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February 22, 2021

Anthony Dennis
Environmental Health Director
Florida Department of Health
Alachua County Health Department
224 SE 24th Street
Gainesville, Florida 32641

Re: UPDATE – Addendum to Letter Health Consultation: Joseph A. Williams Elementary School [DEP FAC ID 8735777]

Dear Mr. Dennis:

The Florida Department of Health (FDOH), Public Health Toxicology Section is committed to ensuring that people at contaminated sites have the best information available to understand the chemicals and the health risks.

This health consultation evaluates supplemental environmental data (indoor air, outdoor air, sub-slab vapor and soil) collected at Joseph A. William Elementary School (site) and serves as an addendum to the previous health consultation letter provided on July 15, 2020[1].

Based on the review of the supplementary air and soil data from this site, FDOH does not expect the occurrence of health risks associated with exposure to indoor air, outdoor air and soil vapor intrusion. While there is the possibility of vapor intrusion from the soil beneath the buildings, the evaluations of possible exposure to indoor and outdoor air chemicals were given primary consideration as these pathways constitute the pathways of most concern.

Chemicals in air at the site including benzene, carbon tetrachloride and chloroform were above their respective health screening values[2], also called comparison values (CV) set by the Agency for Toxic Substances and Disease Registry (ATSDR). These chemicals were looked at further for potential human health risks. After an in-depth evaluation of the potential human health risk, the estimated daily dose[3] calculated did not exceed its respective ATSDR minimal risk level (MRL[4]). The chemical specific ATSDR

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[1] www.floridahealth.gov/environmental-health/hazardous-waste-sites/Reports/_documents/hc-letter-j-wlms-elem-sch.pdf

[2] **Screening levels** (also comparison values – CV) are estimates of chemical concentrations in the environment (water, soil, air, etc.) that a person can be exposed to without considerable health risk. Screening levels are health-based and set far below levels known to cause harmful effects.

[3] **Dose**: A quantity of a chemical taken in over a specific time.

[4] A **minimal risk level (MRL)** is developed to protect the most sensitive populations. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified route and duration of exposure. To derive an MRL, the lowest chemical daily dose observed to cause the most sensitive health effect (for example a developmental effect) is identified. Then this chemical dose is lowered by applying one or more numbers called uncertainty factors. This way the MRL is set far below any daily dose known to cause the most sensitive effects.

MRLs are set at a level at which, e.g., benzene, carbon tetrachloride and chloroform in air are unlikely to increase risk of developing adverse non-cancer health effects.

Laboratory method detection limits used for some chemicals such as 1,2,4-trichlorobenzene, 1,2-dichlorethane, 1,4-dioxane and hexachlorobutadiene in air are greater than their respective ATSDR's CV making it difficult to eliminate potential exposure and risk from these contaminants in indoor/outdoor air at the specified locations. Method detection limits of those chemicals would need to be below the respective ATSDR CV to be able to perform an in-depth evaluation that compares health risk to the level of concern.

Concentrations of some polycyclic aromatic hydrocarbons (PAHs) are presented as a toxicity- weighted sum of these chemical concentrations called the benzo(a)pyrene (BaP) – toxicity equivalency quotient (TEQ)[5]. The BaP TEQ in sub-slab soil samples exceeded their respective ATSDR health risk values. The concentrations were not detected at levels of concern in the sub slab vapor samples, which is a better indicator of potential intrusion of the vapor from these chemicals into the air of the buildings.

Site Description

Joseph A. Williams Elementary school is located at 1245 SE 7th Avenue in Gainesville, Alachua County, Florida. The school has an enrollment of 565 students serving students in kindergarten through fifth grade.

Records from a tank registration form dated June 1, 1987 show that 4 underground storage tanks (USTs) were present and used to store fuel (heating) oil at various locations of the school. All four tanks were removed, and an analysis and sampling of groundwater and soil did not detect any petroleum contamination above Florida's Department of Environmental Protection (FDEP) Cleanup Target Levels (CTLs), promulgated in Chapter 62-780, Florida Administrative Code.

An additional assessment conducted in 2016 near the locations of the former USTs found equivalent BaP-TEQ levels in soil exceeding the respective Florida Soil CTL (SCTL). These findings warranted an urgent source removal of contaminated soil down to 4 feet below surface at two areas – one located to the northeast in front of School Building #1 and one located between School Building # 2 [Media] and #5 [Art and Music]. In 2018, more soil was removed from the north and west of School Building 1 [Administration] to protect students and faculty. Confirmatory soil sampling conducted during soil removal activities between 2017 and 2018 showed that BaP-TEQ, naphthalene and 1-methylnaphthalene levels still exceeded the FDEPs SCTL.

In July 2020, FDOH conducted a human health risk assessment based on the soil, groundwater and ambient air quality data collected between 2016 and 2019. (Health Consultation Letter dated July 15, 2020[1]). FDOH concluded that the occurrence of health risks associated with exposure to groundwater and soil chemicals is not expected. FDOH was unable to evaluate the possibility of vapor intrusion and possible associated health risk due to data limitations and recommended the sampling and assessment of indoor and outdoor air data for the presence of at least BaP-TEQs.

