the effectiveness of the system. The groundwater underlying the residential neighborhood, south of the Dupont facility, is impacted by chlorinated volatile organic solvents (Corporate Remediation Group 2008). The pump and treat system is preventing further contamination from leaving the Dupont site and treated water is being injected back into the aquifer at the edge of the off-site plume. Chlorinated volatile organic compounds (VOCs) volatilizing from shallow groundwater are a potential source of VOCs in soil gas and sub-slab soil gas overlying the groundwater plume. Buildings within the chlorinated VOC groundwater plume are primarily single-family homes which, based on observations to date, have basements with concrete floor slabs, creating a potential exposure pathway to residents in the affected area.

During the first half of 2008, DuPont conducted sub-slab soil gas sampling at select locations in off-site areas above the plume (Corporate Remediation Group, 2008). These results indicated exceedances of the comparison levels for chlorinated VOCs. In accordance with the New Jersey Department of Environmental Protection (NJDEP) vapor intrusion guidelines, a protective vapor mitigation system was offered to each of these residents (Corporate Remediation Group 2008). Additional testing of indoor air and/or sub-slab soil gas sampling was offered to 436 homes identified as being in the potential vapor migration area. At present 368 homes have been sampled and/or designed for installation of a mitigation system. Post-mitigation sampling is currently underway to test the efficacy of the mitigation systems installed. More recently, concurrent sub-slab soil gas and indoor air samples were collected from 39 residences for a better evaluation of the soil vapor pathway (O'Brien & Gere 2009). The main conclusion from this study was that while the shallow groundwater concentrations remain low, the soil gas results (especially for PCE and TCE) were elevated above NJDEP Soil Gas Screening Levels in 95 percent of the homes tested.

Previous Remedial Investigations

Due to the substantial off-site soil and sediment contamination along Acid Brook and Wanaque River, remedial actions have been focused on investigating and cleaning up the areas. All soil contamination at off-site properties near Acid Brook was cleaned up. The on-site portions of the Acid Brook and its banks were also cleaned up (ATSDR 1994; USEPA 2009a).

A groundwater monitoring program was developed for the PLW Site in 1995. This program was based on an extensive review of all the data collected from 126 monitoring wells (36 off-site and 90 on-site). The primary constituents of concern in groundwater, both on- and off-site, consist of ten chlorinated VOCs which are monitored on a semiannual basis from 33 wells (15 on-site and 18 off-site). A groundwater pump and treat system was implemented in August 1998. Five recovery wells extract, on average, 8 million gallons of groundwater per month from the Acid Brook Valley alluvial aquifer. Groundwater containing chlorinated VOCs is treated by air stripping, and the treated groundwater is reintroduced into the ground via subsurface infiltration beds located on-site along DuPont's southwest boundary. Since 1995, shallow groundwater concentrations have decreased by approximately an order of magnitude, and the data suggest that the off-site shallow groundwater plume is dissipating in the residential area (Corporate Remediation Group, 2008). It is noted that the pump and treat system is preventing further contamination from leaving the PLW Site and is furthermore flushing clean water into the edge of the off-site plume by injecting the treated water back into the aquifer.

During March and May 2008, groundwater sampling was conducted at select off-site monitoring wells to further characterize water quality conditions at the top of the shallow aquifer. Shallow groundwater results exceeded the NJDEP and USEPA groundwater screening levels for the vapor intrusion pathway for tetrachloroethylene (PCE) and trichloroethylene (TCE) at a number of the monitoring wells located southeast of the Acid Brook Valley Manufacturing Area. Vapor intrusion has evolved rapidly over the last few years as a potential exposure pathway of concern in the investigation and remediation of contaminated sites (NJDEP 2005). Vapor mitigation systems were offered as a protective measure at the residences located within the 1 microgram per liter (µg/L) shallow groundwater boundary.

At the sampling event in March through May 2008, DuPont also conducted sub-slab soil gas sampling at select locations in off-site areas of shallow groundwater contamination. This work focused on residences located near the two monitoring wells with the highest detected levels of PCE and TCE. Sub-slab soil gas analytical results for the selected residences exceeded the comparison level of 16 micrograms per cubic meter ($\mu g/m^3$) for PCE at all seven residences, while TCE concentrations exceeded the comparison level of 11 $\mu g/m^3$ at six of the seven residences. Installation of a protective vapor mitigation system was offered to each of these residents (Corporate Remediation Group, 2008).

A potential vapor migration area (PVMA) was established based on the 1 µg/L groundwater iso-concentration contour line, as interpolated from the March/May 2008 shallow groundwater analytical data. A protective vapor mitigation system and indoor air sampling has been and continues to be offered to residences within the potential vapor migration area. Sub-slab soil gas sampling has been conducted at residences in the areas along the edges of the PVMA to determine potential vapor pathway conditions. This area has been designated as the expanded investigation area along the 1 µg/L groundwater contour boundary (Corporate Remediation Group, 2008). Based on additional sampling results from a targeted group of 39 residences thought to represent neighborhood conditions, NJDEP recommended that residents within the PVMA should install vapor mitigation systems (O'Brien & Gere 2009).

Prior ATSDR/NJDHSS Involvement

In 1994, based on health concerns of citizens, ATSDR completed a petitioned public health assessment of the Acid Brook Area. It concluded that this site presented a public health hazard because of human exposure to contaminants in soil, sediment, surface water, groundwater and fish in the Acid Brook area. It was recommended that access to the PLW property be restricted, ensure that all private wells down-gradient from PLW are not being used as a drinking water supply, continue to monitor groundwater at and down-gradient from PLW, and to conduct a community health investigation for Acid Brook residents to better evaluate health outcomes (ATSDR 1994).

In the summer of 1994, NJDHSS conducted a lead and mercury biological screening of children living in Pompton Lakes to evaluate the potential exposures to lead and mercury found in contaminant runoff. Blood-lead and urine-mercury were selected as the biomarkers for determining recent exposure to these metals. The screening did not find any evidence of unusual exposure to lead and mercury in children tested. Parental reported information on learning disorders was found to be significantly higher for children living in the contaminated areas compared to other children in Pompton Lakes.

Land Use and Demographics

According to 2000 United States Census data, 7,091 people reside within one mile of the site (see Figure 2).

Site Visits

Several informal site visits have taken place between June 2008 and March 2009, when the site was visited for public meetings and an availability session. The residential neighborhood, adjacent to the former DuPont site, was viewed to get a better understanding of the layout and the proximity to the PLW site. Some residences had a mitigation system installed and these were viewed from the outside.

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two tiered approach. First, maximum concentrations of detected substances are compared to media-specific comparison values (known as environmental guideline comparison values - CVs). If concentrations exceed the comparison values, these contaminants are selected for further evaluation. The second evaluation consists of the derivation of an Exposure Point Concentration (explained in detail in the following section) for each contaminant whose maximum value is elevated above the CVs. The Exposure Point Concentration for a contaminant is subsequently compared to the CVs; if it is elevated above the CVs, the contaminant is classified as a Contaminant of Concern (COC).

Environmental Guideline Comparison

The ATSDR chronic Environmental Media Evaluation Guide (EMEG) and Cancer Risk Evaluation Guide (CREG) were selected as the CVs. EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects. CREGs are media-specific comparison values that are used to identify concentrations of cancer-causing substances that are likely to result in an increase of cancer rates in an exposed population. Where the ATSDR CVs do not exist, USEPA Screening Levels or NJDEP's site-specific Indoor Air Screening Levels (NJDEP SL) were used.

The primary focus in this document is indoor air as it has the most direct relationship regarding exposure to area residents. Sub-slab soil gas results have demonstrated elevated concentrations of VOCs (O'Brien & Gere 2009); however these results are not evaluated as the residents do not have direct exposure to this via inhalation.

Table 1 lists the contaminants that were detected in residential indoor air for the Pompton Lakes neighborhood. These contaminants are classified as being plume-related and non-plume related. The basis of this distinction is from past site operations and the detection of a contaminant in groundwater samples (ATSDR 1994, Corporate Remediation Group 2008). If a contaminant was detected in groundwater and in indoor air, it is denoted as being plume-related. Contaminants that are detected in indoor air but are not present in the groundwater measurements are denoted as being non-plume related contaminants.

Table 1 also provides the summary statistics (range, arithmetic mean etc.) of the VOCs that were detected in indoor air. Of the plume-related indoor air contaminants, PCE and 1,2-DCA were detected in 116 and 69 residences, respectively. Additionally, 1,1,1-TCA and TCE were detected at 51 and 24 residences, respectively. Among the contaminants that have been characterized as being non-plume related, toluene was detected in the highest number of residences (329), followed by trichlorofluoromethane (316), acetone (310) and n-hexane (307) out of 337 sampled residences.

As previously mentioned, the maximum concentration levels of contaminants were compared to either the CVs or the NJDEP SLs. If the concentrations were elevated over either comparison value, the contaminant was retained for further analysis as follows:

Exposure Point Concentration Calculation

Although the maximum concentration of contaminants is usually used to identify COC, it would be inappropriate to calculate site health risks based on the single highest concentration. This is because a single measurement is unlikely to represent the contamination at the entire site. Alternatively, a ‘conservative estimate’ of the average chemical concentration, known as the exposure point concentration (EPC) can be used to effectively represent a concentration at a site. An exposure point is an area location within which an exposed population’s contact with an environmental medium (e.g., air, soil) is assumed to be equally likely (USEPA 2009b).

An EPC is an estimate of the true arithmetic mean concentration of a chemical in a medium at an exposure point. However, because the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, the USEPA recommends that the 95th percentile upper confidence limit (UCL) of the arithmetic mean be used when calculating exposure and risk at that location. To this end, USEPA has recently developed software (ProUCL®) that computes the UCL for a given data set by a variety of alternative statistical approaches and then recommends specific UCL values as being the most appropriate for that particular data set (USEPA 2007).

For this site, the ProUCL® 4.0 was used to estimate indoor air EPCs for those contaminants that were elevated above the CVs, (see Table 1). The EPC for the retained contaminants is listed in Table 2. If the EPC was found to be elevated above the comparison values, it was considered to be a contaminant of concern (COC), as summarized below:

Plume-related:

- Carbon tetrachloride
- 1,2-dichloroethane
- Methylene chloride
- Tetrachloroethylene
- Trichloroethylene
- Vinyl chloride

Non-Plume related:

- Benzene
- 1,3-butadiene
- Chloroform
- 1,4-dichlorobenzene
- 1,2-dichloropropane
- Methyl tert-butyl ether

There are indoor sources for the non-plume related COC. These include emissions from burning coal and oil, evaporation from solvents, tobacco smoke, paint strippers, varnishes, furniture finish removers, and gasoline. Appendix A includes a table that lists sources for common indoor air contaminants.

At the request of the community, a literature review was conducted to determine information regarding background levels of volatile compounds in homes. A majority of the studies were done in urban areas throughout the United Sates, although some studies were conducted in other countries. The results indicate the range of expected volatile concentrations resulting from use of consumer products, building materials and activities such as smoking and cooking (NJDEP 2005). These findings are summarized below:

Contaminant	**Range of Median Values (µg/m^3)**
Carbon tetrachloride	0.6 – 1.5
1,2-dichloroethane	not determined
Tetrachloroethylene	ND[a] – 8.7
Trichloroethylene	ND - 8
Vinyl chloride	not determined
Benzene	1 - 15
1,3-butadiene	not determined
Chloroform	0.03 – 3.3
1,4-dichlorobenzene	0.08 - 2
1,2-dichloropropane	not determined
Methylene chloride	0.5
Methyl tert-butyl ether	6

[a]Not Detected

Another vapor intrusion site in Colorado includes approximately 3,000 residences impacted by the groundwater plume containing PCE, as a result of operations at Schlage Lock Company (ATSDR 2008). Of these residences, a total of 115 homeowners requested indoor air sampling and provided written access agreements. Of the 132 total samples collected (including duplicates), 58% (73/132) of the samples had non-detectable (ND) concentrations of PCE. The concentration of PCE ranged from ND – 84 $\mu g/m^3$ with an average concentration of 5.8 $\mu g/m^3$ (ATSDR 2008). Background levels of PCE have also been documented through indoor air sampling at two sites in Colorado, Redfield Rifle Scopes site and CDOT's Materials Testing Laboratory. The mean background concentration of PCE found in residential homes near these sites was 1.12 and 1.62 $\mu g/m^3$ with a 95% Upper Confidence Limit (UCL) of the mean of 2.22 and 2.23 $\mu g/m^3$, respectively (ATSDR 2006).

It must be noted that background data from other sites is only presented to roughly characterize the concentrations of VOCs found in this assessment and is not meant for evaluation of health effects pertaining to these levels. Background data from other sites should not be used as the basis for determining if there is or is not a site-related impact.

