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December 21, 2009

Mr. Bill Williams
Village of Tuckahoe Building Department
65 Main Street
Tuckahoe, New York 10707

Re: Soil Vapor Intrusion (SVI) Evaluation
Indoor Air Sampling Results-March 2009
15 Marbledale Road, Tuckahoe, Westchester County

Dear Mr. Williams:

On March 12, 2009, Environmental Management, Ltd (EML), on behalf of Weissman Holdings, LLC, formerly Kings Electronics Co., Inc. (Kings), collected three air samples (the 2009 Sampling) from the Village of Tuckahoe's Department of Public Works, located at 15 Marbledale Road in Tuckahoe (the Building). These samples were taken at the request of the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH), collectively the "State," and were a follow-up to sub-slab soil vapor sampling that occurred on March 10, 2006, and then yearly soil vapor intrusion sampling on March 30, 2006 (the 2006 Sampling), March 22, 2007 (the 2007 Sampling), and March 26, 2008 (the 2008 sampling). The results of the prior sampling were reported to you in my letters of March 23, 2006, July 19, 2006, November 7, 2007, and July 3, 2008.

The current sampling included one sub-slab soil vapor sample, one indoor air sample from the Building's office area and one outdoor air sample. The air samples were sent to a NYS ELAP certified laboratory to test for trichloroethene (TCE), tetrachloroethene (PCE) and other volatile organic compounds (VOCs). TCE is a VOC commonly used as a solvent to remove grease from metal. PCE is a manufactured chemical that is widely used in the dry-cleaning of fabrics, including clothes. It is also used for degreasing metal parts and in manufacturing of other chemicals. These samples were collected as part of an on-going investigation of "soil vapor intrusion" of VOCs (see enclosed titled *Soil Vapor Intrusion: Frequently Asked Questions* for more information) in the area surrounding the former Kings building.

We have evaluated the sample results and have attached a table that sets forth the results of the 2009 Sampling, as well as the 2006, 2007, and 2008 Sampling. TCE is trending downward in indoor air (from 1.6 µg/m^3 in 2006, to 0.95 in 2007 to 0.62 in 2008 and leveling there at 0.68 in 2009) and in the sub-slab (from 170 to 160 to 130 to 85 respectively). The 2009 TCE sampling results fall into a range where NYSDOH allows either no further air sampling or further monitoring. (PCE soil vapor is not a concern as, based on all yearly PCE results, no further action would be required). Kings is recommending that no

further air sampling at DPW is required based on this decreasing trend in TCE. The concentration detected in the sub-slab is not expected to significantly affect indoor air quality.
A more detailed evaluation of the sampling results follows.

SAMPLING RESULTS

Chemicals are part of our everyday life. They are found in the many products we use such as cleaners, glues and paints. They are also found in new furniture, carpet or freshly dry-cleaned clothing. Similarly, chemicals are also found in outdoor air because of gasoline stations, dry cleaners or other commercial/industrial facilities. Commonly found concentrations of these chemicals in indoor air and outdoor air are referred to as "typical background levels." These levels are determined from the results of samples collected in homes, offices and outdoor areas not near known sources of VOCs (for example, a home not known to be near a chemical spill, a hazardous waste site, a dry-cleaner, or a factory).

To help assess the type of VOCs suspected to be in the air in and around your Building, EML collected three air samples. In addition, in February and March of 2009, an indoor air quality questionnaire and building inventory were completed. A copy of the completed questionnaire and inventory form is enclosed. It includes a list of products present in your Building that might contain VOCs.

During the inventory, the investigation also used a real-time vapor meter (also known as a photoionization detector, PID) that detects many VOCs that may be in the air. This instrument was used to help determine if products containing VOCs and stored or used in your Building might be contributing to the levels detected in the air samples. The PID readings recorded on the DPW office floor plan (labeled "Field Instrument Reading" on page 6 of the inventory form) indicate whether VOCs are being released from the stored products used within your indoor air.

We have summarized the results of the three air samples in the enclosed Table I, as well as a comparison in Table II of the 2009 results with 2006, 2007, and 2008 results. We are also enclosing the laboratory report for each sample collected in 2009. The sample identification number is found on each report following "Container ID."

<u>Indoor Air in Office</u> – *Sample ID DPW-2*; *Container ID AC01164*
TCE was detected at a concentration of 0.68 micrograms per cubic meter (µg/m³) in your office indoor air, which is similar to last year (at 0.62) and down from 1.6 in 2006 and 0.95 in 2007. NYSDOH's guideline for TCE in air is 5.0 µg/m³. This level is lower than the levels that have caused health effects in animals and humans. The guideline is based on the assumption that people are exposed to TCE in air all day, every day for as long as a lifetime. This is rarely true for most people, who are exposed for only part of the day and part of their lifetime. The concentrations in your office indoor air sample are lower than this guideline.

PCE was reported as "not detected" this year.

As a maintenance and repair garage for vehicles, equipment and small engine repair, and as detailed in your product inventory, many of the products used and stored in the Building are sources of chemicals found in your samples. In other words, some of the chemicals that were in your indoor air are present in products you store and use in your Building. For example, m&p xylenes (which is unrelated to the Kings investigation) was detected at concentrations above typical background concentrations for indoor air. M&p xylenes are found in gasoline and oils. If you have any questions about this compound, or any other, you can contact the NYSDOH, as detailed at the end of this letter.

Sub-slab Vapor – *Sample ID DPW-1; Container ID AC00948*
A number of VOCs, including TCE at a concentration of 85 µg/m³ (down from 170 on 2006, 160 in 2007, and 130 in 2008), and PCE at a concentration of 26 µg/m³, were detected in the sub-slab vapor sample beneath the Building.

Outdoor Air – *Sample ID DPW-3; Container ID AC01103*
TCE and PCE were not detected this year.

Overall, based on the data, soil vapor may be impacting your indoor air, however at levels below NYSDOH guidelines. As a result of the decreasing trend in sub-slab soil vapor concentrations over the past four years, Kings is recommending that no further air sampling at DPW is warranted as the concentration detected in the sub-slab is not expected to significantly affect indoor air quality.

ENCLOSURES
In addition to the tables summarizing your sample results and a copy of the product inventory for your property, we are enclosing the following fact sheets:

1. What is Exposure? Information Sheet, which describes how a person may come into contact with chemicals in the environment;
2. Soil Vapor Intrusion: Frequently Asked Questions Sheet, which describes the process referred to as "soil vapor intrusion;"
3. Tetrachloroethene (PERC) Fact Sheet, which provides additional information on PCE and the NYSDOH guideline for PCE in air; and
4. Trichloroethene (TCE) Fact Sheet, which provides additional information on TCE and the NYSDOH guideline for TCE in the air.

