



DEP Sampling Study at USA TODAY Report Sites

Stony Brook Elementary School, York, Pennsylvania

Background

In response to a USA TODAY special report titled "The Smokestack Effect – Toxic Air and America's Schools", the Pennsylvania Department of Environmental Protection (DEP), Bureau of Air Quality (BAQ) conducted air sampling for toxic pollutants at a select group of schools in Pennsylvania. The schools were chosen based on their modeled relative ranking above the reference school (Meredith Hitchens Elementary School in Ohio) cited in the report. Additional schools were chosen where USA TODAY conducted their own sampling and risk analysis, and proposed the school required further investigation.

The Stony Brook Elementary School was one of 38 schools in Pennsylvania where the modeled ranking was above the reference school and in the top 1% of all schools in the United States. The model listed chromium and nickel as the major pollutants of concern at this site. Additionally, of the 95 schools where "snapshot" air samples were taken by the USA TODAY, this school was listed with a group of 56 other schools where results showed levels of pollutants that could lead to unacceptable health risks. The USA TODAY listed benzene and chromium as the pollutants of concern based on the sampling. See USA TODAY's information on their website at <http://smokestack.usatoday.com/>.

Findings

The total excess lifetime cancer risk based on DEP sampling is 4.0 in a 100,000. The risk calculation assumes an adult weighing 70 kilograms (154 pounds) will breathe 20 m³ (706 ft³) of air each day for 365 days a year, over a 70-year lifetime of exposure. This falls in the range of risk that USA TODAY's determined with their sampling. This level of cancer risk also falls within the US Environmental Protection Agency's (EPA) generally acceptable risk range of 1-in-10,000 to 1-in-a-million.

Because the DEP sampling found the concentrations of the pollutants measured at this site to be below non-cancer health benchmarks, non-cancer health effects are not expected from breathing the air at this school.

DEP Sampling

Two types of air sampling were conducted at Stony Brook. One type sampled for concentrations of toxic metals in particles including arsenic, beryllium, cadmium, chromium, manganese, lead, nickel and zinc. The other type of sampling looked for concentrations of volatile organic compounds (VOC's). The DEP laboratory conducts a "blanket" analysis of 56 target VOCs which include 34 "Hazardous Air Pollutants" listed in the 1990 Clean Air Act Amendments and additional compounds emitted by a wide variety of industries, motor vehicles and other sources.

The toxic metals samples were collected over a 96-hour period using a high-volume particulate sampler with quartz-fiber filters, and were analyzed by the DEP Laboratory. The procedure is based on the EPA Compendium Methods IO-2 and IO-3.

The VOC sampling used evacuated stainless steel canisters that were analyzed by the DEP laboratory. The procedure is based on EPA Compendium Method TO-15. The VOC samples were 24-hours in duration.

The DEP laboratory can detect very low levels of pollutants in the range well below 1 microgram (ug)(one millionth of a gram) per cubic meter (m³) of air.

Summarizing the Data

In summarizing the sampling data, DEP calculated average concentrations from three samples for each toxic metal compound. If a compound was not detected, or found at a concentration below the Reporting Limit (RL) in all three samples, an average was not calculated. If a compound was detected in at least one sample, the average was calculated using ½ the lab RL for any non-detects.

Similarly for VOC's, if a compound was not detected, or found at a level below the Method Detection Limit (MDL) in all three samples, an average was not calculated and the risk not determined. If a compound was detected in at least one sample, the average was calculated using ½ the lab MDL for any non-detects, and the risk was then determined

Note that there are neither state nor national air quality standards for most of these pollutants (except for lead). Therefore, the DEP evaluated the health risks associated with breathing the measured concentrations of these pollutants using risk assessment methods approved by the EPA.

Overview of Risk Factors and Reference Doses

The excess lifetime cancer risk for each compound was calculated using unit risk factors (URFs), and the risk for non-cancer health effects was calculated using reference air concentrations (RfCs). The URF is a measure of the probability of developing cancer from exposure over a lifetime to a specified concentration of a given chemical. The RfC is the concentration below which no (non-cancer) adverse health affects are expected to occur over a lifetime of continuous exposure. The EPA Integrated Risk Information System (IRIS) database was the primary source for the risk factors. In some cases, there were no inhalation risk data for a chemical in the IRIS database, so other sources were referenced.

The URF and RfC are derived by assuming an adult weighing 70 kilograms (154 pounds) will breathe 20 m³ (706 ft³) of air each day for 365 days a year, over a 70-year lifetime of exposure.