Discussion

The method for assessing whether a health hazard exists to a community is to determine whether there is a completed exposure pathway from a contaminant source to a receptor population and then whether exposures to contamination are high enough to be of health concern.

Exposure Pathway Analysis

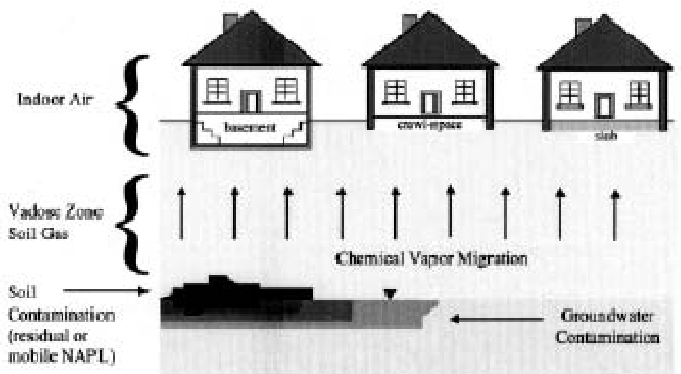
An exposure pathway is a series of steps starting with the release of a contaminant into the environment and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;
3. point of exposure;
4. route of exposure; and
5. a receptor population.

Generally, the ATSDR considers three exposure pathway categories: 1) completed exposure pathways, that is, all five elements of a pathway are present; 2) potential exposure pathways, that is, one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways, that is, one or more of the elements is absent.

Factors that favor the transport of chemicals of concern at the Pompton Lakes site include elevated levels of the VOCs, such as PCE, TCE, and chloroform detected in groundwater soil gas and indoor air. NJDEP detected VOCs in sub-slab soil gas and the indoor air in sampled residences, indicating a completed exposure pathway. Soil gas underneath buildings can migrate (intrude) into the indoor air through cracks or openings in the slab and walls in a process known as vapor intrusion (see Appendix B for Vapor Intrusion Fact Sheet)

The exposure assessment involves examining the way that individuals could come into contact with site-related contamination. This health consultation focuses solely on inhalation of contaminated indoor air as a result of the vapor intrusion pathway in residential properties. VOCs have high vapor pressure, which means the vapors of these contaminants readily enter the atmosphere. Vapor intrusion refers to the migration of VOC vapors from a subsurface source, through the soil, and into overlying homes and buildings where people can be exposed. Subsurface sources may include contaminated groundwater and/or soils. The figure below is a generalized schematic of how vapor intrusion works.



(Source: USEPA 2002)

Environmental contamination is not the only source of VOCs in indoor air. VOCs are present in a number of household sources including building materials, cleaners, furniture treatments, paint, plastics, sealants, and cosmetics. In fact, studies have found that the levels of VOCs in indoor air may be as high as five times the levels found in outdoor air regardless of whether the building was located in industrialized, urban areas or rural settings (EPA 2006). Once VOCs are present within the building or dwelling, occupants inhale them during regular indoor activities.

<u>Inhalation of contaminants of concern in indoor air (past)</u>. For the past, there is a completed exposure pathway for inhalation of plume-related and non-plume related COC to children and adults at sampled residences. The pathway involves vapor migrating upwards through contaminated subsurface media and entering the indoor air of the residence through intrusion pathways (i.e. basement slab cracks or gaps) where people will inhale vapors and become exposed.

Current and future exposures for inhalation of plume-related COC to children and adults at some sampled residences have been interrupted if the recommended mitigation was implemented. The mitigation involves the installation of a sub-slab vapor extraction system. For the residences that have chosen not to have the system installed, the current and future exposure pathway would be classified as being completed for the plume-related COC. For these residences, the estimated health risks will be proportional to risks assessed for past exposures as outlined in the sections below.

Public Health Implications

When determining the public health implications of exposure to hazardous contaminants, NJDHSS considers how much of the contaminant people might come into contact with and compares these contaminant exposure doses with health based comparison values. The evaluation is conducted by comparing estimated exposure doses, derived from site-specific exposure conditions, to dose-based comparison values (known as health guideline comparison values) to determine the likelihood of adverse health effects.

When contaminant exposure dose levels are below health-based comparison values, health impacts from exposure to those levels are unlikely. Contaminant levels exceeding comparison values do not necessarily indicate that health impacts are likely, but instead, warrant further evaluation.

Non-Cancer Health Effects

To assess non-cancer health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of adverse, non-cancer health effects. MRLs are developed for a route of exposure, i.e., ingestion or inhalation, over a specified time period, e.g., acute (less than 14 days); intermediate (15 - 364 days); and chronic (365 days or more). MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies, and are adjusted by a series of uncertainty (or safety) factors or through the use of statistical models. In toxicological literature, observed effect levels include:

- no-observed-adverse-effect level (NOAEL); and
- lowest-observed-adverse-effect level (LOAEL).

NOAEL is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. LOAEL is the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals. In order to provide additional perspective on these health effects, the calculated exposure doses were then compared to observed effect levels (e.g., NOAEL, LOAEL). As the exposure dose increases beyond the MRL to the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

If the NOAEL is not available, the BMCL (benchmark concentration level) can be used. A BMCL is a characterization of the concentration corresponding to a specified increase in the probability of a specified response. For example, a $BMCL_{10}$ is the estimated dose corresponding to an increase of 0.10 in the probability of the specified response relative to the probability of that same response at dose zero (USEPA 2009c; 2009g).

To ensure that MRLs are sufficiently protective, the extrapolated values can be several hundred times lower than the observed effect levels in experimental studies.

Table 3 provides both plume-related and non-plume related COC and their related MRLs. For the six plume-related COC, none were above the ATSDR chronic and acute MRL. For the COC below their MRLs, adverse non-cancer health effects from exposures to these contaminants in the residences are unlikely. For the six non-plume-related COC, two contaminants (1,3-butadiene and 1,4-dichlorobenzene) were measured in indoor air of residences above the ATSDR MRLs. The public health implication for these two non-plume related contaminants is given below:

1,3-butadiene: The 95% UCL of the arithmetic mean concentration was calculated to be 4.5 $\mu g/m^3$ (see Table 2). The USEPA Reference Concentration is 2 $\mu g/m^3$, which is based on ovarian atrophy in mice (USEPA 2009d). The LOAEL for the USEPA study is 2,000 $\mu g/m^3$ (ATSDR 1993). Since the mean concentration is approximately 440 times lower than the LOAEL, non-cancer health effects are unlikely from exposure to this contaminant in indoor air. One residence had a value of 24 $\mu g/m^3$; while this value is above the MRL, it is still below the LOAEL value of 2,000 $\mu g/m^3$.

Most people are exposed to low levels of 1,3-butadiene in the air because it is released to the environment during its production, use, storage, and disposal and is present in gasoline, automobile exhausts, and cigarette smoke (IARC 2009a, USEPA 2009e). There were not any studies located that measured 1,3-butadiene in indoor air. 1,3-butadiene levels in residences in Pompton Lakes ranged from 0.4 – 24 ug/m^3.

1,4-dichlorobenzene: The 95% UCL of the arithmetic mean concentration was calculated to be 113 $\mu g/m^3$. The inhalation MRL, as provided by the ATSDR, is 60 $\mu g/m^3$, based on severe changes in the nasal olfactory system in female rats (ATSDR 2006). The $BMCL_{10}$ is 1,620 $\mu g/m^3$. Since the mean concentration is approximately 14 times lower than the $BMCL_{10}$, non-cancer health effects are not expected from exposure to this contaminant in indoor air. One residence had a value of 1,100 ug/m^3; while this value is above the MRL, it is still below the $BMCL_{10}$ value of 1,620 $\mu g/m^3$.

The general population is mainly exposed to 1,4-dichlorobenzene through breathing vapors from 1,4-dichlorobenzene products used in the home, such as mothballs and toilet deodorizer blocks (USEPA 2009f). The Total Exposure Assessment

Methodology (TEAM) study measured 1,4-dichlorobenzene levels in personal overnight samples collected from more than 570 individuals in four states. Levels detected ranged from 0.03 to 1,550 μg/m^3 and mean levels ranged from 7 to 56 μg/m^3. Exposure sources were not pinpointed (IARC 2009b). The levels in residences in Pompton Lakes ranged from 1 to 1,100 ug/m^3.

While levels of 1,3-butadiene and 1,4-dichlorobenzene detected in the indoor air at residences are unlikely to cause adverse health effects, it is recommended that household sources be identified to best extent possible and be removed to decrease exposures. It should be noted that there is generally some uncertainty regarding the exact source of contamination in the indoor air environment because of the various sources of VOCs in indoor and/or outdoor air. As mentioned earlier, several consumer products contain VOCs, which contribute to low background levels found almost ubiquitously in the ambient air (see Appendix A). The evaluation of adverse health effects is made on the basis of current measurements of contaminants in indoor air, which only provides a snapshot estimate, i.e., concentration levels at a single point in time. It is unknown if past levels of these non-plume related contaminants could have been higher or lower in the residences; therefore the health effects may be either underestimated or overestimated for past exposures.

Cancer Health Effects

The site-specific lifetime excess cancer risk (LECR) indicates the cancer potential of contaminants. LECR estimates are usually expressed in terms of excess cancer cases in an exposed population in addition to the background rate of cancer. For perspective, the lifetime risk of being diagnosed with cancer in the United States is 46 per 100 individuals for males, and 38 per 100 for females; the lifetime risk of being diagnosed with any of several common types of cancer ranges approximately between 1 in 100 and 10 in 100 (SEER 2005). Typically, health guideline CVs developed for carcinogens are based on a lifetime risk of one excess cancer case per 1,000,000 individuals. ATSDR considers estimated cancer risks of less than one additional cancer case among one million persons exposed as insignificant or no increased risk (expressed exponentially as 10^{-6}).

According to the United States Department of Health and Human Services (USDHHS), the cancer classification of contaminants detected at a site is as follows:

1 = Known human carcinogen
2 = Reasonably anticipated to be a carcinogen
3 = Not classified

The LECR was calculated by multiplying the cancer exposure dose by the inhalation unit risk (IUR). The IUR is defined by the USEPA as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 μg/m^3 in air (EPA 2009f).

$$LECR = EC \times IUR \times ED \times (ET/AT)$$

where:

LECR = Lifetime Excess Cancer Risk
EC = Exposure Concentration in ug/m^3
IUR = Inhalation Unit Risk in $(ug/m^3)^{-1}$
ED = Exposure Duration in hours per day
ET = Exposure Time in years
AT = Averaging Time in years

There were two scenarios that were considered in the evaluation of cancer risks. Since indoor air data is available for the basement areas in residences, time spent in the basement is an important contributor to the overall exposure to the contaminants of concern via the vapor intrusion pathway. Two different exposure durations were assumed for the cancer risk estimation. The first assumes an exposure duration of 16 hours a day to represent time spent in the basement inclusive of activities such as sleeping and engaging in recreational activities/household chores. The other scenario assumes an exposure duration of 2 hours as time spent in the basement engaging in household chores/recreational activities. These scenarios are thought to be realistic assumptions to provide a range of time potentially spent in the basement, considered as the place where maximum exposures to the contaminants would occur. Other assumptions are default assumptions that the USEPA uses for risk assessment. All assumptions are summarized in the following table:

<table>
<tr><th>IUR</th><th>ED</th><th>ET</th><th>AT</th></tr>
<tr><td rowspan="2">Contaminant specific value</td><td>16 hours per day</td><td rowspan="2">30 years</td><td rowspan="2">70 years</td></tr>
<tr><td>2 hours per day</td></tr>
</table>

Table 4 lists the calculated the increased cancer risks for plume-related and non-plume related COC. The risks are expressed in scientific notation, which is simply a method for expressing either very large or very small numbers. For example, 1,000,000 can be expressed in scientific notation as 1×10^6; and 0.001 can be expressed as 1×10^{-3}, respectively.

Plume-related cancer risks: Based on the UCL of the arithmetic mean concentrations of plume-related contaminants of concern detected in the indoor air, the calculated cumulative LECR was determined to be eight in 100,000 based on 16 hours per day exposure duration. This means that there would be eight excess cancer cases in a population of 100,000 people. For the more realistic exposure scenario of 2 hours per day, it was determined that one excess cancer case would occur in a population of 100,000 people. Both these scenarios result in what is considered a very low increase in cancer risk.

Non-Plume related cancer risks: Based on the UCL of the arithmetic mean concentrations of non-plume related contaminants of concern detected in the indoor air, the calculated cumulative LECR for exposures was determined to be one in 10,000 based on 16 hours per day exposure duration. This is considered a low increase in cancer risk. For the 2 hours per day scenario, the cumulative LECR was calculated to be one in 100,000 which means that there would be one excess cancer case in a population of 100,000 people. This is considered a very low increase in cancer risk.

