

Health Consultation

Public Health Implications and Interpretation of
Exposure to Benzene in Residential Indoor Air

(FORMER) WHITE SWAN LAUNDRY AND CLEANER, INCORPORATED
(a/k/a MAGNOLIA AVENUE GROUNDWATER CONTAMINATION SITE)

WALL TOWNSHIP, MONMOUTH COUNTY, NEW JERSEY

EPA FACILITY ID: NJSFN0204241

SEPTEMBER 25, 2002

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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

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Prepared by:

**Superfund Site Assessment Branch
Division of Health Assessment and Consultation
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry**

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
EMEG	Environmental Media Evaluation Guide
EPA	United States Environmental Protection Agency
HCV	Health-based Comparison Value
IRIS	Integrated Risk Information System
LECR	Lifetime Excess Cancer Risk
MCHD	Monmouth County Health Department
ND	Not Detected
NJDEP	New Jersey Department of Environmental Protection
NJDHSS	New Jersey Department of Health and Senior Services
PCE	Perchloroethylene (tetrachloroethylene)
RfC	Reference Concentration
RMEG	Reference Dose Media Evaluation Guide
TCE	Trichloroethylene
VOC	Volatile Organic Chemical

Summary

This Health Consultation has been prepared in response to a request that was submitted to the Agency for Toxic Substances and Disease Registry (ATSDR) by U.S. Environmental Protection Agency (EPA) Region II in April 2002, to assist in evaluating the public health implications of exposure to benzene that was detected in indoor air sampling of about 220 residences in Wall Township, Monmouth County, New Jersey. Concern has been raised by local residents and school officials about possible exposure by inhalation to chemicals that have been found in the ground water in the vicinity of the (former) White Swan Laundry and Cleaner, Inc. (also known as the Magnolia Avenue Ground Water Contamination) site, located in Wall Township, Monmouth County, New Jersey.

It is known that a shallow ground water plume containing trichloroethylene (TCE) and tetrachloroethylene (perchloroethylene) (PCE) extends in an easterly direction from sources located in Wall Township. Concern has been raised regarding the potential for exposure to these contaminants and benzene via inhalation of vapors that may have been transported from the ground water into residences and other structures, and that may subsequently have volatilized in the indoor air.

ATSDR has provided the following public health interpretation of the levels of benzene that have been found in the indoor air as a result of sampling about 220 residences of Wall Township as part of the on-going investigation of the (former) White Swan Laundry and Cleaner, Inc. site:

- All exposures to benzene above 32 micrograms per meter cubed ($\mu\text{g}/\text{m}^3$) represent a lifetime risk of cancer that is greater than that due to background levels;
- All exposures to benzene between 6 and 32 $\mu\text{g}/\text{m}^3$ represent a slightly increased lifetime cancer risk that is greater than that due to background levels; and
- All exposures to benzene below 6 $\mu\text{g}/\text{m}^3$ represent little or no additional lifetime cancer risk that is greater than that due to background levels.

ATSDR considers exposure to benzene at 32 $\mu\text{g}/\text{m}^3$ and above to be a “**Public Health Hazard**”. Actions taken by EPA to mitigate these exposures are protective of public health. Although exposures between 6 and 32 $\mu\text{g}/\text{m}^3$ represent a slightly increased risk of cancer above the background risk, ATSDR believes that the actions taken by the New Jersey Department of Environmental Protection (NJDEP), to reduce exposures in this range to below typical background levels, to be protective of public health. Taking into consideration indoor background levels in U.S. homes and the very low risk of an adverse cancer effect, ATSDR considers all exposures to benzene below 6 $\mu\text{g}/\text{m}^3$ to represent a “**No Apparent Public Health Hazard**”.

Most of the levels of benzene found in the homes in Wall Township are below ATSDR Minimal Risk Level (MRL) for exposures of intermediate duration (15-365 days). The maximum concentration of benzene that has been measured is about 30 times below the “less serious neurological effect” level that was determined in one animal study. None of the benzene levels were above ATSDR’s acute MRL. Therefore, at the maximum benzene level that was detected, acute or intermediate duration exposures are not likely to result in any serious adverse non-cancer health effects.