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[5] Most **PAHs** are suspected or known to cause cancer and act as mutagens, though, only limited information is available for most of them. When assessing the risk of exposure, many of the individual PAHs are considered to be of equivalent toxicity as BaP [Marty et al. 1994]. Studies have shown, that estimating the potential risk to a mixture of PAHs rather than individual ones using their toxic equivalency factors based on BaP seems to be more accurate [Collins et al. 1998, Clement 1988, Nisbet & LaGoy 1992]. The output is presented as BaP – Toxic equivalency factor (TEF) or **BaP – Toxic equivalency quotient (TEQ).**

Environmental Data

For this supplemental health consultation evaluation, FDOH reviewed indoor air, outdoor air, sub-slab soil vapor and sub-slab soil data collected by the Florida Department of Environmental Protection (FDEP) through Geosyntec Consultants in August and November 2020.

Six indoor air and four outdoor air sampling locations were selected for further sampling and investigation:

Indoor:
- Building 1 [classroom, file room and an office]
- Building 2 [computer room in the northeast corner of the building]
- Building 5 [music room in the northwest corner of the building]
- Building 7 [cafeteria stage in the western portion of the building]

Outdoor:
- Near Buildings 1, 2, 5 and 7 (to establish baseline/background)

Sub-slab vapor and air sampling was conducted following EPA Method TO-13A (for PAHs) and EPA Method TO-15 (for volatile organic compounds – VOCs). Indoor and outdoor air data were collected over 8-hour time weighted average. Each indoor sampling location was placed as close to where soil was excavated. Sub-slab soil samples were collected following EPA Method 8270 (semi-VOCs) and 8260 (MTBE - methyl tert-butyl ether and BTEX - benzene, toluene, ethylbenzene and xylenes).

Sub-slab vapor air and soil samples were not further evaluated for potential health risks as data collection occurred to investigate whether detected petroleum constituents in indoor air during the August 2020 sampling event were related to potential presence of petroleum constituents in the subsurface beneath Buildings 1 and 2. In addition, exposure to the sub-slab soil via dermal contact and ingestion is highly unlikely.

Additional indoor air sampling was conducted by GLE Associates, Inc. on January 7, 2021. Sampling data are available for naphthalene and acenaphthene levels. Sampling locations and methods are unknown to FDOH. Due to these uncertainties, these data are not considered for the evaluation of potential, adverse health risk.

Risk Evaluation

Screening and Identifying Contaminants of Concern
To evaluate the risk of harm to public health from site-related chemicals, FDOH determines the contaminated elements and the relative contamination levels. It screens the site-related data using comparison values (CVs) developed by the Agency for Toxic Substances and Disease Registry (ATSDR). Each CV is a concentration of a chemical in the environment (i.e. water or soil) below which FDOH does not expect harm to public health. FDOH identifies contaminants higher than their respective ATSDR CVs or those that are considered carcinogenic for further evaluation. Contaminants of concern values greater than their respective air Agency for Toxic Substances and Disease Registry (ATSDR) Comparison value (CV) are considered for further evaluation.

Exposure Pathway Analysis
Once the first step of screening has been conducted, FDOH looks at ways people could be exposed to contaminated elements, called exposure pathways. Chemical contamination is a concern for human health, if people can get exposed to (come in contact with) the chemical. Without human contact, the chemical cannot enter the body and cause harmful effects. If exposure is possible, several aspects determine the actual risk of harm. If there is contact or exposure, how much of the contaminants the public contacts (concentration), how often they contact them (frequency), for how long they contact them (duration), and the hazard level of the contaminant (toxicity) all determine the risk of harm.

Exposures occur if a contamination source has all of the following:

- an environmental medium to hold or transport it; like air, soil or water
- an exposure point where people contact it
- an exposure route through which it enters the body
- an exposed population who contacts it

The identification of an exposure pathway does not necessarily mean that harm to health will occur.

Health Risk Estimation
This health risk evaluation estimates the possibility of increased non-cancer and cancer health risks via inhalation of possible contaminated air (indoor and outdoor). A so called 'hazard quotient' is estimated to determine if no cancer health effects are likely to occur. In addition, increased cancer risk is estimated to determine if the concentration of the chemicals found at this site could increase the risk of cancer.

FDOH health risk assessor followed the ATSDR's "Guidance for Inhalation Exposures (GIE)" published on December 1, 2020. The guidance provides health assessors with direction on how to estimate air-related exposures to contaminants of concern based on a variety of exposure scenarios, including some for schools.

Appendix A provides a detailed overview and explanation of the steps taken to evaluate possible adverse human health risk at schools for indoor/outdoor air inhalation exposure.

Results and Findings

Identification of Contaminants of Possible Concern
Table 1 and 2 show the concentration ranges for detected contaminants found in indoor and outdoor air samples collected in- and outside of Buildings 1, 2, 5 and 7 at J. Williams Elementary School in August and November 2020, as well as January 2021 in comparison to their respective ATSDR's CV.