The results are essentially the same for both categories of COC; therefore the cumulative cancer risk from inhaling all the COC will be considered to provide a conservative cancer risk estimate. Based on the UCL of the arithmetic mean concentrations of contaminants of concern detected in the indoor air, the calculated cumulative LECR for exposures to all contaminants for an exposure duration of 16 hours per day for 30 years was approximately two in 10,000. This means that there would be two excess cancer cases in a population of 10, 000 which is considered a low increase in cancer risk. For the more common scenario which assumes individuals spending 2 hours per day for 30 years in the basement, the cumulative LECR was calculated to be approximately two in 100,000. This is considered a very low increase in cancer risk. As previously mentioned, it is unknown if past levels of non-plume related contaminants could have been higher or lower in the residences. However it has been documented that the shallow groundwater concentrations have decreased by approximately an order of magnitude since 1995 and the data suggest that the off-site shallow groundwater plume is dissipating in the residential area (Corporate Remediation Group, 2008). It is possible that levels of contaminants could have been higher in the groundwater plume in the past and consequently the levels of plume-related COC could have been higher in residential indoor air. Therefore adverse health effects may be underestimated for these COC for past exposures.

For a select group of residences there may be increased cancer risks if the measured COC levels in indoor air were found to be above the target concentration as listed below:

Contaminants	**Target Concentration[a] ($\mu g/m^3$)**	**No. residences above the Target Conc.**
Plume-related:		
Carbon tetrachloride	23	0
1,2-dichloroethane	13	2
Methylene chloride	745	2
Tetrachloroethene	59	1
Trichloroethene	175	0
Vinyl Choride	80	0
Non-Plume related:		
Benzene	45	0
1,3-butadiene	12	1
Chloroform	15	1
Methyl tert-butyl ether	1,346	0

[a] Target Concentration was derived for a LECR of 1E-04 assuming an exposure duration of 16 hours per day for 30 years.

The target concentrations were derived by assuming a 16 hours per day exposure duration for a period of 30 years that would result in a LECR of one in 10,000. This is a very conservative assumption and is not considered a likely exposure scenario. It would be prudent to either a) install the mitigation system if a plume-related COC was detected at a concentration higher than the target concentration, or b) to identify and remove household sources to the best extent possible to decrease exposures if a non-plume related COC was detected at a concentration higher than the target concentration.

Community Concerns

The NJDHSS and ATSDR strive to identify the community's concerns about a site during the development of a health assessment or consultation in order to ensure that those concerns are addressed. For the DuPont Pompton Lakes site, we have met with community members, individually and in groups, at several meetings held in Pompton Lakes. These included NJDEP meeting in June and July, 2008 and March, 2009, a NJDHSS and ATSDR Availability Session in October 2008, and a meeting for parents in March 2009. NJDHSS also received concerns through the NJDEP and through local elected and health officials.

The community had raised following health concerns:

- **specific cancers, including brain, breast and kidney, as well as overall cancer incidence questions, were raised**. The New Jersey Cancer Epidemiology Services responded in a preliminary assessment addressing specific questions about brain cancer incidence in a defined geographic area in a letter to Mayor Katie Cole. A more in depth analysis of cancers potentially related to site contaminants in the plume area has been completed in a separate Health Consultation (ATSDR 2009).
- **health risks to children from exposures, including learning disabilities.** This health consultation does review potential health risks to children exposed to site-related contaminants. In addition, the NJDHSS and ATSDR invited pediatricians from the Mt. Sinai Medical Center's Pediatric Environmental Health Specialty Unit (PEHSU) to meet with parents in March 2009 and discuss what is known about these contaminants and children's health.
- **fetal exposures and risks.** The two non-plume related COC that were evaluated for non-cancer health effects were 1,3-butadiene and 1,4-dichlorobenzene. There were no studies available regarding developmental effects in humans after inhalation exposure to 1,3-butadiene. Rat studies showed that the fetal toxicity of 1,3-butadiene was expressed by a statistically significant increased incidence of skeletal abnormalities (wavy ribs, irregular rib ossification) when exposed to a concentration of 2,250,000 $\mu g/m^3$ and major abnormalities (defects of the skull, spine, sternum, long bones, and ribs) when exposed to 18,000,000 $\mu g/m^3$ group. In another study, decreased fetal weight was observed in male mice fetuses after exposure to 90 $\mu g/m^3$ of 1,3-butadiene. Increased incidences of extra ribs were found in fetuses from groups exposed to

450,000 µg/m^3 of 1,3-butadiene (ATSDR 1993). 1,4-Dichlorobenzene does not appear to be associated with fetal toxicity (ATSDR 2006).

- **interpretation of indoor air and soil gas results.** Staff provided interpretation of the results in person at the public meetings/availability session and by phone.
- **risks and exposures through the use of irrigation wells for gardening.** Plants are able to break down or degrade volatile chemicals. Consequently, volatile chemicals taken up by plants may be present temporarily in the roots and stems of the plant, but are much less likely to be present in the leaves or other above-ground, potentially edible parts of the plant. In summary, the literature review indicates that uptake and accumulation of volatile chemicals in plants and subsequent exposures by home gardeners and their families are likely to be low (see Appendix C).
- **risks and exposures through the use of irrigation wells watering lawns and filling swimming pools**. The use of this water by residents may have exposed them to groundwater contaminants through incidental ingestion (e.g., an occasional drink from the hose), dermal contact and inhalation. This was evaluated using concentrations of VOCs detected in the groundwater to calculate the exposure dose when inhaling resulting ambient concentrations when watering lawns. Results from a previously evaluated site in Wall Township, New Jersey were used for a comparative analysis (ATSDR 2007a). The evaluation concluded that adverse health effects from inhalation of contaminants during lawn and garden watering were not expected. The magnitude of the groundwater concentration was higher in Wall Township than in Pompton Lakes. The maximum PCE and TCE levels in Wall Township were 1,068 and 243 µg/L, respectively as compared to 29 and 12 µg/L, respectively in Pompton Lakes. Thus the same conclusion can be applied for the Pompton Lakes site. A similar conclusion was derived for the use of irrigation wells to fill swimming pools pathway (ATSDR 2007a).
- **potential for an impact to outdoor air if every house had a mitigation system.** Appendix D provides a fact sheet from the New York Department of Environmental Conservation (NY DEC) for a site in the state of New York (the IBM Endicott site) with similar issues to Pompton Lakes, NJ. Ventilation systems were installed in approximately 500 homes or buildings. The community was also concerned whether the ventilation systems were impacting the ambient air, or the air outside their homes. The NY DEC and the New York State Department of Health (NYS DOH) collected ambient air data and determined that use the use of the 500 ventilation systems did not result in ambient air levels of public health concern. NYS DEC and NYS DOH do not expect any health effects from exposure to the VOC concentrations measured in the community's ambient air.
- **exposures and other health concerns (Crohn's Disease, fibromyalgia, breathing difficulties, asthma, allergies).** No information was found to link exposure to 1,3-butadiene or 1,4-dichlorobenzene with Crohn's Disease or fibromyalgia. A mice study found an increase in respiratory changes after chronic exposure to 2,800,000 µg/m^3 of 1,3-butadiene (ATSDR 1993). A study

suggests that exposure to 1,4-dichlorobenzene at levels found in the general population may result in decreases in lung function (ATSDR 2006).

Mixture Assessment

Exposures to mixtures of PCE, 1,1,1-TCA, TCE, and chloroform are likely to be additive in nature in producing nervous system effects or non-cancer kidney or liver effects (ATSDR Interaction Profiles 2004; 2007b). However, the levels of these volatile organic compounds measured in indoor air in homes sampled as part of investigation were all below ATSDR's Minimal Risk Levels for non-cancer health effects. Even the combination of these VOCs would not be expected to produce non-cancer health effects on the central nervous system, liver or kidney in area residents. Exposures to mixtures of TCE, PCE, and chloroform - the three chemicals of concern that are suspected to cause cancer - are also likely to be additive in nature in producing cancer risks as shown in the theoretical calculations in the cancer health effects section.

Health Outcome Data

A companion health consultation has been prepared to evaluate the incidence of cancer in the residential area above the DuPont groundwater plume for the period 1979 through 2006. The purpose of this investigation was to evaluate whether cancer incidence in this community was similar to average state rates. The select cancer types analyzed included bladder, brain and central nervous system, female breast, colorectal, esophageal, pancreas, lung, leukemia, non-Hodgkin lymphoma, liver, bone, stomach, and kidney. Further details and conclusions can be found in the health consultation (ATSDR 2009).

Conclusions

More than 90 years of operation of the former DuPont Pompton Lakes site have resulted in the generation of hazardous wastes and environmental contamination on- and off-site, including the groundwater under nearby residences. Waste management practices resulted in significant contamination of surface water, soil and sediment, and groundwater contamination both on- and off-site. Volatile organic compounds that are present in the groundwater can enter residential indoor air via a process known as vapor intrusion. Plume-related contaminants of concern for the residential neighborhood include carbon tetrachloride, 1,2-dichloroethane, methylene chloride, tetrachloroethene, trichloroethene and vinyl chloride. Other non-plume related contaminants of concern such as benzene, 1,3-butadiene, chloroform, 1,4-dichlorobenzene, 1,2-dichloropropane and methyl tert-butyl ether were also identified during environmental monitoring. NJDHSS and ATSDR reached the following conclusions regarding exposures to residents at the Pompton Lakes site:

Plume-related contaminants of concern

NJDHSS and ATSDR conclude that current and future exposures to plume-related contaminants in indoor air at residences where properly functioning mitigation systems have been installed will not occur, and therefore will not harm people's health. The exposure pathway has been interrupted for these residences due to the installation of the vapor mitigation systems.

NJDHSS and ATSDR conclude that current and future exposures to plume-related contaminants in indoor air at residence where mitigation systems have not been installed may harm people's health. For the houses where residents have chosen not to have the system installed, the estimated health risks will be proportional to risks assessed for past exposures as discussed previously. There are several variables that affect vapor intrusion such as: temperature, wind, moisture, integrity of basements and change in the direction and composition of the groundwater plume. Recent sub-slab soil gas samples collected from a representative group of 39 residences found that the soil gas contamination (especially for PCE and TCE) were elevated above NJDEP Soil Gas Screening Levels in 95 percent of the homes tested. If the variables that affect vapor intrusion were to change, there is potential for the elevated sub-slab soil gas to be released into residential indoor air at levels that may harm people's health.

NJDHSS and ATSDR cannot conclude if past exposures to plume-related contaminants in indoor air at residences located south of the DuPont facility may have harmed people's health. Although there were not any plume-related COC that exceeded the CVs for non-cancer health effects, it is unknown if past levels of these contaminants were higher in the residences since the indoor air concentrations only provide an estimate of concentration levels at a single point in time. For cancer health effects, lifetime excess cancer risks were estimated to be low in comparison to the background risk of cancer. This conclusion is based on current plume conditions; the extent of past plume contamination is unknown and could have been higher since it has been documented that the shallow groundwater concentrations have decreased by approximately an order of magnitude in the last 14 years.

Non-plume related contaminants of concern

NJDHSS and ATSDR conclude that current and future exposures to non-plume related contaminants in indoor air at residences located south of the DuPont are not expected to harm people's health. Although the most likely average concentrations of non-plume related contaminants of concern (1,4-dichlorobenzene and 1,3-butadiene) were above their respective health guideline comparison values, the likelihood of potential non-cancer adverse health effects is low. For cancer health effects, lifetime excess cancer risks were calculated to be a very low increase in cancer compared to background cancer rates.

NJDHSS and ATSDR cannot conclude if past exposures to non-plume related contaminants in indoor air at residences south of the DuPont facility could have harmed *people's health.* It is unknown what past levels of these contaminants were in the residences, especially since consumer products are the most likely source for the indoor air levels of these contaminants.

The installation of the vapor system will not mitigate exposure to non-plume related COC as identified in this document. The vapor system only extracts vapors from the sub-slab, i.e., from underneath the basement floor, and will not remove ambient sources (for example, consumer products) of vapors present indoors. More information on these is given in Appendix E. It is important to note that the theoretical cancer risks described in this document do not represent an exact risk. There are inherent uncertainties associated with any risk assessment and indoor air sampling. Regarding the indoor air sampling uncertainties, the USEPA notes that concentrations of compounds found in indoor air are often subject to temporal and spatial variations, which may complicate estimates of exposure. It is also unknown what the year round concentration of the non-plume-related contaminants is in the home. Thus, the conclusions stated in this document could be an over or under estimate of the actual risk to any one individual.

Recommendations

1. Based on the information currently available, it is recommended that all residences impacted by the groundwater plume get the mitigation system installed.

2. It is essential that New Jersey Department of Environmental Protection ensures that DuPont installs and maintains the mitigation systems.

