Health Consultation

NORTH BRUNSWICK TOWNSHIP HIGH SCHOOL SITE
NORTH BRUNSWICK, MIDDLESEX COUNTY, NEW JERSEY

EPA FACILITY ID: NJD103805370

Prepared by the
New Jersey Department of Health and Senior Services

SEPTEMBER 29, 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.

HEALTH CONSULTATION

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Summary

Introduction	The New Jersey Department of Health and Senior Services (NJDHSS) and the Agency for Toxic Substances and Disease Registry (ATSDR) have reviewed recent data to provide interpretation and a public health evaluation of site-related contamination detected at the North Brunswick Township High School (NBTHS) site located on Raider Road in North Brunswick, Middlesex County. Through a Cooperative Agreement with the ATSDR, the NJDHSS prepared this health consultation to provide further evaluation to the public health assessment completed for the NBTHS site in January 2009. ATSDR and NJDHSS's top priority is to ensure that the community around the site has the best information possible to safeguard its health.
Conclusion	*NJDHSS and ATSDR have reached two conclusions regarding potential health implications to exposures present for the NBTHS site.*
Conclusion 1	*NJDHSS and ATSDR conclude that past, present and future exposures through incidental ingestion of arsenic contaminated soil present at the NBTHS property and evaluated within this health consultation are not expected to harm people's health.*
Basis for Conclusion	There are completed past exposures to children and adults to arsenic contaminated surface soil (0-0.5 feet) present in soil piles located in the northwest and northeast wooded areas of the NBTHS property. Current and future exposures have been eliminated at the northwest soil pile based on its removal in July 2009. Future exposures at the northeast soil piles will be eliminated pending successful completion of remedial actions planned for this area in 2010. Adverse non-cancer health effects are not expected to occur to children and adults as the comparison of average arsenic concentrations present at soil piles in the northwest and northeast wooded areas were below health-based comparison values. The lifetime excess cancer risk from exposures to average arsenic concentrations in soil for these areas is considered a very low increase in risk when compared to the background risk of cancer. There are completed past, present and future exposures to NBTHS students and adult faculty to arsenic in surface soil for the athletic practice field located on the NBTHS property. Arsenic

concentrations in surface soil for this area were below the New Jersey Department of Environmental Protection (NJDEP) soil cleanup criteria and does not require any future remediation.

Adverse non-cancer health effects are not expected to occur to students and adults as the arsenic concentrations present at soil at the athletic practice field were below health-based comparison values. There is no expected increase in the lifetime excess cancer risk from exposures to arsenic in surface soil for this area when compared to the background risk of cancer.

Next Steps	The NJDEP should continue oversight of soil remedial activities at the NBTHS site to ensure site-related contaminants are reduced to below NJDEP's regulatory cleanup criteria through either soil removal and/or installation of engineering controls. Soil removal actions should include provisions to prevent migration of dust during removal and/or soil stockpiling activities to uncontaminated areas.
Conclusion 2	*NJDHSS and ATSDR conclude that past, present and future exposures through inhalation of identified contaminants of concern present in indoor air at the NBTHS and within sampled nearby residences is not expected to harm people's health.*
Basis for Conclusion	There are completed past exposures to students and adult faculty at the NBTHS to identified contaminants of concern, primarily trichloroethylene (TCE), in indoor air. There are completed past exposures to children and adults to identified contaminants of concern, primarily TCE, in indoor air for eight of the ten sampled residences. These exposures are not expected to cause adverse non-cancer health effects as contaminant concentrations remain below health-based comparison values. The lifetime excess cancer risk from exposures to contaminants of concern in indoor air represent no expected increase to a very low increase in risk when compared to the background risk of cancer. Current and future exposures are considered interrupted as the NJDEP is monitoring indoor air at the NBTHS and the ten residences to assure chronic exposures to TCE in indoor air at concentrations exceeding NJDEP's Indoor Air Screening Level are not expected to occur to residents.
Next Steps	NJDEP should continue oversight of remedial activities regarding site-related contamination in groundwater to reduce concentrations to below the NJDEP's ground water vapor intrusion screening levels, or a NJDEP approved alternative, to minimize or eliminate the threat of vapor intrusion to the NBTHS and the surrounding community.

NJDEP should consider the option to collect sump water samples during indoor air sampling to more accurately assess whether TCE and other contaminants detected in indoor air are originating from a site-related vapor intrusion source or have contributions from background sources.

The NJDHSS and the ATSDR will review and evaluate future remedial actions and control measures to address remaining soil and groundwater contamination related to the NBTHS site, including groundwater contamination/vapor intrusion for the NBTHS and nearby residential area.

For More Information

This health consultation will be provided to board of education and township officials, NJDEP, and the Middlesex County Public Health Department. NJDHSS will notify area residents that this report is available for their review and provide a copy upon request.

The ATSDR and NJDHSS have concurrently released a health consultation titled *Analysis of Cancer Incidence in North Brunswick, North Brunswick Township High School Site* which addresses communities concerns on cancer for North Brunswick Township and for the population living within the census tract of the NBTHS site.

Questions about this Health Consultation should be directed to the NJDHSS at (609) 584-5367.

Statement of Issues

In June 2004, township officials and the New Jersey Department of Environmental Protection (NJDEP) requested assistance from the New Jersey Department of Health and Senior Services (NJDHSS) in the interpretation and public health evaluation of site-related contamination detected during ongoing investigations being conducted for the North Brunswick Township High School site, Raider Road, North Brunswick, Middlesex County. Through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), the NJDHSS reviewed environmental data and prepared this health consultation to determine the public health implications associated with contamination found at the high school and for the nearby residential area.

This health consultation provides recent environmental data and planned remedial actions for the site as an update to the January 8, 2009 Public Health Assessment (PHA).

Background and Site History

The North Brunswick Township High School (NBTHS) is a public school located on Raider Road in North Brunswick Township, Middlesex County, New Jersey (see Figure 1). The high school is bordered by residential areas to the north and south; undeveloped woodland to the east; and Veteran's Park (approximately 16.9 acres) to the west (see Figure 2). Site background and history detailing past remedial investigations and actions has been provided in the January 8, 2009 Public Health Assessment (PHA) prepared for this site.

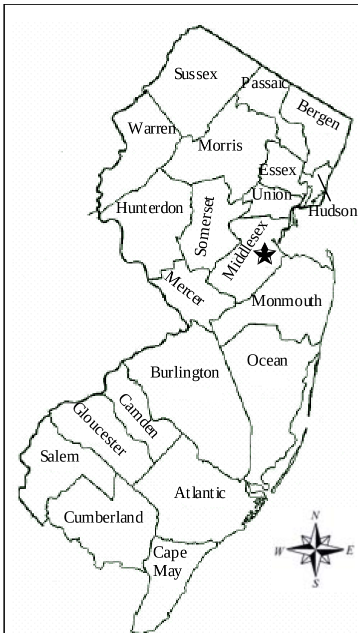

Figure 1: Location of North Brunswick High School

NBTHS Property

Athletic Practice Field

On March 4, 2008, soil samples were collected from the NBTHS athletic practice fields located on the northwest portion of the school property (see Figure 3). The purpose of this investigation was to determine if soil in this area was impacted by site contaminants. This investigation was prompted through public comment by an area resident expressing concern that this area be investigated as it is frequently used by the high school student population as a practice area for sports-related activities.

Northwest Wooded Area

On March 4, 2008, a pile of waste material/soil fill material was discovered by personnel from the North Brunswick Township Board of Education (BOE) and Kleinfelder, environmental consultant to the BOE (see Figure 4). The size of the soil pile is approximately 100 cubic yards and was located in close proximity to the 10 cubic yard waste soil pile identified and removed during July/August 2004 remedial activities (G. Hunsberger, Kleinfelder, personal communication, October 2008). The origin of the newly discovered pile and when it was deposited is not clearly known; however, this material is likely to be associated with the 10 cubic yard pile placed in this area by the high school grounds crew in the early 1980s (see January 8, 2009 PHA).

Soil samples were collected at several intervals between March through June 2008 from the soil pile and surrounding impacted area at depth from 0 to 1 foot. Analysis indicates arsenic was detected at concentrations exceeding the New Jersey Department of Environmental Protection (NJDEP) residential direct contact soil cleanup criteria (RDCSCC) of 19 mg/Kg (NJDEP 2008). Based on delineation soil samples the total area of impact exceeding the RDCSCC is approximately 1,800 square feet. The above area was temporarily fenced-in to prevent unauthorized access until remedial actions were completed on July 1, 2009 (G. Hunsberger, Kleinfelder, personal communication, July 2009).

<u>Northeast Wooded Area</u>

Based on the discovery of the waste soil pile in the northwest wooded area, visual investigations conducted in April 2008 by BOE and Kleinfelder personnel identified eight additional piles of soil/waste material (see Figure 5). These soil piles are located in the wooded area along the northeast property boundary of the high school property. Analysis of soil samples collected in August and October 2008 indicated four of the eight soil piles had arsenic concentrations exceeding the NJDEP RDCSCC of 19 mg/Kg. The total volume of contaminated material from these four piles is estimated to be approximately 115 cubic yards. These waste soil piles may also be associated with activities related to the previously deposited waste soil material in the early 1980s.

This area is tentatively scheduled for a soil removal action during remedial activities scheduled for the nearby Veteran's Park in 2010 (G. Hunsberger, Kleinfelder, personal communication, July 2009).

Groundwater-Related Issues

<u>Groundwater Investigation</u>

Quarterly groundwater monitoring has been conducted from July 2004 through September 2008 from a total of 22 groundwater wells located on the NBTHS property, the PSE&G easement, Veteran's Park, and the nearby residential area. Groundwater is sampled on a quarterly basis to monitor contaminant concentrations and contaminant plume movement. The predominant contaminant in groundwater is trichloroethylene (TCE) which, based on the most recent sampling data, ranges in concentrations from non-detect to 4,870 micrograms per liter (µg/L). The groundwater plume containing the highest TCE concentrations is located in the area between the new high school building addition (southwest perimeter) and the residential area to the south of the high school (see Figure 6). Approximations of TCE concentrations, as interpreted through isopleth maps, range from non-detect to 1,000 µg/L within the residential area. Groundwater flow is generally toward the south in the direction of the residential area.

Due to contaminant concentrations in groundwater, vapor intrusion monitoring continues to be conducted for the NBTHS and residences within the groundwater contaminant plume area.

Groundwater was also sampled from a sump located near the orchestra pit within the auditorium of the new building addition of the NBTHS. A granular-activated carbon bed treatment system has been installed to treat low concentrations of trichloroethylene (TCE) present in water within the sump. Sump water is sampled monthly with the treated effluent discharged to the sewer system by permit with the Middlesex County Utilities Authority (G. Hunsberger, Kleinfelder, personal communication, May 2007).

NBTHS – Vapor Intrusion Investigation

Indoor air samples were collected on seven occasions from April 2004 through September 2008. Indoor air samples were collected within the NBTHS based on concerns over possible vapor intrusion from contaminated subsurface media located below the southwest portion of the NBTHS (including the new addition). Additionally, during construction of the new building addition, a vapor suppression system was installed to help prevent the migration of subsurface contaminant vapors into the building interior (G. Hunsberger, Kleinfelder, personal communication, May 2007).

Nearby Residential Area – Vapor Intrusion Investigation

Vapor intrusion investigation continues within the residential area, located to the south of the NBTHS, to monitor whether contaminants in groundwater are impacting the indoor air quality within homes. A summary of environmental contaminants detected in indoor air for the nearby residential area includes the most recent environmental data from the sampling period of June 2004 through April 2009. The current April 2009 vapor intrusion investigation area has been extended to include a total of 10 residences (identified as *Residences A through J*) based on the extent of TCE contamination in groundwater.

Groundwater Remedial Efforts

Groundwater is planned for remediation through modern technology methods pending additional remedial investigation. A groundwater Classification Exemption Area (CEA) will be established through NJDEP to address remaining TCE concentrations in groundwater to reduce to levels that are considered low enough not to cause a threat to public health including the nearby residential area described below.

Planned Future Remedial Actions

Discussion regarding the remedial actions planned for lead and arsenic contaminated soil for the areas encompassing Veteran's Park, the PSE&G easement (NBTHS property), and areas to the south of Roosevelt Avenue, including Block 143, Lots 94.01 and 95.01 are discussed in the January 2009 PHA completed for the site. Remedial actions are tentatively scheduled to begin in 2010 (G. Hunsberger, Kleinfelder, personal communication, July 2009).

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Demographics

Using 2000 United States Census data, the ATSDR estimates that there are about 11,326 individuals residing within a one-mile radius of the North Brunswick High School site (see Figure 7).

Community Health Concerns

In response to cancer concerns expressed by the community, the ATSDR and NJDHSS have concurrently released a health consultation titled *Analysis of Cancer Incidence in North Brunswick, North Brunswick Township High School.* Within this document the NJDHSS Environmental and Occupational Health Surveillance Program has reviewed cancer incidence data from 1979 through 2006 (most current year) for the population living within North Brunswick Township and within the census tract of the NBTHS site. As the NJDHSS State Cancer Registry began in 1979, cancer incidence data for New Jersey does not pre-date 1979.

Based on groundwater investigation, the residential area currently under investigation has recently been expanded to include a total of ten residences. Public meetings were held in December 2008 and May 2009 to inform these residents of recent investigation data and future remedial actions to address TCE contamination found in indoor air within residences and TCE contamination within groundwater. NJDHSS provided information to address health concerns regarding exposure to TCE contamination in indoor air detected at the residences.

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two tiered approach: 1) a screening analysis; and 2) a more in-depth analysis to determine public health implications of site-specific exposures. First, maximum concentrations of detected substances are compared to media-specific environmental guideline comparison values (CVs). If concentrations exceed the environmental guideline CV, these substances, referred to as Contaminants of Concern (COC), are selected for further evaluation. Contaminant levels above environmental guideline CVs do not mean that adverse health effects are likely, but that further evaluation is necessary. Once exposure doses are estimated, they are compared with health guideline CVs to determine the likelihood of adverse health effects.

Environmental Guideline Comparison

There are a number of CVs available for the screening environmental contaminants to identify COCs. These include ATSDR Environmental Media Evaluation Guides (EMEGs) and Reference Media Evaluation Guides (RMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) were also considered as comparison values. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10-6) persons exposed during their lifetime (70 years). In the absence of an ATSDR CV, other comparison values may be used to evaluate contaminant levels in environmental media. These include the NJDEP Residential Direct Contact Soil Cleanup Criteria (RDCSCC); the New Jersey Maximum Contaminant Levels (NJMCLs) for drinking water; USEPA Region 6 Human Health Media-Specific Screening Levels (SLs) [1] and NJDEP Indoor Air Screening Levels (IASLs) for air. The NJDEP RDCSCC are based on human health impacts and also consider environmental impacts and natural background concentrations. For example, the RDCSCC for arsenic at 19 mg/kg is based on natural background concentrations within New Jersey and is, in comparison, higher than the CREG for arsenic at 0.5 mg/kg. SLs are contaminant concentrations corresponding to a fixed level of risk (i.e., a Hazard Quotient of 1, or lifetime excess cancer risk of one in one million, whichever results in a lower contaminant concentration) in water, air, biota, and soil. These health-based benchmarks are derived from the evaluation of cancer and non-cancer effects using current toxicity criteria.

Substances exceeding applicable environmental guideline CVs were identified as COCs and evaluated further to determine whether these contaminants pose a health threat to exposed or potentially exposed receptor populations. If environmental guideline CVs are unavailable, these contaminants are selected for further evaluation.

Soils on North Brunswick Township High School Property

A summary of recent environmental investigations conducted at the NBTHS property is provided based on information obtained from investigations conducted from April 2004 through October 2008. Investigation of soil contamination present at the high school was initiated following the July 2003 discovery of buried waste material during construction activities for the high school expansion project. Recent soil investigations were conducted for the athletic practice fields and for waste soil piles located within a wooded area to the northeast of the high school.

Athletic Practice Fields

Nine surface (0 to 0.5 foot, including one duplicate sample) and eight subsurface (0.5 to 1 foot) soil samples were collected from the athletic practice fields (see Figure 3). Samples were collected from the worn areas of the field and analyzed for arsenic and lead. Concentrations of arsenic and lead in surface soil ranged from 4.5 to 7.4 mg/kg and 21 to 43 mg/kg, respectively. Concentrations of arsenic and lead in subsurface soil ranged from 3.8 to 6.8 mg/kg and 9.3 to 40 mg/kg, respectively.

Based on maximum concentrations detected, arsenic is a COC in both surface and subsurface soil (see Table 1).

Northwest Wooded Area

Eleven surface (0 to 0.5 foot) and five subsurface (0.5 to 2 feet, including one duplicate) soil samples collected were collected within the soil pile and surrounding area of impact (see Figure 4). Concentrations of arsenic in surface and subsurface soil ranged from 4.8 - 826 mg/kg

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[1] Note: The USEPA's current Media-Specific SL for TCE of 1.2 micrograms per cubic meter (μg/m^3) has changed from their previous Risk-Based Concentration (RBC) of 0.016 (μg/m^3). Indoor air TCE concentrations cited in the January 2009 PHA for the site were evaluated using the USEPA RBC as the comparison value.

and 6 - 131 mg/kg, respectively. Based on maximum concentrations detected, arsenic is a COC in both surface and subsurface soil within an 1,800 square foot area (see Table 2a). It is noted this area was remediated by July 1, 2009, and soil concentrations are now below the NJDEP soil cleanup criteria of 19 mg/kg for arsenic (G. Hunsberger, Kleinfelder, personal communication, July 2009).

Northeast Wooded Area

Thirty one surface (0 to 0.5 foot) and four subsurface (0.5 to 2 feet) soil samples were collected within the four soils pile and surrounding area of impact (see Figure 5).

Concentrations of arsenic in surface and subsurface soil ranged from 2.5 - 147 mg/kg and 4.6 - 41 mg/kg, respectively. Based on maximum concentrations detected, arsenic is a COC in both surface and subsurface sofor these soil piles (see Table 2b).

Groundwater and Vapor Intrusion

North Brunswick Township High School Property

Groundwater samples were collected from July 2004 through December 2008 from 23 groundwater monitoring wells located within the investigation area as part of the quarterly groundwater monitoring program overseen by NJDEP. Based on groundwater sampling data and well location, the groundwater table varies from approximately 5 to 20 feet below ground surface. Groundwater samples were analyzed for VOCs plus 10 non-target compounds (VOC+10), and total/dissolved metals for focused COCs including antimony, arsenic, barium, copper, lead, nickel, thallium and zinc.

