Health Consultation

Evaluation of Indoor Air Quality

CORONA DEL SOL HIGH SCHOOL

TEMPE, MARICOPA COUNTY, ARIZONA

EPA FACILITY ID: AZR000034983

SEPTEMBER 29, 2008

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

Health Consultation: A Note of Explanation

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

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

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Prepared By:

Arizona Department of Health Services
Office of Environmental Health
Environmental Health Consultation Services
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Executive Summary

Arizona Department of Health Services (ADHS) was requested to provide assistance in addressing concerns about air quality at Corona del Sol High School in Tempe, AZ. This health consultation follows up a previous report produced by ADHS in May 2008 and addresses previously unaddressed issues regarding possible exposure to and potential health risks from formaldehyde and volatile organic compounds (VOCs) in the indoor air at the school.

There is a perceived excess of brain tumors among students and staff at Corona de Sol High School. Questions were raised as to whether indoor air quality could be contributing to brain tumors. To address these concerns, Health Effects Group, Inc (HEG) under contract with Tempe Union High School District (TUHSD) conducted a series of environmental investigations. HEG examined carbon monoxide (CO), carbon dioxide (CO_2), humidity, temperature, mold, and bacteria. In addition, ADHS conducted a survey among the students and staff to obtain a list of cases, verify the types of tumors, classify the reported tumors as benign or malignant, and to evaluate various other characteristics such as patient's age, gender, and type of cancer. ADHS has reported the results of this assessment in a previous (May 2008) health consultation, which found no link to the tumors, but did recognize a general problem with stagnant air in some areas of the school.

HEG's reports also indicated possible uses and applications of different organic solvents. To assure the safety of students and staff, TUHSD requested HEG to conduct additional air monitoring focusing on formaldehyde and VOCs at the school.

In conducting this health consultation, ADHS reviewed the airborne levels of contaminants reported by the school's environmental consultant, reviewed the toxicological literature concerning the concentration of chemicals found, compared the reported levels to accepted comparison values (CVs), evaluated the potential exposure pathways and the duration of exposure, and considered the characteristics of the exposed population. ADHS used this approach to determine if the detected formaldehyde and VOC concentrations at the Corona del Sol High School pose a public health hazard.

After reviewing the available data, ADHS has made the following determinations: 1) the measured air levels of formaldehyde and VOCs were well below all air health screening values for non cancerous health effects, 2) they were also far below all exposure levels that have ever been associated with cancer effects in animals or humans. Therefore, the measured levels of formaldehyde and VOCs pose *no-apparent public health hazard* to the students and staff at the Corona del Sol High School.

Purpose

The Superintendent of Tempe Union High School District (TUHSD) contacted the Arizona Department of Health Services (ADHS) and requested assistance in addressing concerns about air quality at the school. The Corona del Sol Parent Coalition also expressed their concerns and desire for a health consultation which provides information related to exposure to formaldehyde and volatile organic compounds (VOCs). This report presents an assessment of human health risks from exposure to indoor air at Corona del Sol High School, Tempe, AZ as a follow-up to a May 2008 ADHS report.

Background and Statement of Issues

Corona del Sol High School was constructed in 1970's and currently has an enrollment of approximately 2,750 students and 200 staff. There is a perceived excess of brain tumors among students and staff at Corona de Sol High School who have noted approximately 8 to 12 brain tumors in the last few years. To address these concerns, Health Effects Group, Inc (HEG) under contract with TUHSD conducted a series of environmental investigations to examine the levels of carbon monoxide (CO), carbon dioxide (CO_2), humidity, and temperature. They also collected and identified microbial air samples in selected classroom and common areas.

To assist the TUHSD, ADHS conducted a survey among the students and staff to verify the type of tumor, whether the reported tumors are benign or malignant, and to evaluate various other characteristics such as patient's age, gender, and type of cancer. ADHS prepared a report entitled *Public Health Evaluation of Indoor air Quality* (ADHS 2008) based on the cancer case reports, basic information about the affected individuals, and results of the survey and available indoor air quality parameters (e.g. CO, CO_2, humidity, temperature, and microbial sampling results). The report indicated that the detected high concentrations of CO_2 (greater than 1,000 parts per million, ppm) could be causing drowsiness, lethargy, and a sense of "stale air" among students and staff. The review panel concluded ADHS does not have sufficient data to establish a link between the reported brain tumors and environmental factors. ADHS noticed that no environmental samples had been collected for chemical analysis in previous investigations. However, the reports indicated plans for such sampling. In addition, HEG reported the presence of various chemicals including organic solvents, including ethanolamine, formalin (a formaldehyde containing solution), glycol ethers, hydrocarbon-based solvents, quaternary ammonium compounds, tetrachloroethylene (also known as perchloroethylene or PERC), and vinyl chloride at the school (HEG 2006).