The excess lifetime cancer risk is calculated for each compound by multiplying its URF by the average concentration. The individual risks for each chemical are added to get the total excess lifetime cancer risk at that site.

The excess lifetime cancer risk numbers are written in an exponential format (e.g. 1.0E-04). Refer to Table 1 when interpreting these numbers. For example, an excess lifetime cancer risk of 1.2E-05 means that 1.2 more people in a population of 100,000 (or 12 more in a million) are likely to develop cancer. This is above and beyond the national lifetime cancer risk of slightly less than 1 in 2 in men, and slightly more than 1 in 3 in women.

Table 1. Interpreting the risk numbers.

Risk	Exponential	Decimal	Read as...
1.0E-08	1x10 ⁻⁸	0.00000001	1 in 100 million
1.0E-07	1x10 ⁻⁷	0.0000001	1 in 10 million
1.0E-06	1x10 ⁻⁶	0.000001	1 in 1 million
1.0E-05	1x10 ⁻⁵	0.00001	1 in 100,000
1.0E-04	1x10 ⁻⁴	0.0001	1 in 10,000

Any risk estimate is based on a number of assumptions and some of the assumptions DEP made for this study include:

- The average concentration of the three samples collected is the concentration that the student will be exposed to over a lifetime;
- The concentrations measured at the sampling site are representative of exposures to the student population in the school;
- Hexavalent chromium (chrome VI) concentrations are assumed to be 1/7th the total chromium concentration;
- The effects of exposure to multiple chemicals are additive;
- The only excess risk considered in this report is due to inhalation.

The hazard quotient (non-cancer health risk) associated with each of the relevant compounds is calculated by simply dividing the compound average concentration by the respective RfC. The individual hazard quotients for each compound are summed to get the hazard index. If this value is less than one, and inhalation is the only source of exposure, then those chemicals concentrations are not likely to cause adverse non-cancer health effects.

Excess Lifetime Cancer Risk

The goal of Federal and State Air Pollution Agencies, when dealing with the emission of a toxic pollutant from an industrial source is to limit the risk from that pollutant to the surrounding community to less than one in a million excess lifetime cancer risk (from inhalation). The risk to communities is generally higher due to the fact there are multiple sources and multiple pollutants. In conducting risk assessments at hazardous waste cleanup projects and superfund sites, EPA generally considers a lifetime cancer risk to an individual of between 1-in-10,000 and 1-in-a-million as an acceptable range.

The excess lifetime cancer risk for inhalation, based on the average concentration of toxic metals from DEP sampling, is 4.6 in a million (4.6E-06) and is shown in Table 2. The excess lifetime cancer risk for inhalation, based on the average concentration of VOC's from DEP sampling, is 3.6 in 100,000 (3.6E-05) and is shown in Table 3.

The total excess lifetime cancer risk, which is calculated by summing the risk for metals and VOC's, is 4.0 in 100,000 (4.0E-05). This value falls between the 1-in-10,000 and 1-in-a-million range. With the conservative assumptions used by the DEP in conducting this risk assessment, the actual risk may be lower. For the purpose of comparison, Tables 2 and 3 also show the excess lifetime cancer risks for inhalation based on the 2007 average annual monitoring data from DEP air toxic monitors across the Commonwealth. The total risk of 4.0 in a 100,000 calculated for the Stony Brook Elementary School is under the combined statewide cancer risk for VOC's and toxic metals of 5.7 in 100,000.

Non-Cancer Health Effects

There were no toxic metals or VOC's with average concentrations above their respective RfC (a hazard quotient less than 1). Furthermore, the hazard index (the individual hazard quotients summed) was below 1 as well. Consequently, non-cancer health effects are not expected from breathing the air at the school.

The EPA has set National Ambient Air Quality Standards (NAAQS) for six principal pollutants, including lead, to protect public health and welfare. The NAAQS for lead is a 0.15 ug/m³ average in any 3-month period (also known as a 3-month rolling average). None of the lead concentrations from the DEP sampling approached this level and therefore are not a concern.

Differences Between the DEP and USA TODAY Studies

The USA TODAY report used the Risk-Screening Environmental Indicator (RSEI) model to rank each school relative to one another based on the pollutants likely to be in the air outside the school. The RSEI is a *screening tool* developed by the EPA to put Toxic Release Inventory (TRI) emission data into a health context. The model is used as a priority-setting tool to focus resources in areas that will provide the "greatest potential risk reduction". RSEI results do not provide quantitative risk estimates and therefore the DEP does not use it as such. TRI emissions data are self-reported by facilities and may contain errors. Pollutant concentrations measured through sampling are generally considered more reliable than modeled concentrations.