Grab groundwater samples collected in October 2003 indicated several COC were present. However, groundwater is routinely monitored from 22 permanent monitoring wells which represent consistent data to identify COCs in groundwater. Based on maximum concentrations detected in groundwater from permanent monitoring wells, COCs include antimony, arsenic, copper, lead, nickel, thallium, benzene, 1,2-dichloroethane (1,2-DCA), 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethene (cis), tetrachloroethylene (PCE), TCE, 1,1,2-trichloroethane and vinyl chloride (see Table 3). The predominant contaminant in groundwater is TCE as depicted in the most recent December 2008 isopleth map in Figure 6.

Indoor Air, North Brunswick Township High School Property

Indoor air samples were collected over a 24-hour period using SUMMA® canisters and analyzed for targeted VOCs including 1,2-dichloroethane, cis-1,2-dichloroethene, TCE and vinyl chloride using USEPA Method TO-15 for the April 2004 through September 2008 sampling period. As of the June 2007, additional VOCs have been analyzed in indoor air including benzene, trans-1,2-dichloroethene, methyl tert-butyl ether (MTBE), tetrachloroethylene (PCE), toluene, and total xylenes. NJDEP selected these additional compounds as their presence in groundwater warranted inclusion for the vapor intrusion monitoring (Kleinfelder 2008).

Previous sampling data from April 2004 through December 2006 was presented in the January 2009 PHA report completed for the site. Indoor air samples collected from June 2007 through September 2008 were obtained from the students' common area, student and faculty cafeterias, Rooms 243 and 244, auditorium (new addition), groundwater treatment room and the orchestra pit sump area.

TCE was detected at the NJDEP Indoor Air Screening Level (IASL) of 3 micrograms per cubic meter ($\mu g/m^3$) in June 2007 at the orchestra sump pit. The presence of TCE near the orchestra pit sump likely present due to the infiltration of TCE contaminated groundwater within the sump. Due to this detection of TCE, in June 2007 a blower was installed to the passive radon mitigation system to aid in the removal of TCE vapors below the concrete slab of the auditorium. TCE has not been detected in indoor air samples collected in July 2007, December 2007 and September 2008 following the installation of the blower. A remediation system was installed to treat sump water within the orchestra pit prior to discharge to the county sewer system (G. Hunsberger, Kleinfelder, personal communication, April 2009).

PCE was detected at the NJDEP IASL of 3 $\mu g /m^3$ for one sample collected from student cafeteria in December 2007. There were two other detections of PCE at the auditorium and groundwater treatment room at concentrations below the NJDEP IASL of 3 $\mu g /m^3$.

Benzene was detected at the NJDEP IASL of 2 $\mu g /m^3$ for two samples collected from student cafeteria and the groundwater treatment room in December 2007. Benzene was not detected above the NJDEP IASL at the students common area, faculty cafeteria, room 244, auditorium (new addition), and the orchestra pit sump in December 2007. As benzene has not been detected in groundwater above its vapor intrusion groundwater screening level of 15 µg/L, NJDEP does not consider the groundwater to be a likely source of benzene in indoor air (per NJDEP statement made during the May 2009 public meeting with area residents).

Analytical results indicated benzene, PCE, and TCE were detected in indoor air above their respective environmental guideline CVs; however, it is noted there were no exceedances above CVs for the most recent September 2008 data. 1,2-Dichloroethane and vinyl chloride were not detected in indoor air; however, following ATSDR policy, one half of the reported analytical detection limits for these compounds were lower than their respective environmental guideline CVs. Therefore, PCE, TCE, 1,2-dichloroethane, and vinyl chloride are considered COCs for indoor air at NBTHS (see Table 4).

Indoor Air, Nearby Residential Area

The predominant contaminant in groundwater for the nearby residential area to the south of the NBTHS is TCE. Concentrations of TCE in the groundwater plume for the residential area ranges from non-detect to 4,870 micrograms per liter (µg/L) (see Figure 6). Based on groundwater delineation results, four additional residences (Residences G through J) have been included in the residential vapor intrusion investigation to determine if groundwater contaminants are impacting indoor air quality within these homes.

Indoor air sampling data encompasses the period of June 2004 through April 2009. Indoor air samples have been collected primarily in the basement area from ten residences. Additionally, four of the residences have had indoor air samples collected from the first floor living space area in June 2004 and July 2007. Results indicate that TCE was positively detected in eight of the ten residences. Historically, four residences had TCE concentrations exceeding the NJDEP Indoor Air Screening Level (IASL) for TCE at 3 µg/m^3. The most recent round of data indicates three additional residences, G through I, had TCE of concentrations exceeding the NJDEP IASL. Based on average concentrations, there are five residences exceeding the applicable environmental CVs (see data summary table below).

Indoor Air TCE Concentrations in Indoor Air					
Residence	**Number of Samples**	**Range of TCE Concentrations (µg/m^3)***	**Average TCE Concentrations (µg/m^3)**	**April 2009 TCE Concentrations (µg/m^3)**	**Environmental Guideline Comparison Values (µg/m^3)**
A – 42 (c1)	5	ND – 0.75J	0.19	0.22	3 (a) 1.2 (b)
B – 40 (c1)	5	ND – 0.42J	0.08	ND	
C – 37 (c1)	4	ND – 0.32J	0.16	ND	
D – 38 (c2)	5	ND - **6.5**	**1.74**	ND	
E – 36	3	ND - **2.4**	**1.33**	**1.6**	
F – 35	2	ND	ND	ND	
G – 33	1	**3.5**	**3.5**	**3.5**	
H – 31	1	**7**	**7**	**7**	
I – 29	1	**10**	**10**	**10**	
J -32	1	ND	ND	ND	
Background	6	ND	ND	ND	

(a) - NJDEP Indoor Air Screening Value
(b) - United States Environmental Protection Agency (EPA) - Region 6 Human Health Media-Specific Screening Level
(c) – One indoor air sample was also collected from 1st floor in addition to basement area in June 2004 (c1) and July 2007 (c2) where TCE was not detected above the comparison values.
ND – Not Detected (detection levels below current comparison values).
Micrograms of TCE per cubic meter of air
Bolded numbers indicate exceedance of comparison value
J = Estimated Value

Additional contaminants detected in indoor air exceeding the NJDEP IASL or environmental CV include benzene, 1,2-DCA, methyl tert-butyl ether (MTBE), PCE, toluene and total xylenes (see Table 5).

Benzene, toluene, and total xylenes have not been detected in groundwater above their respective NJDEP vapor intrusion groundwater screening levels of 15 µg/L, 310,000 µg/L, and 7,000 µg/L. Therefore, based on current groundwater data, these contaminants are unlikely to be found in indoor air as a result of vapor intrusion. As these compounds are associated with petroleum products, their concentrations in indoor air are likely attributed to vehicle emissions and interior storage of gasoline/petroleum-based products (gasoline cans, gas-powered equipment, vehicles, etc.). The average concentrations detected for these compounds are provided in Table 5. Regarding benzene, the average concentrations detected within all 10 residences have been within the general range of concentrations detected in ambient air (see Table 6). An exception is noted for Residence I where benzene was detected in April 2009 at an elevated concentration of 35.1 $\mu g/m^3$. Information provided from the Kleinfelder and NJDEP indicates the source of this detection is most likely associated with interior storage of petroleum-based products and gas-powered equipment (Kleinfelder 2009).

MTBE has not been detected in groundwater samples collected from monitoring wells MW-1 through MW-8 in April 2005 and has, therefore, not exceeded the NJDEP vapor intrusion groundwater screening level of 78 µg/L. Additionally, there has been no evidence of a petroleum type of release to groundwater. Therefore, NJDEP has ruled out MTBE as a vapor intrusion source to the residences (G. Hunsberger, Kleinfelder, personal communication, May 2009). Detections of MTBE in indoor air exceeding the NJDEP IASL for Residences A, C and E are likely attributed to interior storage of gasoline, vehicles and gasoline powered equipment.

PCE has been detected (range ND to 16.1 µg/L) in groundwater above its respective NJDEP vapor intrusion groundwater screening level of 1 µg/L primarily in monitoring well MW-9 and to a lesser extent in wells MW-3 and MW-24 (see Figure 6). These groundwater monitoring wells are located in the vicinity of the southwest corner of the NBTHS (new building addition). Five rounds of groundwater samples collected from these monitoring wells since September 2007 had concentrations ranging from non-detect to 2.3 µg/L. Based on average concentrations, PCE has been detected in indoor air above the environmental guideline CV for Residences B, D and E. Following protocols in the NJDEP's Vapor Intrusion Guidance Manual (NJDEP 2006), sump water samples were collected for Residence B in 2004 and 2005 and Residence D in 2006 which indicate there were no detections of PCE exceeding the groundwater vapor intrusion screening levels. Additional investigation of Residence E indicated dry cleaning bags were located in the basement at the time of sampling in April 2009 (G. Hunsberger, Kleinfelder, personal communication, June 2009). Based on this information, PCE in indoor air is likely associated with various consumer products and services such as recently dry cleaned clothing, cleaners, solvents, and glues.

1,2-DCA has been detected (range ND to 49 µg/L) in groundwater above its respective NJDEP vapor intrusion groundwater screening level of 1 µg/L primarily in monitoring well MW-23 (hydraulically upgradient from residential area) and to a lesser extent in wells MW-3 and MW-7 (see Figure 6). These groundwater monitoring wells are located in the vicinity of the southwest area of the NBTHS (new building addition) and in the southeast area of Veteran's Park. Concentrations of 1,2-DCA in groundwater for MW-3, which is the closest hydraulically upgradient well to the residential area, have not exceeded the NJDEP vapor intrusion groundwater screening level since June 2007. 1,2-DCA was not previously detected in indoor air at sampled residences; however, April 2009 results indicate it has been detected above the environmental guideline CV for Residences B, D and G. While concentrations remain relatively low in groundwater and are below the NJDEP IASL in indoor air, there is insufficient data to rule out that concentrations in indoor air originate solely from background sources.

Additionally, while 1,2-DCA was not detected in indoor air samples for the remaining seven residences, following ATSDR policy, one half of the reported analytical detection limit exceeded its respective environmental guideline CV. As such, 1,2-DCA is considered a COC for all residences.

Vinyl chloride is a breakdown product of TCE as it degrades in the environment. Vinyl chloride has been detected (range ND to 20.9 µg/L) in groundwater above it's respective NJDEP vapor intrusion groundwater screening level of 1 µg/L primarily in monitoring wells MW-3 (hydraulically upgradient from residential area) and MW-24 and to a lesser extent in wells MW-4, MW-5, MW-8 and MW-23 (see Figure 6). Monitoring wells MW-3 and MW-24 are located near the southwest corner of the NBTHS (new building addition). Concentrations of vinyl chloride in groundwater for MW-3 have exceeded the NJDEP vapor intrusion groundwater screening level as recent as December 2008. While vinyl chloride was not detected in indoor air samples, following ATSDR policy, one half of the reported analytical detection limit exceeded its respective environmental guideline CV. Therefore, this compound is considered a COC for all residences.

Water samples were collected from the basement sumps of Residences B and D from 2004 through 2006 to determine if the source contaminants other than TCE in indoor air were attributable to background sources. While 1,2-DCA and vinyl chloride were not detected above their respective NJDEP vapor intrusion groundwater screening levels in sump water for Residences B and D, there is no sump water data to correlate with April 2009 indoor air results to rule out vapor intrusion.

Based on the review of data described above, TCE, 1,2-DCA and vinyl chloride are considered COCs in indoor air for the residences under investigation. A list of consumer sources and typical ambient background concentrations of compounds present within investigated residences are provided in Appendix A. A list of published information sources for homeowners on how to reduce sources of indoor air contaminants and measures to improve indoor air quality and ATSDR ToxFAQs for 1,2-DCA, gasoline, MTBE, PCE, TCE and vinyl chloride are also included in Appendix A.

Summary of Contaminants of Concern

A summary of the COCs is provided by investigation area in addition to those provided in the January 2009 PHA.

<table>
<tr><th colspan="2">North Brunswick High School Property</th></tr>
<tr><td colspan="2">Athletic Practice Fields – Surface (0-0.5 feet) and Subsurface Soil (>0.5 feet)</td></tr>
<tr><td colspan="2">Metals</td></tr>
<tr><td colspan="2">Arsenic</td></tr>
<tr><td colspan="2">Northwest/Northeast Wooded Area – Surface (0-0.5 feet) and Subsurface Soil (>0.5 feet)</td></tr>
<tr><td colspan="2">Metals</td></tr>
<tr><td colspan="2">Arsenic</td></tr>
<tr><th colspan="2">NBTHS/Nearby Residential Area</th></tr>
<tr><td colspan="2">Groundwater</td></tr>
<tr><td>Metals</td><td>VOCs</td></tr>
<tr><td>Antimony, Arsenic, Copper, Lead, Nickel, Thallium</td><td>Benzene, 1,2-DCA, 1,1-Dichloroethene, 1,2-Dichloroethene (cis), PCE, TCE, 1,1,2-Trichloroethane and Vinyl Chloride</td></tr>
<tr><th colspan="2">North Brunswick High School Property</th></tr>
<tr><td colspan="2">Indoor Air</td></tr>
<tr><td colspan="2">VOCs</td></tr>
<tr><td colspan="2">1,2-DCA, PCE, TCE, Vinyl Chloride</td></tr>
<tr><th colspan="2">Nearby Residential Area</th></tr>
<tr><td colspan="2">Indoor Air</td></tr>
<tr><td colspan="2">VOCs</td></tr>
<tr><td colspan="2">1,2-DCA, TCE, Vinyl Chloride</td></tr>
</table>

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 whether exposures to contamination are high enough to be of health concern. Site-specific exposure doses can be calculated and compared with health guideline CVs.

Assessment Methodology

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media 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. receptor population.

Generally, the ATSDR considers three exposure 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. Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

The exposure pathways for the identified areas of concern in this update include children and adults comprising the school student, school employee and area resident population associated with NBTHS and residential vapor intrusion investigation area. The evaluated exposure pathways for site-related contaminants are presented in Table 7.

Completed Exposure Pathways

Ingestion of contaminated surface soils (past, present, future). There is a completed exposure pathway regarding ingestion of contaminated surface soil (0 - 0.5 foot) for the athletic practice field and the soil piles in the northwest (past exposures) and northeast wooded areas located on the NBTHS property. As there are multiple exposure locations, the time-frame regarding past, present, and/or future exposures is dependent on the exposure location (see Table 7). Exposed individuals include students (adult) and adult faculty at the NBTHS for the athletic practice field. As the northwest and northeast wooded areas can be freely accessed and do not have a dedicated use by the NBTHS students or faculty, exposed individuals include area residents (children and adults) for the contaminated soil piles in these areas.

The NJDEP RDCSCC for arsenic is 19 mg/Kg which is based on natural background concentrations. However, if a contaminant exceeds an Environmental Guideline CV, it is established as a COC and is considered for further evaluation regardless of the locations from which environmental samples are collected, in this case from the athletic practice field area.

It is further noted that exposures for contaminated soil piles in the northwest and northeast wooded areas are from 1980 to the present. The starting point for exposures at these areas is based on available information which indicates that the soil piles were likely generated in the early 1980s. Exposures at the soil pile in the northwest pile area are considered eliminated with the removal of arsenic contaminanted soil in July 2009. Remediation of arsenic contaminated soil present in the northeast wooded areas will be concurrent with planned remedial activities for Veteran's Park tentatively scheduled to occur in 2010 (G. Hunsberger, Kleinfelder, personal communication, July 2009).

Inhalation of TCE in indoor air at NBTHS (past). For the past, there is a potential exposure pathway regarding the inhalation of air contaminated with PCE, TCE, 1,2-dichloroethane and vinyl chloride. Although 1,2-dichloroethane and vinyl chloride were not detected, the detection limits for these compounds exceeded their respective environmental CVs. However, for the purposes of this report, only detected concentrations of COCs were used to assess potential exposures. The potential exposure pathway involves these contaminant vapors migrating upwards through contaminated subsurface media and entering the interior of the NBTHS where the contaminated air is inhaled. Due to an exceedance of the NJDEP IASL for

TCE in June 2007, a blower was installed to the passive radon mitigation system to aide in the removal of TCE vapors below the concrete slab of the auditorium. The predominant contaminant, TCE, has not been detected in indoor air samples collected from July 2007 through September 2008 following the installation of the blower. Therefore, following the July 2007 blower installation, exposures to students or faculty regarding indoor air contaminants appear to have been interrupted for the present and future.

Inhalation of VOCs in indoor air at residences (past). There is a completed exposure pathway regarding the inhalation of indoor air contaminated with TCE for five residences (D, E, G, H and I) and 1,2-DCA for 3 residences (B, D and G). It is noted that while vinyl chloride was not detected in any residences and 1,2-DCA was not detected for 7 residences, it could not be excluded as a completed exposure pathway as one-half of the analytical detection limit for the sample exceeded applicable environmental guideline CVs. However, for the purposes of this report, only detected concentrations of COCs were used to assess potential exposures. The pathway involves these contaminant vapors migrating upwards through contaminated subsurface media and entering the indoor air of these residences where the contaminated air is inhaled.

Eliminated Pathways

Ingestion of contaminated subsurface soils (past, present, future). ATSDR considers the top three inches of soil as the direct contact layer for incidental ingestion of soil. As such, subsurface contaminants present at depths greater than 6 inches (0.5 foot) are not considered a direct contact exposure hazard. Therefore, there are no completed exposures for the northwest and northeast wooded areas of the NBTHS property concerning subsurface soils.

Ingestion of groundwater (past, present, future). According to information obtained from a groundwater well search (Kleinfelder 2007), the NJDEP has verified five domestic wells are located 0.4 to 0.5 mile downgradient from site. A visual inspection of the area during investigation activities did not disclose the presence of four of the five wells. These four wells (installed 1952 through 1959) were likely destroyed during commercial development of the area. The commercial properties at these locations have been verified to be connected to the public supplied water system (G. Hunsberger, Kleinfelder, personal communication, October 2008). Additionally, documentation indicates that city water was supplied during the development of the area in the early 1960s (Powell-Harpstead 2003).