3. To the extent feasible, the groundwater plume should be remediated to eliminate the vapor intrusion pathway.

4. Residents with elevated levels of non-plume related contaminants can choose to identify the sources of the chemicals in indoor air and take steps to reduce or eliminate exposures.

Public Health Action Plan (PHAP)

The purpose of a PHAP is to ensure that this health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR and NJDHSS to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by the NJDHSS and the ATSDR are as follows:

Public Health Actions Undertaken by NJDHSS and ATSDR

1. The NJDHSS and ATSDR reviewed available environmental data and other relevant information for the Pompton Lakes site to determine human exposure pathways and public health issues.

2. The NJDHSS and ATSDR have met with community members, individually and in groups, at several meetings held in Pompton Lakes. These included NJDEP meeting in June and July, 2008 and March, 2009, NJDHSS and ATSDR Availability Sessions in October 2008, and a meeting for parents in March 2009 (see PHAP #4 below).

3. The NJDHSS and ATSDR have prepared a companion health consultation to evaluate the incidence of cancer in the residential area above the DuPont groundwater plume.

4. NJDHSS, upon discussion with the community, extended an invitation to Mt. Sinai Medical Center's Pediatric Environmental Health Specialty Unit (PEHSU) to present a general overview of what is known about children's risks from exposures to environmental contaminants in general and trichloroethylene and tetrachloroethylene, in particular. This occurred on March 31, 2009 and consisted of a presentation, followed by a question and answer period to address health concerns pertaining to children.

Public Health Actions Planned by NJDHSS and ATSDR

1. Copies of this health consultation will be provided to concerned residents in the vicinity of the site via the township libraries and the Internet.

2. In cooperation with the NJDEP public meetings can be scheduled, if needed, to discuss the findings of this report and to determine and address any additional community concerns.

3. As additional site-related contamination data become available, the NJDHSS and ATSDR will prepare health consultation(s) in order to evaluate the public health implications of potential contamination.

4. New environmental, toxicological, or health outcome data, or the results of implementing the recommendation and proposed actions, may determine the need for additional actions at this site. The ATSDR and the NJDHSS will reevaluate and expand the PHAP as warranted.

5. NJDHSS and ATSDR will assist residents in identifying non-plume related sources of exposures, upon request. In addition, Appendix 5 of this report provides information on potential sources.

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Certification

This health consultation was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This health consultation is in accordance with approved methodology and procedures existing at the time it was initiated.

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

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Table 1: Plume-related and Non-Plume related contaminants detected in indoor air samples from 337 residences from June – November 2008 at Pompton Lakes

Contaminants	No. Non-Detects	No. Detects	Minimum µg/m^3	Maximum µg/m^3	Average µg/m^3	Comparison Value µg/m^3	NJDEP SL[a] µg/m^3	Retained as COC[b]
Plume-related:								
Carbon tetrachloride	332	5	ND	10	1.60	0.07 (CREG[c])	1	**Yes**
1,2-dichloroethane	268	69	0.8	20	2.81	0.04 (CREG)	0.8	**Yes**
1,2-dichloroethene *(cis)*	333	4	ND	3	0.88	36 (NJDEP SV)	36	No
1,2-dichloroethene *(trans)*	336	1	ND	1	0.50	0.63 (EPA SL[d])	73	No
Methylene chloride	228	109	1	1,300	28.86	2 (CREG)	4	**Yes**
Tetrachloroethene	221	116	1	68	4.95	0.41 (EPA SL)	1	**Yes**
1,1,1-trichloroethane	286	51	1	170	9.08	4,000 (EMEG[e])	1,000	No
Trichloroethene	313	24	1	6	2.18	1.2 (CalEPA[f])	1	**Yes**
Vinyl chloride	336	1	ND	0.6	0.30	0.1 (CREG)	0.5	**Yes**
Non-Plume related:								
Acetone	27	310	0.7	4,300	66.79	30,000 (EMEG)	3,300	**Yes**
Benzene	53	284	0.6	42	2.59	0.1 (CREG)	0.6	**Yes**
1,3-butadiene	311	26	0.4	24	2.08	0.03 (CREG)	0.4	**Yes**
2-butanone	62	275	1	150	9.21	5,000 (RfC[g])	5,100	No
Chlorobenzene	332	5	1	6	3.75	52 (EPA SL)	51	No
Chloroform	280	57	1	88	2.74	0.04 (CREG)	1	**Yes**
Chloromethane	118	219	1	9	1.31	100 (EMEG)	95	No
2-chlorotoluene	333	4	1	6	2.33	6,300 (EPA SL)	73	No
Cyclohexane	120	217	0.7	38	2.14	6,000 (RfC)	6,200	No
1,4-dichlorobenzene	286	51	1	1,100	34.86	60 (EMEG)	1	**Yes**
Dichlorodifluoromethane	110	227	2	380	6.87	210 (EPA SL)	180	**Yes**
1,2-dichloropropane	331	6	1	6	3.50	30 (EMEG)	0.9	**Yes**
Ethylbenzene	135	202	0.8	96	3.15	1,000 (EMEG)	1,100	No
n-Hexane	30	307	0.7	3,300	13.39	2,000 (EMEG)	730	**Yes**

Table 1 -cont- Contaminants detected in indoor air samples from 337 residences from June – November 2008 at Pompton Lakes

Contaminants	No. Non-Detects	No. Detects	Minimum µg/m³	Maximum µg/m³	Average µg/m³	Comparison Value µg/m³	NJDEP SL µg/m³	Retained as COC
Methyl isobutyl ketone	317	20	2	23	5.29	3,000 (RfC)	3,100	No
Methyl tert-butyl ether	309	28	0.9	130	11.11	2,000 (EMEG)	2	**Yes**
Styrene	227	110	0.9	25	1.81	900 (EMEG)	1,000	No
Tert-butyl alcohol	334	3	ND	22	5.83	5,200 (EPA SL)	66	No
Toluene	8	329	0.8	1,100	18.95	300 (EMEG)	5,100	No
1,1,1-trichloroethane	331	6	1	9	5.50	4,000 (EMEG)	1,000	No
Trichlorofluoromethane	21	316	1	79	2.62	730 (EPA SL)	730	No
1,1,2-trichloro-1,2,2-trifluoroethane	326	11	1	67	8.25	NA	31,000	No
Xylenes (m&p)	129	208	2	340	9.88	200 (EMEG)	110	**Yes**
Xylenes (o)	148	189	0.9	130	3.54	200 (EMEG)	110	**Yes**

[a]Screening Lalue; [b]Contaminant of Concern; [c]ATSDR Cancer Risk Evaluation Guide; [d]USEPA Screening Level; [e]ATSDR Environmental Media Evaluation Guide; [f]California USEPA value; [g]USEPA Reference Concentration

Table 2: Exposure Point Calculation using USEPA ProUCL®

Contaminants	Exposure Point Concentration µg/m^3	Comparison Value µg/m^3	Contaminant of Concern
Plume-related:			
Carbon tetrachloride	5	0.07	**Yes**
1,2-dichloroethane	4.3	0.04	**Yes**
Methylene chloride	94.5	2	**Yes**
Tetrachloroethene	7.9	0.41	**Yes**
Trichloroethene	3.5	1	**Yes**
Vinyl chloride	0.6	0.1	**Yes**
Non-Plume related:			
Acetone	170	3,300	No
Benzene	5.3	0.1	**Yes**
1,3-butadiene	4.5	0.03	**Yes**
Chloroform	7.44	0.04	**Yes**
1,4-dichlorobenzene	113	1	**Yes**
Dichlorodifluoromethane	26	180	No
1,2-dichloropropane	3.5	0.9	**Yes**
n-Hexane	84	730	No
Methyl tert-butyl ether	24.3	2	**Yes**
Xylenes (m&p)	29	110	No
Xylenes (o)	10.6	110	No

Table 3: Comparison of COC with ATSDR MRLs for estimation of non-cancer health effects

Contaminants	Exposure Point Concentration μg/m³	Minimum Risk Level μg/m³
Plume-related:		
Carbon tetrachloride	5	200
1,2-dichloroethane	4.3	2,000
Methylene chloride	94.5	1,000
Tetrachloroethene	7.9	300
Trichloroethene	3.5	500
Vinyl chloride	0.6	80
Non-Plume related:		
Benzene	5.3	10
1,3-butadiene	**4.5**[a]	2
Chloroform	7.44	100
1,4-dichlorobenzene	**113**	60
1,2-dichloropropane	3.5	30
Methyl tert-butyl ether	24.3	2,000

[a] Values that are bolded represent concentrations detected above the Minimum Risk Level

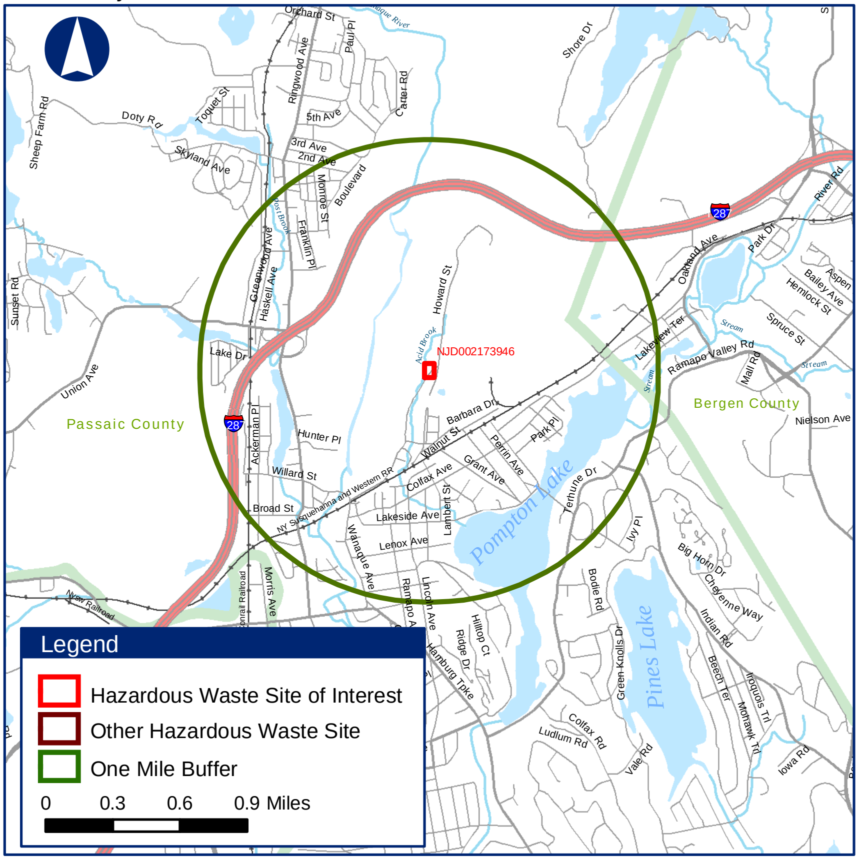
Table 4: Estimation of Lifetime Excess Cancer Risk for the carcinogenic contaminants of concern

Contaminants	DHHS[a] Cancer Class	Exposure Point Concentration $\mu g/m^3$	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	LECR[b] (ED[c]=16 h/d)	LECR (ED=2 h/d)
Plume-related:					
Carbon tetrachloride	2	5	1.50E-05	2.14E-05	2.68E-06
1,2-dichloroethane	2	4.3	2.65E-05	3.26E-05	4.07E-06
Methylene chloride	2	95	4.70E-07	1.28E-05	1.59E-06
Tetrachloroethene	2	7.9	5.90E-06	1.33E-05	1.66E-06
Trichloroethene	2	3.5	2.00E-06	2.00E-06	2.50E-07
Vinyl chloride	1	0.6	4.40E-06	7.54E-07	9.43E-08
Sum of plume-related =				**8E-05**	**1E-05**
Non-Plume related:					
Benzene	1	5.3	7.80E-06	1.18E-05	1.48E-06
1,3-butadiene	1	4.5	3.00E-05	3.86E-05	4.82E-06
Chloroform	2	7.4	2.30E-05	4.86E-05	6.08E-06
Methyl tert-butyl ether	3	24	2.60E-07	1.78E-06	2.23E-07
Sum of non-plume related =				**1E-04**	**1E-05**
Total of plume and non-plume related =				**2E-04**	**2E-05**

[a]Department of Health and Human Services Cancer Class: 1 = known human carcinogen; 2 = reasonably anticipated to be a carcinogen; 3 = not classified; [b]Lifetime Excess Cancer Risk; [c]Exposure Duration

E. I. Dupont Pompton Lake
Pompton Lakes, NJ

EPA Facility ID: NJD002173946



Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane New Jersey FIPS 2900 Feet