Soil gas and ground water investigations should continue, in order to determine the extent and contribution of site-related contaminants being transported from ground water into the indoor air of homes and businesses. If these or other investigations provide additional information on local background levels of PCE in residential indoor air, the conclusions of this Health Consultation may be re-evaluated.

The above conclusions are based on a residential exposure scenario and do not apply to the evaluation of the public health implications of indoor air exposures under non-residential situations (e.g., schools and commercial buildings).

Background and Statement of Issues

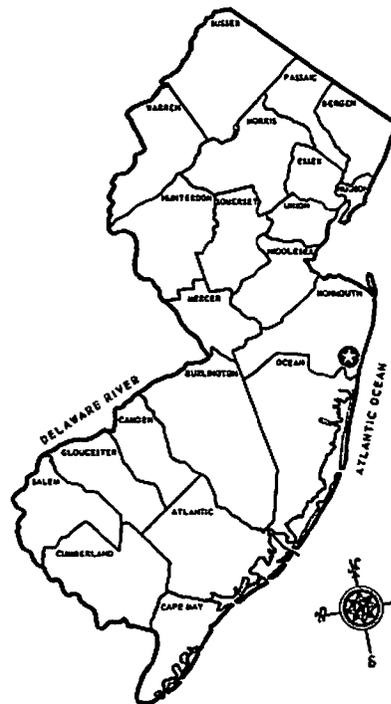
The U.S. Environmental Protection Agency (EPA) Region II requested that the Agency for Toxic Substances and Disease Registry (ATSDR) assist in evaluating the public health implications of benzene concentrations that were detected in indoor air sampling of about 220 residences in Wall Township, Monmouth County, New Jersey. The sampling was conducted in conjunction with the on-going investigation of releases of hazardous substances from the White Swan Laundry and Cleaner, Inc. site and from other sources of ground water contaminants.

In 1997, the Monmouth County Health Department (MCHD) became aware of tetrachloroethylene (PCE) contamination of irrigation wells in the vicinity of Magnolia Avenue in Wall Township, New Jersey. Between 1999 and 2000, the MCHD and the New Jersey Department of Environmental Protection (NJDEP) performed a joint study of shallow ground water that mapped a plume of PCE and trichloroethylene (TCE) contamination about 2.5 miles long and one mile wide. The contamination plume extends from Wall Township into the Boroughs of Manasquan and Sea Girt and continues to the coastline (NJDEP, 2001).

In October 1999, at the request of the MCHD and EPA, ATSDR was asked to review the information regarding the ground water contamination and to advise the community about the usage of the irrigation wells. ATSDR determined that the amount of PCE in the ground water posed no health concerns or hazards when used for non-potable purposes (ATSDR, 1999).

During the period from 1998 to 2000, the NJDEP conducted site investigations at the three facilities identified as potential sources. Soil and ground water sampling confirmed that a release of volatile organic compounds (VOCs) had occurred at each of the sites. The (former) White Swan Laundry and Cleaner (aka Fleet Bank or Summit Bank) property, Gulf Service Station, and Sun Cleaners have been identified as contributing sources to the Magnolia Avenue ground water contamination (NJDEP, 2001).

On February 23, 2001, the owners of the (former) White Swan Laundry and Cleaner property entered into a memorandum of agreement with the NJDEP to conduct a site investigation and remedial investigation of the property. During the remedial investigation, the NJDEP concluded that



a ground water plume of contamination might be adversely affecting the indoor air quality of nearby residential properties (NJDEP, 2001).

Sampling by Fleet Bank at its branch office on Sea Girt Avenue found high levels of PCE contamination in shallow ground water. Based on these results, on October 25, 2001, the NJDEP conducted indoor air quality testing of three residences and one commercial property located near to the Fleet Bank property. The NJDEP provided the residents and the owners of the commercial property with fans for ventilating the basements of each of these buildings where PCE was detected.