One domestic well remains approximately 0.5 miles from the site at the time of the June 2007 Remedial Investigation Report was issued. The depth and installation date of this well has not been confirmed. Groundwater investigation activities indicate contaminants in groundwater have been delineated to the area near the NBTHS and do not extend to this well location (G. Hunsberger, Kleinfelder, personal communication, October 2008). As such, there were no completed exposures via this pathway for the five domestic wells.

Public Health Implications of Completed Exposure Pathways

Once it has been determined that individuals have or are likely to come in contact with site-related contaminants (i.e., a completed exposure pathway), the next step in the public health assessment process is the calculation of site-specific exposure doses. This is called a health guideline comparison which involves looking more closely at site-specific exposure conditions, the estimation of exposure doses, and comparison to health guideline CVs. Health guideline CVs are based on data drawn from the epidemiologic and toxicologic literature and often include uncertainty or safety factors to ensure that they are amply protective of human health.

The maximum and average contaminants concentrations detected in surface soil and indoor air were used to update the assessed risk of non-cancer and cancer health effects to the exposed population. ATSDR considers the top three inches of soil the contact layer for incidental soil ingestion exposure. NJDEP requires a soil sample to be collected in a 6-inch interval; therefore, soil samples collected from the top six inches of soil were used to assess incidental soil ingestion exposure. Toxicological summaries for the contaminants evaluated in this section are provided in Appendix B.

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).

When MRLs for specific contaminants are unavailable, other health based comparison values such as the USEPA's Reference Dose (RfD) and Reference Concentrations (RfC) are used. The RfD is an estimate of a daily oral exposure and the RfC is an estimate of a daily inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure.

<u>Incidental Ingestion of Soil – NBTHS</u>

Contaminated surface soil for the NBTHS property has been identified at the athletic practice field and the northwest and northeast wooded areas on the NBTHS property.

Exposures for the former "The Oval" area, the football field and unpaved areas are based on incidental ingestion of contaminated soil during high school related activities. Non-cancer exposure doses were calculated using the following formula:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor representing the site-specific exposure scenario; and,
BW = body weight (kg)

The following site-specific exposure assumptions (USEPA 1997, 2008) were used to calculate past contaminant doses to NBTHS students, faculty and area residents. The exposure assumptions for the population at the NBTHS are based on information provided in background documentation and discussion with NBTHS faculty. Regarding the NBTHS, the exposure period is conservatively estimated to include daily exposure for the entire school year for both students and faculty accessing the athletic practice field.

Athletic Practice Field

Exposed Population	Body Weight	Ingestion Rate	Exposure Assumptions	Number of Years Exposed [(a)]
Student (14 to 18 years old)	67 kg	100 mg/day	5 days per week 36 weeks per year	4
Adult Faculty	70 kg			40

(a) For the athletic practice field area where lead and arsenic are below regulatory cleanup levels. Faculty exposure based on an approximated maximum term of employment at school.

Northwest and Northeast Wooded Area

Exposed Population	Body Weight	Ingestion Rate	Exposure Assumptions	Number of Years Exposed [(a)]
Child (6 to 16 years old)	44 kg	200 mg/day	3 days per week 26 weeks per year	10
Adult	70 kg	100 mg/day		28

(a) For the northwest and northeast wooded area where lead and arsenic are below regulatory cleanup levels. Based on the approximated time period when the soil piles were generated (circa 1980) for these areas.

Athletic Practice Field

Arsenic. Based on the maximum concentration of arsenic detected in surface soil for this area, the chronic exposure dose calculated for students and adult faculty (i.e., 0.00000545 and 0.00000521 mg/kg/day, respectively) did not exceed the ATSDR MRL of 0.0003 mg/kg/day (see Table 8). As such, non-cancer adverse health effects for students or faculty associated with exposure to arsenic detected in the soil for this area are not expected.

It is noted that arsenic concentrations in soil at the athletic practice field are likely present due to natural background levels and not associated with historic landfill activities. The NJDEP RDCSCC for arsenic is 19 mg/Kg which is based on natural background concentrations.

Lead. The maximum concentration of lead detected in surface soil for this area did not exceed the NJDEP RDCSCC of 400 mg/kg; therefore, the potential for adverse health effects associated with exposure to lead detected in the surface soil at the athletic practice field are not expected.

Northwest Wooded Area (NBTHS Property)

Arsenic. Based on the maximum concentration of arsenic detected in surface soil for this area, the potential chronic exposure dose calculated for child and adult residents (i.e., 0.000803 mg/kg/day and 0.000253, respectively) exceeded the ATSDR MRL of 0.0003 mg/kg/day for child residents (see Table 9). The calculated child exposure dose is approximately equal to the no observable adverse effect level (NOAEL) of 0.0008 mg/kg/day. However, based on the average concentration of arsenic detected (the more likely exposure scenario), the potential chronic exposure dose calculated for child and adult residents (i.e., 0.000117 mg/kg/day and 0.0000367, respectively) did not exceed the ATSDR MRL of 0.0003 mg/kg/day. As such, non-cancer adverse health effects for child and adult residents associated with past exposure to arsenic detected in the soil for this area are not expected.

It is noted that exposures to contaminated soil for this area are considered eliminated with the removal of contaminated soil completed in July 2009 (G. Hunsberger, Kleinfelder, personal communication, July 2009)

Arsenic is a naturally occurring element. A few of its uses include as a wood preservative (inorganic form) and as a pesticide (organic form). As it has been documented that the area was historically used as a municipal dump which received pharmaceutical/laboratory research wastes, elevated concentrations of arsenic in soil within the waste-fill area are presumed to have originated from the landfilled wastes. Inorganic arsenic has been historically used in the development of pharmaceuticals and as part of cancer treatment therapy. Arsenic was a constituent in Fowler solution, containing 1% potassium arsenite, which was a commonly used for treatment of psoriasis. Arsphenamine was historically used for as a standard treatment for syphilis. By the mid-1990s, the medicinal use of arsenic was limited primarily for the treatment of trypanosomiasis. The decline in the medicinal use of arsenic in the past 100 years is due to concerns about the toxicity and potential carcinogenicity of chronic arsenic therapy.

Long-term (chronic) exposure to low levels of inorganic arsenic can cause a "darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso" (ATSDR 2001). Dermal (skin) contact with inorganic arsenic may cause redness and swelling. Organic arsenic compounds are considered less toxic than inorganic arsenic compounds' however, at high doses, the health effects may be similar. The chronic MRL for arsenic (0.0003 mg/kg/day) is based on the health endpoint of skin lesions developed in farmers exposed to arsenic contaminated well water (ATSDR 2000).

Northeast Wooded Area (NBTHS Property)

Arsenic. Based on the maximum concentration of arsenic detected in surface soil for this area, the potential chronic exposure dose calculated for child and adult residents (i.e., 0.000143 mg/kg/day and 0.0000449, respectively) did not exceed the ATSDR MRL of 0.0003 mg/kg/day (see Table 9). As such, non-cancer adverse health effects for area child and adult residents associated with exposure to arsenic detected in the soil for these areas are not expected.

Indoor Air – NBTHS Building Interior

The chronic inhalation RfC for TCE is based on the LOAEL (i.e., central nervous system effects in two occupational studies) of 38,000 μg/m^3. The RfC incorporates a safety factor of 1,000 to account for the use of the LOAEL, human variability (including sensitive populations such as children), (EPA 2001). There were no detected TCE concentrations exceeding the intermediate MRL of 500 μg/m^3 nor the chronic RfC of 40 μg/m^3 within the NBTHS (see Table 10). Therefore, adverse non-cancer health effects are not expected to occur for past and present exposures to TCE in indoor air to adults and students at the NBTHS. Adverse non-cancer health effects are not expected to occur for future exposures to TCE in indoor air to these populations as the area is under active investigation and mitigation measures are being applied by NJDEP to reduce TCE concentrations to below the NJDEP IASL of 3 μg/m^3. As such, non-cancer adverse health effects for area students and adult faculty associated with exposure to TCE detected in indoor air are not expected.

<u>Inhalation of VOCs in Indoor Air – Residential Area</u>

There were no detected TCE concentrations exceeding the intermediate MRL of 500 μg/m^3 nor the chronic RfC of 40 μg/m^3 all sampled residences (see Table 11). Therefore, adverse non-cancer health effects are not expected to occur for past and present exposures to TCE in indoor air to adults and children living at the sampled residences. Adverse non-cancer health effects are not expected to occur for future exposures to TCE in indoor air to these populations as the area is under active investigation and mitigation measures are being applied by NJDEP to reduce TCE concentrations to below the NJDEP IASL of 3 μg/m^3.

There were no detected 1,2-DCA concentrations exceeding the chronic MRL of 2,000 μg/m^3 nor the chronic RfC of 2,500 μg/m^3 for Residences B, D and G (see Table 11). As such, non-cancer adverse health effects for child and adults residents associated with exposure to 1,2-DCA detected in indoor air are not expected.

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 between 1 and 10 in 100 (SEER 2005). Typically, health guideline CVs developed for carcinogens are based on 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 class of contaminants detected at a site is as follows:

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

The risk of cancer was evaluated for soil based on the site-specific exposure scenario and exposure location. Cancer exposure doses were calculated using the following formula:

$$\text{Cancer Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW}$$

where C = concentration of contaminant in soil (mg/kg);
IR = intake rate of contaminated soil (mg/day);
EF = exposure factor representing the site-specific exposure scenario;
CF = conversion factor (10^{-6} kg/mg); and
BW = body weight (kg).

The site-specific assumptions and recommended exposure factors (EPA 2002) used to calculate the LECR are the same as those used to assess non-cancer health effects. The LECR for adults was calculated by multiplying the cancer exposure dose by the cancer slope factor (CSF). The CSF is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(mg/kg/day)^{-1}$.

Several COCs are identified for the NBTHS property and the residential area; however, only COCs having CSFs are used to estimate the LECR to exposed individuals. Please refer to the *Completed Pathways* section of this report for specific discussions regarding evaluated potential exposure at areas of concern.

Arsenic has been identified in soil for the athletic practice field and the soil piles in the northwest and northeast wooded areas of the NBTHS property. Exposure criteria for students, faculty and area residents (children and adults) for these areas are provided in the *Non-Cancer Health Effects* section of this report.

<u>Ingestion of Contaminated Soil – NBTHS</u>

Athletic Practice Field

Based on the average (the likely scenario) and maximum (an unlikely scenario) contaminant concentrations detected in soil, the LECRs for students were less than 1 in 1,000,000, which is considered to be no expected increased risk of cancer.

Based on the average (the likely scenario) and maximum (an unlikely scenario) contaminant concentrations detected in soil, the LECRs were estimated to be 4 in 1,000,000 and 5 in 1,000,000 for adult faculty exposed for a 40-year period, which is a very low increase in risk compared to the background risk of cancer (see Table 12).

Northwest Wooded Area (NBTHS Property)

Based on the average (the likely scenario) and maximum (an unlikely scenario) contaminant concentrations detected in soil, the LECRs were estimated to be 25 in 1,000,000 and 170 in 1,000,000 for child residents aged 6 though 16 exposed for a ten-year period.

Based on the average (the likely scenario) and maximum (an unlikely scenario) contaminant concentrations detected in soil, the LECRs were estimated to be 22 in 1,000,000 and 150 in 1,000,000 for adult residents exposed for a 28-year period. The above LECRs represent a very low increase in risk when compared to the background risk of cancer based on the average (see Table 13).

Northeast Wooded Area (NBTHS Property)

Based on the average (the likely scenario) and maximum (an unlikely scenario) contaminant concentrations detected in soil, the LECRs were estimated to be 5 in 1,000,000 and 31 in 1,000,000 for child residents aged 6 though 16 exposed for a ten-year period.

Based on the average (the likely scenario) and maximum (an unlikely scenario) contaminant concentrations detected in soil, the LECRs were estimated to be 4 in 1,000,000 and 27 in 1,000,000 for adult residents exposed for a 28-year period. The above LECRs represent a very low increase in risk when compared to the background risk of cancer based on the average (see Table 13).

Inhalation of VOCs in Indoor Air

The risk of cancer for past exposures regarding the inhalation of indoor air contaminated with TCE was evaluated for students and adult faculty at the NBTHS and for children and adults of nearby residences. Additionally, past exposures regarding the inhalation of indoor air contaminated with 1,2-DCA at Residences B, D and G was evaluated for children and adults residing within these locations. Exposure concentrations to indoor air contaminants and LECRs were calculated using the following formulas (US EPA 2009):

$$EC = \frac{C \times ET \times EF \times ED}{AT}$$

where EC = exposure concentration (µg/m^3);
C = concentration of contaminant in air (µg/m^3);
ET = exposure time (hours/day);
EF = exposure frequency (days/year);
ED = exposure duration (years); and
AT = averaging time (70 years).

$$LECR = EC \times IUR$$

where EC = exposure concentration (µg/m^3); and
IUR = inhalation unit risk of contaminant in air (µg/m^3)$^{-1}$;

The LECR for residents was calculated by multiplying the cancer exposure concentration in indoor air by the inhalation unit risk (IUR). The IUR is defined by the US EPA 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 2008b).

NBTHS Building Interior

The LECR was estimated for the student and adult faculty population for the NBTHS using TCE concentrations in indoor air from the April 2004 through April September 2008 indoor air investigation period. Site specific assumptions and recommended exposure factors (EPA 2002, 2009) were used to calculate the exposure concentration based on the student and adult faculty exposure period as described in the *Non-Cancer Health Effects* section.

<u>Student and Adult Faculty Exposures (past).</u> Based on the arithmetic mean of detected TCE and PCE concentrations in the indoor air, LECRs were estimated to be less than 1 in 1,000,000 for students and adult faculty which is considered to be no expected increase in risk when compared to the background risk of all or specific cancers (see Table 14).

Nearby Residential Area

The LECR was estimated for residents within eight of the ten nearby residences having detections of TCE in indoor air from the June 2004 through April 2009 indoor air investigation period. Site-specific assumptions and recommended exposure factors (EPA 2002, 2009) were used to calculate the exposure concentration based on the maximum length of residency.

<u>Resident Exposures (past, present).</u> Based on the arithmetic mean of detected TCE concentrations in the indoor air, LECRs were estimated to be less than 1 in 1,000,000 for adult and child residents at Residences A, C, and E which is considered to be no expected increase in risk when compared to the background risk of all or specific cancers (see Table 15).

It is noted that there is only one sampling event for Residences G through J. Based on the detected TCE concentration in the indoor air, LECRs were estimated to be 4 in 1,000,000 or less for adult and child residents at Residences H and I which is considered a very low increase in risk when compared to the background risk of all or specific cancers (see Table 15).

Based on the arithmetic mean of detected TCE and 1,2-DCA concentrations in the indoor air at Residences B, D and G (note: one sample), LECRs were estimated to be less than 9 in 1,000,000 for adult and child residents which is considered a very low increase in risk when compared to the background risk of all or specific cancers (see Table 15).

There were no detected TCE concentrations at Residences F and J; therefore, there is no associated LECR for these residences.

Although the estimated risk of developing cancer from past exposure to TCE in indoor air is considered low, remedial actions were implemented for Residences A through F to ensure future inhalation exposure to TCE remains below the NJDEP's RIASL. Additionally, Residences G through I are planned for additional vapor intrusion investigation in June 2009. If TCE concentrations in indoor air are found to originate from vapor intrusion, these residences will be assessed for mitigation measures which should reduce contaminants in indoor air to below the applicable NJDEP IASLs.

Health Outcome Data

In May and September of 2004, North Brunswick residents contacted the NJDHSS Cancer Epidemiology Program regarding several individuals who live near or attended North Brunswick Township High School who had been diagnosed with cancer in the past several years. In response to this concern, the Cancer Epidemiology Program reviewed cancer incidence data from 1979 through 2001 for North Brunswick Township and Middlesex County. According to the Cancer Epidemiology Program, the number and distribution of cancer types in Middlesex County did not appear to be unusual when compared to the state; in addition, a review of North Brunswick Township data by gender and age group did not indicate an unusual occurrence of any type of cancer (see January 2009 PHA).

Based on continuing community concerns, NJDHSS and ATSDR have prepared an updated analysis of cancer incidence for the period 1979-2006, which is described in a companion health consultation (ATSDR 2009).

Child Health Considerations

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances because they eat and breathe more than adults. They also play outdoors and often bring food into contaminated areas. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

As the soil piles located in the northwest and northeast wooded areas of the NBTHS property have been accessible to children in the past, incidental ingestion of arsenic contaminated surface soil may have occurred. Based on the average concentrations (the likely scenario) of arsenic in surface soil, adverse non-cancer health effects associated with this exposure pathway are not expected to occur in children. The LECR from the incidental ingestion of arsenic contaminated surface soil from these areas indicate there is a very low increase in risk posed to children based on average soil concentrations.

For the residential area, non-cancer health effects associated with the inhalation of contaminants of concern, including TCE, from vapor intrusion sources in indoor air detected at the ten residences sampled are not expected to occur in children. For cancer health effects, the LECR at these locations indicate there is a no expected increase to a very low increase in risk posed to children based primarily on TCE concentrations detected in indoor air.

Conclusion

Prior to development, an area within the present location of the North Brunswick High School (NBTHS) was used as a municipal dump which received various wastes including pharmaceutical/ laboratory research materials dating back to the 1940s through to approximately 1967. The waste material was partially discovered during school construction activities circa 1971/1972; however, the extent of the buried waste material was not fully encountered until 2003 during a school expansion project. In June 2004, township officials and the New Jersey Department of Environmental Protection (NJDEP) requested assistance from the New Jersey Department of Health and Senior Services (NJDHSS) in the interpretation and public health evaluation of site-related contamination detected at the site. A detailed assessment to evaluate the potential health implications for exposures to site-related contaminants for impacted media has been provided in the January 2009 public health assessment report (PHA) for this site. As an update to the 2009 PHA, this health consultation report includes recent investigation data used to provide further evaluation of potential health implications for exposures to site-related contaminants detected in soil and indoor air at the North Brunswick High School (NBTHS) and in indoor air at the nearby residential area.

The primary contaminants of concern (COCs) for the investigated areas include arsenic in surface soil and trichloroethylene (TCE) in indoor air for the NBTHS property, TCE in groundwater, and TCE in indoor air for ten residences under investigation. Additionally, 1,2-dichloroethane (1,2-DCA) is also a COC for three residences; however, it is noted that the detected concentrations of this compound did not exceed NJDEP's Indoor Air Screening Level.

NJDHSS and ATSDR conclude that past, present and future exposures through incidental ingestion of arsenic contaminated soil present at the NBTHS property and evaluated within this health consultation are not expected to harm people's health.