On behalf of Kings, I thank you for your permission to sample the Building. In conclusion, if you have any questions regarding the sampling results, please feel free to contact me by phone at 845-429-1141, or to call Nicole Bonsteel from NYSDEC at toll free number 888-459-8667. If you have questions regarding any results or compounds not discussed in this letter or any health questions or concerns, you may call Carl Obermeyer at NYSDOH at 845-794-2045 or email him at cjo01@health.state.ny.us.

Very truly yours,
Environmental Management, Ltd.

Donald J. Wanamaker

Donald J. Wanamaker
President

Enclosures
cc: Nicole M. Bonsteel, NYSDEC
Carl Obermeyer, NYSDOH

TABLE I

Findings, March 2009 Air Sampling
Village of Tuckahoe Department of Public Works (**DPW**)
15 Marbledale Road, Tuckahoe, Westchester County, New York

Results are reported in micrograms per cubic meter (µg/m³ or mcg/m³)

Compound	Indoor Air, Office March 2009 **DPW-2** AC01164	Sub-Slab, Office March 2009 **DPW-1** AC00948	Outdoor Air March 2009 **DPW-3** AC01103
Trichloroethene	0.68	85	--
Tetrachloroethene	--	26	--
1,1,1-Trichloroethane	--	14	--
cis-1,2-Dichloroethene	--	--	--
Acetone	37	31	--
Benzene	4.4	3.2	1.0
Carbon Disulfide	--	2.4	--
Chloroform	--	39	--
Ethylbenzene	4.7	18	--
m&p-Xylenes	17	73	0.94
2-Butanone (MEK)	1.9	8.5	0.95
4-Methyl-2-pentanone (MIBK)	--	--	--
Methylene chloride	--	--	--
o-Xylene	6.8	27	
Toluene	30	60	2.2
Trichlorotrifluoroethane	0.72	0.83	0.72
Trichlorofluoromethane	1.7	1.6	1.7
1,4-Dichlorobenzene	--	2.9	--
2-Hexanone	--	1.8	--
Vinyl Acetate	--	--	--
Carbon Tetrachloride	0.56	0.69	0.62

-- Not detected above quantification limit

Compound	Indoor Air, Office March 2009 **DPW-2** AC01164	Sub-Slab, Office March 2009 **DPW-1** AC00948	Outdoor Air March 2009 **DPW-3** AC01103
Additional, 2009:			
Propene	16	2.6	0.82
CFC-12	3.3	4.9	3.3
Chloromethane	0.86	--	0.82
Ethanol	86	48	--
Acrolein	0.72	0.89	--
2-Propanol	67	8.5	0.83
MTBE	--	1.9	--
Ethyl Acetate	2.8	12	1.0
n-Hexane	10	2.7	--
Tetrahydrofuran (THF)	--	--	--
Cyclohexane	3.0	2.4	--
n-Heptane	6.1	7.2	--
n-Butyl Acetate	--	28	--
n-Octane	2.6	6.7	--
Styrene	--	6.0	--
n-Nonane	2.8	14	--
Cumene	0.65	1.8	--
alpha-Pinene	2.4	3.1	--
n-Propylbenzene	4.3	8.0	--
4-Ethyltoluene	8.3	16	--
1,3,5-Trimethylbenzene	8.2	15	--
1,2,4-Trimethylbenzene	30	55	--
d-Limonene	40	17	--
Naphthalene	1.4	5.6	--

-- Not detected above quantification limit

TABLE II

Results of 2006 through 2009 Soil Vapor Sampling -- DPW

Village of Tuckahoe Department of Public Works - 15 Marbledale Road, Tuckahoe, Westchester County, New York

Results are reported in micrograms per cubic meter (µg/m³ or mcg/m³)

	DPW-2 Indoor Air, Office				**DPW-1 Sub-Slab, Office**				**DPW-3 Outdoor Air**			
Compound	March 2006	March 2007	March 2008	March 2009	March 2006	March 2007	March 2008	March 2009	March 2006	March 2007	March 2008	March 2009
Trichloroethene	1.6	0.95	0.62*	0.68	170	160	130*	85	1	0.43	0.35*	ND
Tetrachloroethene	1.2	1.0	0.51	ND	30	26	32	26	0.96	0.77	0.27	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	23	19	16	14	ND	ND	ND	ND
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone[1]	ND	ND	25	37	ND	ND	16 [2]	31	ND	ND	7.9	ND
Benzene	5.5	3.4	3.0	4.4	0.73	ND	1.1	3.2	2.7	1.5	1.0	1.0
Carbon Disulfide	ND	ND	ND	ND	12	4.6	2.9	2.4	0.78	ND	ND	ND
Chloroform	ND	ND	ND	ND	7	53	61	39	ND	ND	ND	ND
Ethylbenzene	6.7	4.5	4.2	4.7	ND	ND	5.2	18	1.5	ND	ND	ND
m&p-Xylenes	23	19	18	17	1.5	2.9	20	73	5.2	2.6	1.3	0.94
2-Butanone (MEK) [3]	ND	14	2.1	1.9	ND	ND	3.0	8.5	ND	ND	1.7	0.95
4-Methyl-2-pentanone (MIBK)	ND	ND	4.0	ND	ND	ND	2.9	ND	ND	ND	ND	ND
Methylene chloride	0.93	ND	ND	ND	ND	ND	ND	ND	0.89	ND	ND	ND

* Trichloroethene was detected within the trip blank at 0.40 µg/m³

[1] Due to acetone detected in the trip blank in 03/06 sampling, the general reporting limit of acetone was revised to 73 µg/m³. Acetone detected in trip blank during the 03/07 sampling resulted in a revised reporting limit of 89 µg/m³.

[2] Matrix interference due to coelution with a non-target compound; results may be biased high.

[3] Due to methyl ethyl ketone (MEK) detected in the trip blank in the 03/06 sampling, the general reporting limit of MEK was revised to 9 µg/m³. MEK detected in trip blank during the 03/07 sampling resulted in a revised reporting limit of 10 µg/m³.

o-Xylene	7.9	6.3	5.9	6.8	ND	1.4	17	27	1.9	ND	ND	
Toluene	32	21	22	30	6.0	1.8	7.5	60	9.3	6.8	2.3	2.2
Trichlorotrifluoroethane	ND	ND	ND	0.72	0.87	0.71	ND	0.83	ND	ND	ND	0.72
Trichlorofluoromethane	1.4	1.3	1.2	1.7	1.4	1.2	1.2	1.6	1.4	1.4	1.2	1.7
1,4-Dichlorobenzene	45	1.2	ND	ND	ND	ND	ND	2.9	2	ND	ND	ND
2-Hexanone	0.94	ND	ND	ND	3	ND	ND	1.8	ND	ND	ND	ND
Vinyl Acetate[4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ND	0.91	ND	0.56	ND	ND	ND	0.69	ND	ND	ND	0.62
Additional - 2009:												
Propene				16				2.6				0.82
CFC-12				3.3				4.9				3.3
Chloromethane			ND	0.86			ND	ND			ND	0.82
Ethanol				86				48				ND
Acrolein				0.72				0.89				ND
2-Propanol				67				8.5				0.83
MTBE			ND	ND			ND	1.9			ND	ND
Ethyl Acetate				2.8				12				1.0
n-Hexane				10				2.7				ND
Tetrahydrofuran (THF)				ND				ND				ND
Cyclohexane				3.0				2.4				ND
n-Heptane				6.1				7.2				ND
n-Butyl Acetate				ND				28				ND
n-Octane				2.6				6.7				ND
Styrene			ND	ND			ND	6.0			ND	ND
n-Nonane				2.8				14				ND
Cumene				0.65				1.8				ND