> Concentrations of ***benzene, carbon tetrachloride*** and ***chloroform*** exceeded their respective ATSDR CV for either indoor and/or outdoor air sampled in and outside of either Building 1, 2, 5 and/or 7. Contaminants with concentrations exceeding their respective ATSDR CV are identified as contaminants of possible concern and further investigated evaluating their potential to cause an increased risk of adverse health effects. ***Methylene chloride*** and ***tetrachloroethene*** concentrations did not exceed their respective ATSDR CV but are considered carcinogenic and therefore automatically considered as a contaminant of concern for further evaluation. Table 3 provides a summary of maximum indoor and outdoor air concentration measured for the identified contaminants of concern used for the health risk evaluation.
>
> Laboratory method detection limits for chemicals such as ***1,2,4-trichlorobenzene, 1,2-dichlorethane, 1,4-dioxane*** and ***hexachlorobutadiene*** are greater than their respective ATSDR's CV.

Air concentrations of acenaphthene and naphthalene collected in January 2021 did not exceed their respective ATSDR CV and were not considered for further evaluation. Additionally, an in-depth health risk evaluation would have been driven by too many uncertainties, some of which include sample collection methods.

Identification of Exposure Pathway
FODH health risk assessors have identified that the inhalation of benzene, carbon tetrachloride and chloroform contaminated indoor and outdoor air, respectively, is the only possible exposure pathway with the possibility of causing adverse health effects in students and workers at the school, and therefore should be further investigated:

	Exposure inhalation to possible contaminated indoor and outdoor air	
Completed Pathway	***Environmental Element***	- Indoor and outdoor air
	Exposure Point	- J. Williams Elementary School - Indoor and Outdoor of Buildings 1,2,5 and 7
	Exposure Route	- Inhalation
	Exposed population	- students age 5 < 6-years with seasonal breaks - students age 5 < 6-years with no seasonal breaks - students age 6 < 11-years with seasonal breaks - students age 6 < 11-years with no seasonal breaks - full-time workers - part-time workers

While sub-slab soil data are available and benzo(a)pyrene (BaP-TEQ)[5] (21.8mg/kg)[6] in the sub-slab soil exceeded its respective ATSDR CV, BaP-TEQ is not likely to pose a possible health risk as direct skin and ingestion exposure to the soil can be eliminated. Furthermore, none of the constituents used to derive the BaP-TEQ[5] were detected in sub-slab vapor and/or indoor air samples[6]. This verifies that BaP-TEQ constituents are not off-gassing via vapor intrusion into indoor air. Therefore, this pathway, was not further investigated either.

Non-Cancer & Cancer Health Risk Evaluation

Table 4 provides all input parameters used to evaluate the increased non-cancer and cancer health risk for students (kindergarten through 5th grade) and workers at J. Williams Elementary School when inhaling benzene, carbon tetrachloride and chloroform contaminated indoor and /or outdoor air above their respective ATSDR's Comparison Values.

Tables 5 through 8 show the estimated results for increased non-cancer and cancer risk for students and workers at J. Williams Elementary School exposed to (a) indoor and (b) outdoor air in/near Buildings 1, 2, 5 and 7 containing benzene, carbon tetrachloride and chloroform above their respective ATSDR CV, as well as for the carcinogens methylene chloride and tetrachloroethene, where applicable.

Estimated Hazard Quotients (non-cancer risk) for benzene, carbon tetrachloride, chloroform methylene chloride and tetrachloroethene were below 1 and estimated increased cancer risks were less than 1 in a million in all exposure scenarios [see ***Identification of Exposure Pathway***].

Conclusion and Recommendations

Based on the findings shown in Tables 1 through 8, FDOH health risk assessors do not expect an increased development of non-cancer health effects in students (age 5 to <11 years) and workers at J. Williams Elementary School due to exposure to contaminated indoor and outdoor air while spending time at the school. The estimated increased cancer risk at the site for students and workers of less than one in a million, in general, is considered extremely low.

Some contaminant concentrations in indoor and outdoor air such as, but not limited to, benzene concentration in outdoor air collected at Building 7 and chloroform concentrations in indoor air collected from Building 5 and 7 exceeded their respective ATSDR CVs but are marked with a laboratory identifier used to highlight the laboratory method detection limit (MDL) typically assigning chemicals as "non-detected" (Table 3). A MDL is defined as the minimum measured concentration of a chemical that can be reported with 99% confidence that the measured chemical concentration is distinct from the laboratory

[6] Geosyntec Consultants (2020). "Supplemental Site Assessment Report" – Alachua County School Board – J. Williams Elementary School, Gainesville, Alachua County, Florida. Dated December 22, 2020.

method blank sample[7] (EPA 2016), Meaning, that the chemical concentration measured in the "contaminated" sample is not due to contamination resulting from the laboratory process. It is important to understand that a "non-detect" can mean that the chemical was not in the sample, and it can also mean that the chemical was in the sample in a concentration too low to detect by the laboratory analytical method. Therefore, it is not possible to eliminate potential exposure and risk from chemicals in indoor/outdoor air at the location where the laboratory method detection limit is above ATSDR's CV. In addition, these values can also not be used for an in-depth evaluation due to the uncertainties that have been previously mentioned.

Some of the other data used for the health risk evaluation were highlighted by a laboratory detection limitation used for "estimated values" due to the laboratory limits during the analysis. While the chemical was positively identified; the associated concentration is the approximate concentration of the chemical in the sample:

- benzene (indoor air, Building 1)
- carbon tetrachloride (indoor air, Buildings 1 and 2)
- chloroform (indoor air, Buildings 1 and 2)
- tetrachloroethene (indoor air, Building 1)

While the "estimated" concentrations can be used for the human health risk evaluation it is important to understand that these values do not represent the actual concentration and can either over-estimate or under-estimate the potential risk from exposure via inhalation of benzene, carbon tetrachloride, chloroform and/or tetrachloroethene contaminated indoor/outdoor air.