There are completed past exposures to children and adults to arsenic contaminated surface soil (0-0.5 feet) present in soil piles located in the northwest and northeast wooded areas of the NBTHS property. Current and future exposures have been eliminated at the northwest soil pile based on its removal in July 2009. Future exposures at the northeast soil piles will be eliminated pending successful completion of remedial actions planned for this area in 2010.

Adverse non-cancer health effects are not expected to occur to children and adults as the comparison of average arsenic concentrations present at soil piles in the northwest and northeast wooded areas were below health-based comparison values. Based on past and present exposures to average (the likely scenario) contaminant concentrations in soil piles located within the above areas of the NBTHS property, the highest calculated lifetime excess cancer risk (LECR) are 25 in 1,000,0000 and 22 in 1,000,000, respectively. This represents a very low increase in risk of cancer to this population when compared to the background risk of cancer.

There are completed past, present and future exposures to NBTHS students and adult faculty to arsenic in surface soil for the athletic practice field located on the NBTHS property. Arsenic concentrations in surface soil for this area were below the New Jersey Department of Environmental Protection (NJDEP) soil cleanup criteria and does not require any future remediation. Arsenic concentrations in soil at the athletic practice field are likely present due to natural background levels and not associated with historic landfill activities.

Adverse non-cancer health effects are not expected to occur to students and adults as the arsenic concentrations present at soil at the athletic practice field were below health-based comparison values. LECRs calculated based on past and present exposures to average (the likely scenario) contaminant concentrations in soil and indoor air for students and adult faculty at NBTHS are less than one in 1,000,000 and 4 in 1,000,000, respectively. This represents no expected increase to a very low increase in risk of cancer to this population when compared to the background risk of cancer.

NJDHSS and ATSDR conclude that past, present and future exposures through inhalation of identified contaminants of concern present in indoor air at the NBTHS and within sampled nearby residences is not expected to harm people's health.

There are completed past exposures to children and adults to identified contaminants of concern, primarily TCE, in indoor air for eight of the ten sampled residences. These exposures are not expected cause adverse non-cancer health effects as contaminant concentrations remain below health-based comparison values. LECRs calculated based on past and present exposures to average (the likely scenario) contaminant concentrations in indoor air for child and adult residents at Residences A, C, and E are less than 1 in 1,000,000 and at Residences B, D, G, H and I are less than 9 in 1,000,000. This represents no expected increase to a very low increase in risk of cancer to this population. LECRs were not calculated for Residences F and J as evaluated contaminants in indoor air were either not detected or were found attributable to background or consumer-related activities.

Current and future exposures are considered interrupted as the NJDEP is monitoring indoor air at the ten residences where chronic exposures to TCE in indoor air at concentrations exceeding NJDEP's Indoor Air Screening Level are not expected to occur to residents.

The ATSDR and NJDHSS have concurrently released a health consultation titled *Analysis of Cancer Incidence in North Brunswick, North Brunswick Township High School Site* which addresses communities concerns on cancer for North Brunswick Township and for the population living within the census tract of the NBTHS site.

A groundwater Classification Exemption Area (CEA) will be established in the future through the NJDEP to address remaining TCE concentrations in groundwater to reduce levels that are considered low enough not to cause a threat to public health including the nearby residential area.

Recommendations

1. Sump water or sub-slab soil gas samples should be collected in conjunction with indoor air samples during each sampling event for all residences under investigation. This is recommended to more accurately assess whether TCE and other contaminants detected in indoor air are originating from vapor intrusion or have contributions from background sources.

2. If possible, analytical detection limits for contaminants under investigation in indoor air should be set for the lowest environmental CV in order to more accurately determine if contaminant concentrations are exceeding these values.

3. NJDEP should continue oversight of remedial activities regarding TCE contamination in groundwater to reduce concentrations to below the NJDEP's ground water vapor intrusion screening levels, or a NJDEP approved alternative, to minimize or eliminate the threat of vapor intrusion to the surrounding community.

4. NJDEP should continue monitoring the effectiveness of the vapor ventilation systems installed at the six nearby residences. Powered ventilation systems installed at residences should be operational until the threat of vapor intrusion has been reduced where it no longer poses a threat to public health.

5. NJDEP should continue oversight of soil remedial activities for the NBTHS property to ensure site-related contaminants are reduced to below NJDEP's regulatory cleanup criteria through either soil removal and/or installation of engineering controls. Soil removal actions should include provisions to prevent migration of dust during removal and/or soil stockpiling activities to uncontaminated areas, including the high school property.

Public Health Action Plan

The purpose of a Public Health Action Plan is to ensure that this Public 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 the ATSDR and the NJDHSS to follow-up on this plan to ensure that it is implemented. The public health actions to be implemented by the ATSDR and NJDHSS are as follows:

Public Health Actions Taken

1. The ATSDR and NJDHSS reviewed information and relevant data to evaluate the potential health implications for exposures to site-related contaminants detected in soil and indoor air at the NBTHS and in indoor air at the nearby residences.

2. A health consultation was completed by the NJDHSS in August 2005 evaluating the potential health implications for exposures to site-related contaminants detected in soil and indoor air at three residential properties located near the North Brunswick Township High School (ATSDR 2009). An update to the investigation of this residential area has

been incorporated into this PHA to provide an update regarding the public health interpretation of exposure at six residences based on remedial actions and additional investigations since the issuance of the prior health consultation report.

3. A public health assessment (PHA) was completed by the NJDHSS in January 2009 evaluating the potential health implications for exposures to site-related contaminants detected in soil, settled dust and indoor air at the North Brunswick Township High School; in soil at the Judd Elementary School, Veteran's Park, and the PSE&G easement area; and in indoor air at six nearby residences. An update to this PHA has been incorporated into this health consultation to provide further additional assessment regarding the public health interpretation of potential exposures at the NBTHS and ten nearby residences based on remedial actions and continued investigations since the issuance of the prior PHA.

4. The NJDHSS attended public meetings held in February 2007, January and December 2008, and May 2009 with area residents concerning remedial investigations and planned future remedial actions to address remaining soil and groundwater contamination for the NBTHS site and nearby residential area.

5. The ATSDR and NJDHSS are concurrently releasing two Health Consultation documents in the fall of 2009, this report and the *Health Consultation – Analysis of Cancer Incidence in North Brunswick, North Brunswick Township High School Site*

Public Health Actions Planned

1. This health consultation and its companion document will be provided to board of education and township officials, NJDEP, and the Middlesex County Public Health Department. NJDHSS will notify area residents that these reports are available for their review and provide a copy upon request. Representatives of the ATSDR and NJDHSS are available to discuss the results of this report with interested parties.

2. The NJDHSS and the ATSDR will continue to review data as it is made available. The NJDHSS and the ATSDR will review and evaluate future remedial actions and control measures to address remaining soil and groundwater contamination related to the NBTHS site, including groundwater contamination/vapor intrusion for the nearby residential area.

References

[ATSDR] Agency for Toxic Substances and Disease Registry. 1995. Toxicological profile for Automotive Gasoline. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997. Toxicological profile for Tetrachloroethylene. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997. Toxicological profile for Trichloroethylene. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2000. Toxicological profile for Toluene. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2001. Toxicological profile for 1,2-Dichloroethane. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005. Site-Related Contamination At Three Nearby Residences, North Brunswick Township High School Site, North Brunswick, Middlesex County, New Jersey. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005. Public health assessment guidance manual (update). Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006. Toxicological profile for Methyl-tert-butyl Ether. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006. Toxicological profile for Vinyl Chloride. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for Arsenic. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for Benzene. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for Lead. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for Xylenes. US Department of Health and Human Services, Atlanta, Georgia.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2009. Environmental and Health Guideline Comparison Values. Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2009. Public Health Assessment for North Brunswick Township High School Site, North Brunswick, Middlesex County, New Jersey. January 8, 2009.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2009. Health Consultation – Analysis of Cancer Incidence in North Brunswick, North Brunswick Township High School Site, North Brunswick, Middlesex County, New Jersey.

Kleinfelder. 2009. December 2008 Groundwater Sampling Letter Report. February 27, 2009 to Carolyn Ent, NJDEP.

Kleinfelder. 2007. Supplemental Remedial Investigation Report/Remedial Action Workplan for Soil and Waste Material Block 143, Lots 94.01 and 95.01. June 12, 2007 to Carolyn Ent, NJDEP.

Kleinfelder. 2008. June through December 2007 Air Sampling Results Summary Letter. February 20, 2008 to William O'Connor, North Brunswick Township Board of Education.

Kleinfelder. 2008. Schedule for the Implementation of the Remedial Action Workplan. June 6, 2008 to Carolyn Ent, New Jersey Department of Environmental Protection.

Kleinfelder. 2008. Soil Sampling Results Summary for North Brunswick Township High School Practice Fields. April 3, 2008 to Carolyn Ent, New Jersey Department of Environmental Protection.

Kleinfelder. 2008. Addendum to Remedial Action Workplan, Soil Pile in Northwest Woods. September 2, 2008 to Carolyn Ent, New Jersey Department of Environmental Protection.

Kleinfelder. 2009. Addendum to Veteran's Park Remedial Action Workplan, Eight Soil Piles in Northeast Woods. January 29, 2009 to Carolyn Ent, New Jersey Department of Environmental Protection.

Kleinfelder. 2009. Air Sampling Results at the Orchestra Pit Letter Report. January 26, 2009 to William O'Connor, North Brunswick Township Board of Education.

[NBTPS] North Brunswick Township Public Schools. 2008. Notification of Remedial Activities, North Brunswick Township High School, Block 143, Lot 69 (Northwest Woods Area). October 22, 2008 letter to area residents.

Powell-Harpstead, Inc. 2006. Air Sampling Results Summary Letter North Brunswick High School. March 8, 2006 to Marshall Sigall, North Brunswick Township Board of Education.

Samuel Waxman and Kenneth C. Anderson. History of the Development of Arsenic Derivatives in Cancer Therapy. Oncologist, April 2001; 6: 3 - 10.

[NJDEP] New Jersey Department of Environmental Protection. 2006. Vapor Intrusion Guidance. Trenton, New Jersey. October 2006.

[NJDEP] New Jersey Department of Environmental Protection. 2008. Letter response: Soil Sampling Results Summary for North Brunswick Township High School Practice Fields Dated April 3, 2008 to Robert Lombard, North Brunswick Township Administrator and Dr. Brian Zychowski, Superintendent North Brunswick Township High School. Trenton, New Jersey. July 10, 2008.

[USEPA] US Environmental Protection Agency. 1985. Development of statistical distributions or ranges of standard factors used in exposure assessments. Office of Health and Environmental Assessment; EPA report No. EPA 600/8-85-010. Washington, DC. 1985.

[USEPA] US Environmental Protection Agency. 1997. National Center for Environmental Assessment. Office of Research and Development. Exposure Factors Handbook. Washington, DC. August 1997.

[USEPA] US Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Standard Default Exposure Factors Interim Final. Office of Emergency and Remedial Response. Washington, DC. March 25, 1991.

[USEPA] US Environmental Protection Agency. 1991. Federal Register, 40 CFR Part 745 Lead; Identification of Dangerous Levels of Lead; Final Rule. Washington, DC. January 5, 2001.

[USEPA] US Environmental Protection Agency. 2002d. National Center for Environmental Assessment. Office of Research and Development. Child-specific Exposure Factors handbook (Interim Report). Washington, DC. September 1, 2002.

[USEPA] US Environmental Protection Agency. 2008. National Center for Environmental Assessment. Office of Research and Development. Child-Specific Exposure Factors Handbook. Washington, DC. September 2008.

[USEPA] US Environmental Protection Agency. 2008b. National Center for Environmental Assessment. Office of Research and Development. Integrated Risk Information System, Glossary of Terms. Available from: http://www.epa.gov/iris/help_gloss.htm#content

[USEPA] US Environmental Protection Agency. 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). Office of Superfund Remediation and Technology Innovation. Washington, DC. January 2009.

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CERTIFICATION

The Public Health Assessment for the North Brunswick Township High School site, North Brunswick, Middlesex County, New Jersey 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. It is in accordance with approved methodology and procedures existing at the time the Public Health Assessment was initiated.

for Gregory V. Ulirsch, M.S., Ph.D.
Technical Project Officer, CAT, CAPEB, DHAC
Agency for Toxic Substances and Disease Registry

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

Alan Yarbrough
Team Leader, CAT, CAPEB, DHAC
Agency for Toxic Substances and Disease Registry

Table 1: Contaminants in Soil - North Brunswick Township High School: Athletic Practice Fields.
Sample Date: March 4, 2008.

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP RDCSCC [(a)]	
METALS - Surface Soil (0 - 0.5 foot)								
Arsenic	9	9	4.5	7.4	5.7	0.5 (CREG) [(b)]	19	**Yes**
Lead	9	9	21	43	29	NA	400	No
METALS - Subsurface Soil (0.5 - 1 foot)								
Arsenic	8	8	3.8	6.8	5.4	0.5 (CREG) [(b)]	19	**Yes**
Lead	8	8	9.3	40	20	NA	400	No

(a) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (b) Cancer Risk Evaluation Guide; NA - Not Available

Table 2a: Contaminants in Soil: One Waste Soil Pile, Northwest Wooded Area - North Brunswick Township High School. Sample Date: March - June, 2008.

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP RDCSCC [(a)]	
METALS: Surface Soil (0 - 0.5 feet)								
Arsenic	11	11	4.8	826	120	0.5 (CREG) [(b)]	19	**Yes**
METALS: Subsurface Soil (0.5 - 2.0 feet)								
Arsenic	4	4	6.0	131	41	0.5 (CREG) [(b)]	19	**Yes**

(a) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (b) Cancer Risk Evaluation Guide

Table 2b: Contaminants in Soil: Four Waste Soil Piles, Northeast Wooded Area - North Brunswick Township High School. Sample Date: August - October, 2008.

Contaminant	Number of Samples	Number of Detections	Concentration: milligrams/kilogram					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP RDCSCC [(a)]	
METALS: Surface Soil (0 - 0.5 feet)								
Arsenic	31	31	2.5	147	20	0.5 (CREG) [(b)]	19	**Yes**
METALS: Subsurface Soil (0.5 - 2.0 feet)								
Arsenic	4	4	4.6	41	20	0.5 (CREG) [(b)]	19	**Yes**

(a) New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria; (b) Cancer Risk Evaluation Guide

Table 3: Summary of Contaminant Concentrations in Groundwater:
North Brunswick Township High School/Veteran's Park/Residential Areas. Sample Data: July 2004 through December 2008

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP GWQC [a]	
TOTAL METALS: Well Count: 22								
Antimony	107	2	ND	13	0.2	4 (RMEG) [b]	6	**Yes**
Arsenic	182	64	ND	133	6	0.02 (CREG) [c]	3	**Yes**
Barium	67	26	ND	1,480	156	2,000 (RMEG)	6,000	No
Copper	73	25	ND	1,000	45	100 (EMEG) [d]	1,300	**Yes**
Lead	180	117	ND	428	10	15 (MCL) [e]	5	**Yes**
Nickel	164	59	ND	447	34	100 (LTHA) [f]	100	**Yes**
Thallium	26	7	ND	33	6	0.5 (LTHA)	2	**Yes**
Zinc	63	61	ND	999	131	2,000 (LTHA)	2,000	No
TOTAL METALS - UPGRADIENT WELL MW-1								
Antimony	2	0	ND	ND	ND	4 (RMEG)	6	No
Arsenic	6	2	ND	52	15	0.02 (CREG)	3	**Yes**
Barium	4	2	ND	1,800	502	2,000 (RMEG)	6,000	No
Copper	5	3	ND	213	53	100 (EMEG)	1,300	**Yes**
Lead	6	5	ND	183	36	15 (MCL)	5	**Yes**
Nickel	5	3	ND	592	135	100 (LTHA)	100	**Yes**
Thallium	4	0	ND	ND	ND	0.5 (LTHA)	2	No
Zinc	4	2	ND	253	73	2,000 (LTHA)	2,000	No
DISSOLVED METALS: Well Count: 17								
Antimony	53	1	ND	10	0.2	4 (RMEG)	6	**Yes**
Arsenic	92	35	ND	23	4.0	0.02 (CREG)	3	**Yes**
Barium	51	17	ND	759	122	2,000 (RMEG)	6,000	No
Copper	57	3	ND	85	2.5	100 (EMEG)	1,300	No
Lead	86	8	ND	40	0.9	15 (MCL)	5	**Yes**
Nickel	84	31	ND	253	39	100 (LTHA)	100	**Yes**
Thallium	20	2	ND	15	1.4	0.5 (LTHA)	2	**Yes**
Zinc	46	37	ND	580	95	2,000 (LTHA)	2,000	No

Table 3 - continued

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/liter					Contaminant of Concern
			Minimum	Maximum	Average	Environmental Guideline Comparison Value	NJDEP GWQC [(a)]	
DISSOLVED METALS - UPGRADIENT WELL MW-1								
Antimony	2	0	ND	0	0	4 (RMEG)	6	No
Arsenic	4	1	ND	8.7	2.18	0.02 (CREG)	3	**Yes**
Barium	3	1	ND	880	293	2,000 (RMEG)	6,000	No
Copper	3	0	ND	0	0	100 (EMEG)	1,300	No
Lead	4	1	ND	3	0.75	15 (MCL)	5	No
Nickel	3	0	ND	0	0	100 (LTHA)	100	No
Thallium	2	1	ND	20	10	0.5 (LTHA)	2	**Yes**
Zinc	2	0	ND	0	0	2,000 (LTHA)	2,000	No
VOLATILE ORGANIC COMPOUNDS: Well Count 23								
Benzene	224	25	ND	4	0.13	0.6 (CREG)	1	**Yes**
Chloroform	224	14	ND	6.6	0.11	70 (LTHA)	70	No
Chloromethane	224	2	ND	2.9	0.01	30 (LTHA)	3	No
1,2-Dichlorobenzene	203	8	ND	3.3	0.05	600 (LTHA)	600	No
1,4-Dichlorobenzene	196	3	ND	0.64	0.01	75 (LTHA)	75	No
1,1-Dichloroethane	224	6	ND	2.4	0.03	NA	50	No
1,2-Dichloroethane	223	28	ND	49	0.97	0.4 (CREG)	2	**Yes**
1,1-Dichloroethene	224	9	ND	14.9	0.20	7 (MCL)	1	**Yes**
1,2-Dichloroethene (cis)	223	126	ND	1,930	20.45	70 (MCL)	70	**Yes**
1,2-Dichloroethene (trans)	224	33	ND	46	1.74	100 (MCL)	100	No
Ethylbenzene	224	7	ND	7.6	0.09	700 (LTHA)	700	No
Tetrachloroethylene	224	9	ND	16.1	0.12	5 (MCL)	1	**Yes**
Toluene	224	14	ND	9.9	0.20	200 (EMEG)	1,000	No
Trichloroethylene	224	164	ND	4,870	296	5 (MCL)	1	**Yes**
1,1,2-Trichloroethane	224	4	ND	1.4	0.02	0.6	3	**Yes**
Vinyl Chloride	224	48	ND	20.9	0.93	0.03 (CREG)	1	**Yes**
Xylenes	224	10	ND	20.8	0.26	2,000 (RMEG)	1,000	No
VOLATILE ORGANIC COMPOUNDS - UPGRADIENT WELL MW-1								
Above VOCs	5	0	ND	ND	ND	-	-	No