[4] Due to vinyl acetate detected in the trip blank during the 03/07 sampling, the general reporting limit of vinyl acetate was revised to 26.5 µg/m³.

alpha-Pinene				2.4				3.1				ND
n-Propylbenzene				4.3				8.0				ND
4-Ethyltoluene				8.3				16				ND
1,3,5-Trimethylbenzene				8.2				15				ND
1,2,4-Trimethylbenzene				30				55				ND
d-Limonene				40				17				ND
Naphthalene				1.4				5.6				ND

ND Not detected above quantification limit

What is Exposure? - Information Sheet

Exposure is contact. No matter how dangerous a substance or activity, without exposure, it cannot harm you.

Amount of exposure:

Over 400 years ago, a scientist said "...nothing [is] without poisonous qualities. It is only the dose that makes a thing poison." The **dose** is the amount of a substance that enters or contacts a person. An important factor to consider in evaluating a dose is body weight. If a child is exposed to the same amount of chemical as an adult, the child (who weighs less) can be affected more than the adult. For example, children are given smaller amounts of aspirin than adults because an adult dose is too large for a child's body weight.

The greater the amount of a substance a person is exposed to, the more likely that health effects will occur. Large amounts of a relatively harmless substance can be toxic. For example, two aspirin tablets can help to relieve a headache, but taking an entire bottle of aspirin can cause stomach pain, nausea, vomiting, headache, convulsions or death

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Routes of exposure:

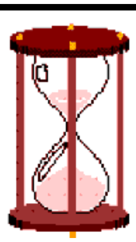
There are three major means by which a toxic substance can come into contact with or enter the body. These are called routes of exposure.

Inhalation (breathing) of gases, vapors, dusts or mists is a common route of exposure. Chemicals can enter and irritate the nose, air passages and lungs. They can become deposited in the airways or be absorbed through the lungs into the bloodstream. The blood can then carry these substances to the rest of the body.

Direct contact (touching) with the skin or eyes is also a route of exposure. Some substances are absorbed through the skin and enter the bloodstream. Broken, cut or cracked skin will allow substances to enter the body more easily.

Ingestion (swallowing) of food, drink, or other substances is another route of exposure. Chemicals that get in or on food, cigarettes, utensils or hands can be swallowed. Children are at greater risk of ingesting substances found in dust or soil because they often put their fingers or other objects in their mouths. Lead in paint chips is a good example. Substances can be absorbed into the blood and then transported to the rest of the body.

The route of exposure can determine whether or not the toxic substance has an effect. For example, breathing or swallowing lead can result in health effects, but touching lead is not usually harmful because lead is not absorbed particularly well through the skin.



Length of exposure:

Short-term exposure is called **acute exposure**. Long-term exposure is called **chronic exposure**. Either may cause health effects that are immediate or health effects that occur days or years later.

Acute exposure is a short contact with a chemical. It may last a few seconds or a few hours. For example, it might take a few minutes to clean windows with ammonia, use nail polish remover or spray a can of paint. The fumes someone might inhale during these activities are examples of acute exposures.

Chronic exposure is continuous or repeated contact with a toxic substance over a long period of time (months or years). If a chemical is used every day on the job, the exposure would be chronic. Over time, some chemicals, such as PCBs and lead, can build up in the body and cause long-term health effects.

Chronic exposures can also occur at home. Some chemicals in household furniture, carpeting or cleaners can be sources of chronic exposure.

Sensitivity:

All people are not equally **sensitive** to chemicals, and are not affected by them in the same way. There are many reasons for this.

- People's bodies vary in their ability to absorb and break down or eliminate certain chemicals due to **genetic differences.**
- People may become **allergic** to a chemical after being exposed. Then they may react to very low levels of the chemical and have different or more serious health effects than nonallergic people exposed to the same amount. People who are allergic to bee venom, for example, have a more serious reaction to a bee sting than people who are not.
- Factors such as **age, illness, diet, alcohol use, pregnancy and medical or nonmedical drug use** can also affect a person's sensitivity to a chemical. Young children are often more sensitive to chemicals for a number of reasons. Their bodies are still developing and they cannot get rid of some chemicals as well as adults. Also, children absorb greater amounts of some chemicals (such as lead) into their blood than adults.

For more information call:

New York State Department of Health
Flanigan Square Room 316
547 River Street
Troy, NY 12180-2216

1-800-458-1158

Questions or comments: ceheduc@health.state.ny.us
Revised: June 2000

NEW YORK STATE
DEPARTMENT OF HEALTH

SOIL VAPOR INTRUSION

Frequently Asked Questions

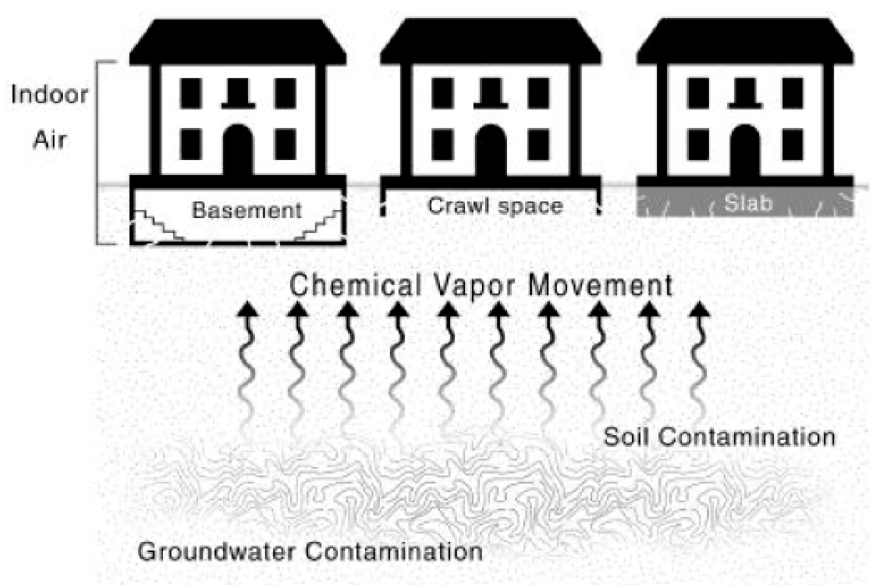
What is soil vapor intrusion?