Most outdoor air samples were collected adjacent to the school buildings of concern. Outdoor air data are supposed to represent background/ambient air data. Some of the concentrations measured in the outdoor air samples could be impacted by indoor air. Collection of true background data is important to ascertain the source and/or their contribution to the levels found in indoor air.

Sub-slab vapor air and soil samples were collected by Geosyntec Consultants but not further assessed for evaluating potential health risks as data collection occurred to investigate whether detected petroleum constituents in indoor air during the August 2020 sampling event were related to potential presence of petroleum constituents in the subsurface beneath Buildings 1 and 2. In addition, exposure to the sub-slab soil via dermal contact and ingestion is highly unlikely.

It is important to note that according to the field notes of the Geosyntec Report, Attachment 3, certain industrial cleaning and paint products were stored in the rooms where indoor air sampling occurred. These products could potentially contain evaporating chemicals such as benzene, which is widely used in paints, glues, furniture wax, thinners, adhesives and detergents. Therefore, some of the chemical concentration measured in indoor air could be due to the use of industrial cleaning supplies and paint. Although these sources may only have a minor contribution to the concentrations found in indoor air, they could contribute to the overall exposure. It is recommended that these products are stored out of children's reach. Furthermore, proper ventilation is suggested to air the rooms properly to limit exposure for children and staff.

FDOH recommends continued monitoring of vapor intrusion air, as well as indoor and outdoor air quality. Sampling occurred in August and November by Geosyntec Consultants, as well as in January by GLE Associates, Inc. In general, the process of vapor intrusion and, ultimately, possible air contamination is a complex, and often difficult transport process to predict. Hence, results of vapor and air contaminant sampling events are very sensitive to seasonal variability mainly due to chemical characteristics. Seasonal variabilities include temperature changes, pressure changes, increase and/or decrease in

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[7] Method blank sample – A chemical free water sample that is processed in exactly the same manner as the contaminated samples. The main function of this clean sample is to document contamination resulting from the analytical process.

raining events (weather/humidity) and many other events that are caused by seasonal changes. Some research has shown that variations in indoor air pressure and air exchange rate can contribute to significant changes in indoor air contaminant vapor concentrations (Shen and Suuberg 2016). Other factors not caused by seasonal changes such as building ventilation could also contribute to a high variability in indoor air data.

If you have any questions or comments concerning this letter, please contact the Health Risk Assessment Program at 877-798-2772 or at phtoxicology@flhealth.gov.

Sincerely,

Olasunkanmi Fasakin
Environmental Specialist III

OF/gal
Enclosure
cc: Kendra Goff, PhD, DABT, CPM, CEHP, Bureau Chief
Elke Ursin, PMP, CPM, Public Health Toxicology Administrator

Letter Preparation
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Table 1: Concentration range (minimum and maximum) of compounds detected in indoor and outdoor air samples collected by Geosyntec Consultants at the Joseph A. Williams Elementary School in August and November 2020.

Compound	ATSDR CV ***[USEPA Residential Ambient Air RSL]***	Unit	Indoor Concentration			Outdoor Concentration		
			Min	**Max**	***Further evaluation [Y/N]***	**Min**	**Max**	***Further evaluation [Y/N]***
1,1,2-Trichloro-1,2,2-Trifluoroethane	*[30]*	μg/m³	U	U	N	0.35	0.39	N
1,2,4-Trichlorobenzene	*[0.002]*	μg/m³	U	U	Y**	U	U	Y**
1,2,4-Trimethylbenzene	60	μg/m³	0.22J	1.4	N	0.096	0.13	N
1,2-Dichloroethane	0.038	μg/m³	U	U	Y*	U	U	Y*
1,4-Dichlorobenzene	60	μg/m³	U	U	N	U	U	N
1,3,5-Trimethylbenzene	60	μg/m³	0.12	0.67J	N	U	U	N
1,3-Dichlorobenzene	*[200]*	μg/m³	0.55	0.55	N	U	U	N
1,4-Dioxane	0.2	μg/m³	U	U	Y**	U	U	Y**
Acetone	31,000	μg/m³	10	47	N	6.9	9.2	N
Benzene	0.13	μg/m³	**0.15**	**1.1**	**Y**	0.11	**0.43**	**Y**
Carbon disulfide	700	μg/m³	0.12	16	N	0.46	2.5	N
Carbon tetrachloride	0.17	μg/m³	0.11	**0.38J**	**Y**	**0.24**	**0.31**	**Y**
Chlorobenzene	*[0.02]*	μg/m³	U	U	Y**	U	U	Y**
Chloroform	0.043	μg/m³	**0.19J**	**0.2J**	**Y**	U	U	Y*
Chloromethane	90	μg/m³	1.1	3.2	N	0.95	1.3	N
Cyclohexane	600	μg/m³	0.13J	0.45	N	U	U	N
Dichlorodifluoromethane	*[100]*	μg/m³	1.2	2.9	N	1.1	1.3	N
Ethylbenzene	260	μg/m³	0.25	0.93	N	0.087	0.13	N
Hexachlorobutadiene	0.045	μg/m³	U	U	Y**	U	U	Y**
Hexane	700	μg/m³	0.54	1.5J	N	U	U	N
Isopropyl alcohol	*[210]*	μg/m³	3.8	93	N	1.9	4.8	N
Isopropylbenzene	3,000	μg/m³	0.1	0.14	N	U	U	N
m-Xylene & p-Xylene	*[100]*	μg/m³	0.52J	2.9	N	0.25	0.39	N
Methyl Ethyl Ketone	*[5,200]*	μg/m³	0.92J	5.1	N	1.3	4.9	N
Methylene chloride	63	μg/m³	1.4	48	Y*	0.4	0.4	Y*
o-Xylene	*[100]*	μg/m³	0.34	1.2	N	0.1	0.16	N
Styrene	850	μg/m³	0.087	0.77J	N	0.085	0.085	N
Tetrachloroethene	3.8	μg/m³	U	0.22J	Y*	U	1.5	Y*
Toluene	3,800	μg/m³	1.2	4.9	N	0.32	0.61	N
Total Xylenes	100	ppb v/v	0.298	0.93	N	0.058	0.129	N
Trichlorofluoromethane	*[5,200]*	μg/m³	0.78	1.4	N	0.86	0.88	N
Acenaphthene	NA	μg/m³	0.016J	0.45J		U	U	
Fluorene	NA	μg/m³	0.021J	0.15J		U	U	
Phenanthrene	NA	μg/m³	0.11J	0.86J		U	U	
Naphthalene	3	μg/m³	0.18J	1.0J	N	U	U	N