(a) New Jersey Department of Environmental Protection Groundwater Quality Criteria; (b) Reference Media Evaluation Guide; (c) Cancer Risk Evaluation Guide; (d) Environmental Media Evaluation Guide; (e) Maximum Contaminant Level; (f) Lifetime Health Advisory; NA - Not Available; ND - Not Detected

Table 4: Contaminants in Indoor Air - North Brunswick Township High School.
Sample Date: April 2004 through September 2008

Contaminant	Number of Samples [a]	Number of Detections	Concentration: micrograms/cubic meter						Contaminant of Concern
			Minimum	Maximum	Average	Last Round 09/30/2008	Environmental Guideline Comparison Value	NJDEP IASL [d]	
VOLATILE ORGANIC COMPOUNDS									
Benzene	16	8	0	**2**	**0.63**	ND (DL = <0.64)	0.1 (CREG) [e]	2	No [j]
1,2-Dichloroethane	31	0	0.035 [b] (DL = <0.07)	0.41 [b] (DL = <0.81)	NA	0.41 [b] (DL = <0.81)	0.04 (CREG)	2	**Yes** [c]
1,2-Dichloroethene (cis)	31	0	ND (DL = <0.79)	ND (DL = <0.79)	NA	ND (DL = <0.79)	NV [f]	36	No
1,2-Dichloroethene (trans)	16	0	ND (DL = <0.79)	ND (DL = <0.79)	NA	ND (DL = <0.79)	63 (SL)N [k]	73	No
Methy tert-butyl ether	16	0	ND (DL = <0.72)	ND (DL = <0.72)	NA	ND (DL = <0.72)	2,000 (EMEG) [g]	2	No
Tetrachloroethylene	16	3 [h]	ND	**3**	0.38	0.7 [b] (DL=<1.4)	0.41 (SL)C	3	**Yes**
Toluene	16	16	1.7	6	3.54	1.7	300 (EMEG)	5,100	No
Trichloroethylene	38	3 [i]	ND	**3**	0.11	ND (DL = <1.1)	1.2 (SL)C	3	**Yes**
Vinyl Chloride	31	0	0.024 [b] (DL = <0.048)	0.26 [b] (DL=<0.51)	NA	0.26 [b] (DL=<0.51)	0.1 (CREG)	1	**Yes** [c]
Total Xylenes	16	14	ND (DL = <0.87)	57	10	1.6	100 (SL)C	110	No

(a) - Contaminants detected in four ambient air samples were within background concentrations; (b) - Non-detect result: concentration at 1/2 the report detection limit (DL) in parenthesis - based on last round of sampling September 2008; (c) Contaminant not detected above the NJDEP IASL; (d) New Jersey Department of Environmental Protection Indoor Air Screening Level; (e) Cancer Risk Evaluation Guide; (f) NV - No present value; (g) Environmental Media Evaluation Guideline; (h) Detections present at auditorium, groundwater treatment room, and student cafeteria; (i) Detections present at Guidance Office and sump pit; (j) - Determined by NJDEP to originate from background sources; (k) USEPA Region 6 Human Health Media-Specific Screening Levels;
ND - Not Detected; NA - Not Applicable

Table 5: Summary of Contaminants in Indoor Air - 10 Residences
Sample Date: June 2004 through April 2009

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/cubic meter					Contaminant of Concern	Number of Residences Above CVs[g]
			Minimum	Maximum	Average	Environmental Guideline Comparison Value (CVs)	NJDEP IASL [c]		
VOLATILE ORGANIC COMPOUNDS									
Benzene	28	27	ND	**35.1**	**4.17**	0.1 (CREG) [d]	2	No [i]	10
1,2-Dichloroethane	28	3	ND	**1.5**	**0.12**	0.04 (CREG)	2	**Yes**	3 h (7 residents)
1,2-Dichloroethene (cis)	28	0	0.41 [a] (DL = <0.81)	0.41 [a] (DL = <0.81)	0.41 [a] (DL = <0.81)	NA	36	No	0
1,2-Dichloroethene (trans)	28	1	ND	0.44	0.02	63 (SL)N [e]	73	No	0
Methy tert-butyl ether	21	7	ND	**6.1**	1.01	2,000 (EMEG) [f]	2	No [i]	2
Tetrachloroethylene	28	8	ND	**12**	**1.04**	0.41 (SL)C	3	No [i]	3 h (3 residents)
Toluene	28	26	ND	**648**	48	300 (EMEG)	5,100	No [i]	1
Trichloroethylene	28	12	ND	**10**	**1.26**	1.2 (SL)C	3	**Yes**	5
Vinyl Chloride	28	0	0.26 [a] (DL = <0.51)	0.26 [a] (DL = <0.51)	0.26 [a] (DL = <0.51)	0.1 (CREG)	1	**Yes** [b]	0 h (9 residents)
Total Xylenes	28	27	ND	**244**	24	100 (SL)C	110	No [i]	0

(a) - Non-detect result: concentration at 1/2 the report detection limit (DL) in parenthesis; (b) Contaminant not detected, however, 1/2 detection limit for result exceeded the comparison value; (c New Jersey Department of Environmental Protection Indoor Air Screening Level; (d) Cancer Risk Evaluation Guide; (e) USEPA Region 6 Human Health Media-Specific Screening Levels; (f) Environmental Media Evaluation Guidelines; (g) Based on average detected concentrations; (h) Number in parenthesis (i.e. h-7) - indicates number of residences where contaminant not detected but 1/2 detection limit exceeded CV; (i) - Determined by NJDEP to originate from background sources; ND - Not Detected; NA - Not Available; Bolded numbers indicate exceedance of CV.

Table 6: Contaminants Detected in Ambient Air - Residential Area
Sample Date: June 2004 through April 2009

Contaminant	Number of Samples	Number of Detections	Concentration: micrograms/cubic meter		
			Minimum	Maximum	Average
VOLATILE ORGANIC COMPOUNDS					
Benzene	7	5	ND	2.2	0.63
1,2-Dichloroethane	7	0	ND	ND	ND
1,2-Dichloroethene (cis)	7	0	ND	ND	ND
1,2-Dichloroethene (trans)	7	0	ND	ND	ND
Methy tert-butyl ether	4	0	ND	ND	ND
Tetrachloroethylene	7	1	ND	0.81	0.12
Toluene	7	6	ND	29	5.56
Trichloroethylene	7	0	ND	ND	ND
Vinyl Chloride	7	0	ND	ND	ND
Total Xylenes	7	6	ND	13	2.79

ND - Not Detected

Table 7 – Evaluated Exposure Pathways

Pathway	Pathway Exposure Pathway Elements					Pathway Classification
	Environmental Medium	Route of Exposure	Location	Exposed Population	Point of Exposure	
Soil	Surface Soil (0 – 6 inches)	Ingestion	North Brunswick Township High School	Students and Adult Faculty	Athletic Practice Field	Past, Present & Future – Completed
					Soil Pile in Northwest Wooded Area	Past – Completed Present & Future – Eliminated [a]
					Soil Piles in Northeast Wooded Areas	Past, Present & Future – Completed [b]
Indoor Air	Indoor Air	Inhalation	North Brunswick Township High School	Students and Adult Faculty	Auditorium Area	Past – Completed Present & Future – Interrupted [c]
			6 Residences	Area Residents (Child and Adult)	Basement Interior	Past – Completed Present & Future – Interrupted [d]

(a) Soil pile in northwest wooded area - exposures considered eliminated through remedial actions completed in July 2009.
(b) Soil piles in northeast wooded area – future exposures should become eliminated pending completion of remedial actions scheduled for 2010.
(c) Following the June 2007 blower installation, present and future exposures to students or faculty regarding indoor air contaminants are considered to be interrupted.
(d) Present and Future exposures are considered interrupted as the New Jersey Department of Environmental Protection (NJDEP) is actively monitoring the residences to prevent chronic exposures regarding inhalation of contaminants of concern, primarily TCE, in indoor air at concentrations exceeding the Indoor Air Screening Level.

Table 8: Comparison of Soil Ingestion Exposure Dose with Health Guideline Comparison Values (CVs) for Non-Cancer Health Effects. North Brunswick High School - Athletic Practice Field.

Contaminant of Concern	Average (Maximum) (mg/kg)	Average Exposure Dose (Maximum Exposure Dose) (mg/kg/day)		Health Guideline CVs (mg/kg/day)		Potential for Non-Cancer Health Effects [e]
		Student [a]	Adult [b]	ATSDR MRL [c]	USEPA RfD [d]	
Arsenic	5.7 (7.4)	4.20E-06 (5.45E-06)	4.02E-06 (5.21E-06)	3E-04 C	3E-04	No
Lead	29 (43)	2.13E-05 (3.16E-05)	2.04E-05 (3.05E-05)	NA	NA	No

(a) Student exposure assumptions: 5 days/week, 36 weeks/year; 67 kg body weight; 100 mg/day ingestion rate; (b) Adult exposure assumptions: 5 days/week, 36 weeks/year; 70 kg body weight; 100 mg/day ingestion rate; (c) Agency for Toxic Substances Disease Registry's Minimal Risk Level (C= Chronic > 364 days); (d) Reference Dose; (e) Based on the average exposure dose which presents the most likely scenario; Value in parenthesis based on maximum concentration; NA - Not Available

It is noted that arsenic concentrations were detected below the NJDEP RDCSCC of 19 mg/kg for areas outside the waste-fill boundary area, including the athletic practice field. Therefore, as arsenic exists naturally in the environment, concentrations detected at these locations are considered to be part of background concentrations and are not likely associated with past landfill activities. However, for the purposes of the HC, contaminants which exceed an Environmental Guideline CV are established as COCs and are considered for further evaluation regardless of the locations from which environmental samples are collected, in this case from areas outside the waste-fill boundary.

Table 9: Comparison of Soil Ingestion Exposure Dose with Health Guideline Comparison Values (CVs) for Non-Cancer Health Effects. Northwest and Northeast Wooded Areas - Surface Contact Layer.

Contaminant of Concern	Average (Maximum) (mg/kg)	Average Exposure Dose (Maximum Exposure Dose) (mg/kg/day)		Health Guideline CVs (mg/kg/day)		Potential for Non-Cancer Health Effects [e]
		Child [a]	Adult [b]	ATSDR MRL [c]	USEPA RfD [d]	
Northwest Wooded Area - Surface Soil						
Arsenic	120 (826)	1.17E-04 (8.03E-04)	3.67E-05 (2.53E-04)	3E-04 C	3E-04	No
Northeast Wooded Area - Surface Soil						
Arsenic	20 (147)	1.95E-05 (1.43E-4)	6.11E-6 (4.49E-05)	3E-04 C	3E-04	No

(a) Child exposure assumptions: 3 days/week, 26 weeks/year; 44 kg body weight, 10 year exposure; 200 mg/day ingestion rate; (b) Adult exposure assumptions: 3 days/week, 26 weeks/year, 28 year exposure; 70 kg body weight; 100 mg/day ingestion rate; (c) Agency for Toxic Substances Disease Registry's Minimal Risk Level (C= Chronic > 364 days); (d) Reference Dose; (e) Based on the average exposure dose which presents the most likely scenario; Value in parenthesis based on maximum concentration.

Table 10: Comparison of Indoor Air Contaminant Concentrations with Health Guideline Comparison Values (CVs) - North Brunswick Township High School.
Sample Data: April 2004 through September 2008

Contaminant	Maximum ($\mu g/m^3$) *	Average ($\mu g/m^3$)	Health Guideline CVs - ($\mu g/m^3$)		Potential for Non-Cancer Health Effects
			ATSDR MRL [(a)]	U.S. EPA RfC [(b)]	
VOLATILE ORGANIC COMPOUNDS					
1,2-Dichloroethane	0.41 [(c)] (DL = <0.81)	0.41 [(c)] (DL = <0.81)	2,000 C	NA	No
Tetrachloroethylene	3	0.38	300 C	270	No
Trichloroethylene	3	0.11	500 I	40	No
Vinyl Chloride	0.26 [(c)] (DL = <0.51)	0.26 [(c)] (DL = <0.51)	80 I	100	No

* - Micrograms per cubic meter

(a) - Agency for Toxic Substance and Disease Registry Minimal Risk Levels (I = Intermediate 15-364 days, C= Chronic > 364 days); (b) U.S. Environmental Protection Agency's Reference Concentration: considered for lifetime exposure to contaminant without deleterious effects;

(c) - Non-detect result: concentration at 1/2 the report detection limit (DL) in parenthesis; NA - Not Available

Table 11: Comparison of Indoor Air TCE and 1,2-DCA Concentrations with Health Guideline Comparison Values (CVs) for Non-Cancer Health Effects. Nearby Residential Area. Sample Data: June 2004 through April 2009.

Residence	Range of Detected TCE Concentrations (µg/m³) *	Average of Detected TCE Concentrations (µg/m³)	Health Guideline CVs (µg/m³) ATSDR MRL [(a)]	Health Guideline CVs (µg/m³) U.S. EPA RfC [(b)]	Potential for Non-Cancer Health Effects
A	ND – 0.75J	0.19	500 I	40	No
B	ND – 0.42J	0.08			
C	ND – 0.32J	0.16			
D	ND - 6.5	1.7			
E	ND - 2.4	1.3			
F	ND	ND			
G	3.5	3.5			
H	7	7			
I	10	10			
J	ND	ND			

Residence	Range of Detected 1,2-DCA Concentrations (µg/m³) *	Average of Detected 1,2-DCA Concentrations (µg/m³)	Health Guideline CVs (µg/m³) ATSDR MRL [(a)]	Health Guideline CVs (µg/m³) U.S. EPA RfC [(b)]	Potential for Non-Cancer Health Effects
B	ND – 1.5	0.30	2000 C	2,400	No
D	ND – 0.45	0.09			
E	1.3	1.30			

* - Micrograms per cubic meter

(a) - Agency for Toxic Substance and Disease Registry Minimal Risk Levels (I = Intermediate 15-364 days, C = Chronic >364 days);

(b) U.S. Environmental Protection Agency's Reference Concentration: considered for lifetime exposure to contaminant without deleterious effects; J - Estimated Value; ND - Not Detected (detection limit below CVs)

Table 12: Calculated LECR with Contaminants in Soil at North Brunswick High School: High School Athletic Practice Field - Surface Soil Contact Layer

Contaminant of Concern	DHHS Cancer Class [a]	Average (Maximum) (mg/kg)	Exposure Dose (mg/kg/day)		CSF [d] $(mg/kg/d)^{-1}$	LECR [e]	
			Student [b] Avg. (Max.)	Adult [c] Avg. (Max.)		Student Avg. (Max.)	Adult Avg. (Max.)
METALS							
Arsenic	1	5.7 (7.4)	2.41E-07 (3.13E-07)	2.29E-06 (2.98E-06)	1.5	3.61E-07 (4.69E-07)	3.44E-06 (4.47E-06)

(a) Department of Health and Human Services Cancer Class: 1 = known human carcinogen; 2 = reasonably anticipated to be a carcinogen; 3 = not classified; (b) Student exposure assumptions: 5 days/week, 36 weeks/year, 4 year exposure duration; 67 kg body weight; 100 mg/day ingestion rate; (c) Adult faculty exposure assumptions: 5 days/week, 36 weeks/year, 40 year exposure duration; 70 kg body weight; 100 mg/day ingestion rate; (d) Cancer Slope Factor; (e) Lifetime Excess Cancer Risk; Values in parenthesis based on maximum concentrations; NA - Not Available

It is noted that arsenic concentrations were detected below the NJDEP RDCSCC of 19 mg/kg for areas outside the waste-fill boundary area, including the athletic practice field. Therefore, as arsenic exists naturally in the environment, concentrations detected at these locations are considered to be part of background concentrations and are not likely associated with past landfill activities. However, for the purposes of the HC, contaminants which exceed an Environmental Guideline CV are established as COCs and are considered for further evaluation regardless of the locations from which environmental samples are collected, in this case from areas outside the waste-fill boundary.

Table 13: Calculated LECR with Contaminants in Surface Soil at the Northwest and Northeast Wooded Areas: Soil Piles - Surface Soil Contact Layer.

Contaminant of Concern	DHHS Cancer Class [(a)]	Average (Maximum) (mg/kg)	Exposure Dose (mg/kg/day)		CSF [(d)] $(mg/kg/d)^{-1}$	LECR [(e)]	
			Child [(b)] Avg. (Max.)	Adult [(c)] Avg. (Max.)		Child Avg. (Max.)	Adult Avg. (Max.)
Northwest Wooded Soil Pile Area							
Arsenic	1	120 (826)	1.67E-05 (1.15E-04)	1.47E-05 (1.01E-04)	1.5	2.50E-05 (1.72E-04)	2.20E-05 (1.52E-04)
Northeast Wooded Soil Pile Area							
Arsenic	1	20 (147)	2.78E-06 (2.05E-05)	2.45E-06 (1.80E-05)	1.5	4.17E-06 (3.07E-05)	3.67E-06 (2.70E-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) Child resident exposure assumptions: 3 days/week, 26 weeks/year, 10 year exposure duration; 44 kg body weight; 200 mg/day ingestion rate; (c) Adult resident exposure assumptions: 3 days/week, 26 weeks/year, 28 year exposure duration; 70 kg body weight; 100 mg/day ingestion rate; (d) Cancer Slope Factor; (e) Lifetime Excess Cancer Risk; Values in parenthesis based on maximum concentrations

Table 14: Calculated LECRs Based on TCE and PCE Concentrations in Indoor Air
North Brunswick Township High School.
Sample Data: April 2004 through September 2008

Exposed Population	Average of Detected TCE (PCE) Concentrations ($\mu g/m^3$) [(a)]	TCE (PCE) Exposure Concentrations [(b)] ($\mu g/m^3$)	USEPA IUR [(c)] $(\mu g/m^3)^{-1}$	LECR
Student (14 to 18 years old)	0.11 (0.38)	0.001 (0.004)	2E-06 [(d)] (5.9E-06) [(e)]	2.31E-08
Adult Faculty		0.02 (0.05)		3.47E-07

Notes:
(a) - micrograms per cubic meter.
(b) - Exposure concentration based on the average concentration adjusted to the following exposure assumptions:
Student: 8 hours/day, 5 days/week, 36 weeks/year, 4 year exposure duration, 70 year averaging;
Adult: 12 hours/day, 5 days/week, 36 weeks/year, 40 year exposure duration (based on approximated maximum term of employment), 70 year averaging (USEPA 2002d, 2009)
(c) - Inhalation Unit Risk (cancer slope factor) for human inhalation exposure.
(d) - IUR for TCE
(e) - IUR for PCE with concentrations provided in parenthesis.