At the request of the NJDEP, the EPA announced plans on December 5, 2001, to take over the investigation of the contaminated ground water plume that underlies portions of Wall Township and the Boroughs of Sea Girt and Manasquan. The EPA also announced that they agreed to evaluate the site for listing on the National Priorities List (NPL), *i.e.*, Superfund. Since that time, EPA has collected about 300 indoor air samples from at least 220 residential and business locations. The sampling has also included several schools within the area, including Sea Girt Elementary School, Old Mill School, and Brookside School (EPA, 2002).

In accordance with their mandate to protect public health under the National Contingency Plan (NCP), EPA has installed ventilation systems at all homes with benzene and PCE levels that would be considered a health risk, and the NJDEP is working with the homeowners whose homes had slightly elevated levels and are interested in undertaking remedial measures. [Note: A companion Health Consultation to this document specifically addresses residential exposure to PCE (ATSDR, 2002).] In April 2002, the EPA sent the results of indoor air sampling of the 220 residences to individual homeowners. Included with this letter, ATSDR provided a fact sheet containing a public health interpretation of the benzene air exposures, a contaminant of concern for the site (see Appendix A). Although it has not been definitively determined that benzene is a site-related contaminant, it has been detected in many samples of air from homes in the area, thus suggesting that benzene might be related to one of the potential sources of ground water contamination that are being investigated.

Discussion

Health Assessment Methodology

In the course of creating Public Health Assessments and Health Consultations, ATSDR evaluates the environmental and human components that lead to human exposure from releases of hazardous substances from a given site. A pathways analysis consists of five elements: (1) a source of contamination; (2) transport through an environmental medium; (3) a point of human exposure; (4) a route of human exposure; and, (5) a receptor population. ATSDR classifies exposure pathways into three groups: (1) "completed pathways", that is, those in which exposure is reasonably expected

to have occurred, to occur, or to occur in the future; (2) “potential pathways”, that is, those in which exposure might have occurred, may be occurring, or may yet occur, and, (3) “eliminated pathways”, that is, those that can be eliminated from further analysis because at least one of the five elements listed above is missing and will never be present, or in which no contamination of concern can be identified.

After the pathways are designated as “completed”, “potential”, or “eliminated”, ATSDR follows a two-step methodology to comment on public health issues related to exposure pathways at hazardous waste sites. First, ATSDR obtains representative environmental monitoring data for the site of concern and compiles a list of site-related contaminants. ATSDR compares this list of contaminants to health-based values (health comparison values or HCVs) to identify those contaminants that do not have a realistic possibility of causing adverse health effects. Second, for the remaining contaminants, ATSDR evaluates site-specific conditions to determine what exposure scenario is realistic for a given exposure pathway. Given this exposure scenario, ATSDR determines a dose and compares this dose to scientific studies to determine whether the extent of exposure indicates a public health hazard.

The health-based comparison values used in this report are concentrations of contaminants that the current public health literature suggests are “safe” or “harmless”. These comparison values are quite conservative because they include ample safety factors that account for the most sensitive populations. ATSDR typically uses HCVs as follows: if a contaminant is never found at levels greater than its comparison value, ATSDR concludes the levels of corresponding contamination are “safe” or “harmless”. If, however, a contaminant is found at greater than its HCV, ATSDR designates the pollutant as a contaminant of concern and examines it further in the assessment. Because HCVs are based on extremely conservative assumptions, the presence of concentrations greater than an HCV does not necessarily suggest that adverse health effects will occur among the exposed population.

Exposure Pathways and Contaminant of Concerns

The exposure pathway of concern that is evaluated in this Health Consultation is inhalation of benzene that is in the indoor air of private residences near the (former) White Swan Laundry and Dry Cleaner site. It has been assumed that benzene from at least one of the potential sources has contaminated the ground water, has been transported to soils beneath the homes, and finally has infiltrated these homes through cracks in the foundation or directly from soils into homes.