Y	*Chemical concentration is above ATSDR CV and therfore chosen for further evaluation.*
Y*	*Chemical concentration is below ATSDR CV but compound is a carcinogen an therefore automatically chosen for further evaluation.*
Y*	*Chemical concentration is below method detection limit (MDL). Though MDL is above ATSDR CV and chemical is a carcinogen and therefore automatically chosen for further evaluation.*
Y**	*Chemical concentration is below MDL. Thgough, MDL is above ATSDRs CV. Possibility of potential risk cannot be eliminated. Compound needs ot be further evaluated.*

ATSDR = Agency for Toxic Substances and Disease Registry
CV = Comparison value
J = Laboratory Report Identifier – Estimated value; value may not be accurate. Spike recovery or relative percent difference outside of criteria.
μg/m³ = microgram per cubic meter
N = No
NA = Not available
Min/Max = Minimum/Maximum
Y = Yes
RSL = US EPA Regional Screening Level
U = Laboratory Report Identifier – The compound was analyzed for but not detected (was below method detection limit)
USEPA = U.S. Environmental Protection Agency
Y = Yes

Table 2: Concentration range (minimum and maximum) of compounds in air samples collected by GLE Associates, Inc. at the Joseph A Williams Elementary School in January 2021.

Compound	ATSDR CV [*USEPA Residential Ambient Air RSL*]	Units	Location [*Indoor/Outdoor*]	Min	Max	*Further evaluation Y/N*
Acenaphthene	NA	µg/m^3	Unknown	<0.00006	<0.0009	N
Naphthalene	3	µg/m^3	Unknown	<0.00006	0.0009	N

ATSDR = Agency for Toxic Substances and Disease Registry
CV = Comparison value
µg/m^3 = microgram per cubic meter
N = No
NA = Not available
Max = Maximum
Min = Minimum
RSL = USEPA Regional Screening Level
USEPA = U.S. Environmental Protection Agency
Y = Yes
< = Less than

Table 3: Maximum concentration of identified contaminant of concerns (COCs) (see Table 1: benzene, carbon tetrachloride and chloroform) used for further risk evaluation found in either/or **indoor** and **outdoor air** collected at the Joseph A Williams Elementary School between August and November 2020.

Building #	Location	Benzene (µg/m³)	Carbon Tetrachloride (µg/m³)	Chloroform (µg/m³)	Methylene chloride (µg/m³)	Tetrachloroethene (µg/m³)
1	Indoor	0.55J	0.38J	0.19J	20	0.22J
2		1.1	0.32J	0.2J	48	U
5		0.22	0.3	U	4.9	U
7		0.25	0.23	U	1.4	U
1	Outdoor	0.43	0.24	U	U	U
2		0.14	0.26	U	0.4	U
5		0.11	0.24	U	U	U
7		U	0.31	U	U	1.5
	ATSDR CV	**0.13**	**0.17**	**0.043**	**63**	**3.8**
	IUR (µg/m³) $^{-1}$	*7.8E-06*	*6.0E-06*	*2.3E-05*	*1.00E-08*	*2.60E-07*

Red: *Concentration of a chemical of concern is above ATSDRs CV and therefore the chemical is further evaluated.*

Blue: *Chemical of concern was "not detected" (also called "non-detect") by the laboratory analysis method used. Though, in this specific case, the detection limited of the laboratory analysis used was higher than the ATDSR CV. It is important to understand that a "non-detect" can mean that the chemical was not in the sample, and it can also mean that the chemical was in the sample in a concentration too low to detect by the laboratory analysis method. Therefore, it is not possible to eliminate potential exposure and risk when the detection limit is above ATSDR's CV, but it is also not possible to perform an in-depth evaluation due to the lack of data.*