The causes of brain cancer are largely unknown. Although several environmental factors have been associated with brain tumors, exposure to high-dose ionizing radiation is the only proven risk factor (Fisher et al. 2006). Other risk factors such as occupational exposure to pesticide, vinyl chloride, formaldehyde, and petroleum products have had inconclusive results (NCTR 1984; Wrensch et al. 2002). Since the safety of students and staff is of primary importance, TUHSD requested HEG to conduct additional air monitoring focusing on formaldehyde and VOCs at the school. The purpose of this report is to review the testing results and provide recommendations.

Evaluation Process

ADHS provides site-specific public health recommendations on the basis of a review of toxicological literature, the levels of environmental contaminants detected at a site compared to accepted comparison values (CVs), an evaluation of potential exposure pathways, the duration of exposure, and the characteristics of the exposed population. ADHS used this approach to determine if the detected formaldehyde and VOC concentrations at the Corona del Sol High School posed a public health hazard.

Comparison values are screening tools used with environmental data relevant to the exposure pathways. CVs are conservatively developed based on the available scientific data and consideration for the most sensitive groups (e.g. children). If public exposure concentrations related to a site are below the corresponding CV, then the exposures are not considered of public health concern and no further analysis is conducted. However, while concentrations below the CV are not expected to lead to any observable adverse health effect, it should not be inferred that a concentration greater than the CV would necessarily lead to adverse health effects. Depending on site-specific environmental exposure factors (e.g. duration and amount of exposure) and individual human factors (e.g. personal habits, occupation, and/or overall health), exposure to levels above the comparison value may or may not lead to a health effect. Therefore, the CVs should not be used to predict the occurrence of adverse health effects.

ADHS used the following CVs for the screening process to identify contaminants of concern for this document:

- ATSDR's Environmental Media Evaluation Guide for acute or chronic exposure (EMEG)
- ATSDR's Cancer Risk Evaluation Guide (CREG)
- EPA's Reference Concentration (RfC)
- EPA's Regional Screening Level (RSL)
- EPA Region 9's Preliminary Remediation Goal (PRG)

When determining what environmental guideline value to use, this health consultation followed Agency for Toxic Substances and Disease Registry's (ATSDR) general hierarchy and used professional judgment to select CVs that best apply to the site conditions.

Discussion

Air Sampling

HEG, Inc. completed the following air monitoring in the selected classrooms and common areas on April 29, 2008 (HEG 2008).

Formaldehyde

Both personal and area air monitoring for formaldehyde were conducted. The science teacher instructing cat dissection was the selected subject for personal air monitoring. Area air monitoring was conducted in the science class room and selected adjacent class rooms during the

dissection of cats preserved in a formalin-containing embalming solution. Appendix A provides a map showing the sampling locations. The results indicated that all short-term (15 minutes) and work-shift samples (approximately 340 minutes) were below the detection limits. The detection limits of full shift and short-term monitoring periods are 0.03 parts per million (ppm) and 0.1 ppm, respectively.

Volatile Organic Compounds (*VOCs*)

VOC air monitoring was conducted in selected locations within the A, C, and E-wings of the school, including the science classrooms, film development classrooms, and the automotive shop. An SKC 2000 air sampling pump was used to collect air samples which were then analyzed for VOCs by thermal desorption gas chromatography-mass spectrometry (GC/MS) according to the Environmental Protection Agency (EPA) Compendium Method TO-17. ADHS also reviewed information on quality assurance and quality control (QA/QC) specifications for data quality to verify the acceptability and adequacy of data. For example, ADHS reviewed available chain of custody sheets, project narratives, and laboratory certifications. The laboratory analysis methods and the QA/QC procedures were appropriate.