Table 15: Calculated LECRs Based on Detected Concentrations of TCE and 1,2-DCA in Indoor Air - Nearby Residential Area Sample Data: June 2004 through April 2009

Residence	Exposed Population	Average of Detected TCE (1,2-DCA) Concentrations (µg/m^3) (b)	TCE (1,2-DCA) Exposure Concentrations (b) (µg/m^3)	USEPA IUR (c) (µg/m^3)$^{-1}$	LECR
A	Adult/Child	0.19	0.04	2E-06 (d) (2.6E-05) (e)	7.76E-08
B		0.084 (0.30)	0.02 (0.06)		1.59E-06
C		0.16	0.03		6.20E-08
D		1.74 (0.09)	0.35 (0.0018)		1.16E-06
E		1.3	0.3		5.33E-07
F		ND	ND		NA
G		3.5 (1.3)	0.70 (0.26)		8.16E-06
H		7	1.40		2.80E-06
I		10	2.00		4.00E-06
J		ND	ND		NA

Notes:

(a) - micrograms per cubic meter.
(b) - Based on the maximum length of residency for current residents. Exposure Assumptions: 365 days a year exposure frequency, 14 years, 70 years averaging time (USEPA 2002d, 2009)

(c) - Inhalation Unit Risk (cancer slope factor) for human inhalation exposure.

(d) - IUR for TCE

(e) - IUR for 1,2-DCA applied to Residences B, D, and G with concentrations provided in parenthesis.
NA - Not Applicable

Figure 2: Site location showing North Brunswick Township High School, including the Areas of Concern – athletic practice field, northwest and northeast soil pile areas and surrounding residential areas.

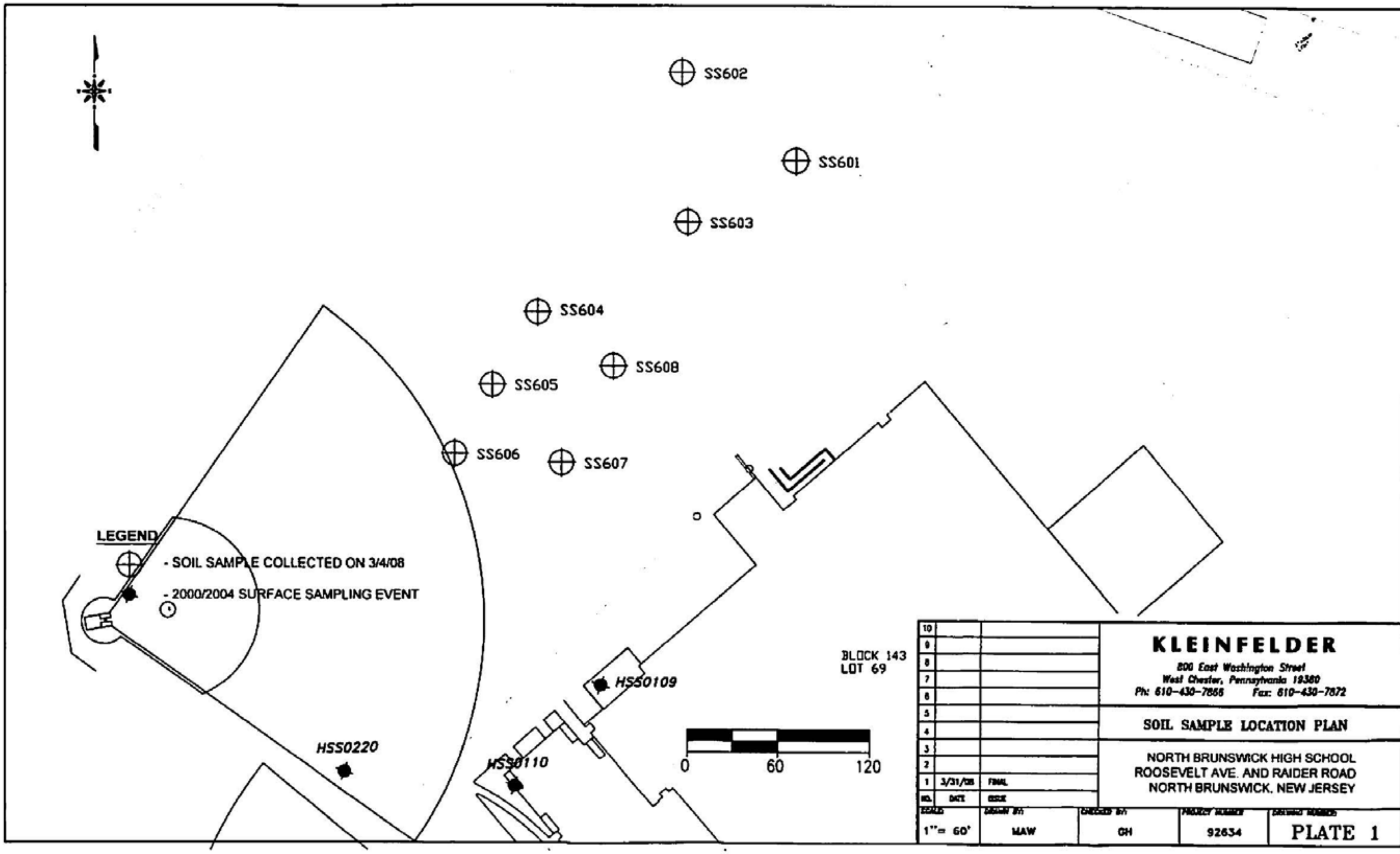


Figure 3: Athletic practice field area including soil sample locations.

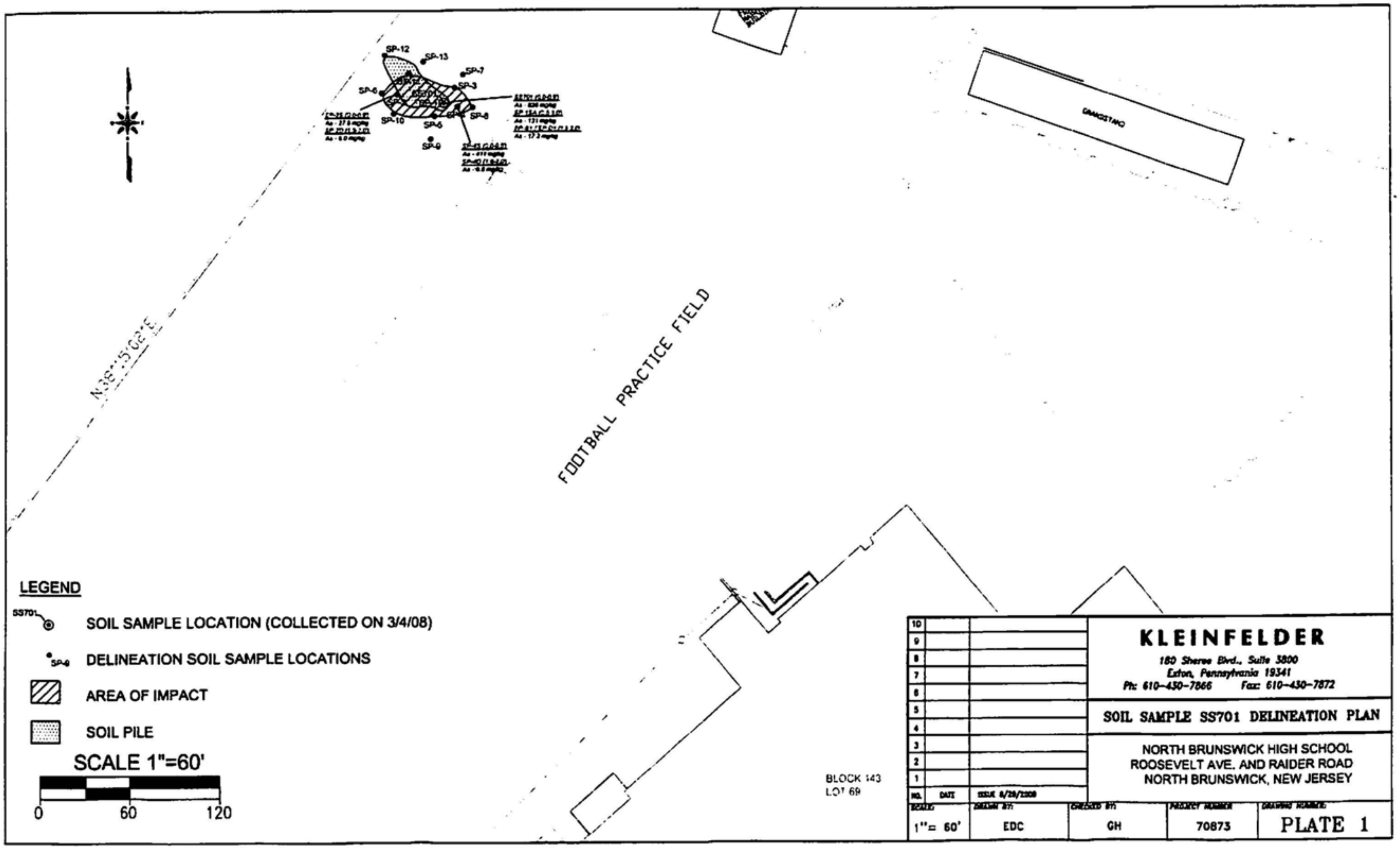


Figure 4: Northwest soil pile area including sample locations and soil delineation boundaries.

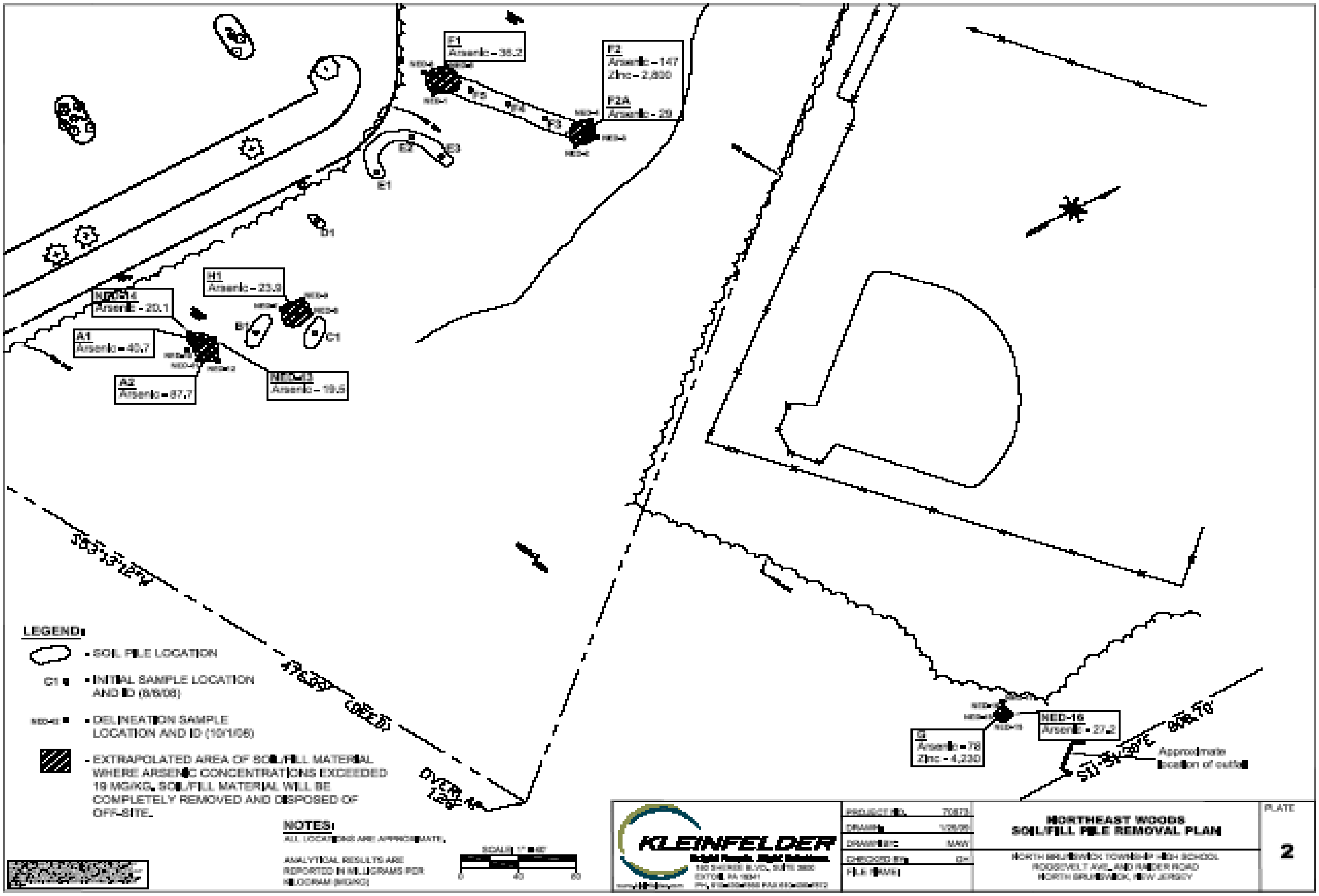


Figure 5: Northeast soil pile areas including sample locations and soil delineation boundaries.

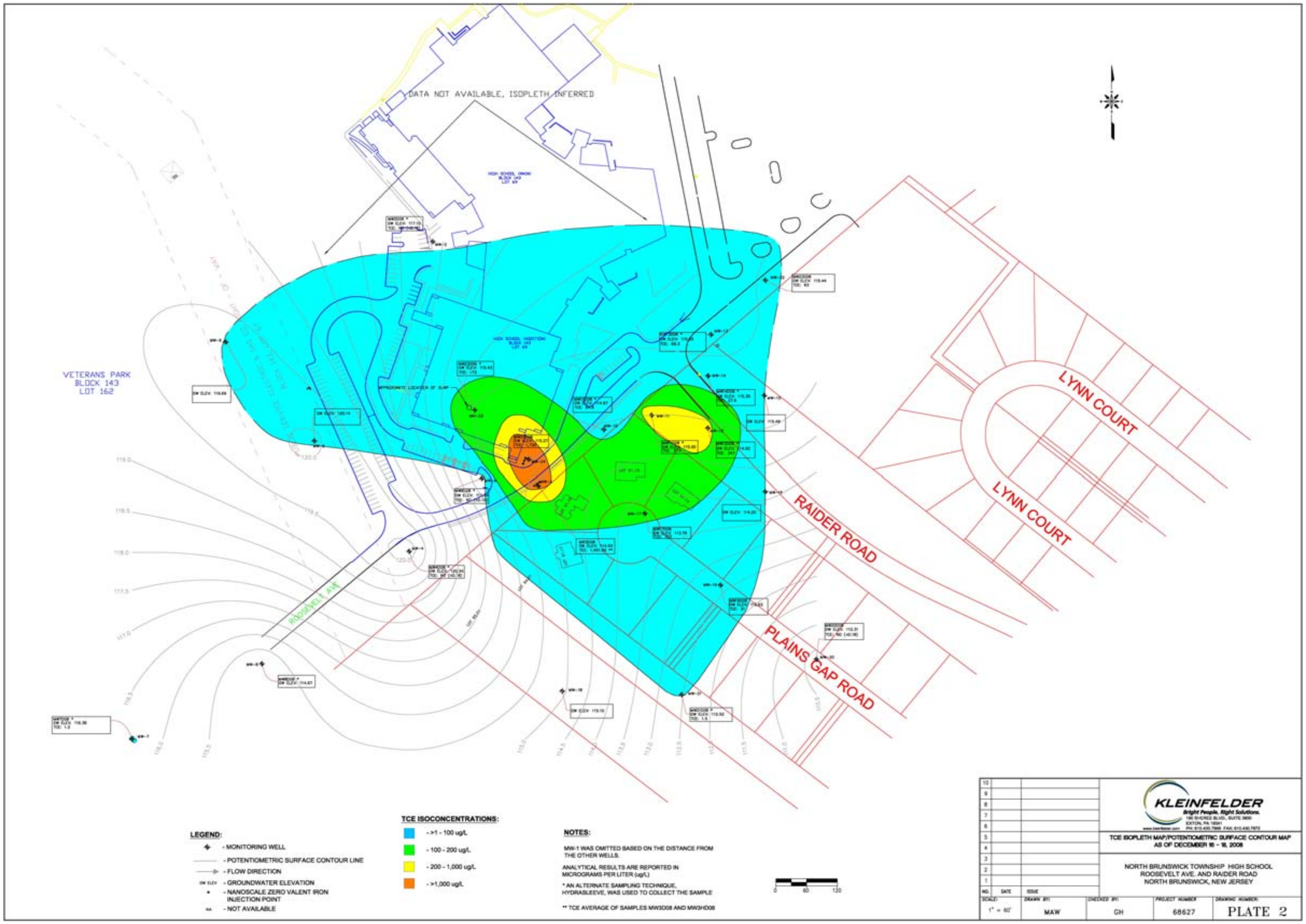
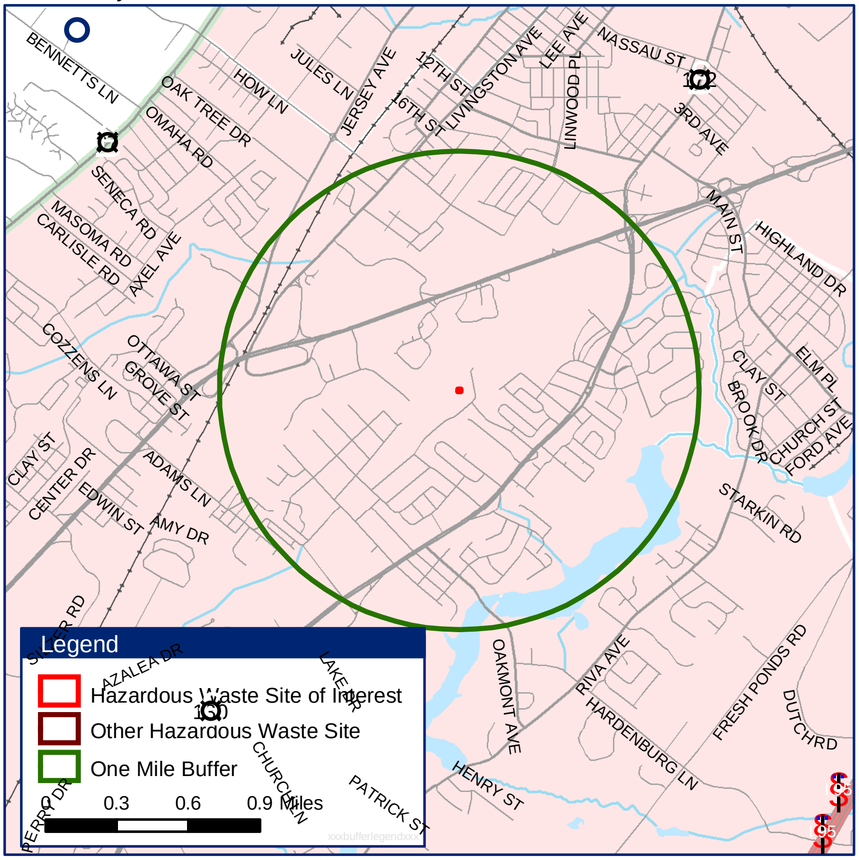


Figure 6: Trichloroethylene contaminant plume in groundwater at the south end of the North Brunswick Township High School and within the nearby residential area.