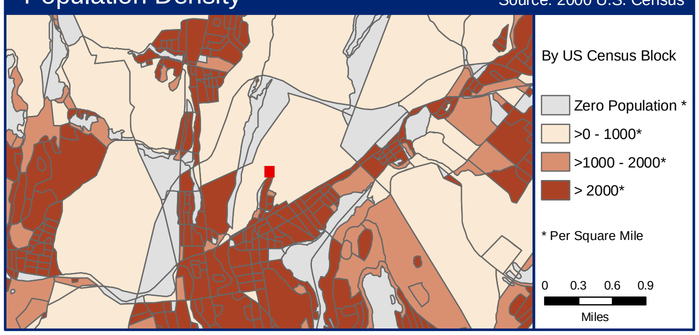
Site Location: Passaic County, NJ

Demographic Statistics
Within One Mile of Site*

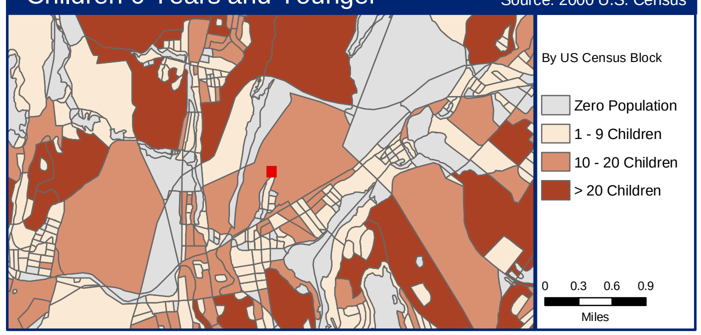
Total Population	7,091
White Alone	6,458
Black Alone	122
Am. Indian & Alaska Native Alone	25
Asian Alone	230
Native Hawaiian & Other Pacific Islander Alone	1
Some Other Race Alone	164
Two or More Races	91
Hispanic or Latino**	478
Children Aged 6 and Younger	621
Adults Aged 65 and Older	1,190
Females Aged 15 to 44	1,494
Total Housing Units	2,783

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

Population Density
Source: 2000 U.S. Census

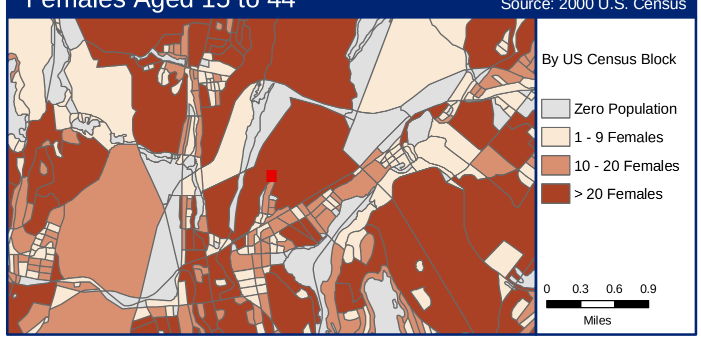


Children 6 Years and Younger
Source: 2000 U.S. Census



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

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



<project=03329><userid=JXA0><geo=Passic County, NJ><keywords=NJD002173946, E. I. Dupont, Pomton>

Figure 2: Demographic Information for the Pompton Lakes Site based on 2000 U.S. Census

APPENDIX A

Uses and Typical U.S. Background Concentration of Selected Chemicals Detected in Residential and Commercial Indoor Air Samples

Chemical	Usage[a]	Sources of Common Exposure[b]	Background Concentrations ($\mu g/m^3$)[c]
Acetone	Solvent; paint strippers; rubber cement; cleaning fluids; nail polish remover.	See Usage.	2 - 80[d]; 16[g]; 19 (indoor)[g]
Benzene	Solvents, gasoline, resins and plastics; nylon; paints; adhesives (especially carpet); printing; pesticides;	Gasoline emissions; cigarette smoke; paints and adhesives; particle board and wood composites; wood smoke	1 (average outdoor – Monmouth County, New Jersey)[h]
1,3-Butadiene	Intermediate (potential impurity) in many plastics and polymers; fungicides; latex paint; acrylics; fuel	Vehicle emissions; tobacco smoke; wood fires; waste incinerators; electric wire coatings; thermal degradation of plastics	0.38 (indoor) 14 (cigarette smoke)[d]
Chloroform	Refrigerant manufacturing; raw material for polytetrafluoroethylene plastics; insecticidal fumigant; solvent; cleansing agent in fire extinguishers; by-product in chlorination of potable water; former use in cough syrup, toothpastes, and toothache compounds..	Bathroom showers using chlorinated water; see Usage.	10-500 (10 min shower)[d]; 0.5 - 4 [d]; 0.1 - 2 [g]
1,4 - Dichlorobenzene	Deodorant; pesticide; resins and plastics; solvent; dyes; degreaser; wood preservative; motor oils; paint	Mothballs; toilet deodorants; air fresheners; tobacco smoke; pesticide application	3.45 (indoor non-smoker)[d]; 10.22(indoor smoker)[d]; 1 - 4 (average outdoor)[d] 0.08-240 (indoor - study)[g]
1,2 - Dichloroethane	Manufacture of vinyl chloride; formerly used in varnish, paints, finish removers, adhesives, soaps, degreasing agent	Fugitive emissions from industries, treatment plants, hazardous waste sites; landfills; occupational settings; ambient air	0.3 (indoor non-smoker avg)[f]; 0.03 (indoor non-smoker avg)[f]; 0.04-0.4 (outdoor - study)[f]

Chemical	Usage[a]	Sources of Common Exposure[b]	Background Concentrations ($\mu g/m^3$)[c]
Ethylbenzene	Production of synthetic rubber; general and resin solvent; gasoline additive.	Self-serve gasoline fill-ups; vehicle emissions; painting; new or remodel construction.	1 - 12 (outdoor - average) [d]
n-Hexane	Gasoline; rubber cement; typing correction fluid; perfume aerosols; cleaning agent; paint diluent; alcohol denaturant; solvent in extraction of soybean oil, cottonseed oil and other seed oils. Constituent in natural gas.	Combustion of motor fuels, heating oil fuels or other petroleum products; natural gas; glues, stains, paints, varnishes, adhesives, and cleaning agents.	14 (average outdoor) [d]; 7 [g]
Methylene Chloride	Industrial solvent; hairspray; paint strippers; spray paint; rug cleaners; insecticides; furniture polish.	See Usage	Less than 10[d] ; 0.17 (average)[g]
Methyl t-Butyl Ether (MTBE)	Used as an octane booster in gasoline (gasoline refinement)	Automobile gasoline refueling; inside automobiles when driving; refueling lawn mowers; chain-saws; or other gasoline-powered equipment	3.6 (median) [d] ; Less than 1 (estimated average)[f]
Tetrachloroethylene (PCE)	Solvent; degreaser; dry cleaning and textile production; water repellants; pharmaceuticals; pesticides; refrigerants; insulating fluids; correction fluid (e.g., white out) and inks; adhesives	Dry cleaned garments; paint removers; fabric cleaning products (e.g., stain removers, etc.); lubricants; wood products	1-4 (average)[d]; 7 (average)[g]
1,2,4- Trimethylbenzene	Dyes, fragrances, and plastics; solvent and paint thinner; sterilizing agent; degreaser; gasoline additive; synthetic wood products.	Self-serve gasoline fill-ups; indoor painting or printing	10-12 (indoor)[d] 2.8 - 5.9 (outdoor)[f]

Chemical	Usage[a]	Sources of Common Exposure[b]	Background Concentrations (µg/m³)[c]
1,3,5- Trimethylbenzene	Building materials; Dyes; UV inhibitor in plastics; solvent and paint thinner; gasoline additive.	Self-serve gasoline fill-ups; indoor painting or printing; new or remodel construction.	3-8 (indoor)[d] 3-15 (outdoor)[d]
Toluene	Manufacture of benzoic acid, explosives, dyes, artificial leather, perfumes; solvent for paints, lacquers, gums, and resins; printing inks; gasoline additive; spot removers; cosmetics; antifreeze; adhesive solvent in plastic toys and model airplanes.	Self-serve gasoline fill-ups; vehicle emissions; cigarette smoke; consumer products; nail polish; indoor painting; new or remodel construction (carpets).	3 - 140 (outdoor)[d] 42 (outdoor - average)[d] 20 – 60 µg/cigarette[d]
Xylenes (Total)	Manufacture of benzoic acid; dyes, hydrogen peroxide, perfumes, insect repellants, epoxy resins, pharmaceuticals, paints, varnishes, general solvent for adhesives and paints; gasoline additive; used in leather industry.	Self-serve gasoline fill-ups; vehicle emissions; indoor painting; new or remodel construction.	17 (outdoor - average)[d]

[a]National Library of Medicine's (NLM) Hazardous Substances Data Bank (HSDB)
[b]ATSDR Toxicological Profile
[c]The background concentrations presented are not specific to the Sal's Auto Repair site in particular, but are presented to provide the homeowner some perspective as to levels typically found in U.S. homes
[d]HSDB, 2002, at www.toxnet.nlm.nih.gov
[e]Chemical profiles at www.scorecard.org
[f]EPA, 1988
[g]Tox Profile at www.atsdr.cdc.gov
[h]EPA, 1999

APPENDIX B

Fact Sheet

Evaluating Indoor Air near VOC Contaminated Sites

What are VOCs?

Volatile organic compounds (VOCs) are a class of chemicals that readily evaporate at room temperature. Gasoline, dry cleaning fluid, degreasing agents (solvents) and paint thinners are several examples of products that contain these compounds. VOCs may be found in soil and/or ground water due to spillage onto the ground, leaks from underground storage tanks and other types of discharges.

How VOCs in soil or ground water can affect indoor air

If VOCs contaminate soil or ground water at a site, it is important to evaluate nearby buildings for possible impacts from **vapor intrusion**. Vapor intrusion occurs when gases from the contaminated soil or ground water seep through cracks and holes in foundations or slabs of buildings and accumulate in basements, crawl spaces or living areas, as shown in the diagram below.

A variety of factors can influence whether vapor intrusion will occur at a building located near soil or ground water contaminated with VOCs. These include, but are not limited to, the concentration of the contaminants, the type of soil, the depth to ground water, the construction of the building, the condition of the foundation or slab and the existence of underground utilities that can create pathways for vapors to travel.

Short term exposure to high levels of organic vapors can cause eye and respiratory irritation, headache and/or nausea. Breathing low levels of organic vapors over a long period of time may increase an individual's risk for respiratory ailments, cancer and other health problems.

Organic vapors can be present inside a building at potentially harmful levels without being detectable by odor. **Sub-slab soil gas testing**, **near-slab soil gas testing** and/or **indoor air testing** are usually required to determine whether vapor intrusion is occurring at a property.

Testing for vapor intrusion

If your home or building is located near VOC-contaminated soil or ground water, NJDEP or an environmental contractor may ask permission to evaluate your property for vapor intrusion. This process typically involves first conducting sub-slab soil gas testing to check for vapors beneath the building, followed by indoor air testing, if necessary. During sub-

(over)

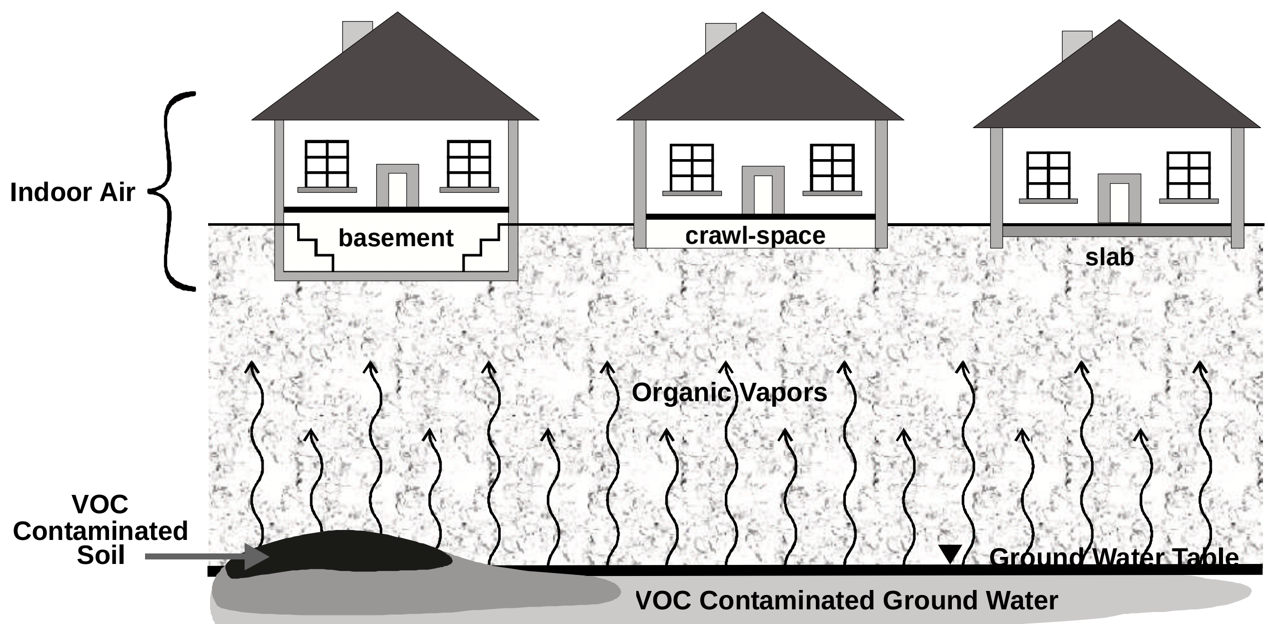


Diagram adapted from USEPA's *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Ground Water and Soils, November 2002*

New Jersey Department of Environmental Protection
Site Remediation Program
(609) 984-3081 • Office of Community Relations

(continued)

slab testing, a small hole is bored through the basement floor or slab and a sample of the **soil gas** (the air trapped between the soil particles) is collected using an evacuated air testing canister (see below). If it is not possible to collect a soil gas sample from beneath the floor or slab, the sample may be collected by placing a probe in the soil directly adjacent to the building (near-slab testing). The soil gas sample is then sent to a certified laboratory to be analyzed for VOCs. If the analysis shows VOCs related to the subsurface contamination are present above NJDEP's Soil Gas Screening Levels (SGSL), then indoor air testing is necessary.