Exposure Pathway Analysis

Identifying exposure pathways is important in a health consultation, because presence of a contaminant in the environment does not necessarily mean that people are actually coming into contact with that contaminant, thereby allowing the contaminant to be a threat to public health. Exposure pathways have been divided into three categories: completed, potential, and eliminated. There are five elements are considered in the evaluation of exposure pathways:

- a *source* of contamination,
- a *media* such as soil or air through which the contaminant is transported,
- a *point of exposure* where people can contact the contaminant,
- a *route of exposure* by which the contaminant enters or contacts the body; and
- a *receptor* population

Completed pathways exist when the five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring now. In a potential exposure pathway, one or more elements of the pathway cannot be identified, but it is possible that the element might be present or might have been present. In eliminated pathways, at least one of the five elements is and was missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant. Identifying an exposure pathway does not admit the presence or concentration of potential contaminants; it is simply a way of determining the possibility of exposure as if the contaminants were present in the medium.

Table 1 shows the exposure pathway evaluation result. ADHS further evaluated the completed and potential exposure pathways to determine whether realistic exposures are sufficient in magnitude, duration or frequency to result in adverse health effects.

Table 1. Exposure pathway evaluation.

Exposure Pathway Elements					Time	Type of Exposure Pathway
Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Estimated Exposed Population**		
Chemicals in labs at school	Air	Classroom, Common area	Inhalation	Students, Staff	Past	Potential
					Current	Completed
					Future	Potential

Public Health Implication

Formaldehyde

At room temperature, formaldehyde is a colorless, flammable gas with a pungent, distinct odor. Formaldehyde originates from both natural and manufactured sources. It has many industrial uses, including fertilizer, paper, plywood, and cosmetics. In ambient air, the major sources of formaldehyde appear to be power plants, manufacturing facilities, incinerators, and automobile exhaust emissions. In the atmosphere, formaldehyde is formed from other chemicals; at home, it is produced by cigarettes and other tobacco products, gas cookers, and open fireplaces. It also used as a preservative in some foods, such as some types of Italian cheeses, dried foods, and fish. In rural areas, formaldehyde is typically found at about 0.2 parts per billion (ppb; 1 ppm = 1,000 ppb) in outdoor air; in suburban areas, levels are about 2–6 ppb (ATSDR 1999). The average concentrations reported in U.S. urban areas are in the 11–20 ppb range.

Potential health effects due to acute exposure (< 14 days) to formaldehyde were evaluated by using the short-term monitoring results. The comparison value used for formaldehyde was ATSDR's acute EMEG for formaldehyde (0.04 ppm). The acute inhalation EMEG was derived from animal and human studies. After a 2-hour exposure the Lowest-Observed-Adverse-Effect-Level[1] (LOAEL) was 0.4 ppm and the major effects were nasal and eye irritations which were mild and reversible. An uncertainty factor of 9 was used to account for the human variability and the use of LOAEL (the LOAL is divided by 9 = 0.04 ppm).

All air sampling measurements had detection limits of 0.1 ppm. Therefore, ½ of the detection limit (½ of 0.1) was used to compare with ATSDR's acute EMEG. It shows that ½ of the detection limit (0.05 ppm) exceeded the ATSDR's acute EMEG (0.04 ppm).

[1] The lowest tested dose of a substance that has been reported to cause adverse health effects in people or animals.

Work-shift sampling results were used to assess potential health effects associated with long term (> 1 year) exposure to formaldehyde. One half of the detection limit (0.015 ppm) was used for the evaluation. The results indicated that 0.015 ppm exceeds the ATSDR's chronic EMEG (0.008 ppm) and CREG (0.00006 ppm). ATSDR's EMEG is based on a 0.24 ppm LOAEL with the assumption of continuous, 24-hour a day exposures. When workers were exposed daily for about 10.4 years to average formaldehyde concentrations of 0.24 ppm, they experienced mild irritation of the eyes and upper respiratory tract and mild damage to nasal tissue. To account for human variability and the use of a LOAEL, the formaldehyde chronic MRL includes an uncertainty factor of 30. It was estimated that students and staff exposure during the spring semester (when dissection takes place) was 8 hrs per day and 90 days per year (exposure frequency) for 4 years for students and 35 years for staff (exposure duration). Taking into account the exposure frequency and exposure duration, ADHS determined it is unlikely that students and staff at the school would experience non-cancerous harmful effects from formaldehyde in the air.