Also, the USA TODAY used a "snapshot" sample (one sample) to quantify the levels of toxic pollutants near the school. A better approach is to collect multiple samples to account for factors such as weather conditions, emission schedules, etc. The DEP took three samples and averaged the results for each compound that was analyzed.

A major difference between the DEP and USA TODAY results occurs in the treatment of the total chromium results. Chromium can take multiple forms in the air including chromium III, a relatively harmless form and essential nutrient in diet, and chromium VI, the form linked to cancer. The USA TODAY assumed that the total chromium result from their sampling was composed entirely of the more harmful variety. The DEP would not make this extreme assumption, but would still conservatively estimate the ratio of Chrome VI to Chrome III as 1 to 6. However, no chromium was detected in the three DEP samples.

Another reason for differences in sampling results may be due to the way the samples were collected and analyzed. Requests for more information on the USA TODAY's sampling and analysis methods, protocols, and quality assurance documents have not been answered at the time of this writing.

Conclusion

Although through modeling, the USA TODAY ranked the Stony Brook Elementary School higher than the reference school mentioned in their report, and from the sampling, they ranked the school as one which may have unacceptable health risks to the student, sampling by DEP for the stated pollutants of concern (benzene, chromium and nickel) does not indicate an unacceptable risk to the students attending the school.

For additional information on modeled toxic concentrations in the United States down to the census tract level, see the EPA National Air toxics Assessment (NATA) web site at:
<http://www.epa.gov/ttn/atw/natamain/>.

Table 2. DEP toxic metal sampling results at the Stony Brook Elementary School.

CAS #	Metal	USA TODAY Sample ^a ug/m ³	DEP Samples ^b				Unit Risk Factor (URF) m ³ /ug	Source URF	Excess Lifetime Cancer Risk ^c	2007 PA Excess Lifetime Cancer Risk ^d	Reference Air Conc. (RfC) ug/m ³	Source RfC	Hazard Quotient ^e
			12/12/08 ug/m ³	12/17/08 ug/m ³	12/25/08 ug/m ³	Average ug/m ³							
7440-38-2	Arsenic	0.00154	0.00036	0.00086	0.00173	0.00098	4.3E-03	IRIS	4.2E-06	3.6E-06	1.5E-02	CalEPA	0.1
7440-41-7	Beryllium	<LOD	<RL	<RL	<RL		2.4E-03	IRIS			2.0E-02	IRIS	
7440-43-9	Cadmium	0.00003	0.00006	0.00015	0.00010	0.00010	1.8E-03	IRIS	1.9E-07	4.6E-07			
7440-47-3	Chromium (Total)	0.00216	<RL	<RL	<RL								
18540-29-9	Chromium VI (Assumed) ^f						1.2E-02	IRIS		5.0E-06	1.0E-01	IRIS	
7439-92-1	Lead ^g	0.00190	0.00157	0.00840	0.00230	0.00409	1.2E-05	CalEPA	4.9E-08	8.9E-08			
7439-96-5	Manganese	0.00830	0.00161	0.00470	0.00216	0.00282					5.0E-02	IRIS	0.1
	Nickel ^h	0.00008	0.00025	0.00055	0.00025	0.00035	2.4E-04	IRIS	8.3E-08	6.3E-07			
7440-66-6	Zinc	0.00680	0.00907	0.02639	0.01265	0.01604							
Total									4.6E-06	9.9E-06		Hazard Index	0.1

^a Samples were collected over a 96-hour period on 37mm filters.

^b Samples were collected over a 96-hour period beginning on the date shown using EPA Method IO-2 and IO-3.

^c Risk due to inhalation is based on the average of three samples (ELCR = Avg x URF). Risk is not calculated for compounds that were not detected in all three samples.

^d Calculated by averaging data collected in 2007 at the Chester, Erie, Lancaster, Lewisburg, Marcus Hook, Reading and Swarthmore toxic monitoring sites.

^e A Hazard Quotient < 1 indicates no expected non-cancer health effects (HQ = Avg / RfC). The HQ is not calculated for compounds that were not detected in all three samples.

^f Chromium VI concentration assumed to be 1/7th the Total Chromium concentration by DEP for study purposes.

^g The NAAQS standard for lead is 0.15 ug/m³ (rolling 3-month average).

^h The URF for Nickel is the IRIS value for Nickel (Refinery Dust).

<LOD	- Compound concentration less than the Lab Limit of Detection.
<RL	- Compound not detected, or less than the Lab Reporting Limit (RL), in all three DEP samples.
#	- Compound not detected. DEP substituted 1/2 the Reporting Limit to calculate average.