Studies by the EPA have shown that most homes in the U.S. have measurable levels of organic chemicals in indoor air. While outdoor air contains many organic chemicals, a surprising finding from EPA studies is that the concentrations of organic chemicals in indoor air are usually higher than in outdoor air. These higher indoor air levels of VOCs presumably come from consumer products that are brought into the homes, from off-gassing of home building materials, and from personal activities. EPA studies showed that certain human activities were associated with having

increased levels of chemicals in indoor air. Examples of these activities are listed below (EPA, 1987):

- smoking indoors increases benzene, xylene, ethyl benzene, and styrene levels in indoor air;
- bringing dry cleaning home causes higher PCE levels in indoor air;
- using hot water in the home increases chloroform levels in indoor air; and
- using room air fresheners, toilet bowl deodorizers, and moth crystals leads to higher levels of para-dichlorobenzene in indoor air.

Additional studies by EPA are underway to determine the contribution of site-related contaminants found in the ground water (including benzene) to the levels of chemicals detected in residential air samples. Therefore, at this time benzene exposures can only be considered a potential exposure pathway related to the site.

The levels of benzene detected in the more than 300 samples of indoor air from 220 residences range from not detected (ND) to 38.4 $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter). In a majority of the homes, benzene was detected in the air at levels above the health comparison value of 0.22 $\mu\text{g}/\text{m}^3$ (based on EPA Region III's Risk-Based Concentration, *i.e.*, RBC). The EPA Region III RBC is based on cancer effects. The ATSDR Cancer Risk Evaluation Guideline for benzene is 0.1 $\mu\text{g}/\text{m}^3$. For non-cancer effects, ATSDR's Minimal Risk Levels, *i.e.*, MRL (see definition below) for intermediate exposures (15-364 days), and for acute exposures (1-14 days), are 13 $\mu\text{g}/\text{m}^3$ and 162 $\mu\text{g}/\text{m}^3$, respectively. Many of the air samples were in the range of what may be considered typical background levels in U.S. homes. Benzene is a component of gasoline emissions, cigarette smoke, paints and adhesives, particle board, wood composites, and wood smoke. The estimated average of the medians (50% values) for typical background levels found in several studies was reported to be approximately 6 $\mu\text{g}/\text{m}^3$, with generally higher levels being found in homes with smokers (Wallace, L., 1996). However, it is important to note that any given level of benzene in a household air sample that falls within this typical background level for indoor air in the U.S. does not necessarily indicate that the benzene is entirely due to a non-site-related source. In addition, there may be differences in the studies of homes in others areas (as reported by Wallace, 1996) versus Wall Township (e.g., basements, age, and construction) and differences in other factors that may effect local indoor background benzene levels. Because benzene is considered a potential site-related contaminant of concern, all exposures above background levels may be related to the site; therefore, ATSDR considers exposures to concentrations of benzene above 6 $\mu\text{g}/\text{m}^3$ to result in a completed (or at least a potential) exposure pathway.

Since the available data represent a snapshot in time, it is not possible for ATSDR to determine the duration and concentration of a resident's exposure. However, given that the exposure is likely to persist without any intervention, it has been assumed, conservatively, that the exposure may continue over a duration of 30 years.

Public Health Implications

Benzene: Chronic Exposure and Non-Cancer Health Effects

To evaluate non-carcinogenic health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants that are commonly found at hazardous waste sites. A MRL is an estimate of a level of daily human exposure to a contaminant below which non-cancerous adverse health effects are unlikely. MRLs are developed for each route of exposure, *e.g.*, ingestion and inhalation, and for the length of exposure, *i.e.*, acute, less than 14 days; intermediate, 15–364 days; and chronic, 365 days or more. Because ATSDR has no methodology to determine amounts of chemicals absorbed through the skin, there are no MRLs for skin exposure. ATSDR presents information on MRLs in its series of Toxicological Profiles on hazardous substances. These chemical-specific profiles provide information on health effects, environmental transport, human exposure, and regulatory status. If a MRL has not been developed for a contaminant, the EPA Reference Dose (RfD) is used (if available). The RfD is an estimate of the daily exposure of the human population to a potential hazard that is likely to be without risk of a non-carcinogenic adverse health effects during a person's lifetime.