The phrase "soil vapor intrusion" refers to the process by which volatile chemicals move from a subsurface source into the indoor air of overlying buildings.

Soil vapor, or soil gas, is the air found in the pore spaces between soil particles. Because of a difference in pressure, soil vapor enters buildings through cracks in slabs or basement floors and walls, and through openings around sump pumps or where pipes and electrical wires go through the foundation. Heating, ventilation or air-conditioning systems may create a negative pressure that can draw soil vapor into the building. This intrusion is similar to how radon gas seeps into buildings.

Soil vapor can become contaminated when chemicals evaporate from subsurface sources and enter the soil vapor. Chemicals that readily evaporate are called "volatile chemicals." Volatile chemicals include volatile organic compounds (VOCs). Subsurface sources of volatile chemicals may include contaminated soil and groundwater, or buried wastes. If soil vapor is contaminated, and enters a building as described above, indoor air quality may be affected.

When contaminated vapors are present in the zone directly next to or under the foundation of the building, vapor intrusion is possible. Soil vapor can enter a building whether it is old or new, or whether it has a basement, a crawl space, or is on a slab (as illustrated in the figure).



[Source: United States Environmental Protection Agency, Region 3]

How am I exposed to chemicals through soil vapor intrusion?

Humans can be exposed to soil vapor contaminated with volatile chemicals when vapors from beneath a building are drawn through cracks and openings in the foundation and mix with the indoor air. Inhalation is the route of exposure, or the manner in which the volatile chemicals actually enter the body, once in the indoor air.

Current exposures are when vapor intrusion is documented in an occupied building. *Potential* exposures are when volatile chemicals are present, or are accumulating, in the vapor phase beneath a building, but have not affected indoor air quality. Potential exposures also exist when there is a chance that contaminated soil vapors may move to existing buildings not currently affected or when there is a chance that new buildings can be built over existing subsurface vapor contamination. Both current and potential exposures are considered when evaluating soil vapor intrusion at a site that has documented subsurface sources of volatile chemicals.

In general, exposure to a volatile chemical does not necessarily mean that health effects will occur. Whether or not a person experiences health effects depends on several factors, including inhalation exposure, the length of exposure (short-term or acute versus long-term or chronic), the frequency of exposure, the toxicity of the volatile chemical, and the individual's sensitivity to the chemical.

What types of chemicals associated with environmental contamination may be entering my home via soil vapor intrusion?

Volatile organic compounds, or VOCs, are the most likely group of chemicals found in soil vapor, and which can move through the soil and enter buildings. Solvents used for dry cleaning, degreasing and other industrial purposes (e.g., tetrachloroethene, trichloroethene, 1,1,1-trichloroethane and Freon 113) are examples of VOCs. Examples of petroleum-related VOCs from petroleum spills are benzene, toluene, ethyl benzene, xylenes, styrene, hexane and trimethylbenzenes.

Is contaminated soil vapor the only source of volatile chemicals in my indoor air?

No. Volatile chemicals are also found in many household products. Paints, paint strippers and thinners, mineral spirits, glues, solvents, cigarette smoke, aerosol sprays, mothballs, air fresheners, new carpeting or furniture, hobby supplies, lubricants, stored fuels, refrigerants and recently dry-cleaned clothing all contain VOCs. Household products are often more of a source of VOCs in indoor air in homes than contaminated soil vapor.

Indoor air may also become affected when outdoor air containing volatile chemicals enters your home. Volatile chemicals are present in outdoor air due to their widespread use. Gasoline stations, dry cleaners, and other commercial/industrial facilities are important sources of VOCs to outdoor air.

What should I expect if soil vapor intrusion is a concern near my home?

If you live near a site that has documented soil, groundwater and/or soil vapor contaminated with volatile chemicals, you should expect that the potential for vapor intrusion is being, or has been, investigated. You may be contacted by the site owner or others working on the cleanup with information about the project. Your cooperation and consent would be requested before any testing/sampling would be done on your property. You may ask the person contacting you any questions about the work being done. You can also contact the NYSDOH's project manager for the site at 1-800-458-1158 (extension 2-7850) for additional information.

How is soil vapor intrusion investigated at sites contaminated with volatile chemicals?

The process of investigating soil vapor intrusion typically requires more than one set of samples to determine the extent of vapor contamination. Furthermore, four types of environmental samples are collected: soil vapor samples, sub-slab vapor samples, indoor air samples and outdoor air (sometimes referred to as "ambient air") samples.

Soil vapor samples are collected to characterize the nature and extent of vapor contamination in the soil in a given area. They are often collected before sub-slab vapor and/or indoor air samples to help identify buildings or groups of buildings that need to be sampled. Soil vapor samples are used to determine the *potential* for human exposures. *Soil vapor* samples are not the same as *soil* samples.

Sub-slab vapor samples are collected to characterize the nature and extent of vapor contamination in the soil immediately beneath a building with basement foundations or a slab. Sub-slab vapor results are used to determine the potential for *current* and *future* human exposures. For example, an exposure could occur in the future if cracks develop in the building's foundation or changes in the operation of the building's heating, ventilation or air-conditioning system are made that make the movement of contaminated soil vapor into the building possible.

Indoor air samples are collected to characterize the nature and extent of air contamination within a building. Indoor air sample results help to evaluate whether there are *current* human exposures. They are also compared to sub-slab vapor and outdoor air results to help determine where volatile chemicals may be coming from (indoor sources, outdoor sources, and/or beneath the building).

Outdoor air samples are collected to characterize site-specific background air conditions. Outdoor air results are used to evaluate the extent to which outdoor sources, such as automobiles, lawn mowers, oil storage tanks, gasoline stations, commercial/industrial facilities, and so forth, may be affecting indoor air quality.

What should I expect if indoor air samples are collected in my home?

You should expect the following:

- Indoor air samples are generally collected from the lowest-level space in a building, typically a basement, during the heating season. Indoor air samples may also be collected from the first floor of living space. Indoor air is believed to represent the greatest exposure potential with respect to soil vapor intrusion.
- Sub-slab vapor and outdoor air samples are usually collected at the same time as indoor air samples to help determine where volatile chemicals may be coming from (indoor sources, outdoor sources, and/or beneath the building).
- More limited sampling may be performed outside of the heating season. For example, sub-slab vapor samples without indoor air or outdoor air samples may be collected to identify buildings and areas where comprehensive sampling is needed during the heating season.
- An indoor air quality questionnaire and building inventory will be completed. The questionnaire includes a summary of the building's construction characteristics; the building's heating, ventilation and air-conditioning system operations; and potential indoor and outdoor sources of volatile chemicals. The building inventory describes products present in the building that might contain volatile chemicals. In addition, we take monitoring readings from a real-time organic vapor meter (also known as a photoionization detector or PID). The PID is an instrument that detects many VOCs in the air. When indoor air samples are collected, the PID is used to help determine whether

products containing VOCs might be contributing to levels that are detected in the indoor air.