North Brunswick High School

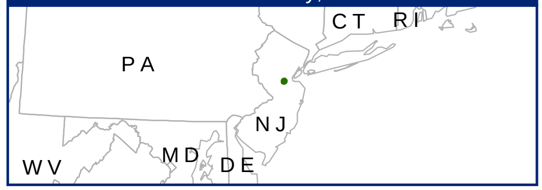
North Brunswick, NJ

EPA Facility ID: NJD103805370



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: Middlesex County, NJ

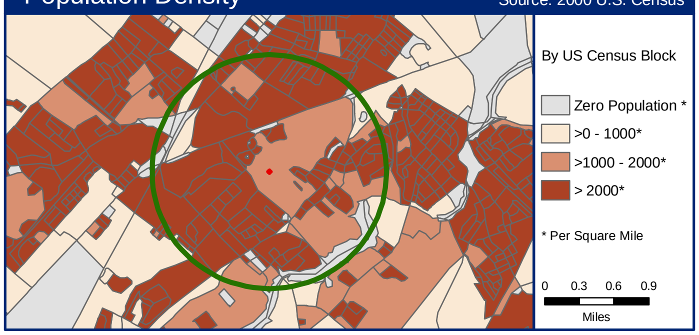


Demographic Statistics
Within One Mile of Site*

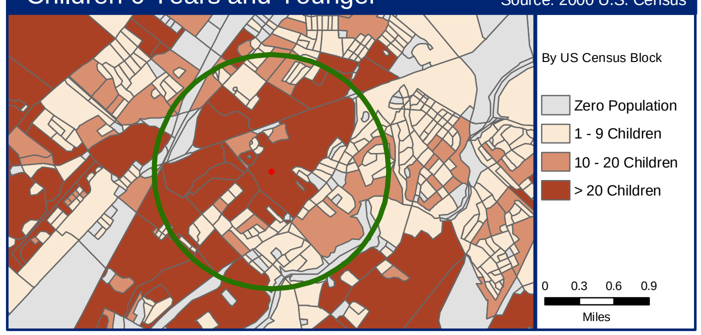
Total Population	11,326
White Alone	7,027
Black Alone	1,890
Am. Indian & Alaska Native Alone	8
Asian Alone	1,507
Native Hawaiian & Other Pacific Islander Alone	2
Some Other Race Alone	508
Two or More Races	384
Hispanic or Latino**	1,232
Children Aged 6 and Younger	1,105
Adults Aged 65 and Older	1,003
Females Aged 15 to 44	2,744
Total Housing Units	4,312

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

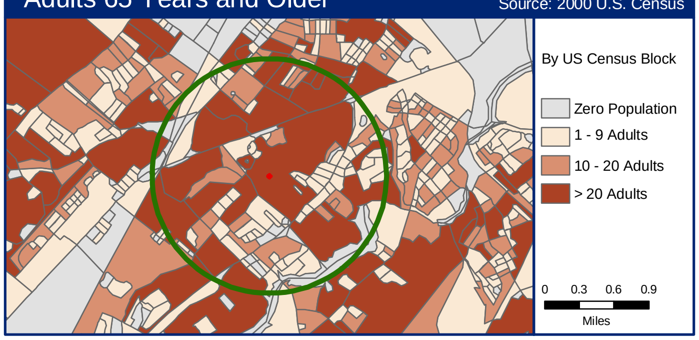
Population Density
Source: 2000 U.S. Census



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



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



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

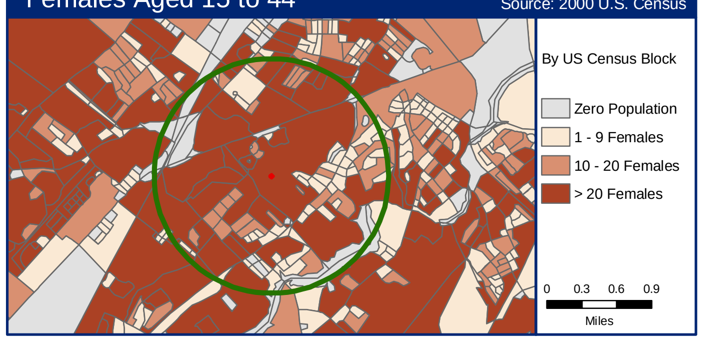


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Figure 7 Demographics information for the North Brunswick Township High School site based on 2000 census data.

Appendix A

Indoor Air Quality Information Sources

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.state.nj.us/health/eoh/tsrp/index.html

Appendix A: Uses and Typical U.S. Background Concentrations of Selected Contaminants of Concern Detected in Residential Indoor Air Samples – North Brunswick Township High School Site, North Brunswick Township, New Jersey

Chemical	Usage[a-g]	Sources of Common Exposure[b]	Background Concentrations ($\mu g/m^3$)[c]
Benzene	Solvents, gasoline, resins and plastics; nylon; paints; adhesives (especially carpet); printing; pesticides; detergents/disinfectants; dyes; photographic processing	Gasoline emissions; cigarette smoke; paints and adhesives; particle board and wood composites; wood smoke	1 (average outdoor – Monmouth County, New Jersey)[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]
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)[e]
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	1-5 (indoor average)[d]
Trichloroethylene (TCE)	Solvent; degreaser; dry cleaning and textile production; adhesives, paint removers; correction fluid (e.g., white out) and spot removers	Present main use as a metal degreaser; dry cleaned garments; paint removers; fabric cleaning products (e.g., stain removers, etc.)	0.2-4 (ambient average)[f]
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 North Brunswick Township High School site in particular, but are presented to provide the homeowner some perspective as to levels typically found in U.S. homes and ambient air.
[d]HSDB, 2002, at www.toxnet.nlm.nih.gov
[e]EPA, 1988
[f]Tox Profile at www.atsdr.cdc.gov
[g]EPA, 1999

ATSDR

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

1,2-DICHLOROETHANE

CAS #107-06-2

This fact sheet answers the most frequently asked health questions (FAQs) about 1,2-Dichloroethane. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to 1,2-dichloroethane usually occurs by breathing contaminated air in workplaces that use 1,2-dichloroethane. Breathing or ingesting high levels of 1,2-dichloroethane can cause damage to the nervous system, liver, kidneys, and lungs and may cause cancer. This substance has been found in at least 570 of the 1,585 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is 1,2-dichloroethane?

1,2-Dichloroethane, also called ethylene dichloride, is a manufactured chemical that is not found naturally in the environment. It is a clear liquid and has a pleasant smell and sweet taste.

The most common use of 1,2-dichloroethane is in the production of vinyl chloride which is used to make a variety of plastic and vinyl products including polyvinyl chloride (PVC) pipes, furniture and automobile upholstery, wall coverings, housewares, and automobile parts. It is also used to as a solvent and is added to leaded gasoline to remove lead.

What happens to 1,2-dichloroethane when it enters the environment?

❏ Most of the 1,2-dichloroethane released to the environment is released to the air. In the air, 1,2-dichloroethane breaks down by reacting with other compounds formed by sunlight. It can stay in the air for more than 5 months before it is broken down.
❏ 1,2-Dichloroethane can also be released into rivers and lakes. It breaks down very slowly in water and most of it will evaporate to the air.
❏ 1,2-Dichloroethane released in soil will either evaporate into the air or travel down through the soil and enter underground water.

How might I be exposed to 1,2-dichloroethane?

❏ The general population may be exposed to 1,2-dichloroethane by breathing air or drinking water that contains 1,2-dichloroethane.
❏ People who work or live near a factory where 1,2-dichloroethane is used, may be exposed to higher than usual levels.
❏ People living near uncontrolled hazardous waste sites may also be exposed to higher than usual levels of 1,2-dichloroethane.

How can 1,2-dichloroethane affect my health?

Nervous system disorders, liver and kidney diseases, and lung effects have been reported in humans ingesting or inhaling large amounts of 1,2-dichloroethane.

In laboratory animals, breathing or ingesting large amounts of 1,2-dichloroethane have also caused nervous system disorders and liver, kidney, and lung effects. Animal studies also suggest that 1,2-dichloroethane may damage the immune system. Kidney disease has also been seen in animals ingesting low doses of 1,2-dichloroethane for a long time. Studies in animals indicate that 1,2-dichloroethane does not affect reproduction.

How likely is 1,2-dichloroethane to cause cancer?

Human studies examining whether 1,2-dichloroethane can cause cancer have been considered inadequate. In animals, increases in the occurrence of stomach, mammary gland, liver, lung, and endometrium cancers have been seen following inhalation, oral, and dermal exposure.

The Department of Health and Human Services (DHHS) has determined that 1,2-dichloroethane may reasonably be expected to cause cancer. The EPA has determined that 1,2-dichloroethane is a probable human carcinogen and the International Agency for Cancer Research (IARC) considers it to be a possible human carcinogen.

How can 1,2-dichloroethane affect children?

We do not know if exposure to 1,2-dichloroethane will result in birth defects or other developmental effects in people. Studies in animals suggest that 1,2-dichloroethane does not produce birth defects.

It is likely that health effects seen in children exposed to high levels of 1,2-dichloroethane will be similar to the effects seen in adults.

How can families reduce the risk of exposure to 1,2-dichloroethane?

The general population is not likely to be exposed to large amounts of 1,2-dichloroethane. In the past, it was used in small amounts in household products such as cleaning agents, pesticides, and wallpaper and carpet glue. Risk of exposure from this source could be eliminated if these older products were immediately discarded.

Children should avoid playing in soils near uncontrolled hazardous waste sites where 1,2-dichloroethane may have been discarded.

Is there a medical test to show whether I've been exposed to 1,2-dichloroethane?

Tests are available to measure 1,2-dichloroethane in breath, blood, breast milk, and urine of exposed people. Because 1,2-dichloroethane leaves the body fairly quickly, these tests need to be done within a couple of days of exposure. These tests cannot be used to predict the nature or severity of toxic effects. These tests are not usually done in the doctor's office.

Has the federal government made recommendations to protect human health?

The EPA allows 0.005 milligrams of 1,2-dichloroethane per liter of drinking water (0.005 mg/L).

The Occupational Safety and Health Administration has set a limit of 50 parts of 1,2-dichloroethane per million parts of air (50 ppm) in workplace air for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2001. Toxicological Profile for 1,2-Dichloroethane. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

ATSDR

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

AUTOMOTIVE GASOLINE

CAS # 8006-61-9

This fact sheet answers the most frequently asked health questions (FAQs) about automobile gasoline. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to automotive gasoline most likely occurs from breathing its vapor at a service station while filling a car's fuel tank. At high levels, automotive gasoline is irritating to the lungs when breathed in and irritating to the lining of the stomach when swallowed. Exposure to high levels may also cause harmful effects to the nervous system. Automotive gasoline has been found in at least 23 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is automotive gasoline?

(Pronounced ô′tə-mō′tĭv găs′ə-lēn′)

The gasoline discussed in this fact sheet is automotive used as a fuel for engines in cars. Gasoline is a colorless, pale brown, or pink liquid, and is very flammable.

Gasoline is a manufactured mixture that does not exist naturally in the environment. Gasoline is produced from petroleum in the refining process.

Typically, gasoline contains more than 150 chemicals, including small amounts of benzene, toluene, xylene, and sometimes lead. How the gasoline is made determines which chemicals are present in the gasoline mixture and how much of each is present. The actual composition varies with the source of the crude petroleum, the manufacturer, and the time of year.

What happens to automotive gasoline when it enters the environment?

- ❑ Small amounts of the chemicals present in gasoline evaporate into the air when you fill the gas tank in your car or when gasoline is accidentally spilled onto surfaces and soils or into surface waters.
- ❑ Other chemicals in gasoline dissolve in water after spills to surface waters or underground storage tank leaks into the groundwater.
- ❑ In surface releases, most chemicals in gasoline will probably evaporate; others may dissolve and be carried away by water; a few will probably stick to soil.
- ❑ The chemicals that evaporate are broken down by sunlight and other chemicals in the air.
- ❑ The chemicals that dissolve in water also break down quickly by natural processes.

How might I be exposed to automotive gasoline?

- ❑ Breathing vapors at a service station when filling the car's fuel tank is the most likely way to be exposed.
- ❑ Working at a service station.
- ❑ Using equipment that runs on gasoline, such as a lawn mower.
- ❑ Drinking contaminated water.
- ❑ Being close to a spot where gasoline has spilled or leaked into the soil.

How can automotive gasoline affect my health?

Many of the harmful effects seen after exposure to gasoline are due to the individual chemicals in the gasoline mixture, such as benzene and lead. Inhaling or swallowing large amounts of gasoline can cause death.

Inhaling high concentrations of gasoline is irritating to the lungs when breathed in and irritating to the lining of the stomach when swallowed. Gasoline is also a skin irritant. Breathing in high levels of gasoline for short periods or swallowing large amounts of gasoline may also cause harmful effects on the nervous system.

Serious nervous system effects include coma and the inability to breathe, while less serious effects include dizziness and headaches.

There is not enough information available to determine if gasoline causes birth defects or affects reproduction.

How likely is automotive gasoline to cause cancer?

The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have not classified automotive gasoline for carcinogenicity. Automotive gasoline is currently undergoing review by the EPA for cancer classification.

Some laboratory animals that breathed high concentrations of unleaded gasoline vapors continuously for 2 years developed liver and kidney tumors. However, there is no evidence that exposure to gasoline causes cancer in humans.

Is there a medical test to show whether I've been exposed to automotive gasoline?

Laboratory tests are available that can measure elevated blood or urine levels of lead (as an indication of exposure to leaded gasoline only), benzene, or other substances that may result from exposure to gasoline or other sources. These methods are sensitive enough to measure background levels and levels where health effects may occur. These tests aren't available in most doctors' offices, but can be done at special laboratories that have the right equipment.

Has the federal government made recommendations to protect human health?

The EPA has established many regulations to control air pollution. These are designed to protect the public from the possible harmful health effects of gasoline.

The American Conference of Governmental Industrial Hygienists (ACGIH) set a maximum level of 890 milligrams of gasoline per cubic meter of air (890 mg/m^3) for an 8-hour workday, 40-hour workweek.

Glossary

Carcinogenicity: Ability to cause cancer.

CAS: Chemical Abstracts Service.

Crude petroleum: Petroleum that has not been processed.

Dissolve: To disappear gradually.

Evaporate: To change into a vapor or a gas.

Irritant: A substance that causes an abnormal reaction.

Mixture: A combination of two or more components.

Refining process: The process by which petroleum is purified to form gasoline.

Tumor: An abnormal mass of tissue.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for automotive gasoline. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

METHYL *TERT*-BUTYL ETHER (MTBE) CAS # 1634-04-4

This fact sheet answers the most frequently asked health questions (FAQs) about methyl *tert*-butyl ether (MTBE). For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Methyl *tert*-butyl ether (MTBE) is a flammable liquid which is used as an additive in unleaded gasoline. Drinking or breathing MTBE may cause nausea, nose and throat irritation, and nervous system effects. MTBE has been found in at least 11 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is methyl *tert*-butyl ether?

(Pronounced mĕth′əl tũr′shē-ĕr′ē byo͞ot′l ē′thər)

Methyl *tert*-butyl ether (MTBE) is a flammable liquid with a distinctive, disagreeable odor. It is made from blending chemicals such as isobutylene and methanol, and has been used since the 1980s as an additive for unleaded gasolines to achieve more efficient burning.

MTBE is also used to dissolve gallstones. Patients treated in this way have MTBE delivered directly to their gall bladders through special tubes that are surgically inserted.

What happens to MTBE when it enters the environment?

- ❑ MTBE quickly evaporates from open containers and surface water, so it is commonly found as a vapor in the air.
- ❑ Small amounts of MTBE may dissolve in water and get into underground water.
- ❑ It remains in underground water for a long time.
- ❑ MTBE may stick to particles in water, which will cause it to eventually settle to the bottom sediment.
- ❑ MTBE may be broken down quickly in the air by sunlight.
- ❑ MTBE does not build up significantly in plants and animals.

How might I be exposed to MTBE?

- ❑ Touching the skin or breathing contaminated air while pumping gasoline.
- ❑ Breathing exhaust fumes while driving a car.
- ❑ Breathing air near highways or in cities.
- ❑ Drinking, swimming, or showering in water that has been contaminated with MTBE.
- ❑ Receiving MTBE treatment for gallstones.