ATSDR's CREG for formaldehyde is 0.00006 ppm. The animal evidence consists primarily of nasal tumors induced in rodents chronically exposed to formaldehyde at levels of 5–10 ppm. Most humans would find these levels unbearable because formaldehyde has a suffocating, highly irritating odor that humans can detect at 0.5–1 ppm (ATSDR 1999). In the rat study, a No-Observed-Adverse-Effect Level[2] (NOAEL) of 2 ppm was established for nasal tumors (Kerns et al. 1983). ATSDR's CREG was determined based on EPA's inhalation risk which assumes a continuous, 24-hour exposure, over a life time. Taking into account the estimated exposure frequency (8 hrs per day and 90 days per year) and exposure duration (4 years for students and 35 years for staff); ADHS determined it is unlikely that students and staff at the school would experience cancerous harmful effects from formaldehyde in the air.

Volatile organic compounds (*VOCs*)

The testing results are separated into four groups based on their sampling locations. Group 1 includes: E272, E276, E218, E7 Hallway, E9 Hallway, and E10 Hallway; Group 2 includes: E2 Hallway and Guidance; Group 3 includes: A313 and A344; Group 4 includes: C122 and C156. The evaluation results indicated that benzene, carbon tetrachloride, chloroform, and methylene chloride exceeded their respective CVs (Table 2). Ethanol, 4-ethyl toluene, heptane, and propane are kept for further evaluation since no CVs are available. The evaluation is discussed below.

[2] The highest tested dose of a substance that has been reported to have no harmful health effects on people or animals.

Table 2. VOC concentrations and identified chemicals of interest

Analyte	Averaged Concentration[a] (ppb)				Health Based CVs (ppb)	Type of CV	Is it a Chemical of Interest?
	Group 1	Group 2	Group 3	Group 4			
Acetone	6.75	6.90	22.0	6.25	13,000	EMEG[b]	No
Benzene	0.26	0.10	0.34	1.11	0.03	CREG[c]	**Yes**
2-Butanone	0.25	0.33	0.22	0.13	2,000	RfC[d]	No
Carbon Disulfide	0.11	0.24	0.11	0.22	300	EMEG	No
Carbon Tetrachloride	0.24	0.05	0.09	0.06	0.01	CREG	**Yes**
Chloroform	0.08	0.07	0.07	0.08	0.008	CREG	**Yes**
Cyclohexane	0.13	0.09	2.33	0.37	1,743	RfC	No
1,4-Dichlorobenzene	0.07	0.19	0.36	0.06	10	EMEG	No
Dichlorodifloromethane	1.51	0.46	0.50	0.51	40	RSL[e]	No
Ethanol	136.3	140.0	12.25	19.0	NA[f]		**Yes**
Ethyl Acetate	0.86	0.43	0.10	0.11	916	PRG[g]	No
Ethylbenzene	1.81	0.59	3.07	0.83	300	EMEG	No
4-Ethyl Toluene	0.07	0.07	0.07	0.18	NA		**Yes**
Freon 11	0.08	0.14	0.12	0.11	125	RSL	No
Freon 113	0.10	0.11	0.08	0.05	3,914	RSL	No
Heptane	0.40	0.97	1.32	0.77	NA		**Yes**
Hexane	0.33	0.77	1.53	2.20	200	EMEG	No
Isopropyl Alcohol	9.42	9.55	1.60	2.20	3,000	CREL[h]	No
4-Methyl-2-Pentanone	2.20	4.65	0.09	0.30	700	RfC	No
Methylene Chloride	0.11	0.09	0.43	2.36	0.9	CREG	**Yes**
Propene	2.02	2.85	23.25	9.30	NA		**Yes**
Styrene	0.08	0.08	0.13	0.09	200	EMEG	No
Tetrachloroethene	0.28	0.29	0.25	0.50	44	EMEG	No
1,1,1-Trichloroethane	0.06	0.12	0.07	0.07	900	RfC	No
1,2,4-Trimethylebenzene	0.12	0.15	0.16	0.82	1.3	PRG	No
1,3,5-Trimethylebenzene	0.07	0.07	0.07	0.21	1.3	PRG	No
Toluene	1.15	1.45	1.89	4.85	80	EMEG	No
Trichloroethene	0.06	0.13	0.07	0.07	100	EMEG	No
Total Xylene[i]	6.81	2.51	9.26	3.35	50	EMEG	No

[a] Average concentration (parts per billion, ppb) is used because the health-based CVs refer to an average concentration; [b] ATSDR's Environmental Media Evaluation Guide; [c] ATSDR's Cancer Risk Evaluation Guide; [d] EPA's Reference Concentration; [e] EPA's Regional Screening Level; [f] Not Available; [g] EPA Region 9's Preliminary Remediation Goal; [h] California's Chronic Reference Exposure Level; [i] It includes m,p-xylene and o-xylene

Benzene

Benzene is a common solvent isolated from coal tar and crude oil. Outdoor (ambient) air concentrations in the United States average 1.9 ppb and range from 0.6–5.9 ppb. Average levels are higher in winter and lower in summer (ATSDR 1997). Levels in urban areas are generally higher than are those in rural areas. Average rural background levels of benzene in air historically range from 0.1–17 ppb (IARC 1982). Mobile sources, such as automobiles, trucks, buses, and motorcycles, may be a significant source of benzene in outdoor air.