What happens if soil vapor contamination or soil vapor intrusion is identified during investigation of a site?

Depending on the investigation results, additional sampling, monitoring or mitigation actions may be recommended. Additional sampling may be performed to determine the extent of soil vapor contamination and to verify questionable results. Monitoring (sampling on a recurring basis) is typically conducted if there is a significant potential for vapor intrusion to occur should building conditions change. Mitigation steps are taken to minimize exposures associated with soil vapor intrusion. Mitigation may include sealing cracks in the building's foundation, adjusting the building's heating, ventilation and air-conditioning system to maintain a positive pressure to prevent infiltration of subsurface vapors, or installing a sub-slab depressurization system beneath the building.

What is a sub-slab depressurization system?

A sub-slab depressurization system, much like a radon mitigation system, essentially prevents vapors beneath a slab from entering a building. A low amount of suction is applied below the foundation of the building and the vapors are vented to the outside (see illustration). The system uses minimal electricity and should not noticeably affect heating and cooling efficiency. This mitigation system also essentially prevents radon from entering a building, an added health benefit. The party responsible for cleaning up the source of the soil vapor contamination is usually responsible for paying for the installation of this system. If no responsible party is available, New York State will install the system. Once the contamination is cleaned up, the system should no longer be needed. In areas where radon is a problem, the NYSDOH recommends that these systems remain in place permanently.

What else can I do to improve my indoor air quality?

Household products and other factors, such as mold growth, carbon monoxide, and radon, can degrade the quality of air in your home. Consider the following tips to improve indoor air quality:

- Be aware of household products that contain VOCs. Do not buy more chemicals than you need at a time.
- Store unused chemicals in tightly-sealed containers in a well-ventilated location, preferably away from the living space in your home.
- Keep your home properly ventilated. Keeping it too air-tight may promote build up of chemicals in the air, as well as mold growth due to the build up of moisture.
- Fix all leaks promptly, as well as other moisture problems that encourage mold growth.
- Make sure your heating system, hot water, dryer and fireplaces are properly vented and in good condition. Have your furnace or boiler checked annually by a professional.
- Test your home for radon; take actions to reduce radon levels if needed.
- Install carbon monoxide detectors in your home; take immediate actions to reduce carbon monoxide levels if needed.

Where can I get more information?

For additional information about soil vapor intrusion, contact the NYSDOH's Bureau of Environmental Exposure Investigation at 1-800-458-1158 (extension 2-7850).

FACT SHEET

TETRACHLOROETHENE (PERC) IN INDOOR AND OUTDOOR AIR

MAY, 2003

This fact sheet answers a few questions about a chemical called tetrachloroethene (PERC), which is widely used to dry-clean clothes. It provides information on health effects seen in humans and animals exposed to PERC in air. It also provides information about the New York State Department of Health (NYSDOH) guideline of 100 micrograms of PERC per cubic meter of air (100 mcg/m^3) or 0.1 milligrams of PERC per cubic meter of air (0.1 mg/m^3). The fact sheet focuses on the health risks from air exposures because most of the PERC released into the environment goes into air.

Prepared by

New York State Department of Health

1. WHAT IS TETRACHLOROETHENE (PERC)?

Tetrachloroethene is a manufactured chemical that is widely used in the dry-cleaning of fabrics, including clothes. It is also used for degreasing metal parts and in manufacturing other chemicals. Tetrachloroethene is found in consumer products, including some paint and spot removers, water repellents, brake and wood cleaners, glues, and suede protectors. Other names for tetrachloroethene include PERC, tetrachloroethylene, perchloroethylene, and PCE. PERC is a commonly used name and will be used in the rest of the fact sheet.

PERC is a nonflammable, colorless liquid at room temperature. It readily evaporates into air and has an ether-like odor. Because most people stop noticing the odor of PERC in air after a short time, odor is not a reliable warning signal of PERC exposure.

2. HOW CAN I BE EXPOSED TO PERC?

People are exposed to PERC in air, water, and food. Exposure can also occur when PERC or material containing PERC (for example, soil) gets on the skin. For most people, almost all exposure is from PERC in air.

PERC gets into outdoor and indoor air by evaporation from industrial or dry-cleaning operations and from areas where chemical wastes are stored or disposed. Groundwater near these areas may become contaminated if PERC is improperly dumped or leaks into the ground. People may be exposed if they drink the contaminated water. They may also be exposed if PERC evaporates from contaminated drinking water into indoor air during cooking and washing. PERC may evaporate from contaminated groundwater and soil and into the indoor air of buildings above the contaminated area. PERC also may evaporate from dry-cleaned clothes and into indoor air or may get into indoor air after PERC-products, such as spot removers, are used. Indoor air PERC levels may get high if PERC-products are used in poorly ventilated areas.