How can MTBE affect my health?

Breathing small amounts of MTBE for short periods may cause nose and throat irritation. Some people exposed to MTBE while pumping gasoline, driving their cars, or working in gas stations have reported having headaches, nausea, dizziness, and mental confusion. However, the actual levels of exposure in these cases are unknown. In addition, these symptoms may have been caused by exposure to other chemicals.

There are no data on the effects in people of drinking MTBE. Studies with rats and mice suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage, and nervous system effects.

How likely is MTBE to cause cancer?

There is no evidence that MTBE causes cancer in humans. One study with rats found that breathing high levels of MTBE for long periods may cause kidney cancer. Another study with mice found that breathing high levels of MTBE for long periods may cause liver cancer.

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified MTBE as to its carcinogenicity.

Is there a medical test to show whether I've been exposed to MTBE?

MTBE and its breakdown product, butyl alcohol, can be detected in your breath, blood, or urine for up to 1 or 2 days after exposure. These tests aren't available at most doctors' offices, but can be done at special laboratories that have the right equipment. There is no other test specific to determining MTBE exposure.

Has the federal government made recommendations to protect human health?

The EPA has issued guidelines recommending that, to protect children, drinking water levels of MTBE not exceed 4 milligrams per liter of water (4 mg/L) for an exposure of 1-10 days, and 3 mg/L for longer-term exposures.

The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended an exposure limit of 40 parts of MTBE per million parts of air (40 ppm) for an 8-hour workday, 40-hour workweek.

Glossary

Carcinogenicity: Ability to cause cancer.

CAS: Chemical Abstracts Service.

Evaporate: To change into a vapor or gas.

Milligram (mg): One thousandth of a gram.

ppm: Parts per million.

Sediment: Mud and debris that have settled to the bottom of a body of water.

References

This ToxFAQs information is taken from the 1996 Toxicological Profile for Methyl *tert*-Butyl Ether produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

TETRACHLOROETHYLENE
CAS # 127-18-4

This fact sheet answers the most frequently asked health questions (FAQs) about tetrachloroethylene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Tetrachloroethylene is a manufactured chemical used for dry cleaning and metal degreasing. Exposure to very high concentrations of tetrachloroethylene can cause dizziness, headaches, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Tetrachloroethylene has been found in at least 771 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is tetrachloroethylene?
(Pronounced tĕt′rə-klôr′ ō-ĕth′ə-lēn′)

Tetrachloroethylene is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal-degreasing. It is also used to make other chemicals and is used in some consumer products.

Other names for tetrachloroethylene include perchloroethylene, PCE, and tetrachloroethene. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell tetrachloroethylene when it is present in the air at a level of 1 part tetrachloroethylene per million parts of air (1 ppm) or more, although some can smell it at even lower levels.

What happens to tetrachloroethylene when it enters the environment?

- Much of the tetrachloroethylene that gets into water or soil evaporates into the air.
- Microorganisms can break down some of the tetrachloroethylene in soil or underground water.
- In the air, it is broken down by sunlight into other chemicals or brought back to the soil and water by rain.
- It does not appear to collect in fish or other animals that live in water.

How might I be exposed to tetrachloroethylene?

- When you bring clothes from the dry cleaners, they will release small amounts of tetrachloroethylene into the air.
- When you drink water containing tetrachloroethylene, you are exposed to it.

How can tetrachloroethylene affect my health?

High concentrations of tetrachloroethylene (particularly in closed, poorly ventilated areas) 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 accidentally exposed to high concentrations or have intentionally used tetrachloroethylene to get a "high."

In industry, most workers are exposed to levels lower than those causing obvious nervous system effects. The health effects of breathing in air or drinking water with low levels of tetrachloroethylene are not known.

Results from some studies suggest that women who work in dry cleaning industries where exposures to tetrachloroethylene can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. However, it is not known if tetrachloroethylene was responsible for these problems because other possible causes were not considered.

Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that tetrachloroethylene can cause liver and kidney damage. Exposure to very high levels of tetrachloroethylene 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.

How likely is tetrachloroethylene to cause cancer?

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

Is there a medical test to show whether I've been exposed to tetrachloroethylene?

One way of testing for tetrachloroethylene exposure is to measure the amount of the chemical in the breath, much the same way breath-alcohol measurements are used to determine the amount of alcohol in the blood.

Because it is stored in the body's fat and slowly released into the bloodstream, tetrachloroethylene can be detected in the breath for weeks following a heavy exposure.

Tetrachloroethylene and trichloroacetic acid (TCA), a breakdown product of tetrachloroethylene, can be detected in the blood. These tests are relatively simple to perform. These tests aren't available at most doctors' offices, but can be performed at special laboratories that have the right equipment.

Because exposure to other chemicals can produce the same breakdown products in the urine and blood, the tests for breakdown products cannot determine if you have been exposed to tetrachloroethylene or the other chemicals.

Has the federal government made recommendations to protect human health?

The EPA maximum contaminant level for the amount of tetrachloroethylene that can be in drinking water is 0.005 milligrams tetrachloroethylene per liter of water (0.005 mg/L).

The Occupational Safety and Health Administration (OSHA) has set a limit of 100 ppm for an 8-hour workday over a 40-hour workweek.

The National Institute for Occupational Safety and Health (NIOSH) recommends that tetrachloroethylene be handled as a potential carcinogen and recommends that levels in workplace air should be as low as possible.

Glossary

Carcinogen: A substance with the ability to cause cancer.

CAS: Chemical Abstracts Service.

Milligram (mg): One thousandth of a gram.

Nonflammable: Will not burn.

References

This ToxFAQs information is taken from the 1997 Toxicological Profile for Tetrachloroethylene (update) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone:1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

TRICHLOROETHYLENE

CAS # 79-01-6

Division of Toxicology ToxFAQs™ **July 2003**

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Trichloroethylene is a colorless liquid which is used as a solvent for cleaning metal parts. Drinking or breathing high levels of trichloroethylene may cause nervous system effects, liver and lung damage, abnormal heartbeat, coma, and possibly death. Trichloroethylene has been found in at least 852 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is trichloroethylene?

Trichloroethylene (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.

Trichloroethylene is not thought to occur naturally in the environment. However, it has been found in underground water sources and many surface waters as a result of the manufacture, use, and disposal of the chemical.

What happens to trichloroethylene when it enters the environment?

- ❑ Trichloroethylene dissolves a little in water, but it can remain in ground water for a long time.
- ❑ Trichloroethylene quickly evaporates from surface water, so it is commonly found as a vapor in the air.
- ❑ Trichloroethylene evaporates less easily from the soil than from surface water. It may stick to particles and remain for a long time.
- ❑ Trichloroethylene may stick to particles in water, which will cause it to eventually settle to the bottom sediment.
- ❑ Trichloroethylene does not build up significantly in plants and animals.

How might I be exposed to trichloroethylene?

- ❑ Breathing air in and around the home which has been contaminated with trichloroethylene vapors from shower water or household products such as spot removers and typewriter correction fluid.
- ❑ Drinking, swimming, or showering in water that has been contaminated with trichloroethylene.
- ❑ Contact with soil contaminated with trichloroethylene, such as near a hazardous waste site.
- ❑ Contact with the skin or breathing contaminated air while manufacturing trichloroethylene or using it at work to wash paint or grease from skin or equipment.

How can trichloroethylene affect my health?

Breathing small amounts may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating.

Breathing large amounts of trichloroethylene may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage.

Drinking large amounts of trichloroethylene may cause nausea, liver damage, unconsciousness, impaired heart function, or death.

Drinking small amounts of trichloroethylene 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 trichloroethylene for short periods may cause skin rashes.

How likely is trichloroethylene to cause cancer?

Some studies with mice and rats have suggested that high levels of trichloroethylene may cause liver, kidney, or lung cancer. Some studies of people exposed over long periods to high levels of trichloroethylene in drinking water or in workplace air have found evidence of increased cancer. Although, there are some concerns about the studies of people who were exposed to trichloroethylene, some of the effects found in people were similar to effects in animals.

In its 9th Report on Carcinogens, the National Toxicology Program (NTP) determined that trichloroethylene is "reasonably anticipated to be a human carcinogen." The International Agency for Research on Cancer (IARC) has determined that trichloroethylene is "probably carcinogenic to humans."

Is there a medical test to show whether I've been exposed to trichloroethylene?

If you have recently been exposed to trichloroethylene, it can be detected in your breath, blood, or urine. The breath test, if it is performed soon after exposure, can tell if you have been exposed to even a small amount of trichloroethylene.

Exposure to larger amounts is assessed by blood and urine tests, which can detect trichloroethylene and many of its breakdown products for up to a week after exposure. However, exposure to other similar chemicals can produce the same breakdown products, so their detection is not absolute proof of exposure to trichloroethylene. This test isn't available at most doctors' offices, but can be done at special laboratories that have the right equipment.

Has the federal government made recommendations to protect human health?

The EPA has set a maximum contaminant level for trichloroethylene in drinking water at 0.005 milligrams per liter (0.005 mg/L) or 5 parts of TCE per billion parts water.

The EPA has also developed regulations for the handling and disposal of trichloroethylene.

The Occupational Safety and Health Administration (OSHA) has set an exposure limit of 100 parts of trichloroethylene per million parts of air (100 ppm) for an 8-hour workday, 40-hour workweek.

Glossary

Carcinogenicity: The ability of a substance to cause cancer.
CAS: Chemical Abstracts Service.
Evaporate: To change into a vapor or gas.
Milligram (mg): One thousandth of a gram.
Nonflammable: Will not burn.
ppm: Parts per million.
Sediment: Mud and debris that have settled to the bottom of a body of water.
Solvent: A chemical that dissolves other substances.

References

This ToxFAQs information is taken from the 1997 Toxicological Profile for Trichloroethylene (update) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html . ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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VINYL CHLORIDE

CAS # 75-01-4

This fact sheet answers the most frequently asked health questions (FAQs) about vinyl chloride. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to vinyl chloride occurs mainly in the workplace. Breathing high levels of vinyl chloride for short periods of time can cause dizziness, sleepiness, unconsciousness, and at extremely high levels can cause death. Breathing vinyl chloride for long periods of time can result in permanent liver damage, immune reactions, nerve damage, and liver cancer. This substance has been found in at least 616 of the 1,662 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is 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 can be formed when other substances such as trichloroethane, trichloroethylene, and tetrachloroethylene are broken down. 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.

Vinyl chloride is also known as chloroethene, chloroethylene, and ethylene monochloride.

What happens to vinyl chloride when it enters the environment?

❏ Liquid vinyl chloride evaporates easily. Vinyl chloride in water or soil evaporates rapidly if it is near the surface.
❏ Vinyl chloride in the air breaks down in a few days to other substances, some of which can be harmful.
❏ Small amounts of vinyl chloride can dissolve in water.
❏ Vinyl chloride is unlikely to build up in plants or animals that you might eat.

How might I be exposed to vinyl chloride?

❏ Breathing vinyl chloride that has been released from plastics industries, hazardous waste sites, and landfills.
❏ Breathing vinyl chloride in air or during contact with your skin or eyes in the workplace.
❏ Drinking water from contaminated wells.

How can vinyl chloride affect my health?

Breathing high levels of vinyl chloride can cause you to feel dizzy or sleepy. 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.

The effects of drinking high levels of vinyl chloride are unknown. If you spill vinyl chloride on your skin, it will cause numbness, redness, and blisters.

Animal studies have shown that long-term exposure to vinyl chloride can damage the sperm and testes.

How likely is vinyl chloride to cause cancer?

The U.S. Department of Health and Human Services 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, brain, lung cancer, and some cancers of the blood have also been observed in workers.

How can vinyl chloride affect children?

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.

How can families reduce the risk of exposure to vinyl chloride?

Tobacco smoke contains low levels of vinyl chloride, so limiting your family's exposure to cigarette or cigar smoke may help reduce their exposure to vinyl chloride.

Is there a medical test to show whether I've been exposed to vinyl chloride?

The results of several tests can sometimes show if you have been exposed to vinyl chloride. Vinyl chloride can be measured in your breath, but the test must be done shortly after exposure. This is not helpful for measuring very low levels of vinyl chloride. The amount of the major breakdown product of vinyl chloride, thiodiglycolic acid, in the urine may give some information about exposure. However, this test must be done shortly after exposure and does not reliably indicate the level of exposure.

Has the federal government made recommendations to protect human health?

Vinyl chloride is regulated in drinking water, food, and air. The EPA requires that the amount of vinyl chloride in drinking water not exceed 0.002 milligrams per liter (mg/L) of water.

The Occupational Safety and Health Administration (OSHA) has set a limit of 1 part vinyl chloride per 1 million parts of air (1 ppm) in the workplace.

The Food and Drug Administration (FDA) regulates the vinyl chloride content of various plastics. These include plastics that carry liquids and plastics that contact food. The limits for vinyl chloride content vary depending on the nature of the plastic and its use.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2006. Toxicological Profile for Vinyl Chloride (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Appendix B

Toxicological Summaries

The toxicological summary provided in this appendix is based on ATSDR's ToxFAQs (http://www.atsdr.cdc.gov/toxfaq.html). Health effects are summarized in this section for the chemicals of concern found in soil and indoor air for the North Brunswick Township High School property and in indoor air for nearby residences under investigation. The health effects described in the section are typically known to occur at levels of exposure much higher than those that occur from environmental contamination. The chance that a health effect will occur is dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons.

Arsenic. Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs. Ingesting high levels of inorganic arsenic can result in death. Lower levels of arsenic can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. Skin contact with inorganic arsenic may cause redness and swelling.

Organic arsenic compounds are used as pesticides, primarily on cotton plants. Organic arsenic compounds are less toxic than inorganic arsenic compounds. Exposure to high levels of some organic arsenic compounds may cause similar effects as those caused by inorganic arsenic.

Several studies have shown that inorganic arsenic can increase the risk of lung cancer, skin cancer, bladder cancer, liver cancer, kidney cancer, and prostate cancer. The World Health Organization (WHO), the DHHS, and the EPA have determined that inorganic arsenic is a human carcinogen

Benzene Benzene is a widely used chemical formed from both natural processes and human activities. It is highly flammable liquid at room temperature. It evaporates easily into the air and has a sweet odor. Benzene is one of the top 20 chemicals used in the United States industry. Industries mix benzene with other chemicals to make plastics, resins, and nylon and synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

Breathing very high levels of benzene can cause death while breathing high concentrations of benzene 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. Long-term exposure to benzene (365 days or longer) can cause harmful effects on the bone marrow, can cause a decrease in red blood cells leading to anemia, and can cause excessive bleeding. Benzene can cause impairment of the immunity system increasing the chance of infection. Studies have shown some women exposed to high levels of benzene in air for many months had irregular menstrual periods and a reduced size of their ovaries. It is not known whether benzene exposure affects the developing fetus in pregnant women or fertility in men. Studies have shown that pregnant animals exposed to benzene in air resulted in low birth weights, delayed bone formation, and bone marrow damage.

The United States Department of Health and Human Services (DHHS) 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.

1,2-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.

Lead. Lead is a naturally occurring metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing. Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from gasoline, paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. People may be exposed to lead by eating food or drinking water that contains lead, spending time in areas where lead-based paints have been used and are deteriorating, and by working in a job or engaging in a hobby where lead is used. Small children are more likely to be exposed to lead by swallowing house dust or soil that contains lead, eating lead-based paint chips or chewing on objects painted with lead-based paint.

Lead can affect many organs and systems in the body. The most sensitive is the central nervous system, particularly in children. Lead also damages kidneys and the reproductive system. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can also damage the male reproductive system. The connection between these effects and exposure to low levels of lead is uncertain.

Children are more vulnerable to lead poisoning than adults. A child, who swallows large amounts of lead, for example by eating old paint chips, may develop blood anemia, severe stomachache, muscle weakness, and brain damage. A large amount of lead might get into a child's body if the child ate small pieces of old paint that contained large amounts of lead. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, however, lead can affect a child's mental and physical growth. Exposure to lead is more dangerous for young children and fetuses. Fetuses can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead.

The DHHS has determined that two compounds of lead (lead acetate and lead phosphate) may reasonably be anticipated to be carcinogens based on studies in animals. There is inadequate evidence to clearly determine whether lead can cause cancer in people.

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."

Toluene. Toluene occurs naturally in crude oil and is a component in gasoline and other fuels. It is also used in making various products including paints, paint thinners, fingernail polish, lacquers, adhesives, rubber, and in some printing and leather tanning processes. It is a colorless liquid with a distinctive smell. Toluene may affect the nervous system. Breathing low to moderate levels in air can cause tiredness, confusion, weakness, memory loss, nausea, loss of appetite, and hearing/color vision loss. These symptoms usually disappear when the exposure is stopped. Inhaling high levels of toluene in a short period can make a person feel light-headed, dizzy, or sleepy. It can also cause unconsciousness or death. High levels of toluene may also affect kidney function. The health effects seen in children exposed to toluene are similar to those effects seen in adults. Breathing very high levels during pregnancy can cause birth defects, mental handicaps, and growth abnormalities in children. Toluene is not known to cause cancer.

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.

Xylenes. Xylene is a colorless, sweet-smelling easily flammable liquid. It occurs naturally in petroleum and coal tar and is formed during forest fires. Xylene is used as a solvent and in the printing, rubber, and leather industries. It is also used as a cleaning agent, a thinner for paint, and in paints and varnishes. It is found in small amounts in airplane fuel and gasoline.

Xylene affects the brain. High levels from exposure for short periods (14 days or less) or long periods (more than 1 year) can cause headaches, lack of muscle coordination, dizziness, confusion, and changes in one's sense of balance. Exposure of people to high levels of xylene for short periods can also cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; problems with the lungs; delayed reaction time; memory difficulties; stomach discomfort; and possibly changes in the liver and kidneys. It can cause unconsciousness and even death at very high levels.

Studies of unborn animals indicate that high concentrations of xylene may cause increased numbers of deaths, and delayed growth and development. In many instances, these same concentrations also cause damage to the mothers. It is unknown if xylene harms the unborn child if the mother is exposed to low levels of xylene during pregnancy.

The IARC has determined that xylene is not classifiable as to its carcinogenicity in humans. Human and animal studies have not shown xylene to be carcinogenic, but these studies are not conclusive and do not provide enough information to conclude that xylene does not cause cancer.