During the investigation, benzene levels ranged from non-detect to 1.3 ppb. The maximum was detected at the automotive shop. The averaged benzene levels were below the ATSDR's chronic EMEG of 3 ppb. However, all averaged benzene levels were higher than ATSDR's CREG of 0.03 ppb. The EMEG represents the concentration of benzene in air to which people may be exposed during a lifetime without experiencing harmful noncancer health effects.

Benzene is a known human carcinogen and is classified as such by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), the EPA, and the American Conference of Governmental Industrial Hygienists (ACGIH). This classification is supported by studies of US rubber workers exposed to high levels of benzene (up to hundreds of ppm or hundred thousands of ppb) during rubber manufacturing, mostly during the 1940s (Infante 1978; Infante et al. 1977). Taking this supporting evidence, cancer-based CVs for inhaled benzene are derived using the methodology of quantitative risk assessments.

With regards to cancerous health effects, the lowest human cancer effects reported in ATSDR's *Toxicological Profile for Benzene* (1997) are 300 ppb for leukemia (Ott et al. 1978) and 690 ppb for leukopenia (Xia et al. 1995). These values represent the lowest measured concentrations in a range of workplace measurements from the two studies (300-3,500 ppb and 690-140,000 ppb, respectively). It is conservative to use the lowest measured concentration as an indicator of exposure in the facilities. In addition, epidemiological studies have suggested that there are thresholds for leukemia. Available studies indicated no detectable excess of leukemia below cumulative exposure of 40 ppm-year[3]. This exposure would be equivalent to about 190 ppb, 24 hours a day, over a 70-year lifetime. This apparent threshold is most likely an overestimation because it is based on the inclusion of all leukemias, not just acute myeloid leukemia (AML). AML is the only form of leukemia consistently associated with high benzene exposures. When only AML is considered, the estimated threshold was found to be at least 200 ppm-years (numerically equivalent to 950 ppb, 24 hours a day, over a 70-year lifetime), based on the original set of exposure estimates (Paustenbach et al. 1992; Wong 1995).

Moreover, no unequivocally adverse health effects have been observed in animals or humans chronically exposed to 1,000 ppb (1 ppm) or less of benzene in air. The benzene levels measured at the school were orders of magnitude below this level. Therefore, none of the

[3] Cumulative exposure has been used to represent estimates of chemical exposure in epidemiology and occupational studies. The notation "ppm-year" represents a numerical attempt to integrate the levels and durations of exposure observed in epidemiology/occupational studies as a combined product. A worker exposed to 2 ppm for 20 years and one exposed to 20 ppm for 2 years both received the "same" cumulative exposure (i.e. expressed in ppm-years).

benzene exposures at the school would be expected to produce any adverse health effects of either a cancerous or noncancerous nature in students and staff.

Carbon Tetrachloride

Carbon tetrachloride (CCl_4) is a clear, quick-evaporating liquid. It does not occur naturally, but has been produced in large quantities to make refrigeration fluid and aerosol can propellant. Because many refrigerants and aerosol propellants affect the planet Earth's ozone layer, the production of these chemicals (including CCl_4) is phasing out, and future manufacturing and use of CCl4 will substantially decline. Nevertheless, because of past and present releases, background levels of CCl_4 remain in air, water, and soil. Concentrations in air of 0.1 ppb are common around the world, with somewhat higher levels of 0.2–0.6 ppb often found in cities (ATSDR 2003).