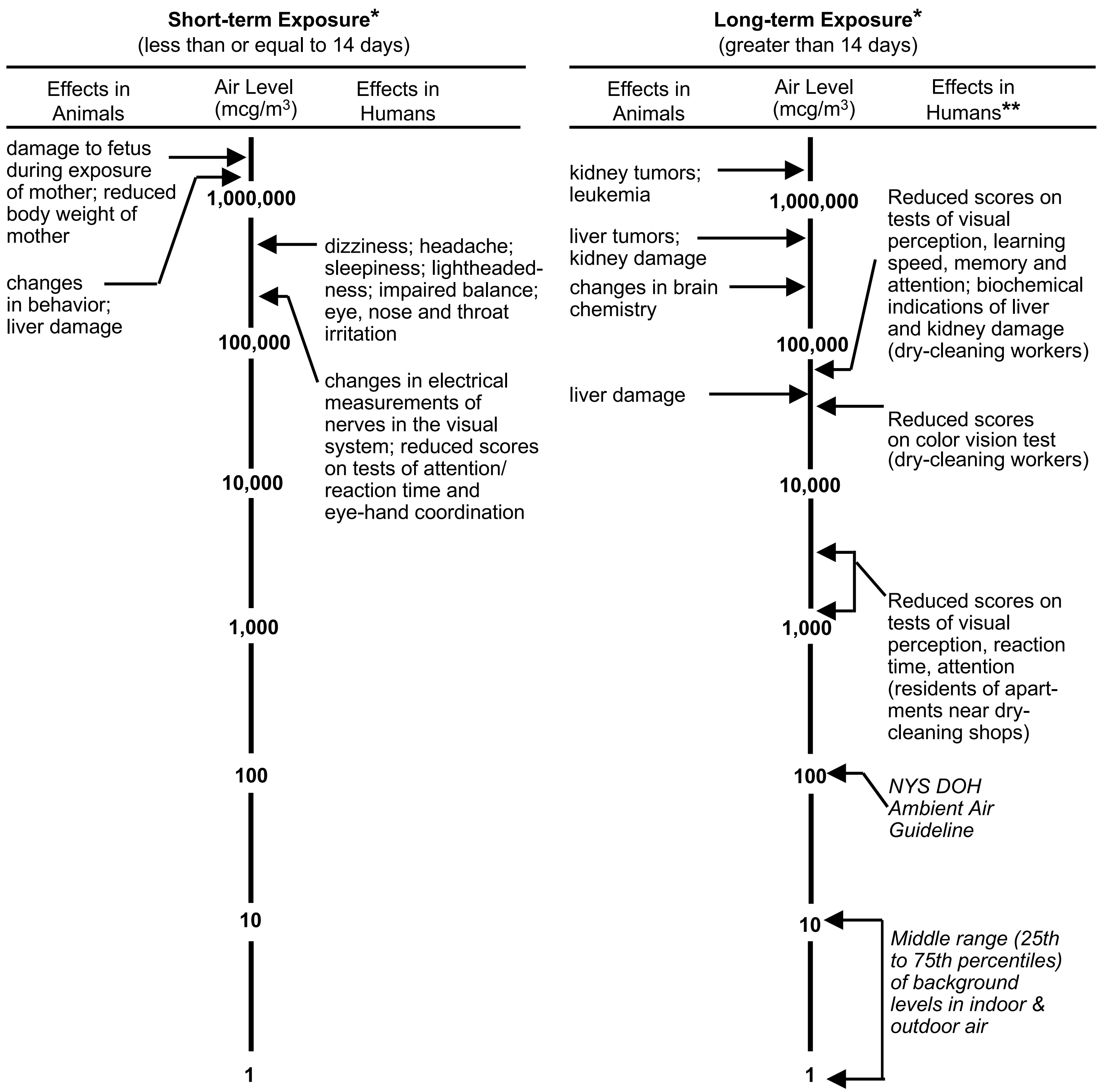
3. HOW DOES PERC ENTER AND LEAVE MY BODY?

When people breathe air containing PERC, the PERC is taken into the body through the lungs and passed into the blood, which carries it to all parts of the body. A large fraction of this PERC is breathed out, unchanged, through the lungs into the air. Some of this PERC is stored in the body (for example, in fat, liver, and brain) and some is broken down in the liver to other compounds and eliminated in urine. PERC can also be found in breastmilk. Once exposure stops, most of the PERC and its breakdown products leave the body in several days. However, it may take several weeks for all of the PERC and its breakdown products to leave the body.

4. WHAT KINDS OF HEALTH EFFECTS CAN BE CAUSED BY EXPOSURE TO PERC IN AIR?

In humans and animals, the major effects of PERC exposure are on the central nervous system, kidney, liver, and possibly the reproductive system. These effects vary with the level and length of exposure. Figure 1 shows the types of health effects seen in humans and animals and the lowest levels of PERC in air at which the effects were seen. The diagram on the right side of the figure shows the effects of long-term exposures in humans and animals whereas the diagram on the left side shows the same information for short-term exposures. Because there is a

Figure 1. Health Effects from Breathing Tetrachloroethene (PERC). The diagram shows the effects observed in humans and animals exposed to measured levels of PERC in air. The diagram contains information on the effects observed after short-term and long-term exposure. Also shown are background levels in indoor and outdoor air.



*Effects are listed at the lowest level (micrograms per cubic meter of air, mcg/m^3) at which they were first observed. They and other effects may also be seen at higher levels. 100 mcg/m^3 = 0.1 mg/m^3 (milligrams per cubic meter of air) = 15 ppb (parts per billion) = 0.015 ppm (parts per million).

**Studies have shown that workplace exposure to PERC is associated with an increased risk of cancer and spontaneous abortion, but studies did not provide good quantitative data on exposure levels.

large amount of information on the human effects of PERC, the rest of the fact sheet will discuss only the human data.

The human effects shown in Figure 1 represent the average response of a group of individuals at an estimated level of exposure (typically, the average of the measured air levels). Because data for individual people are not usually reported, some people (those sensitive to the effects of PERC) may have experienced effects at air levels below the average air level, whereas other people (those resistant to the effects of PERC) may not have experienced effects at air levels above the average air level. The difference in how people respond to the same or similar exposure levels is due, in part, to the individual differences among people. People, for example, differ in age, sex, diet, family traits, lifestyle, genetic background, the presence of other chemicals in their body (e.g., alcohol, prescription drugs), and state of health. These differences can affect how people will respond to a given exposure. One person may feel fine during and after an exposure while another person may become sick. This is known as sensitivity. Differences in sensitivity should be kept in mind when reading the following information on the human health effects of PERC.

Short-Term Exposure - Studies with volunteers show that exposures of 8-hours or less to 700,000 micrograms per cubic meter of air (mcg/m^3) cause central nervous system symptoms such as dizziness, headache, sleepiness, lightheadedness, and poor balance (Figure 1). Exposures to 350,000 mcg/m^3 for 4 hours affected the nerves of the visual system and reduced scores on certain behavioral tests (which, for example, measure the speed and accuracy of a person's response to something they see on a computer screen). These effects were mild and disappeared soon after exposure ended.

Long-Term Exposure – Numerous studies of dry-cleaning workers indicate that long-term exposure (9 to 20 years, for example) to workplace air levels averaging about 50,000 mcg/m^3 to 80,000 mcg/m^3 reduces scores on behavioral tests and causes biochemical changes in blood and urine (Figure 1). The effects were mild and hard to detect. How long these effects would last if exposure ended is not known.

One study reported reduced scores on behavioral tests in 14 healthy adults living (for 10.6 years, on average) in apartments near dry-cleaning shops. The effects were small; the average test scores of the residents were slightly lower than the average score of unexposed people. The range of measured air levels in 13 apartments was 7.6 mcg/m^3 to 23,000 mcg/m^3; one air level was below 100 mcg/m^3, five values were between 100 and 1,000 mcg/m^3, and seven values were above 1,000 mcg/m^3. The average air level in all apartments was 5,000 mcg/m^3 and the median value was about 1,400 mcg/m^3 (that is, half the measured air levels were above 1,400 mcg/m^3 and half were below it). As with the long-term occupational studies, how long these effects would last if exposure ended is not known. Confidence in the understanding of exposure in this study is less than that in the occupational studies.

Some studies show a slightly increased risk of some types of cancer and reproductive effects among workers, including dry-cleaning workers, exposed to PERC and other chemicals. Cancers associated with exposures include cancers of the esophagus, bladder, and non-Hodgkin's lymphoma. Cancers less clearly associated with exposures include cancers of the cervix, tongue, and lung. The reproductive effects associated with exposure included increased risks of spontaneous abortion, menstrual and sperm disorders, and reduced fertility. The data suggest, but do not prove, that the effects were caused by PERC and not by some other factor or factors.

