Letter Health Consultation

Review of Preoccupancy Data

GRANDVIEW HILLS ELEMENTARY SCHOOL
(Formerly Proposed Elementary School # 19)
12024 VISTA PARKE DRIVE
AUSTIN, TRAVIS COUNTY, TEXAS

FEBRUARY 4, 2009

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

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LETTER HEALTH CONSULTATION

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AUSTIN, TRAVIS COUNTY, TEXAS

Prepared By:

Texas Department of State Health Services
Health Assessment & Toxicologist Program
Under a cooperative agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

TEXAS DEPARTMENT OF STATE HEALTH SERVICES

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DAVID L. LAKEY, M.D.
COMMISSIONER

January __, 2009

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Assistant Superintendent
Leander Independent School District
PO Box 218
Leander, TX 78646

RE: **Review of Preoccupancy Data**
Grandview Hills Elementary School
(formerly proposed elementary school #19)
12024 Vista Parke Drive
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Ms. Skoviera:

Background and Statement of Issues

In previous consultations [1, 2], the Texas Department of State Health Services (DSHS) Health Assessment and Toxicology Program (HAT) recommended that the indoor air of Grandview Hills Elementary School (formerly known as proposed elementary school #19) be evaluated after construction of the building was complete but before it was opened for occupancy. This consultation provides an evaluation of the preoccupancy indoor air samples collected by Weston Solutions, Inc.

Discussion

We used indoor air data collected in July 2008, after construction was complete, for this evaluation. The indoor air data consisted of nineteen 8-hour samples collected using SUMMA canisters while the sub-slab venting system was operating. According to Weston Solutions, Inc., during the sampling event the building was completely constructed, the heating, ventilation, and air conditioning (HVAC) unit was on and the temperature was normal (72-78). Crews of workers were moving and constructing furniture. Although the building was closed, workers were moving in and out of the building during these activities. The samples were analyzed for volatile organic compounds (VOCs) by gas chromatography/mass spectrometry (GC/MS) using Environmental Protection Agency (EPA) Method TO-15. Fifteen additional indoor air samples were collected and analyzed for formaldehyde, fungi, and total dust. We did not evaluate the sampling results for fungi and total dust for this report.

We evaluated the potential public health hazards associated with the chemical contaminants found in the indoor air (regardless of the source) by comparing the contaminant concentrations with appropriate noncancer and cancer health-based screening values. Although exceeding a screening value does not mean that adverse health affects will occur, it does indicate that further evaluation may be necessary. A full description of screening values and their uses can be found in previous referenced reports [1, 2].

Acetaldehyde and formaldehyde were the only contaminants that exceeded their respective noncancer screening values (Table 1). The only noncancer screening value available for 1, 2, 4-trimethylbenzene is a provisional screening value for use by the Department of Energy and not recommended for use on this type of site; however, we kept this contaminant on the list for further evaluation. Acetaldehyde, benzene, 1, 2-dichloroethane, and formaldehyde were the only contaminants that exceeded their respective cancer risk screening values (Table 2). The potential public health implications of these contaminants are discussed below.

Acetaldehyde
Acetaldehyde is used in perfumes and fragrances, synthetic flavorings, food preservatives, aniline dyes, plastics, glue products, synthetic rubber, silvering mirrors, fuel mixtures, and cosmetics [3]. The primary adverse health effect associated with acetaldehyde is irritation of the eyes and respiratory tract and the noncancer screening value is based on studies where degeneration of the olfactory epithelium was observed in rats exposed to a human equivalent dose (HED) of 8,700 $\mu g/m^3$. The highest concentration found in the indoor air (19 $\mu g/m^3$) is 450 times lower that the dose upon which the screening value is based. Acute exposure to acetaldehyde also can result in adverse health effects; eye irritation has been observed in sensitive people exposed to 45,000 $\mu g/m^3$ acetaldehyde for 15 minutes. The lowest concentration at which these effects have been observed in people is over 2,000 times greater than the highest concentration measured in the school. Based on the above we would not expect the levels measured in the school to result in adverse noncancer health effects.

EPA classifies acetaldehyde as a probable human carcinogen [3]. This means that exposure to this compound could theoretically increase a person's risk for developing cancer over the course of a lifetime. We estimate the theoretical cancer risks associated with long-term exposure to this contaminant to be 2.9×10^{-7} for children and 1.2×10^{-6} for adults[1]. We would qualitatively interpret these risks as posing no increased risk for developing cancer. Based on the concentrations measured during the July 2008 sampling event we would not expect the levels of acetaldehyde found in the school to result either in noncancer or cancer health effects.