Green: *Concentration of a chemical of concern is below ATSDRs CV. Though, the chemical is identified as a carcinogen and therefore further evaluated.*

ATSDR = Agency for Toxic Substances and Disease Registry
CV = Comparison value
IUR = Inhalation unit risk for cancer (used for risk evaluation)
J = Laboratory Report Qualifier – Result is less than the reporting limit but greater than or equal to the method detection limit and the concentration is an approximate value. (Estimated value; value may not be accurate).
µg/m³ = microgram per cubic meter
U = Laboratory Report Qualifier – The compound was analyzed for but not detected above the method detection limit.
# = Number

Table 4: Input parameter for evaluating the development of possible adverse health risks (increase non-cancer and cancer) due to exposure to (a) indoor and (b) outdoor air at J. Williams Elementary school containing contaminants of possible concern.

(a) Indoor Air Input Parameters

School Grade Level	Age (years)	Seasonal Break	Daily exposure Time (hr/day)	Exposure Frequency (days/week)	Exposure Duration (weeks/yr)	Average Time (yr)	Adjusted Exposure Factor (non-cancer)	Adjusted Exposure Factor (cancer)
Kindergarten	5 < 6	Yes	5.3	5	39	1	0.12	0.002
		No	5.3		47		0.14	0.002
1st to 5th grades	6 < 11	Yes	6.6	5	39	5	0.15	0.009
		No	6.6		47		0.18	0.011
Full-time worker	18 < 64	Yes	7	5	50	20	0.20	0.051
Part-time worker		Yes	3	5		3.1	0.09	0.003

(b) Outdoor Air Input Parameters

School Grade Level	Age (years)	Seasonal Break	Daily exposure Time (hr/day)	Exposure Frequency (days/week)	Exposure Duration (weeks/yr)	Average Time (yr)	Adjusted Exposure Factor (non-cancer)	Adjusted Exposure Factor (cancer)
Kindergarten	5 < 6	Yes	1.43	5	39	1	0.03	0.0004
		No	1.43		47		0.04	0.0004
1st to 5th grades	6 < 11	Yes	1.47	5	39	5	0.03	0.003
		No	1.47		47		0.04	0.003
Full-time worker	18 < 64	Yes	2	5	50	20	0.06	0.015
Part-time worker		Yes	2	5		3.1	0.06	0.002

Yr = Year
Hr = Hour
< = Less than

Table 5: Estimated non-cancer and cancer risk for students at J. Williams Elementary School exposed to (a) indoor and (b) outdoor air in/near Building 1 containing benzene, carbon tetrachloride, chloroform above their respective ATSDR's Comparison Values, as well as the additional carcinogens methylene chloride and tetrachloroethene.

(a) Indoor Air

Seasonal Break?	**Contaminant of Concern**	**Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)**				**Increased Cancer Risk (Lifetime)**		
		School student (age - years)		**Full-time worker**	**Part-time worker**	**School student (age - years)**	**Full-time worker**	**Part-time worker**
		5 < 6	**6 < 11**	**18 < 64**		**5 < 11**	**18 < 64**	
Yes	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride*** ***Tetrachloroethene***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	
No	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride*** ***Tetrachloroethene***	HQ < 1		HQ < 1		< 1E - 06	< 1E – 06	

(b) Outdoor Air

Seasonal Break?	**Contaminant of Concern**	**Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)**				**Increased Cancer Risk (Lifetime)**		
		School student (age - years)		**Full-time worker**	**Part-time worker**	**School student (age - years)**	**Full-time worker**	**Part-time worker**
		5 < 6	**6 < 11**	**18 < 64**		**5 < 11**	**18 < 64**	
Yes	***Benzene*** ***Carbon Tetrachloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	
No	***Benzene*** ***Carbon Tetrachloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	

HQ = Hazard quotient (HQ < 1, no potential increased risk of developing non-cancer health effects)
< = Less than
1E-06 = One in a million
*** <1E-06 → The estimated increased cancer risk via inhalation of contaminated air is less than one in a million, which in general, is considered extremely low.*

Table 6: Estimated non-cancer and cancer risk for students at J. Williams Elementary School exposed to (a) indoor and (b) outdoor air in/near Building 2 containing benzene, carbon tetrachloride and chloroform above their respective ATSDR's Comparison Values, as well as the additional carcinogen methylene chloride.

(a) Indoor Air

Seasonal Break?	Contaminant of Concern	Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)				Increased Cancer Risk (Lifetime)		
		School student (age - years)		Full-time worker	Part-time worker	School student (age - years)	Full-time worker	Part-time worker
		5 < 6	**6 < 11**	**18 < 64**		**5 < 11**	**18 < 64**	
Yes	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	
No	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E – 06	

(b) Outdoor Air

Seasonal Break?	Contaminant of Concern	Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)				Increased Cancer Risk (Lifetime)		
		School student (age - years)		Full-time worker	Part-time worker	School student (age - years)	Full-time worker	Part-time worker
		5 < 6	**6 < 11**	**18 < 64**		**5 < 11**	**18 < 64**	
Yes	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	
No	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E – 06	

HQ = Hazard quotient (HQ < 1, no potential increased risk of developing non-cancer health effect)
< = Less than
1E-06 = One in a million
*** <1E-06 → The estimated increased cancer risk via inhalation of contaminated air is less than one in a million, which in general, is considered extremely low.*

Table 7: Estimated non-cancer and cancer risk for students at J. Williams Elementary School exposed to (a) indoor and (b) outdoor air in/near Building 5 containing benzene and carbon tetrachloride above their respective ATSDR's Comparison Values, as well as the additional carcinogen methylene chloride.