Data on the workplace air levels in these studies ranged from none (reproductive studies) to some (cancer studies); however, workplace air levels during the times these studies were conducted were considerably higher than those found in indoor or outdoor air (see next question).

5. WHAT ARE BACKGROUND LEVELS FOR PERC IN INDOOR AND OUTDOOR AIR IN AREAS THAT ARE NOT NEAR A KNOWN SOURCE OF PERC?

The United States Environmental Protection Agency (US EPA) has collected and analyzed information on PERC levels in indoor and outdoor air. Table 1 contains the results from air samples collected inside and outside of buildings that were not near known sources of PERC and other chemicals (for example, a home not known to be near a chemical spill, a hazardous waste site, a dry-cleaner, or a factory). The middle half (25th to 75th percentile) of PERC levels in indoor and outdoor air samples is about 1 to 10 mcg/m^3. A similar result was found for NYS homes not near known PERC sources. NYSDOH sampled 138 homes between 1989 and 1996 and the level of PERC in the indoor air was below 10 mcg/m^3 in 95% of the homes. Collectively, these data show that background levels of PERC in air are seldom above 10 mcg/m^3.

Table 1.

Sample	PERC Air Levels (mcg/m^3)[A]			Sample Size
	25th Percentile	50th Percentile (Median)	75th Percentile	
Homes & Offices: Nationwide 1970 – 1988[B]				
Indoor	1.7	5.0	11	2,195
Outdoor	0.82	2.4	5.9	3,226
Offices: Nationwide 1994 – 1996[C]				
Indoor	not detected*	3.0	5.9	298
Outdoor		not detected*	3.0	100

[A] These databases contain air-testing results from studies where there were no known sources of chemicals or chemical spills. Outdoor samples were taken at the same time as indoor samples and at a location close to the building sampled.

[B] The US EPA Volatile Organic Compounds Database was published in March 1988.

[C] From 1994 through 1996, US EPA measured volatile organic compounds in indoor and outdoor air at 100 randomly selected public and private office buildings across the US.

* Not detected means that the amount of PERC in the air sample was less than the smallest amount of PERC that could be accurately measured (that is, the level was less than the detection limit); in these studies, the detection limit ranged from 1.4 to 2.0 mcg/m^3.

6. WHAT IS THE NEW YORK STATE DEPARTMENT OF HEALTH'S (NYSDOH) GUIDELINE FOR PERC IN AIR?

NYSDOH recommends that the average air level in a residential community not exceed 100 micrograms of PERC per cubic meter of air (100 mcg/m^3), considering continuous lifetime exposure and sensitive people. Three other ways of expressing the guideline are 0.1 milligrams per cubic meter of air (0.1 mg/m^3), 15 parts per billion (ppb) or 0.015 parts per million (ppm).

The purpose of the guideline is to help guide decisions about the nature of efforts to reduce PERC exposure. Reasonable and practical actions should be taken to reduce PERC exposure when indoor air levels are above background, even when they are below the guideline of 100 mcg/m^3. The urgency to take actions increases as indoor air levels increase, especially when air levels are above the guideline. Finally, NYSDOH recommends taking immediate action to reduce exposure when an air level is ten-times or more higher than the guideline (that is, when the air level is 1,000 mcg/m^3 or higher). In all cases, the specific corrective actions to be taken depend on a case-by-case evaluation of the situation. The goal of the recommended actions is to reduce PERC levels in indoor air to as close to background as practical.

7. SHOULD I BE CONCERNED ABOUT HEALTH EFFECTS IF I AM EXPOSED TO AN AIR LEVEL SLIGHTLY ABOVE THE GUIDELINE?

The guideline is lower than the air levels that caused either non-cancer or cancer effects (Figure 1); thus, the possibility of health effects is low even at air levels slightly above the guideline. In addition, the guideline is based on the assumption that people are continuously exposed to PERC in air all day, every day for as long as a lifetime. This is rarely true for most people, who are more likely to be exposed for a part of the day and part of their lifetime.

8. WHEN SHOULD MY CHILDREN OR I SEE A PHYSICIAN?

If you believe you or your children have symptoms that you think are caused by PERC exposure, you and your children should see a physician. You should tell the physician about the symptoms and about when, how, and for how long you think you and/or your children were exposed to PERC.

9. WHERE CAN I GET MORE INFORMATION?

If you have any questions about the information in this fact sheet or would like to know more about PERC, please call the New York State Department of Health at 1-518-402-7800 or 1-800-458-1158 (extension 2-7800) or write to the following address.

New York State Department of Health
Bureau of Toxic Substance Assessment
Flanigan Square, 547 River Street
Troy, NY 12180-2216

Trichloroethene (TCE) in Indoor and Outdoor Air

Fact Sheet: February 2005

What is trichloroethene?

Trichloroethene is a manufactured, volatile organic chemical. It has been used as a solvent to remove grease from metal. Trichloroethene has also been used as a paint stripper, adhesive solvent, as an ingredient in paints and varnishes, and in the manufacture of other organic chemicals. Other names for trichloroethene include TCE and trichloroethylene. TCE is a common name for trichloroethene and will be used for the rest of this fact sheet.

TCE is a clear, colorless liquid, and has a somewhat sweet odor. It is non-flammable at room temperature and will evaporate into the air.

How can I be exposed to TCE?

People can be exposed to TCE in air, water and food. Exposure can also occur when TCE, or material containing TCE, gets on the skin.

TCE gets into the air by evaporation when it is used. TCE can also enter air and groundwater if it is improperly disposed or leaks into the ground. People can be exposed to TCE if they drink groundwater contaminated with TCE, and if the TCE evaporates from the contaminated drinking water into indoor air during cooking and washing. They may also be exposed if TCE evaporates from the groundwater, enters soil vapor (air spaces between soil particles), and migrates through building foundations into the building's indoor air. This process is called "soil vapor intrusion."

How can TCE enter and leave my body?

If people breathe air containing TCE, some of the TCE is exhaled unchanged from the lungs and back into the air. Much of the TCE gets taken into the body through the lungs and is passed into the blood, which carries it to other parts of the body. The liver changes most of the TCE taken into the blood into other compounds, called breakdown products, which are excreted in the urine in a day or so. However, some of the TCE and its breakdown products can be stored in the fat or the liver, and it may take a few weeks for them to leave the body after exposure stops.

What kinds of health effects are caused by exposure to TCE in air?

In humans, long term exposure to workplace air containing high levels of TCE (generally greater than about 40,000 micrograms of TCE per cubic meter of air (mcg TCE/m^3)) is linked to effects on the central nervous system (reduced scores on tests evaluating motor coordination, nausea, headaches, dizziness) and irritation of the mucous membranes. Exposure to higher levels (generally greater than 300,000 mcg TCE/m^3) for short periods of time can irritate the eyes and respiratory tract, and can cause effects on the central nervous system, including dizziness, headache, sleepiness, nausea, confusion, blurred vision and fatigue. In laboratory animals, exposure to high levels of TCE has damaged the central nervous system, liver and kidneys, and adversely affected reproduction and development of offspring. Lifetime exposure to high levels of TCE has caused cancer in laboratory animals.