During the investigation, the CCl_4 levels ranged from non-detect to 0.15 ppb. The averaged CCl_4 levels were below the ATSDR's chronic EMEG of 30 ppb. Thus, ADHS would not expect these CCl_4 levels to result in any noncancerous health effects in students and staff. However, the average concentrations were above the CCl_4's CREG of 0.01 ppb. Because no inhalation cancer effect levels are listed for either animals or humans in ATSDR's *Toxicological Profile for Carbon Tetrachloride* (2003), the inhalation CREG was extrapolated from the results of oral studies in animals. In the available positive oral studies, rodent liver tumors were observed. The lowest cancerous effect level was 20 milligrams per kilogram per day (mg/kg/day) in mice treated by gavage for 120 days (ATSDR 2003). To inhale an equivalent amount over a 70-year period, the concentration of CCl_4 in air would be around 70 ppb. The highest averaged level of CCl_4 in Corona del Sol High School air (0.24 ppb) was several orders of magnitude lower. And only about 70% of the air that is inhaled reaches the alveoli where it could be absorbed into the bloodstream (Guyton and Hall 1996). ADHS determined it is unlikely that students and staff at the school would experience cancerous harmful effects from carbon tetrachloride in the air.

Chloroform

Chloroform is a colorless liquid with a pleasant, nonirritating odor and a slightly sweet taste. It will burn only when it reaches very high temperatures. In the past, chloroform was used as an inhaled anesthetic during surgery, but it is not used that way today. Today, chloroform is used to make other chemicals and can also be formed in small amounts when chlorine is added to water (ATSDR 1997).

During this investigation, the chloroform levels ranged from non-detect to 1.2 ppb. It was only detected at Room E272. These levels were below the ATSDR's chronic EMEG of 20 ppb. Thus, noncancerous health effects from inhalation exposure to chloroform are not expected. Yet, all average values are above ATSDR's CREG of 0.008 ppb. The chloroform's CREG was extrapolated from the results of oral studies in animals. In the available positive oral studies, mice kidney tumors were observed. The lowest cancerous effect level was 138 mg/kg/day in mice treated by gavage which is equivalent to 602 mg/kg/day in humans (EPA 2008). The highest averaged chloroform level in school was 0.08 ppb. At this concentration, the estimated

daily inhalation intake was 0.0001 mg/kg/day for students and 0.00008 mg/kg/day for staff[4]. These values were several orders of magnitude lower. ADHS determined it is unlikely that students and staff at the school would experience cancerous harmful effects from chloroform in the air.

Methylene Chloride

Methylene chloride is a colorless liquid that has a mild sweet odor. It does not occur naturally in the environment. It can be found in certain aerosol and pesticide products, some spray paints, automotive cleaners, and other household products. It is also widely used as an industrial solvent and as a paint stripper. Most of the methylene chloride released into the environment is a result of its use as an end product by various industries and the use of aerosol products and paint removers in the home. It is primarily released into the air because it evaporates easily. Background concentrations of methylene chloride are usually less than 0.1 ppb, but it has been found in some urban air and at some hazardous waste sites at an average concentration of 11 ppb (ATSDR 2000). Methylene chloride is reasonably anticipated to be a carcinogen by the Department of Health and Human Services. The IARC classifies it as possibly carcinogenic to humans due to limited evidence in humans and less than sufficient evidence in animals. The EPA has classified methylene chloride as a probable human carcinogen due to inadequate evidence for carcinogenicity in humans but sufficient evidence in animal studies.

All methylene chloride detections were below the ATSDR's EMEG of 300 ppb, and are not expected to result in noncancerous health effects. Only one value (Group 4: 2.36 ppb) was above the ATSDR's CREG of 0.9 ppb. The methylene chloride's CREG was based on the results of inhalation studies in mice. In the available positive studies, lung and liver cancer were observed. The lowest cancerous effect level was 1582 mg/kg/day in mice which is equivalent to 356 mg/kg/day in humans (EPA 2008). With the same assumptions described previously, the estimated daily inhalation intake was 0.002 mg/kg/day for students, and 0.0017 mg/kg/day for staff. These values were several orders of magnitude lower. ADHS determined it is unlikely that students and staff at the school would experience cancerous harmful effects from methylene chloride detected in the air. The verification code for this article is 747675

Substances without Comparison Values

Ethanol

Air CVs were not available for ethanol. Ethanol or ethyl alcohol is mostly used in alcoholic beverages in suitable dilutions. It is also used as a solvent in the laboratory and industry, in the manufacture of denatured alcohol and pharmaceutical products (e.g. rubbing compounds, lotions, tonics, colognes), in perfumery, and in organic synthesis. Moreover, it is an octane booster in gasoline and a pharmaceutic aid (i.e. a solvent). Because of its industrial uses, the Occupational Safety and Health Administration (OSHA) set its permissible exposure limit (PEL) for worker