(a) Indoor Air

Seasonal Break?	**Contaminant of Concern**	**Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)**				**Increased Cancer Risk (Lifetime)**		
		School student (age - years)		**Full-time worker**	**Part-time worker**	**School student (age - years)**	**Full-time worker**	**Part-time worker**
		5 < 6	**6 < 11**	**18 < 64**		**5 < 11**	**18 < 64**	
Yes	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	
No	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E – 06	

(b) Outdoor Air

Seasonal Break?	**Contaminant of Concern**	**Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)**				**Increased Cancer Risk (Lifetime)**		
		School student (age - years)		**Full-time worker**	**Part-time worker**	**School student (age - years)**	**Full-time worker**	**Part-time worker**
		5 < 6	**6 < 11**	**18 < 64**		**5 < 11**	**18 < 64**	
Yes	***Benzene*** ***Carbon Tetrachloride***	HQ < 1		HQ < 1		< 1E -06	< 1E -06	
No	***Benzene*** ***Carbon Tetrachloride***	HQ < 1		HQ < 1		< 1E -06	< 1E -06	

HQ = Hazard quotient (HQ < 1, no potential increased risk of developing non-cancer health effect)
< = Less than
1E-06 = One in a million

*** <1E-06 → The estimated increased cancer risk via inhalation of contaminated air is less than one in a million, which in general, is considered extremely low.*

Table 8: Estimated non-cancer and cancer risk for students at J. Williams Elementary School exposed to (a) indoor and (b) outdoor air in/near Building 7 containing benzene and carbon tetrachloride above their respective ATSDR's Comparison Values, as well as the additional carcinogens methylene chloride and tetrachloroethene.

(a) Indoor Air

Seasonal Break?	Contaminant of Concern	Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)				Increased Cancer Risk (Lifetime)		
		School student (age - years)		Full-time worker	Part-time worker	School student (age - years)	Full-time worker	Part-time worker
		5 < 6	6 < 11	18 < 64		5 < 11	18 < 64	
Yes	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	
No	***Benzene*** ***Carbon Tetrachloride*** ***Chloroform*** ***Methylene chloride***	HQ < 1		HQ < 1		< 1E - 06	< 1E – 06	

(b) Outdoor Air

Seasonal Break?	Contaminant of Concern	Increased Non-Cancer Risk (Chronic Hazard Quotient - HQ)				Increased Cancer Risk (Lifetime)		
		School student (age - years)		Full-time worker	Part-time worker	School student (age - years)	Full-time worker	Part-time worker
		5 < 6	6 < 11	18 < 64		5 < 11	18 < 64	
Yes	***Carbon Tetrachloride*** ***Chloroform*** ***Tetrachloroethene***	HQ < 1		HQ < 1		< 1E - 06	< 1E - 06	
No	***Carbon Tetrachloride*** ***Chloroform*** ***Tetrachloroethene***	HQ < 1		HQ < 1		< 1E - 06	< 1E – 06	

HQ = Hazard quotient (HQ < 1, no potential increased risk of developing non-cancer health effect)
< = Less than
1E-06 = One in a million

*** <1E-06 → The estimated increased cancer risk via inhalation of contaminated air is less than one in a million, which in general, is considered extremely low.*

APPENDIX A. EXPLANATION OF HUMAN HEALTH RISK EVALUATION FOR INDOOR/OUTDOOR AIR INHALATION EXPOSURE SCENARIOS.

FDOH health risk assessors followed the ATSDR's "Guidance for Inhalation Exposures (GIE)"[1] published on December 1, 2020. The guidance provides health assessors with direction on how to estimate air-related exposures to contaminants of concern based on a variety of exposure scenarios, including some for schools.

Inhalation exposures are initially evaluated using ATSDRs health-based comparison values (CVs) and other health guidelines. CVs are media-specific concentrations derived from health guidelines using default exposure assumptions and are used to screen/identify contaminants for further evaluation. If a contaminant concentration exceeds its respective ATSDR CV or is a carcinogen, the contaminant is identified as a contaminant of concern (COC) and is considered for a further health risk evaluation. Health guidelines include ATSDR's minimal risk levels (MRLs), EPA reference doses (RfDs) and EPA reference concentrations (RfCs). These health guidelines are for non-cancerous endpoints.