Some studies of people exposed for long periods of time to high levels of TCE in workplace air, or elevated levels of TCE in drinking water, show an association between exposure to TCE and increased risks for certain types of cancer, including cancers of the kidney, liver and esophagus, and non-Hodgkin's lymphoma. One study showed an association between elevated levels of TCE in drinking water and effects on fetal development. Other studies suggest an association between workplace TCE exposure and reproductive effects (alterations in sperm counts) in men. We do not know if the effects observed in these studies are due to TCE or some other possible factor (for example, exposure to other chemicals, smoking, alcohol consumption, socioeconomic status, lifestyle choices). Because all of these studies have limitations, they only suggest, but do not prove, that exposure to TCE can cause cancer in humans and can cause developmental and reproductive effects as well.

What are background levels of TCE for indoor and outdoor air?

The exact meaning of background depends on how a study selected sampling locations and conditions. Generally, sampling locations are selected to be not near known sources of volatile chemicals (for example, a home not near a chemical spill, a hazardous waste site, a dry cleaner, or a factory). In some studies, the criteria for sampling indoor air may require checking containers of volatile chemicals to make sure they are tightly closed or removing those products before samples are taken. The New York State Department of Health (NYSDOH) has used several sources of information on background levels of TCE in indoor and outdoor air. One NYSDOH study of residences heated by fuel oil found that background concentrations of TCE in indoor and outdoor air are less than 1 mcg/m^3 in most cases. In this study, most homes did not have obvious sources of volatile organic compounds (VOCs). In those homes with VOC sources, samples were taken and the data are included in the study.

What are sources of TCE in air in homes?

TCE is found in some household products, such as glues, adhesives, paint removers, spot removers, rug cleaning fluids, paints, metal cleaners and typewriter correction fluid. These and other products could be potential sources for TCE in indoor air.

Another source of TCE in indoor air is contaminated groundwater that is used for household purposes. Common use of water, such as washing dishes or clothing, showering, or bathing, can introduce TCE into indoor air through volatilization from the water.

TCE may also enter homes through vapor intrusion as described on page 1 in the question "How can I be exposed to TCE?".

What is the level of TCE that people can smell in the air?

The reported odor threshold (the air concentration at which a chemical can be smelled) for TCE in air is about 540,000 mcg TCE/m^3. At this level, most people would likely be able to start smelling TCE in air. However, odor thresholds vary from person to person. Some people may be able to detect TCE at levels lower than the reported odor threshold and some people may only detect it at concentrations higher than the reported odor threshold.

If I can't smell TCE in the air, am I being exposed?

Just because you can't smell TCE doesn't mean there is no exposure. Sampling and testing is the best way to know if TCE is present.

What is the NYSDOH's guideline for TCE in air?

After a review of the toxicological literature on TCE, the NYSDOH set a guideline of 5 mcg/m^3 for TCE in air. This level is lower than the levels that have caused health effects in animals and humans. In setting this level, the NYSDOH also considered the possibility that certain members of the population (infants, children, the elderly, and those with pre-existing health conditions) may be especially sensitive to the effects of TCE.

The guideline is not a bright line between air levels that cause health effects and those that do not. The purpose of the guideline is to help guide decisions about the nature of the efforts to reduce TCE exposure. Reasonable and practical actions should be taken to reduce TCE exposure when indoor air levels are above background, even when they are below the guideline of 5 mcg/m^3. The urgency to take actions increases as indoor air levels increase, especially when air levels are above the guideline. In all cases, the specific corrective actions to be taken depend on a case-by-case evaluation of the situation. The goal of the recommended actions is to reduce TCE levels in indoor air to as close to background as practical.

Should I be concerned about health effects if I am exposed to air levels slightly above the guideline? Below the guideline?

The possibility of health effects occurring is low even at air levels slightly above the guideline. In addition, the guideline is based on the assumption that people are continuously exposed to TCE in air all day, every day for as long as a lifetime. This is rarely true for most people who are likely to be exposed for only part of the day and part of their lifetime.

How can I limit my exposure to TCE?

TCE can get into indoor air through household sources (for example, commercial products that contain TCE), from contaminated drinking water, or by vapor intrusion. As with any indoor air contaminant, removing household sources of TCE will help reduce indoor air levels of the chemical. Maintaining adequate ventilation will also help reduce the indoor air levels of TCE. If TCE is in the indoor air as a result of vapor intrusion, a sub-slab depressurization system, much like a radon mitigation system, will reduce exposures by minimizing the movement of vapors that are beneath a slab into a building. If TCE is in the water supply of a house, a carbon filter on the water supply to remove the TCE will minimize ingestion and inhalation exposures.

Is there a medical test that can tell me whether I have been exposed to TCE?

TCE can be measured in people's breath soon after they are exposed. TCE and some of its breakdown products can be measured in the urine and blood. These tests are not routinely available at a doctor's office. Urine and blood tests can indicate that you may have recently (within the last few days) been exposed to a large amount of the chemical. However, they cannot tell you the source of the exposure. Some of the breakdown products of TCE can also be formed from other chemicals.

When should my children or I see a physician?

If you believe you or your children have symptoms that you think are caused by TCE exposure, you or your children should see a physician. You should tell the physician about the symptoms and about when, how and for how long you think you and/or your children were exposed to TCE.

What is the NYSDOH doing to educate physicians about TCE?

The NYSDOH maintains an Infoline (1-800-458-1158) that physicians or the public can call when they have questions related to various types of chemical exposures. A certified occupational and environmental health nurse is available to triage physicians' questions and to direct their inquiries to the appropriate staff member.

The NYSDOH also works closely with the federal Agency for Toxic Substances and Disease Registry (ATSDR), making their educational materials available to physicians upon request. One of these items is an environmental medicine case study entitled "Trichloroethylene (TCE) Toxicity," which provides the opportunity for physicians to earn continuing medical education credits from the Centers for Disease Control and Prevention. Physicians who would like to complete this training are encouraged to contact the NYSDOH for more information. A printed copy can be mailed to the physician or it can be accessed on-line at the following web site http://www.atsdr.cdc.gov/HEC/CSEM/tce/index.html.

Where can I get more information?

If you have any questions about the information in this fact sheet or would like to know more about TCE, please call the NYSDOH at 1-800-458-1158 or write to the following address:

New York State Department of Health
Bureau of Toxic Substance Assessment
Flanigan Square, 547 River Street
Troy, NY 12180-2216

Questions or comments: beei@health.state.ny.us
Revised: February 2005