[1] This calculation estimates a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime of exposure [4]. Cancer risk estimates were calculated using EPA's cancer unit risk factors and exposure durations of 8 hours per day, 5 days per week, and 38 weeks per year for 6 years for children and 25 years for adults. A cancer risk estimate of 2.9×10^{-7} means that if 3,448,275 children were exposed to this contaminant, eight-hours per day, five days per week, 38 weeks per year, for 6-years, over the course of a 70-year lifetime one of those children theoretically could get cancer from that exposure.

Formaldehyde
Formaldehyde is a very common natural substance that is found in both indoor and outdoor air. It is produced by the body during metabolism and is present in most living organisms as a metabolic intermediate. The primary source of formaldehyde in indoor air is the urea formaldehyde (UF) resins used as adhesives in pressed wood products; however, tobacco smoke also can be another major source. Formaldehyde is metabolized rapidly by the body in the cells at the point of contact. This suggests that formaldehyde may not be a systemic toxicant; rather it directly irritates the tissues with which it comes into direct contact [5].

Formaldehyde was detected in all 15 indoor air samples collected in the school and the maximum concentration (46.2 $\mu g/m^3$) was below the acute noncancer screening level (50 $\mu g/m^3$). The average concentration (28 $\mu g/m^3$) was above both the chronic noncancer screening level (10 $\mu g/m^3$) and the cancer screening level (0.08 $\mu g/m^3$). All the samples were below the 49 $\mu g/m^3$ level recommended in the Texas Voluntary Indoor Air Quality Guideline for Governmental Buildings [6] and were not dissimilar to the average indoor air levels (36 to 48$\mu g/m^3$) found in other buildings. As long as formaldehyde is used in building materials it will continue to be present in the indoor environment.

People exposed to formaldehyde have experienced health effects over a wide range of concentrations; however, there are three studies on children that may be of particular importance in evaluating formaldehyde levels in a school. Two studies have suggested that allergic sensitization in children increases with increasing formaldehyde levels [3, 7]; however, because of the study designs we could not use either of these studies to determine a level above which effects might be expected. The third study suggests an association between formaldehyde exposure and asthma in young children [8]. After controlling for other potential indoor pollutants, formaldehyde levels in homes were found to be significantly associated with hospitalizations for asthma in children aged six months to three years. No effects were found in children exposed to levels from 10 to 48 $\mu g/m^3$, a non-significant increased risk was found in children exposed to levels ranging from 49 to 58 $\mu g/m^3$, and a significant increased risk was reported in children exposed to concentrations above 59 $\mu g/m^3$ [8]. We consider the potential association between formaldehyde exposure and asthma in children to be of particular concern since asthma impacts children more than adults and asthma episodes can be more severe in children and result in more hospitalizations. Thus children, particularly asthmatic children, may be at greater risk from acute exposure to formaldehyde.

EPA classifies formaldehyde as a probable human carcinogen [9]. This means that exposure to this compound could theoretically increase a persons risk for developing cancer over the course of a lifetime. We estimate the theoretical cancer risks associated with long-term exposure to this contaminant to be 5.5×10^{-6} for children and 2.3×10^{-5} for adults. We would interpret these risks as posing no apparent increased risk for developing cancer over the course of a lifetime. The actual theoretical cancer risks will be lower because, unless new sources are brought into the structure, formaldehyde levels in newly constructed buildings decreases over time.

Both the average and the maximum levels found in the school were below the levels associated with asthma in young children. Although we would not expect any observable adverse health effects at the levels found in the school, we have classified this contaminant as posing an indeterminate public health hazard because of the possible associations with increased allergic sensitization to common allergens in children.

1,2,4-Trimethylbenzene (1,2,4-TMB)
1,2,4-TMB is used in many household products, such as those used for arts and crafts, household maintenance, and auto products [10]. It is also emitted from various building products such as linoleum tile, vinyl cove molding, black rubber molding, latex paint, cove adhesive, latex caulk, and carpet and carpet adhesive [3]. 1,2,4-TMB is irritating to the eyes, respiratory system, and the skin and can have effects on the central nervous system and blood [3].