IRIS - EPA's Integrated Risk Information System

CalEPA - California EPA

Table 3. DEP VOC sampling results at the Stony Brook Elementary School.

CAS #	Compound	USA TODAY Sample ^a ug/m ³	DEP Samples ^b				Unit Risk Factor (URF) m ³ /ug	Source URF	Excess Lifetime Cancer Risk ^c	2007 PA Excess Lifetime Cancer Risk ^d	Reference Air Concentration (RFC) ug/m ³	Source RFC	Hazard Quotient ^e
			12/15/08 ug/m ³	12/19/08 ug/m ³	12/23/08 ug/m ³	Average ug/m ³							
71-55-6	1,1,1-Trichloroethane		0.191	0.055	0.055	0.100				5.00E+03	IRIS	0.0	
79-34-6	1,1,2,2-Tetrachloroethane		<MDL	<MDL	<MDL		5.80E-05	IRIS					
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane		0.674	0.644	0.628	0.649				3.00E+04	HEAST	0.0	
79-00-5	1,1,2-Trichloroethane		<MDL	<MDL	<MDL		1.60E-05	IRIS					
75-34-3	1,1-Dichloroethane		<MDL	<MDL	<MDL		1.60E-06	CalEPA		5.00E+02	HEAST		
75-35-4	1,1-Dichloroethene		<MDL	<MDL	<MDL					2.00E+02	IRIS		
120-82-1	1,2,4-Trichlorobenzene		<MDL	<MDL	<MDL					4.00E+00	PROV		
95-63-6	1,2,4-Trimethylbenzene		0.339	0.457	0.354	0.383				7.00E+00	PROV	0.1	
106-93-4	1,2-Dibromoethane		<MDL	<MDL	<MDL		6.00E-04	IRIS		9.00E+00	IRIS		
76-14-2	1,2-Dichloro-1,1,2,2-tetrafluoroethane		<MDL	<MDL	<MDL								
95-50-1	1,2-Dichlorobenzene		<MDL	<MDL	<MDL					2.00E+02	HEAST		
107-06-2	1,2-Dichloroethane		0.170	0.040	0.040	0.084	2.60E-05	IRIS	2.2E-06	3.2E-06			
78-87-5	1,2-Dichloropropane		0.693	0.092	0.092	0.293	1.00E-05	CalEPA	2.9E-06		4.00E+00	IRIS 0.1	
108-67-8	1,3,5-Trimethylbenzene		<MDL	<MDL	<MDL					6.00E+00	PROV		
106-99-0	1,3-Butadiene		<MDL	<MDL	<MDL		3.00E-05	IRIS		2.00E+00	IRIS		
541-73-1	1,3-Dichlorobenzene		<MDL	<MDL	<MDL								
106-46-7	1,4-Dichlorobenzene		<MDL	<MDL	<MDL		1.10E-05	CalEPA		8.00E+02	IRIS		
106-94-5	1-Bromopropane		<MDL	<MDL	<MDL								
622-96-8	1-Ethyl-4-methyl benzene		0.688	0.836	0.737	0.754							
78-93-3	2-Butanone (MEK)		16.216	2.948	6.486	8.550				5.00E+03	IRIS	0.0	
591-78-6	2-Hexanone		4.917	0.417	4.507	3.280							
1634-04-2	2-Methoxy-2-methyl propane (MTBE)		<MDL	<MDL	<MDL		2.60E-07	CalEPA		1.9E-08	3.00E+03	IRIS	
108-10-1	4-Methyl-2-pentanone (MIBK)		1.188	0.452	0.452	0.698				3.00E+03	IRIS	0.0	
67-64-1	Acetone		62.724	12.355	18.770	31.283							
71-43-2	Benzene	2.4	1.373	1.916	1.278	1.522	7.80E-06	IRIS	1.2E-05	6.2E-06	3.00E+01	IRIS 0.1	
75-27-4	Bromodichloromethane		<MDL	<MDL	<MDL		3.70E-05	CalEPA					
75-25-2	Bromoform		<MDL	<MDL	<MDL		1.10E-06	IRIS					
74-83-9	Bromomethane		<MDL	<MDL	<MDL					5.00E+00	IRIS		
75-15-0	Carbon disulfide		4.357	0.311	0.311	1.660				7.00E+02	IRIS	0.0	
56-23-6	Carbon tetrachloride	0.8	0.818	0.881	0.881	0.860	1.50E-05	IRIS	1.3E-05	8.0E-06	4.00E+01	CalEPA 0.0	
108-90-7	Chlorobenzene		<MDL	<MDL	<MDL					5.00E+01	PROV		
75-00-3	Chloroethane		<MDL	<MDL	<MDL					1.00E+04	IRIS		
75-01-4	Chloroethene		<MDL	<MDL	<MDL		4.40E-06	IRIS		3.4E-07	1.00E+02	IRIS	