[4] It was estimated by using the following equation: $\text{Daily Inhalation Intake} = \frac{\text{Air Concentation} \times \text{Inhalation Rate}}{\text{Body Weight}}$; Body weight was assumed to be 62.25 kg for students, and 71.8 kg for staff; Inhalation rate was assumed to be 17 m^3/day for students, and 15.2 m^3/day for staff (EPA 1997.)

exposure at 1,000 ppm (or 1,000,000 ppb). The PEL is an 8-hour time weighted average (TWA) air concentration to which workers may be safely exposed repeatedly during 40-hour work weeks for an entire work life. PELs designed to protect healthy workers are usually higher than ATSDR health-based CVs, which were designed to protect the health of the general population, including the very young and the elderly. The ethanol detections during the investigation event were, however, several orders of magnitude below the PEL value. ADHS concluded that the detected levels of ethanol are not expected to produce harmful health effects in exposed students and staff at the Corona del Sol High School.

4-Ethyltoluene

4-Ethyltoluene is a high-volume chemical — U.S. production exceeds 1 million pounds annually (EDF 2008). During this investigation, 4-ethyltoluene ranged from non-detected to 0.29 ppb. The substance was only detected at the Automotive Shop at the level of 0.29 ppb. According to the Registry of Toxic Effects of Chemical Substances database, the inhalation TCLo (lowest published toxic dose; similar to an inhalation LOAEL) was 5,000 mg/m^3 or 1,017 ppm (1,017,000 ppb) in rats and rabbits treated to 4-ethyltoluene 6 hours a day for 100 days. The single detection of 4-ethyltoluene was 3.3 million times lower than this TCLo. Therefore, ADHS does not expect inhalation exposures to 4-ethyl toluene to cause any adverse health effects to the school students and staff.

Heptane

Heptane is produced and used as a solvent in organic synthesis and as a standard for octane-rating determinations (HSDB 2007). Heptane is found in gasoline and petroleum-based products and has a gasoline-like odor. ATSDR does not have any CVs for heptane. The OSHA's PEL for heptane is 500 ppm (or 500,000 ppb) for 8-hour daily exposures, and the NIOSH's recommended exposure limit (REL) is 85 ppm (or 85,000 ppb) for 10-hour daily exposures. Similar to PEL, the REL are levels of a substance in air considered safe for daily worker exposure for an entire work life.

PELs and RELs, which were designed to protect healthy workers, are usually higher than ATSDR health-based CVs, which were designed to protect the health of the general population, including the very young and the elderly. The heptane detections during the investigation event were, however, several orders of magnitude below the PEL and REL values. ADHS concluded that the detected levels of heptane are not expected to produce harmful health effects in exposed students and staff at the Corona del Sol High School.

Propene

The major use of propene is in polymerized form as polypropylene, used to manufacture plastics and carpet fibers. It is also a chemical intermediate in the manufacture of acetone, isopropylbenzene, isopropanol, isopropyl halides, propylene oxide, acrylonitrile, and cumene. Propene is emitted into air by the combustion of fossil fuels and the burning of cigarettes (HSDB 2007). ATSDR does not have any CVs for propene. And because propene is classified as a simple asphyxiant, no occupational standards are available, meaning it has no health effects other

than asphyxiation (loss of consciousness and suffocation). The propene detections during the investigation event were at the ppb level. ADHS concluded that the detected levels of propene are not expected to produce harmful health effects in exposed students and staff at the Corona del Sol High School.

Child Health Considerations

ADHS considers children in its evaluations of all exposures, and we use health guidelines that are protective of children. In general, ADHS assumes that children are more susceptible to chemical exposures than are adults. Children six years old or younger may be more sensitive to the effects of pollutants than adults. Children generally have lower body weights, breathe more air by body weight and air that is closer to the ground, and are more often in contact with the ground than adults. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. The CVs used in this health consultation were developed to be protective of susceptible populations such as children.

Conclusions

The measured air levels of formaldehyde and VOCs were well below all air CVs or health screening values for non cancerous health effects. They were also far below all exposure levels that have ever been associated with cancer effects in animals or humans. Therefore, the measured levels of formaldehyde and VOCs pose *no-apparent public health hazard*[5] to the students and staff at the Corona del Sol High School.

Recommendations

The Arizona Department of Health Services has the following recommendation:

- Review and implement the EPA's Tools for Schools environmental assessment program to improve the school's indoor air quality.
- Monitor the indoor air quality periodically to ensure the health of students and staff.