During indoor air testing, a canister is placed in the basement, crawl space or other part of the building for a period of time (normally 24 hours). If the analysis of the indoor air sample shows VOCs related to the subsurface contamination are present above NJDEP's Indoor Air Screening Levels (IASL), vapor intrusion is likely occurring. Additional evaluation of the property may be needed to confirm this finding.

An evacuated air testing canister. The pressure inside the canister is initially set lower than the indoor air, causing air to flow into the canister when the valve is opened.

Background contamination

Many materials and substances commonly found in commercial and residential settings, such as paints, paint thinners, gasoline-powered machinery, certain building materials and cleaning products, dry cleaned clothing and cigarette smoke, contain VOCs that may be detected by indoor air testing. Even VOCs from motor vehicle emissions and other outdoor sources can contaminate indoor air. When VOCs from these sources are detected during indoor air testing, they are referred to as **background contamination.**

Sometimes it can be difficult to determine whether the VOCs detected inside a building are due to vapor intrusion, background contamination or a combination of both. Before your building is evaluated for vapor intrusion you should receive a copy of NJDEP's *Instructions for Occupants – Indoor Air Sampling Events*. Please follow these instructions to minimize background contamination and help ensure that the test results are as definitive as possible.

Addressing vapor intrusion

If testing confirms vapor intrusion is causing potentially harmful levels of VOCs to accumulate inside a building, a **subsurface depressurization system** may be installed at the property. The system prevents vapors from entering the building by continuously venting the contaminated air beneath the basement slab or crawl space to the exterior of the structure. Subsurface depressurization systems are also used throughout the country to reduce levels of naturally occurring radon gas in buildings. See NJDEP's fact sheet titled *Subsurface Depressurization Systems* for more information about how these systems work.

***Instructions for Occupants — Indoor Air Sampling Events*, the *Subsurface Depressurization Systems* fact sheet and general information about vapor intrusion can be found in NJDEP's Vapor Intrusion Guidance Document, which is available at http://www.state.nj.us/dep/srp/guidance/vaporintrusion**

Information for Residents and Property Owners

Contact Name ____________________

Agency/Company ____________________

Phone Number ____________________

Email Address ____________________

NJDEP Contact & Phone Number ____________________
(if different than above) ____________________

Sampling Date/Time ____________________

Notes/Instructions ____________________

____

____

APPENDIX C

Fact Sheet

UPRR Eugene Yard: Irrigation with Groundwater Containing VOCs

State of Oregon
Department of Environmental Quality

Environmental Cleanup Division
Western Region
1102 Lincoln, Suite 210
Eugene, OR 97401
Phone: (541) 686-7838
(800) 844-8467
Fax: (541) 686-7551
Contact: Gene Wong
www.deq.state.or.us

This flyer is a special issue of the community updates designed to provide information about potential risks associated with the use of groundwater in parts of the Bethel Drive and River Road neighborhoods near the Union Pacific Railroad (UPRR) Eugene Rail Yard (see attached map of study area).

Evaluation of Potential Risks from Eating Homegrown Produce

In some portions of the River Road and Bethel Drive neighborhoods, the shallow groundwater is contaminated with volatile organic compounds (VOCs) associated with historical activities at the Eugene Rail Yard. Some residents in these neighborhoods may use this groundwater to irrigate their home gardens. Recognizing this, UPRR and DEQ recently completed an analysis of the potential risks related to eating fruits and vegetables grown in home gardens that are irrigated in this way. The results of the risk evaluation indicate that the current levels of VOCs are: (1) below harmful levels as determined by DEQ, and (2) safe for irrigating home gardens.

This analysis considered VOCs only. Biological contaminants, such as bacteria, or other chemicals, such as nitrate, are not believed to be related to the Eugene Yard, but may be present at concentrations that could pose a health risk if residential well water is used for drinking.

Background Information

In April 2000, UPRR completed an assessment under DEQ oversight evaluating potential health risks from several types of residential exposures to volatile chemicals. These included breathing volatiles that move from groundwater to outdoor and indoor air, contacting groundwater during outdoor use (e.g., sprinkler), and occasional ingestion of groundwater. Potential risks associated with eating homegrown produce were considered qualitatively in this analysis. The results of this initial study indicated that the levels of contaminants are low and considered safe by DEQ.

In response to questions raised by residents in conversations with DEQ, UPRR and DEQ performed a supplemental analysis to evaluate the potential risks posed by eating garden produce irrigated with groundwater containing VOCs. The supplemental analysis consisted of two parts: a scientific literature review and a risk evaluation. This fact sheet summarizes the findings of the supplemental analysis.

Literature Review

Groundwater chemicals of concern in the vicinity of the Eugene Yard are volatile, meaning that they evaporate easily at normal temperatures. For this reason, the chemicals will tend to volatilize during the irrigation process, rather than be taken up or absorbed by plants.

Research demonstrates that if the volatile chemicals manage to reach the plants and if the chemicals are then absorbed by the plants, the VOCs do not accumulate in plant tissues (Davis *et al.* 1998). Rather, the VOCs are transferred to air through pores in the plants' tissues. The resulting air concentrations do not pose a threat to health because the amounts of chemicals released are very low and they mix readily with surrounding air.

Studies have also shown that chemicals taken up through a plant's root system tend to concentrate in the cells near the surface of the roots (Agustin 1994). In root vegetables such as beets, carrots, and potatoes, these cells are typically lost during washing and peeling of the produce. In above-ground fruits and vegetables (e.g., tomatoes, lettuce, squash, etc.), the roots are not consumed.

Plants are also able to break down or degrade volatile chemicals. Consequently, volatile chemicals taken up by plants may be present temporarily in the roots and stems of the plant, but are much less likely to be present in the leaves or other above-ground, potentially edible parts of the plant (Newman *et al.* 1997).

In summary, the literature review indicates that uptake and accumulation of volatile chemicals in plants and subsequent exposures by home gardeners and their families are likely to be low.

Last Updated: 6/4/01

Risk Evaluation

To supplement the literature search, UPRR and DEQ performed calculations to assess the potential risks associated with eating homegrown produce from gardens irrigated with well water containing VOCs.

Neither USEPA nor DEQ has developed models for evaluating food chain exposures to VOCs; therefore, a model from California State EPA was used to evaluate such exposures. The assumptions of the model are designed to ensure that potential risks are not underestimated. The CalTOX model is freeware and is available at http://www.dtsc.ca.gov/docs/sppt/herd/caltox.html. The assessment assumed that an individual would eat approximately 23 pounds of homegrown produce per month for 12 months of the year. In addition, the assessment assumed that a resident would live in the area for 28 years.

The results of the modeling indicate that potential risks associated with eating homegrown produce irrigated with well water containing VOCs are very low and do not significantly change the overall risks from the groundwater exposures already assessed (outdoor use).

Summary

Eating homegrown produce irrigated with water containing VOCs in the vicinity of the Eugene Yard is safe for adults and children. DEQ suggests that you wash produce as normal prior to consumption.

The results of the supplemental analysis support the previous determination that the screening levels calculated for this project are protective for outdoor uses of groundwater including irrigating home gardens.

The modeling used to estimate potential food chain exposures is based on a number of assumptions designed to ensure that risks are <u>not</u> underestimated. Among these is the assumption that groundwater constituents taken up by plants are present throughout the entire plant at uniform concentrations. However, experimental studies found in the literature review indicate that this is not the case. Rather, constituents taken up by plants are likely to be present primarily in cells located on or near the surface of the plant's roots. Thus, the model assumption that chemical concentrations are uniform throughout the plant yields an overestimate of potential risks.

In addition, experimental studies suggest that VOCs in water taken up by plants will be broken down in the plant cells. Thus, actual VOC concentrations in plants are expected to be less than those estimated in this analysis.

References:

Agustin, R.A.C. 1994. *Analysis of the Potential for Plant Uptake of Trichloroethylene and an Assessment of the Relative Risk from Different Crop Types*. NTIS/AD-A284 800. July 1994.

Davis, L.C., S. Vanderhoof, J. Dana, K. Selk, K. Smith, B. Goplen, and L.E. Erickson. 1998. Movement of Chlorinated Solvents and Other Volatile Organics through Plants Monitored by Fourier Transform Infrared (FT-IR) Spectometry. *Journal of Hazardous Substance Research*, Vol. 4, pp. 1-26.

Newman, L.A., S.E. Strand, N. Choe, J. Duffy, G. Ekuan, M. Ruszaj, B.B. Shurtleff, J.Wilmoth, P. Heilman, and M.P. Gordon. 1997. Uptake and Biotransformation of Trichloroethylene by Hybrid Populars. *Environmental Science and Technology*, Vol. 31, pp. 1062-1067.

Water Testing

In the past, DEQ has tested water from selected residential wells to help define the extent of VOCs in groundwater in the neighborhoods. Recently, at the request of DEQ, UPRR has installed new monitoring wells in both neighborhoods. These wells are specifically designed for sampling. Additional wells are planned to be drilled in the River Road area this summer.

The expanded monitoring well network has allowed us to decrease our reliance on residential well sampling, although some residential wells may be tested in the future on a limited basis. If you are interested in the specific results of groundwater testing for VOCs in your area, contact DEQ (see below).

If you are interested in testing for overall well water quality, you can contact the Oregon Health Division (Ph: 503-731-4000) http://www.ohd.hr.state.or.us/dwp/docs/labs.pdf for a list of certified laboratories.

Community Involvement and Information

Local residents from the Bethel Drive and River Road neighborhoods surrounding the Eugene Yard play an important role in site investigations and cleanup. DEQ will continue to provide updates of environmental activities at the Yard and attend community meetings on a regular basis.