Most of the levels of benzene found in the homes in Wall Township are below ATSDR's intermediate MRL of 13 $\mu\text{g}/\text{m}^3$ for less serious neurological effects that were found in a study of mice (Li et al., 1992). The ATSDR MRL includes an uncertainty or margin-of-safety factor of 90. The maximum level of benzene that has been detected is about 30 times below the "less serious neurological effect" seen by Li et al. None of the benzene levels were above ATSDR's acute MRL. Therefore, at the maximum benzene level that was detected, acute or intermediate duration exposures are not likely to result in any serious adverse health effects. For chronic exposures, the effect of concern is cancer, which is discussed below.

Benzene: chronic exposure and cancer

Exposure to benzene can cause adverse effects on the blood. Persons who breathe high levels of benzene for long periods of time are likely to have reduced red blood cell production, *i.e.*, anemia. Studies of workers have consistently linked benzene exposures with a particular type of leukemia. Studies have also shown that benzene causes cancer in animals (ATSDR, 1997). The primary end point of concern for exposure to benzene in air is leukemia, specifically, acute myelogenous leukemia (AML), the only form of cancer that is consistently associated with high levels of occupational exposures to benzene.

One way to evaluate the possibility of benzene causing cancer in Wall Township residents is to compare the estimated benzene levels in air to the levels in human studies that have caused cancer. While this approach cannot provide a definitive answer that benzene exposure might cause cancer in Wall Township residents, it gives some insight into the likelihood of benzene exposures causing cancer.

Complicating this comparison, however, is the lack of information regarding the time frame and concentrations of exposure over time in any given household. The actual exposures to most residents are likely to be much less than those shown to cause cancer in human and animal studies. In fact, there is little scientific evidence of serious adverse health effects in animals or humans exposed to long-term levels of benzene at concentrations less than 32,000 $\mu\text{g}/\text{m}^3$.

The two exposure levels (Wall Township residents and the human studies) can be compared by using a margin of safety (MOS) approach. A MOS can be calculated by dividing the exposure level in human studies that caused cancer by the estimated exposure concentrations in Wall Township residents. As can be seen in Appendix A, based on various exposure ranges in relation to typical background levels, the MOS ranged from less than 1,000 to greater than 5,333. The MOS for exposures to concentrations of 32 $\mu\text{g}/\text{m}^3$ and above represent a lifetime cancer risk that is greater than the risk due to background benzene levels. Exposure levels between 6 - 32 $\mu\text{g}/\text{m}^3$ represent a slightly increased lifetime excess cancer risk above the cancer risk due to background benzene levels. Exposure to benzene at concentrations below 6 $\mu\text{g}/\text{m}^3$ would result in little or no increased risk of developing cancer, and is at least 5,333 times less than the level that scientific studies have shown cause serious adverse health effects in humans and animals (see Appendix A).

Conclusions

ATSDR has provided the following public health interpretation of the levels of benzene that have been found in the air in about 220 residences of Wall Township that were sampled as part of the on-going investigation of the (former) White Swan Laundry and Cleaner, Inc. site:

- All exposures to benzene above 32 $\mu\text{g}/\text{m}^3$ represent a lifetime risk of cancer that is greater than that due to background levels;
- All exposures to benzene between 6 and 32 $\mu\text{g}/\text{m}^3$ represent a slightly increased lifetime cancer risk that is greater than that due to background levels; and
- All exposures to benzene below 6 $\mu\text{g}/\text{m}^3$ represent little to no additional lifetime cancer risk beyond that due to background levels.