Breathing high concentrations of 1,2,4-TMB could result in pneumonitis. People exposed to high concentrations, 25,000,000 µg/m^3 to 45,000,000 µg/m^3, for short periods of time have experienced headache, fatigue, and drowsiness [3]. Healthy volunteers exposed to 11,000 µg/m^3 of 1,2,4-TMB for 2-hours while working did not report any irritation or central nervous system effects [3]; however, painters that worked for several years with a solvent containing 50% 1,2,4- and 30% 1,3,5-TMB showed nervousness, tension and anxiety, asthmatic bronchitis, anemia, and alterations in blood clotting; the blood clotting may have been due to trace amounts of benzene [3]. The hydrocarbon vapor concentrations ranged from 10,000 to 60,000 parts per billion (ppb).

Neurobehavioral effects were noted in mice exposed in a developmental toxicity study on the C9 fraction of gasoline; this is the fraction that contains 1,2,4-TMB. In the high dose (7,376,620 µg/m^3) group, observations included abnormal gait, labored breathing, weakness, excessive salivation, reduced activity, impaired hind limb function, tremors, and lack of righting reflex. No observed adverse changes were reported at the lower doses (491,575 µg/m^3 and 2,457,873 µg/m^3).

The maximum measured concentration of 1,2,4-TMB found in the indoor air (8.54 µg/m^3) was orders of magnitude lower than the levels known to cause effects in humans; thus, based on the concentrations reported we would not expect exposure to this contaminant at the levels found in the school to result in adverse health effects.

Benzene
Benzene is a colorless liquid with a sweet odor [11]. Benzene is used in the manufacturing of rubbers, lubricants, dyes, detergents, and to make other chemicals such as styrene (for Styrofoam® and other plastics) and cyclohexane (for nylon and synthetic fibers) [11]. Health effects associated with breathing benzene include drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. When exposure stops, most of these health effects cease. Inhalation of benzene also may result in harmful effects in the tissues that form blood cells (bone marrow), resulting in anemia or excessive bleeding. Benzene also affects the immune system. The EPA has determined that benzene is a human carcinogen [11].

Benzene was detected in the indoor air in several samples; however all recorded values are estimated values. The maximum concentration of benzene (0.422 µg/m^3) exceeded the cancer screening level (0.1 µg/m^3) for this compound (but did not exceed screening values for noncarcinogenic health effects).

We estimate the theoretical cancer risks associated with long-term exposure to this contaminant to be 4.7×10^{-8} for children and 1.9×10^{-7} for adults. We would interpret these risks as posing no increased risk for developing cancer over the course of a lifetime.

1,2-Dichloroethane
1,2-Dichloroethane is a clear liquid that has a pleasant smell and a sweet taste [12]. It is used to make vinyl chloride, which is used in plastic and vinyl products such as polyvinyl chloride (PVC) pipes, construction materials, packaging materials, furniture upholstery, and wall coverings. It has also been used in cleaning solutions, adhesives, paint, and varnish [12]. Health effects associated with breathing high concentration of 1,2-dichloroethane include nervous system disorders, liver and kidney disease, and lung effects. The EPA has determined that 1,2-dichloroethane is a probable human carcinogen [12].

1,2-Dichloroethane was detected in one indoor air sample at 2.7 µg/m^3, a value which exceeds the cancer screening value (0.04 µg/m^3) for this contaminant (but did not exceed screening values for noncarcinogenic health effects). We estimate the theoretical cancer risks associated with long-term exposure to this contaminant to be 1×10^{-6} for children and 4.4×10^{-6} for adults. We would interpret these risks as posing a no increased risk for developing cancer over the course of a lifetime.

Chemical Mixtures
As most of the compounds detected in the indoor air are respiratory irritants, it is important to consider the potential for adverse health effects to occur due to exposure to mixtures of these substances. The lack of screening values for some of the substances detected makes it difficult to assess the impact of chemical mixtures in the indoor air. Although most substances measured in preoccupancy indoor air samples were well below health-based screening values, it is possible that some adults and children, particularly sensitive individuals such as those prone to asthma, may experience respiratory irritation, because of the multiple chemicals present in the building. Maintaining good ventilation as set forth in Texas Voluntary Indoor Air Quality Guidelines for Government Buildings [6] will help reduce the potential for adverse health effects.