67-66-3	Chloroform	0.3	0.156	0.049	0.049	0.085	2.30E-05	IRIS	1.9E-06	3.4E-06	3.00E+02	CalEPA 0.0	
74-87-3	Chloromethane		0.888	1.115	1.053	1.019	1.80E-06	HEAST	1.8E-06	1.8E-06	9.00E+01	IRIS 0.0	
156-59-2	cis-1,2-Dichloroethene		<MDL	<MDL	<MDL								
10061-01-6	cis-1,3-Dichloro-1-propene		<MDL	<MDL	<MDL		4.00E-06	IRIS		2.00E+01	IRIS		
110-82-7	Cyclohexane		<MDL	<MDL	<MDL					6.00E+03	IRIS		
124-48-1	Dibromochloromethane		<MDL	<MDL	<MDL		2.70E-05	CalEPA					
75-71-8	Dichlorodifluoromethane		2.868	3.065	2.966	2.966				2.00E+02	HEAST	0.0	
100-41-4	Ethylbenzene	2.9	0.304	0.087	0.304	0.232	2.50E-06	CalEPA	5.8E-07	4.7E-07	1.00E+03	IRIS 0.0	
87-68-3	Hexachloro-1,3-butadiene		<MDL	<MDL	<MDL		2.20E-05	IRIS					
108-38-3	m&p-Xylene	7.4	0.651	0.608	0.869	0.709				1.00E+02	IRIS	0.0	
75-09-2	Methylene chloride		0.417	0.486	0.278	0.393	4.70E-07	IRIS	1.8E-07	1.2E-07	4.00E+02	CalEPA 0.0	
142-82-5	n-Heptane		0.615	1.188	3.237	1.680							
110-54-3	n-Hexane		0.035	1.269	0.035	0.447				7.00E+02	IRIS	0.0	
95-47-6	o-Xylene		0.395	0.565	0.478	0.479				1.00E+02	IRIS	0.0	
115-07-1	Propene		0.175	2.927	1.894	1.665				3.00E+03	CalEPA	0.0	
100-42-5	Styrene		0.375	0.281	0.196	0.284				1.00E+03	IRIS	0.0	
127-18-4	Tetrachloroethene		0.136	0.353	0.136	0.208	5.90E-06	CalEPA	1.2E-06	1.2E-06			
109-99-9	Tetrahydrofuran		<MDL	<MDL	<MDL								
108-88-3	Toluene	11	4.143	4.143	2.561	3.616				5.00E+03	IRIS	0.0	
156-60-5	trans-1,2-Dichloroethene		<MDL	<MDL	<MDL					6.00E+01	PROV		
10061-02-6	trans-1,3-Dichloro-1-propene		<MDL	<MDL	<MDL		4.00E-06	IRIS		2.00E+01	IRIS		
79-01-6	Trichloroethylene (TCE)		<MDL	<MDL	<MDL		1.14E-04	NCEA		2.3E-05	4.00E+01	NCEA	
75-69-4	Trichlorofluoromethane		1.124	1.348	1.292	1.255				7.00E+02	HEAST	0.0	
Total									3.6E-05	4.8E-05		Hazard Index	0.2

^a Samples were collected over a 96 to 168-hour period using passive samplers.

^b Samples were collected over a 24-hour period using EPA Method TO-15.

^c Risk based on the average of three samples (ELCR = Avg x URF). Risk is not calculated for compounds that were not detected in all three samples.

^d Calculated by averaging data collected in 2007 at the Arendtsville, Chester, Erie, Lancaster, Lewisburg, Marcus Hook, Reading and Swarthmore toxic monitoring sites.

^e A Hazard Quotient < 1 indicates no expected non-cancer health effects (HQ = Avg / RFC). The HQ is not calculated for compounds that were not detected in all three samples.

<MDL - Compound not detected, or less than the Method Detection Limit (MDL), in all three DEP samples.

- Compound not detected. DEP substituted 1/2 the Method Detection Limit to calculate average.

IRIS - EPA's Integrated Risk Information System

PROV - EPA's Provisional Peer Reviewed Toxicity Values

HEAST - EPA's Health Effects Assessment Summary Tables

CalEPA - California EPA

NCEA - EPA's National Center for Environmental Assessment