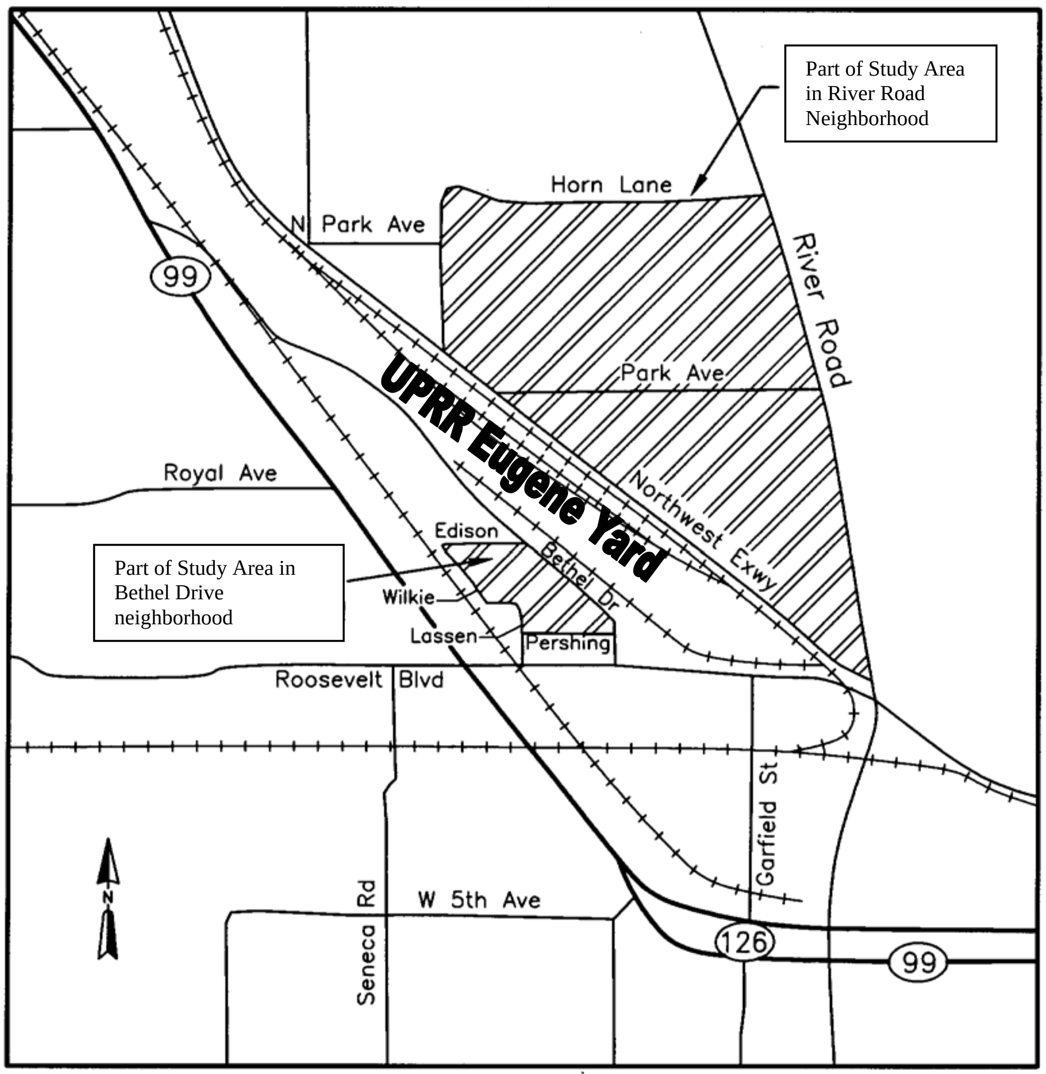
If you have any questions or concerns regarding this fact sheet or other risk assessment activities at the Eugene Rail Yard, or if you would simply like additional information, please feel free to contact any of the project officials listed below.

DEQ: Don Hanson, Project Manager
Eugene Office
Ph: 541-686-7838 ext. 241

UPRR: Gary Honeyman, Environmental Manager (Gary replaced Bob Markworrth as the UPRR Environmental Manager in April 2001).
Ph: 307-745-6532

ERM: Rob Leet, Senior Consultant to UPRR
Ph: (425) 462-8591

Study Area Map



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APPENDIX D

NEW YORK STATE DEPARTMENT OF

ENVIRONMENTAL CONSERVATION

For More Information on the IBM Endicott Ambient Air Monitoring Network and Results, Please Contact:

NYS DEC

Ms. Diane Carlton
NYS DEC, Region 7
615 Erie Blvd West
Syracuse, NY 13204

Phone: (315) 426-7403

For Information on Health-Related Issues, Please Contact:

NYS DOH

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FACT SHEET

IBM Endicott Soil Vapor Remediation and Ambient Air Monitoring Study Results

The New York State Department of Environmental Conservation (NYS DEC) has prepared this fact sheet to inform the public about the results of the ambient air monitoring data collected from May 2005 to May 2006 in Endicott, New York. This fact sheet briefly explains the site remediation history, the ambient air monitoring goal and the air quality measurements during this one-year ambient monitoring study.

Site Remediation History

Chemicals known as volatile organic compounds (VOCs) were formerly used in manufacturing operations at the IBM facility in Endicott. Groundwater contamination at the site resulted from past releases from the facility. Since 1980, IBM has sought to eliminate the spread of contaminated groundwater by capturing it in pumping wells and treating it to remove the VOCs. In 2002, the NYS DEC and the New York State Department of Health (NYS DOH) required IBM to investigate the potential for indoor air contamination with VOCs.

This investigation found elevated levels of VOCs in soil gas and beneath the foundations of homes in the area surrounding the former IBM facility. To date, approximately 500 “sub-slab ventilation systems” at 453 properties have been installed to help remediate the contamination and reduce the potential for VOCs to enter homes and other buildings through a process called soil vapor intrusion. The community requested an evaluation of the potential impact of the large number of ventilation systems on ambient air quality.

Ambient Air Monitoring Study Purpose and Description

In March 2004, NYS DEC and IBM developed a work plan to address the community’s concern. An ambient air monitoring study was planned to evaluate whether emissions from the ventilation systems, used to remediate soil vapors, may be contributing to ambient air VOC levels of public health concern. Seven VOCs were chosen for ambient air monitoring based upon sub-slab and soil gas sampling data. These VOCs are: trichloroethene (TCE), tetrachloroethene (PCE), cis-1,2-dichloroethene, vinyl chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, and methylene chloride.

Four ambient air monitoring sites were located in areas where the ambient air concentrations of VOCs from the ventilation systems were expected to be the highest. Two comparison sites were located in areas where the ambient air was not likely to be affected by the ventilation systems, but may be affected by other VOC sources outside the study area.

Ambient Air Monitoring Study Results

The air monitoring study was conducted by IBM in accordance with the work plan developed by NYS DEC and IBM. Appropriate quality assurance/quality control and data validation measures were taken to help ensure that the data collected during the sampling period accurately characterized the ambient air quality of the study area and community. In order to evaluate whether the ventilation systems were contributing to ambient air VOC levels of public health concern, the measured average concentrations for the seven VOCs were compared to NYS DEC health-based, ambient annual air guideline concentrations (AGCs). The NYS DEC ambient AGCs are conservative values used to permit air pollution sources and are derived to protect the public from adverse chronic health effects (cancer and noncancer) over a lifetime of continuous inhalation exposure. The AGCs for trichloroethene (TCE), tetrachloroethene (PCE), vinyl chloride, 1,1-dichloroethane, and methylene chloride are ambient air concentrations that correspond to an increased lifetime cancer risk of one-in-one million. The AGC for 1,1,1-trichloroethane and cis-1,2-dichloroethylene represent air concentrations that are protective against noncancer health effects. The data from this one-year monitoring program showed all of the average concentrations did not exceed the AGCs. In addition, three VOCs (cis-1,2-dichloroethene, vinyl chloride, 1,1-dichloroethane) were not detected in any ambient air samples during the one-year monitoring period.

Ambient Air Monitoring Study Conclusion

In summary, the use of approximately 500 ventilation systems at 453 properties to remediate soil vapor in Endicott is not resulting in ambient air VOC levels of public health concern. NYS DEC and NYS DOH do not expect any health effects from exposure to the VOC concentrations measured in the community's ambient air. The ventilation systems will continue to operate; inspections of these systems will be periodically conducted, and the soil gas and sub-slab vapor concentrations will continue to be evaluated to monitor the remediation process.

For More Information

The public is encouraged to review the final Endicott Ambient Air Monitoring Network Report. This document is available for review at http://www.dec.state.ny.us/website/der/projects/endicott/ and in the document repository at:

George F. Johnson Memorial Library
1101 Park Street
Endicott, NY 13760

Attn: Reference Desk
Phone: (607) 757-5350
Hours: Mon. and Wed. 10:00 am to 6:00 pm; Tues. and Thurs. 2:00 pm to 9:00 pm; Fri. 10:00 am to 5:00 pm; Sat. Noon to 4:00 pm

APPENDIX E

Information Sources for Indoor Air Quality

The following sources of information are provided as a reference to homeowners and business owners regarding actions and preventative measures on how to help improve the quality of indoor air within their homes or workplace.

"Healthy Indoor Air for America's Homes – Indoor Air Hazards Every Homeowner Should Know About." USEPA. EPA 402-K-98-002. June 2002 available at:
http://www.montana.edu/wwwcxair/

"The Inside Story – A Guide to Indoor Air Quality." USEPA. EPA 402-K-93-007. April 1995 available at:
http://www.epa.gov/iaq/pubs/index.html
"Health Buildings, Health People: A Vision for the 21st Century." USEPA. EPA 402-K-01-003. October 2001 available at:
http://www.epa.gov/iaq/pubs/index.html

"Indoor Air Pollution: An Introduction for Health Professionals." USEPA. EPA 402-R-94-007. 1994 available at:
http://www.epa.gov/iaq/pubs/index.html

"What You Should Know About Using Paint Strippers." Consumer Product Safety Commission. CPSC Publication # F-747-F-95-002. February, 1995 available at:
www.cpsc.gov/cpscpub/pubs/423.html

"Healthy Indoor Painting Practices." USEPA. EPA 744-F-00-001. May 2000 available at:
www.cpsc.gov/cpscpub/pubs/456.pdf

Many of these sources are available in print through the website contact or through:
New Jersey Department of Health and Senior Services
Indoor Environments Program
PO Box 369
Trenton, NJ 08625-0369
609-631-6749
Access on line at:http://www.s

APPENDIX F

Benzene Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is flammable and is formed from both natural processes and human activities. Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals such as plastics, resins, and nylon and synthetic fibers. Benzene is also used to make rubber, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include volcanoes and forest fires. Benzene is also a natural constituent of crude oil, gasoline, and cigarette smoke. Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions. Indoor air generally contains higher levels of benzene from products such as glues, paints, furniture wax, and detergents.

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death. The major effect of benzene from long-term (365 days or longer) exposure is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection. Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries. It is not known whether benzene exposure affects the developing fetus in pregnant women or fertility in men. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

The USDHHS has determined that benzene is a known human carcinogen. Long-term exposure to high levels of benzene in the air can cause leukemia, cancer of the blood-forming organs.

1,3-Butadiene Very large amounts of 1,3-butadiene are produced every year from petroleum. 1,3-Butadiene is used to make man-made rubber, which is then used mostly for car and truck tires. It is also used to make other kinds of rubber and plastics. 1,3-Butadiene is also found in small amounts in gasoline. Small amounts are found in the exhaust of automobiles and trucks at approximately 22.5 $\mu g/m^3$ and in gasoline vapors at 9 $\mu g/m^3$. 1,3-Butadiene is also found in cigarette smoke, and it may also be found in the smoke of wood fires.

Short-term exposure to high levels of 1,3-butadiene causes eye, nose, and throat irritation. Exposure to very high levels could occur during accidental release and could lead to symptoms like drunkenness and unconsciousness, or even to death. The exact levels in air that cause these effects in humans is unknown. Studies of rubber industry workers suggested possible harmful effects such as more cases of heart diseases, blood diseases, and lung diseases from the long-term exposure to low levels of 1,3-butadiene. These rubber industry workers were also exposed to other chemicals along with 1,3-butadiene, so it is not known for sure which chemical (or a combination of them) caused these effects. In addition, the effect of harmful habits like smoking was not considered in the evaluation of health risks of occupational exposure to 1,3-butadiene.

Carbon tetrachloride Carbon tetrachloride does not occur naturally. Exposure to this substance results mostly from breathing air, drinking water, or coming in contact with soil that is contaminated with it. Exposure to very high amounts of carbon tetrachloride can damage the liver, kidneys, and nervous system. Carbon tetrachloride can cause cancer in animals. Carbon tetrachloride is a manufactured chemical that does not occur naturally. It is a clear liquid with a sweet smell that can be detected at low levels. It is also called carbon chloride, methane tetrachloride, perchloromethane, tetrachloroethane, or benziform.

Carbon tetrachloride is most often found in the air as a colorless gas. It is not flammable and does not dissolve in water very easily. It was used in the production of refrigeration fluid and propellants for aerosol cans, as a pesticide, as a cleaning fluid and degreasing agent, in fire extinguishers, and in spot removers. Because of its harmful effects, these uses are now banned and it is only used in some industrial applications.

High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage. These effects can occur after ingestion or breathing carbon tetrachloride, and possibly from exposure to the skin. The liver is especially sensitive to carbon tetrachloride because it enlarges and cells are damaged or destroyed.

Kidneys also are damaged, causing a build up of wastes in the blood. If exposure is low and brief, the liver and kidneys can repair the damaged cells and function normally again. Effects of carbon tetrachloride are more severe in persons who drink large amounts of alcohol.

If exposure is very high, the nervous system, including the brain, is affected. People may feel intoxicated and experience headaches, dizziness, sleepiness, and nausea and vomiting. These effects may subside if exposure is stopped, but in severe cases, coma and even death may occur.

There have been no studies of the effects of carbon tetrachloride on reproduction in humans, but studies in rats showed that long-term inhalation may cause decreased fertility.

Studies in humans have not been able to determine whether or not carbon tetrachloride can cause cancer because usually there has been exposure to other chemicals at the same time. Swallowing or breathing carbon tetrachloride for years caused liver tumors in animals. Mice that breathed carbon tetrachloride also developed tumors of the adrenal gland. The Department of Health and Human Services (DHHS) has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has determined that carbon tetrachloride is possibly carcinogenic to humans, whereas the EPA determined that carbon tetrachloride is a probable human carcinogen.