Conclusions

The only potential continued contaminant of concern is formaldehyde; however, the levels, which will decrease over time, all were similar to those that one might find in any newly constructed building and below the levels at which observable adverse health effects have been found. Based upon the information reviewed we would not expect exposure to the air inside Grandview Hills Elementary School to result in observable adverse health effects, either in children or adults. However, we have classified this as posing an indeterminate public health hazard because of the possible associations with increased allergic sensitization to common allergens that have been reported in children and the lack of an identifiable exposure level for these effects.

Recommendation

To prevent or reduce the contamination of indoor air, Texas Voluntary Indoor Air Quality Guidelines for Government Buildings (DSHS Publication #2-10) [6] should be followed. These guidelines consider public schools as government buildings.

If you have any questions, please contact us at (512) 458-7111 extension 3004.

Sincerely,

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Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CREG	Cancer Risk Evaluation Guides
DSHS	Texas Department of State Health Services
EPA	United States Environmental Protection Agency
GC/MS	gas chromatography/mass spectrometry
HAT	DSHS Health Assessment and Toxicology Program
HED	human equivalent dose
HVAC	heating, ventilation, and air conditioning
MRL	minimum risk level
$\mu g/m^3$	micrograms per cubic meter
ppb	parts per billion
PVC	polyvinyl chloride
RfC	Reference Concentration
TMB	trimethylbenzene
UF	urea formaldehyde
VOC	volatile organic compounds

Table 1. Indoor air data that exceed comparison values for noncarcinogenic effects. All other data points were below comparison values (where available) or other evaluation criteria.

Contaminant	Concentration Range (µg/m^3)	Average Concentration (µg/m^3)	Number of Samples that Exceed Comparison Value	Comparison Value (µg/m^3)	Comparison Value Source[a]
Acetaldehyde	2.87-19	8.8	7	9	RfC
Formaldehyde	19.7-46.2	28.6	15 2	10 40	Chronic MRL Intermediate MRL
1,2,4-Trimethylbenzene	ND-8.54	4.4	2	7.3	EPA Regional Screening Level

[a] For contaminants in air, health-based screening values for noncancer health effects consist of Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimum Risk Levels (MRLs) and EPA's Reference Concentrations (RfC's). Noncancer health-based screening values based on ATSDR's MRLs represent concentrations of substances in environmental media (in this case air) that people may be exposed to for a specified period of time (acute – less than 2 weeks, intermediate – 15 days to 1 year, chronic – more than 1 year) without the expectation of adverse health effects. Noncancer health-based screening values based on EPA's RfC's are an estimate of daily exposures to substances that are not likely to result is adverse health effects during a lifetime of exposure [4].

Table 2. Indoor air data that exceed comparison values for carcinogenic effects. All other data points were below comparison values.

Contaminant	Concentration Range (µg/m^3)	Average Concentration (µg/m^3)	Number of Samples that Exceed Comparison Value	CREG (µg/m^3)[a]	Theoretical Excess Lifetime Cancer Risk [b]
Acetaldehyde	2.87-19	8.8	19	0.5	2.9×10^{-7} 1.2×10^{-6}
Benzene	ND-0.422 J [c]	0.4	4	0.1	4.7×10^{-8} 1.9×10^{-7}
1,2-Dichloroethane	ND-2.7	NA[d]	1	0.04	1.0×10^{-6} 4.4×10^{-6}
Formaldehyde	19.7-46.2	28.6	15	0.08	5.5×10^{-6} 2.3×10^{-5}

[a] For contaminants in air, health-based screening values for cancer health effects consist ATSDR's Cancer Risk Evaluation Guides (CREGs). CREGs are media-specific contaminant concentrations that people may be exposed to with a theoretical excess lifetime risk for cancer of one in one million (1×10^{-6}) [4].
[b] Cancer risk estimates are based on the average concentration of each contaminant. The first value indicates the risk for children, assuming an exposure duration of 6 years. The second value indicates the risk for adults, assuming an exposure duration of 25 years.
[c] J is a lab qualifier used to indicate that the result is estimated
[d] Average concentration was not computed for 1,2-dichloroethane as it was only detected in one sample

Certification

This health consultation for the Grandview Hills Elementary School Pre-Occupancy review was prepared by the Texas Department of State Health Services (DSHS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) in accordance with approved methodologies and procedures existing at the time this health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with its findings.

Team Lead, CAT, CAPEB, ATSDR