Public Health Action Plan

- The Arizona Department of Health Services will continue to review and evaluate data provided for this site.
- The Arizona Department of Health Services will attend public meetings, make presentations, and develop handout literature as requested by the school.

[5] A category used in ATSDR's public health consultations for sites where human exposure to contaminated media (e.g. air) might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

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Certification

This Corona del Sol High School Health Consultation was prepared by the Arizona Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures' existing at the time the health consultation report was initiated.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with the findings.

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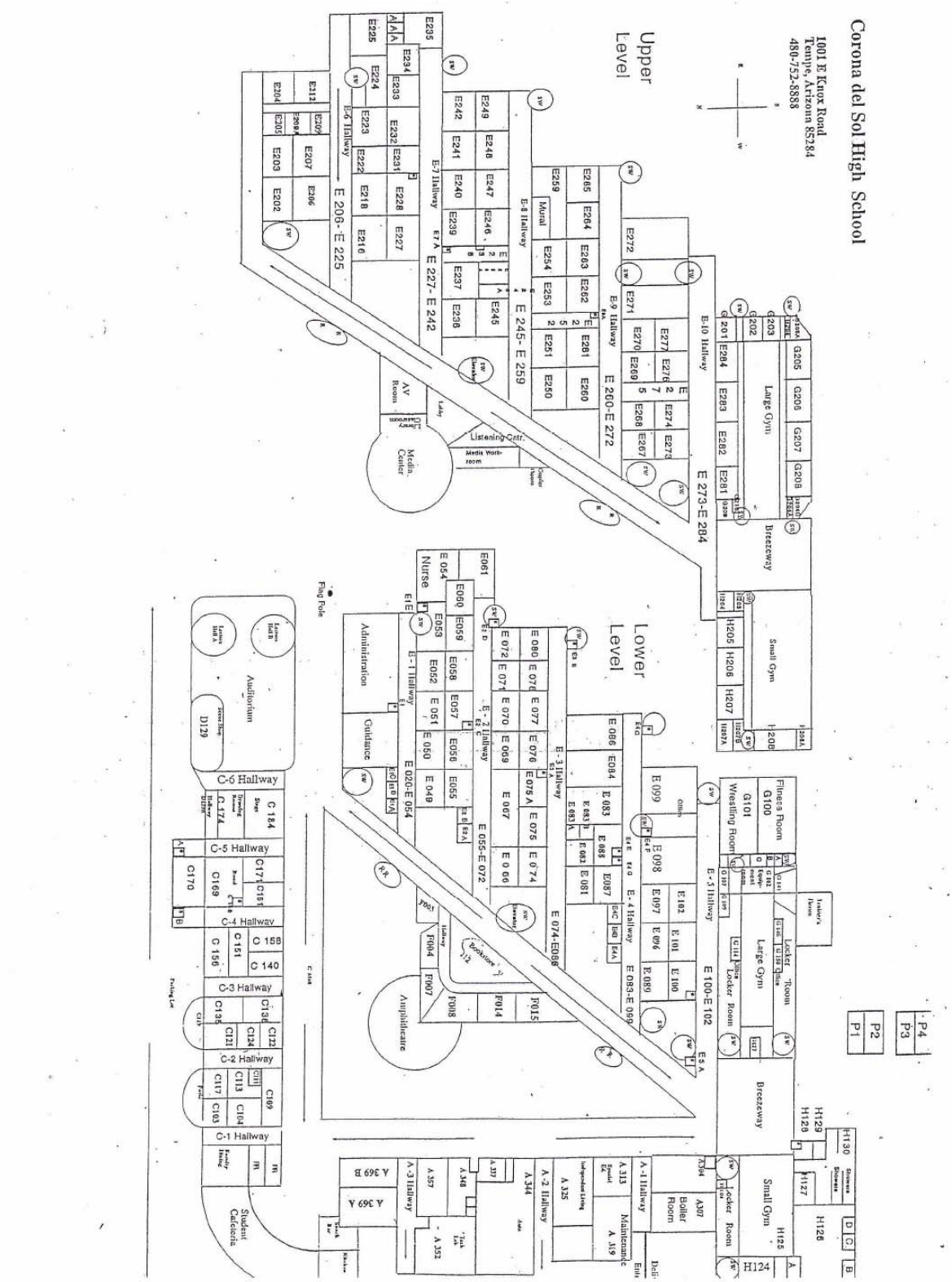
Appendix A



This map is adapted from HEG (2008)