Chloroform Chloroform is a colorless, volatile, nonflammable liquid. It is slightly soluble in water and is miscible with oils, ethanol, ether, and other organic solvents. Chloroform has a nonirritating odor and a slightly sweet taste. It is unstable when exposed to air, light, and/or heat. When heated to decomposition, chloroform emits toxic fumes of hydrochloric acid and other chlorinated compounds. The major use of chloroform is in refrigerant (hydrochlorofluorocarbon-22) and fluoropolymers production. Other uses include the extraction and purification of some antibiotics, alkaloids, vitamins, and flavors; as a solvent for lacquers, floor polishes, and adhesives; in artificial silk manufacturing; in resins, fats, greases, gums, waxes, oils, and rubber; as an industrial solvent in photography and dry cleaning; as a heat transfer medium in fire extinguishers; as an intermediate in the preparation of dyes and pesticides; and as a fumigant for stored grain crops.

The primary routes of exposure are ingestion, inhalation, and dermal contact withwater (e.g., while showering, swimming, cleaning, and cooking). Ingestion of contaminated water is expected to be a primary source of exposure. Chloroform was detected in the atmosphere at concentrations ranging from 0.10 to 10.0 $\mu g/m^3$ and in indoor air at 1.0 to 20.0 $\mu g/m^3$. Exposure via inhalation results in 60% to 80% absorption. Placental transfer of chloroform has also been demonstrated.

Exposures to high levels of chloroform for long periods of time may damage liver and kidneys. Large amounts of chloroform can cause sores when chloroform touches your skin. Reproductive or birth defects in people is unknown. Animal studies have shown that miscarriages occurred in rats and mice that breathed air containing 30 to 300 ppm chloroform during pregnancy and also in rats that ate chloroform during pregnancy. Offspring of rats and mice that breathed chloroform during pregnancy had birth defects. Abnormal sperm were found in mice that breathed air containing 400 ppm chloroform for a few days.

Chloroform is reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity in experimental animals. There is inadequate evidence for the carcinogenicity of chloroform in humans. Several epidemiological and ecological studies indicate that there is an association between cancer of the large intestine, rectum, and/or urinary bladder and the constituents of chlorinated water.

1,4-Dichlorobenzene 1,4-Dichlorobenzene is a chemical used to control moths, molds, and mildew, and to deodorize restrooms and waste containers. It is also called para-DCB or p-DCB. Other names include Paramoth, Para crystals, and Paracide reflecting its widespread use to kill moths. At room temperature, p-DCB is a white solid with a strong, pungent odor. When exposed to air, it slowly changes from a solid to a vapor. Most p-DCB in our environment comes from its use in moth repellent products and in toilet deodorizer blocks.

In air, it breaks down to harmless products in about a month. It does not dissolve easily in water. It is not easily broken down by soil organisms. It evaporates easily from water and soil, so most is found in the air. It is taken up and retained by plants and fish.

There is no evidence that moderate use of common household products that contain p-DCB will result in harmful effects to your health. Harmful effects, however, may occur from high exposures. Very high usage of p-DCB products in the home can result in dizziness, headaches, and liver problems. Some of the patients who developed these symptoms had been using the products for months or even years after they first began to feel ill.

Workers breathing high levels of p-DCB (1,000 times more than levels in deodorized rooms) have reported painful irritation of the nose and eyes. There are cases of people who have eaten p-DCB products regularly for months to years because of its sweet taste. These people had skin blotches and lower numbers of red blood cells.

The US Department of Health and Human Services (DHHS) has determined that p-DCB may reasonably be anticipated to be a carcinogen. There is no direct evidence that p-DCB can cause cancer in humans. However, animals given very high levels in water developed liver and kidney tumors.

There is very little information on how children react to p-DCB exposure, but children would probably show the same effects as adults. No studies in people or animals show that p-DCB crosses the placenta or can be found in fetal tissues. Based on other similar chemicals, it is possible that this could occur. There is no credible evidence that p-DCB causes birth defects. One study found dichlorobenzenes in breast milk, but p-DCB has not been specifically measured.

No studies were located regarding gastrointestinal, immunological, developmental, reproductive, renal, hepatic effects of 1,3-butadiene in humans after inhalation exposure.

1,2-Dichloroethane 1,2-Dichloroethane, also called ethylene dichloride, is a manufactured, colorless liquid with a pleasant smell and sweet taste. It is primarily used in the production of vinyl chloride which is used to make a variety of plastic and vinyl products.

Breathing high levels of 1,2-dichloroethane can cause nervous system disorders, liver and kidney diseases, and affect the lungs and immune system. Livers, kidneys and lungs were the target organs in chronic exposures studies in animals. Studies have not been conclusive that 1,2-dichloroethane causes cancer in humans. In animal studies, increases in stomach, mammary gland, liver, lung, and endometrium cancers have been seen following inhalation, oral and dermal exposures. Exposure to 1,2-dichloroethane has not been shown to affect fertility in people or animals. The US Environmental Protection Agency (EPA) has determined that 1,2-dichloroethane is a probably human carcinogen and the International Agency for Cancer Research (IARC) considers it to be a possible human carcinogen.

1,2-Dichloropropane 1,2-Dichloropropane is a colorless, flammable liquid with a chloroform-like odor. It is moderately soluble in water and readily evaporates into air. It does not occur naturally in the environment. 1,2-Dichloropropane production in the United States has declined over the past 20 years. It was used in the past as a soil fumigant, chemical intermediate, and industrial solvent and was found in paint strippers, varnishes, and furniture finish removers. Most of these uses were discontinued. Today, almost all of the 1,2-dichloropropane is used as a chemical intermediate to make perchloroethylene and several other related chlorinated chemicals.

Individuals who intentionally or accidentally breathe high levels of 1,2-dichloropropane have experienced difficulty breathing, coughing, vomiting, nosebleed, fatigue, and damage to blood cells, liver, and kidneys. Ingestion of cleaning solutions containing 1,2-dichloropropane caused headaches, dizziness, nausea, liver and kidney damage, anemia, coma, and death.

Breathing low levels of 1,2-dichloropropane over short- or long-term periods causes damage to the liver, kidney, and respiratory system in animals. Breathing high levels causes death. Similar effects have been reported when animals were given 1,2-dichloropropane by mouth. Some studies indicate that ingesting 1,2-dichloropropane may cause reproductive effects. One study reported a delay in bone formation of the skull in fetal rats.

It is not known whether 1,2-dichloropropane causes cancer in people. The carcinogenicity of 1,2-dichloropropane has been evaluated in animal studies with rats and mice. Liver tumors have been observed in mice, and mammary gland tumors have been found in rats. The International Agency for Research on Cancer (IARC) has determined that 1,2-dichloropropane is unclassifiable as to human carcinogenicity.

Laboratory animals that breathed in high levels of 1,3-butadiene for a short time died. Mice that survived exposure to 1,3-butadiene longer than 14 days had damage in the organs that make blood cells and damage to nose tissues. Pregnant mice that breathed in low amounts of 1,3-butadiene had miscarriages. Birth defects were found in offspring of rats and mice exposed to 1,3-butadiene during pregnancy. Rats that breathed in lower levels of 1,3-butadiene for more than 1 year had kidney disease and damaged lungs; some of them died. Mice that breathed in lower levels of 1,3-butadiene for more than 1 year had harmful effects in their reproductive organs and damaged livers. Rats and mice that breathed in small amounts of 1,3-butadiene for a long time period developed cancer in many organs.

The Department of Health and Human Services has determined that 1,3-butadiene may reasonably be anticipated to be a carcinogen. This is based on animal studies that found increases in a variety of tumor types from exposure to 1,3-butadiene. Studies on workers are inconclusive because the workers were exposed to other chemicals in addition to 1,3-butadiene.

Methylene Chloride Methylene chloride is a colorless liquid with a mild, sweet odor. It is used as an industrial solvent and as a paint stripper. It may also be found in some aerosol and pesticide products and is used in the manufacture of photographic film. The most likely way to be exposed to methylene chloride is by breathing contaminated air.

Breathing in large amounts of methylene chloride may cause dizziness, nausea, and tingling or numbness of fingers and toes. A person breathing smaller amounts of methylene chloride may become less attentive and less accurate in tasks requiring hand-eye coordination. We do not know if methylene chloride can affect the ability of people to have children or if it causes birth defects. Some birth defects have been seen in animals inhaling very high levels of methylene chloride.

We do not know if methylene chloride can cause cancer in humans. An increased cancer risk was seen in mice breathing large amounts of methylene chloride for a long time. The USDHHS has determined that methylene chloride can be reasonably anticipated to be a cancer-causing chemical, and the EPA has determined that methylene chloride is a probable cancer-causing agent in humans.

Methyl Tert-Butyl Ether (MTBE) MTBE is a flammable liquid made from blending chemicals such as isobutylene and methanol. It has been used as an additive to unleaded gasoline since the 1980s to promote more efficient combustion.

Breathing small amounts of MTBE can cause nose and throat irritation, nausea, headaches, dizziness and mental confusion. People may be exposed to MTBE at gasoline service stations and with the use of gas-powered equipment. There is no evidence that MTBE causes cancer in humans. In animals studies, long term inhalation of high levels of MTBE may cause kidney cancer in rats and liver cancer in mice. The US Environmental Protection Agency (EPA) has not classified MTBE as to its carcinogenicity.

Tetrachloroethylene (PCE) PCE is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal-degreasing. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell PCE when it is present in the air at a level of approximately 7,000 micrograms per cubic meter or more, although some can smell it at even lower levels. People are commonly exposed to PCE when they bring clothes from the dry cleaners.

High concentrations of PCE can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Irritation may result from repeated or extended skin contact with it. These symptoms occur almost entirely in work (or hobby) environments when people have been exposed to high concentrations. In industry, most workers are exposed to levels lower than those causing obvious nervous system effects, although more subtle neurological effects are possible at the lower levels. The health effects of breathing in air or drinking water with low levels of PCE are not known. Results from some studies suggest that women who work in dry cleaning industries where exposures to PCE can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that PCE can cause liver and kidney damage. Exposure to very high levels of PCE can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant.

The U.S. Department of Health and Human Services (USDHHS) has determined that PCE may reasonably be anticipated to be a carcinogen. PCE has been shown to cause liver tumors in mice and kidney tumors in male rats.

Trichloroethylene (TCE) TCE is a nonflammable, colorless liquid with a somewhat sweet odor and a sweet, burning taste. It is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers. TCE dissolves a little in water, and can remain in groundwater for a long time. It quickly evaporates from water, so it is commonly found as a vapor in the air. People can be exposed to TCE by breathing air in and around the home which has been contaminated with TCE vapors from shower water or household products, or by drinking, swimming, or showering in water that has been contaminated with TCE. Breathing small amounts of TCE may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing large amounts of TCE may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage. Drinking large amounts of TCE may cause nausea, liver damage, unconsciousness, impaired heart function, or death. Drinking small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear. Skin contact with TCE for short periods may cause skin rashes.

Some studies with mice and rats have suggested that high levels of TCE may cause liver, kidney, or lung cancer. Some studies of people exposed over long periods to high levels of TCE in drinking water or in workplace air have found evidence of increased cancer. The National Toxicology Program has determined that TCE is “reasonably anticipated to be a human carcinogen,” and the International Agency for Research on Cancer (IARC) has determined that trichloroethylene is “probably carcinogenic to humans.”

Vinyl Chloride Vinyl chloride is a colorless gas. It burns easily and it is not stable at high temperatures. It has a mild, sweet odor. It is a manufactured substance that does not occur naturally. It is a biodegradation intermediate of trichloroethane, trichloroethylene, and tetrachloroethylene. Vinyl chloride is used to make polyvinyl chloride (PVC). PVC is used to make a variety of plastic products, including pipes, wire and cable coatings, and packaging materials.

Breathing high levels of vinyl chloride can cause dizziness. Breathing very high levels can cause you to pass out, and breathing extremely high levels can cause death.

Some people who have breathed vinyl chloride for several years have changes in the structure of their livers. People are more likely to develop these changes if they breathe high levels of vinyl chloride. Some people who work with vinyl chloride have nerve damage and develop immune reactions. The lowest levels that produce liver changes, nerve damage, and immune reaction in people are not known. Some workers exposed to very high levels of vinyl chloride have problems with the blood flow in their hands. Their fingers turn white and hurt when they go into the cold.

It has not been proven that vinyl chloride causes birth defects in humans, but studies in animals suggest that vinyl chloride might affect growth and development. Animal studies also suggest that infants and young children might be more susceptible than adults to vinyl chloride-induced cancer. Animal studies have shown that long-term exposure to vinyl chloride can damage the sperm and testes.

The DHHS has determined that vinyl chloride is a known carcinogen. Studies in workers who have breathed vinyl chloride over many years showed an increased risk of liver cancer; brain cancer, lung cancer, and some cancer of the blood have also been observed in workers.