ATSDR considers exposure to benzene at 32 $\mu\text{g}/\text{m}^3$ and above to be a **“Public Health Hazard”** because of the existence of a completed pathway and an unacceptable risk of cancer beyond background benzene levels [See Appendix B for a description of ATSDR’s Public Health Hazard categories.] Although exposures between 6 and 32 $\mu\text{g}/\text{m}^3$ represent only a slightly increased risk of cancer above the background risk, ATSDR considers the measures taken by the NJDEP to reduce or eliminate exposures in this range to be protective of public health. Taking into consideration typical indoor background levels in U.S. homes and the very low risk of an adverse cancer effect, ATSDR considers all exposures to benzene below 6 $\mu\text{g}/\text{m}^3$ to represent a **“No Apparent Public Health Hazard”**.

The above conclusions are based on a residential exposure scenario and do not apply to the evaluation of the public health implications of indoor air exposures under non-residential situations (e.g., schools and commercial buildings).

Recommendations

On-going soil gas and ground water investigations should continue, in order to determine the extent and contribution of site-related contaminants being transported from ground water into the indoor air of homes and businesses. If these or other investigations provide additional information on local background levels of PCE in residential indoor air, the conclusions of this Health Consultation may be re-evaluated.

Public Health Action Plan (PHAP)

The Public Health Action Plan (PHAP) for the (former) White Swan Laundry and Cleaner, Inc. site contains descriptions of the actions to be taken by ATSDR and other agencies at or in the vicinity of the site. The purpose of a PHAP is to ensure that this Health Consultation not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The environmental sampling data and remedial activities that have been conducted have been evaluated within the context of human exposure pathways and other relevant public health factors. Included is a commitment on the part of ATSDR to monitor this plan to ensure that the plan is implemented. ATSDR will provide follow-up to this PHAP, outlining the actions which have been completed, and actions that are in progress, as needed. The public health actions to be implemented by ATSDR are as follow:

Actions Undertaken

(1) EPA and the NJDEP have sampled the indoor air of numerous residences and other structures, including several schools in the vicinity of the site property. In addition, the EPA and NJDEP, collectively, have taken action to reduce benzene exposure to below the level of public health concern.

(2) ATSDR and NJDHSS have participated in a public availability session with local residents to provide them with a public health interpretation of their individual air sampling results. In addition, ATSDR and NJDHSS have participated in a public meeting to inform the general public of the public health issues of air exposures.

(3) ATSDR has prepared a fact sheet for benzene to accompany individual sampling results sent to the residents by the EPA.

Actions Planned

- (1) ATSDR will provide a copy of this document to all concerned residents in the vicinity of the site.**

- (2) As additional soil gas and ground water data become available, ATSDR and the NJDHSS will evaluate the public health implications of indoor air exposures to other chemicals found to be related to the site.**

- (3) ATSDR will coordinate as deemed necessary with the appropriate environmental agencies to develop plans to implement the recommendations contained in this document.**

Preparers of Report

Preparers of Report:

Gregory Ulirsch
Technical Project Officer
Superfund Site Assessment Branch (SSAB)
Division of Health Assessment and Consultation (DHAC)
Agency for Toxic Substances and Disease Registry

ATSDR Regional Representative:

Arthur Block
Regional Representative, Region II
Regional Operations
Office of the Assistant Administrator

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Appendix A

**Fact Sheet
Benzene Residential Air Exposures
Public Health Interpretations**

**Agency for Toxic Substances and Disease Registry (ATSDR)
Fact Sheet**

***Residential Exposure to Benzene in Air
Public Health Implications and Interpretation***

General Public Health Issues:

- Benzene is found in gasoline emissions, cigarette smoke, paints and adhesives, particle board, wood composites and wood smoke.
- Indoor air studies have shown that background levels in U.S. homes have an average of approximately 6 $\mu\text{g}/\text{m}^3$, with generally higher levels in homes with smokers. This value is not a site-specific background level, but is presented to provide perspective.
- Benzene causes adverse effects to the blood. Persons who breathe high levels of benzene for long periods of time may have reduced red blood cell production leading to anemia.
- Studies of workers have consistently linked benzene exposures with a particular type of leukemia.
- Benzene is known to cause cancer in animals.
- The scientific community has determined that benzene is linked to cancer in humans, particularly leukemia (acute myeloid leukemia or AML), although there is some debate as to whether benzene causes cancer at low concentrations.

Perspective on Site-Specific Exposure:

- To be protective of public health, the interpretation of benzene air exposures in the attached table is based on conservative assumptions.
- The actual length of exposure to residents is not known. Because air sampling results are only available over a short time frame, and the actual exposure levels over time are also not known, the public health interpretation that is presented below may over- or underestimate the chance of getting cancer.
- The risk of someone getting cancer is dependent on many factors; for example, lifestyle, nutritional status, genetics, and other exposures at home and in the workplace.
- The actual exposures to most residents are likely to be much less than those shown to cause cancer in human and animal studies. In fact, there is little scientific evidence of serious adverse health effects in animals or humans exposed to long-term levels of benzene at concentrations less than 32,000 $\mu\text{g}/\text{m}^3$.
- Since benzene is a known human carcinogen, prudent public health practice dictates that, no matter the source, exposure should be minimized.

**Agency for Toxic Substances and Disease Registry (ATSDR)
Public Health Interpretation of Exposure to Benzene in Residential Air**

Concentration of Benzene in Air ($\mu\text{g}/\text{m}^3$)	Public Health Interpretation	Estimated Margin of Safety (MOS)*	Estimated Background Level in U.S. Homes ($\mu\text{g}/\text{m}^3$**)
Less Than 6	Little to no additional lifetime cancer risk beyond the cancer risk due to background benzene levels	Greater Than 5,333	6
6 - 32	Slight additional lifetime cancer risk beyond the cancer risk due to benzene background levels	1,000-5,333	
32 and Above	Increased lifetime cancer risk beyond the cancer risk due to benzene background levels	Equal To or Less Than 1,000	

* Estimated margin of safety (MOS) is based on 32,000 $\mu\text{g}/\text{m}^3$ benzene in air. For example, if benzene were detected at 32 $\mu\text{g}/\text{m}^3$ in a resident's indoor air sample, the margin of safety would represent how much below (in this case 1,000 times) the actual exposure is, when compared to levels, above which scientific studies have shown serious adverse effects in humans and animals.

** Reported value represents the average of the medians for background levels found in several studies, as reported by Wallace, L., Environmental Health Perspectives, Vol. 104, S6, December 1996. This level does not represent specific background levels for the Wall Township, New Jersey area, but are presented to provide perspective. Any level of benzene in a household sample result that falls within this range of background levels for indoor air in the U.S. does not necessarily indicate that the benzene is entirely due to non-site-related sources.

Appendix B: ATSDR Public Health Hazard Categories

ATSDR's Interim Public Health Hazard Categories

Category / Definition	Data Sufficiency	Criteria
<p>A. Urgent Public Health Hazard</p> <p>This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.</p>	<p>This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.</p>
<p>B. Public Health Hazard</p> <p>This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.</p>	<p>This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.</p>
<p>C. Indeterminate Public Health Hazard</p> <p>This category is used for sites in which "critical" data are <i>insufficient</i> with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.</p>	<p>This determination represents a professional judgement that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.</p>	<p>The health assessor must determine, using professional judgement, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.</p>

Category / Definition	Data Sufficiency	Criteria
<p>D. No Apparent Public Health Hazard</p> <p>This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.</p>	<p>This determination represents a professional judgement based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.</p>	<p>Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.</p>
<p>E: No Public Health Hazard</p> <p>This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.</p>	<p>Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future</p>	

**Such as environmental and demographic data; health outcome data; exposure data; community health concerns information; toxicologic, medical, and epidemiologic data; monitoring and management plans.*