Once the COC is identified for further evaluation, the health risk assessor estimates the possible development of non-cancer health risk and/or increased cancer risk due to exposure to contaminated air by following Equations 1 through 3, respectively. Lifetime increased cancer risk can be calculated by adding individual increased cancer risk for each age group.

$$Non - Cancer\ Risk\ (HQ) = \frac{EPC\ (\mu g/m^3)\ x\ EF}{MRL_{Inhalation}(\mu g/m^3)}$$

Equation 1

$$Increased\ Cancer\ Risk\ (ICR) = IUR\ x\ EPC\ (\mu g/m^3)\ x\ EF$$

Equation 2

$$ICR_{Lifetime} = ICR_{5<6yrs} + ICR_{6<11yrs}$$

Equation 3

EPC	*= Exposure point concentration (or maximum concentration) of the contaminant of concern*
EF	*= Exposure factor*
HQ	*= Hazard quotient*
ICR	*= Increased Cancer Risk (shown with example age group exampled for J. Williams Elementary School)*
IUR	*= ATSDR Inhalation unit risk*
$MRL_{Inhalation}$	*= ATSDRs Minimal Risk Level for inhalation exposure (chemical specific)*

The exposure factor (EF) is derived using several variables such as daily exposure times (ET), exposure frequencies (EF_R), exposure durations (ED) and total average times (AT) (Equation 4):

$$EF = ET\ x\ EFR_R\ x\ ED\ x\ AT$$

Equation 4

Understanding the activity patterns of the population that is being evaluated provides assumptions about the components used to compute the exposure factor (EF). The students and employees

[1] [ATSDR] Agency for Toxic Substances and Disease Registry. 2020. Guidance for Inhalation Exposures. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, December 1, 2020.

(workers) at the J. Williams Elementary school are assumed to be exposed to the air intermittently, meaning during school openings/hours only, while ATSDRs air inhalation health guidelines usually provide information for a 24-hour exposure. Therefore, the exposure point concentration (EPC) or maximum concentration of the COC that students and workers at the J. Williams elementary school are potentially exposed to must be adjusted to the actual times, durations and frequencies of exposure. Once the COC concentration is adjusted, the health risk assessor compares the adjusted concentration to the inhalation health guidelines. For carcinogens, the inhalation unit risk (IUR) value is used to estimate cancer risk. The adjustment occurs by calculating a site/scenario specific exposure factor (Equation 5):

$$EF_{Adjust} = \frac{ET_{Site}\ x\ EF_{R_{Site}}\ x\ ED_{Site}\ x\ AT_{Site}}{ET_{Default}\ x\ EF_{R_{Default}}\ x\ ED_{Default}\ x\ AT_{Default}}$$

Equation 5

AT = total average times (AT)
ED = exposure durations
EF = exposure factor
EF_R = exposure frequencies
ET = exposure times

Default = ATSDR default assumption based on 24 hours exposure (residential)
Site = Site and scenario specific input parameters

Once the adjusted EF (EF_{Adjust}) is calculated, the health risk assessor uses EF_{Adjust} to estimate the non-cancer and increased cancer risk using Equations 1 and/or 2.

Example

Location: J. Williams Elementary School
Kindergarten
Elementary School (1^{st} to 5^{th} grade)
Population: Students age 5 to less than 6 years
Student age 6 years to less than 11 years
Seasonal Break? Yes
COC Indoor Air: Benzene
Concentration Building 1: 0.55 μg/m^3

As mentioned, ATSDRs air inhalation health guidelines usually provide information for a 24-hour exposure. Therefore, the maximum concentration of the COC that students at the J. Williams elementary school are potentially exposed to must be adjusted to the actual times, durations and frequencies of exposure:

School Grade Level	Age (yrs)	Daily exposure Time (hr/day)	Exposure Frequency (days/week)	Exposure Duration (weeks/yr)	Average Time (yr)
Kindergarten	**5 < 6**	5.3	5	39	1
1st to 5th grades	**6 < 11**	6.6	5	39	5

➔ ***Exposure Factor Adjustment (Equation 4):***

	Non-Cancer Risk:	***Increased Cancer Risk:***
Kindergarten	$EF_{Adjust} = \dfrac{5.3\,\frac{hr}{day}\ x\ 5\,\frac{days}{week}\ x\ 39\,\frac{weeks}{yr}\ x\ 1\ yr}{24\,\frac{hr}{day}\ x\ 7\,\frac{days}{week}\ x\ 52.14\,\frac{weeks}{yr}\ x\ 1\ yr} = \mathbf{0.12}$	$EF_{Adjust} = \dfrac{5.3\,\frac{hr}{day}\ x\ 5\,\frac{days}{week}\ x\ 39\,\frac{weeks}{yr}\ x\ 1\ yr}{24\,\frac{hr}{day}\ x\ 7\,\frac{days}{week}\ x\ 52.14\,\frac{weeks}{yr}\ x\ 78\ yr} = \mathbf{0.002}$
1st to 5th grades	$EF_{Adjust} = \dfrac{6.6\,\frac{hr}{day}\ x\ 5\,\frac{days}{week}\ x\ 39\,\frac{weeks}{yr}\ x\ 5\ yr}{24\,\frac{hr}{day}\ x\ 7\,\frac{days}{week}\ x\ 52.14\,\frac{weeks}{yr}\ x\ 5\ yr} = \mathbf{0.15}$	$EF_{Adjust} = \dfrac{6.6\,\frac{hr}{day}\ x\ 5\,\frac{days}{week}\ x\ 39\,\frac{weeks}{yr}\ x\ 5\ yr}{24\,\frac{hr}{day}\ x\ 7\,\frac{days}{week}\ x\ 52.14\,\frac{weeks}{yr}\ x\ 78\ yr} = \mathbf{0.009}$

➔ ***Assessing Exposure Non-Cancer Risk and Increased Cancer Risk (Equations 1 through 3):***

	Non-Cancer Risk:	***Increased Cancer Risk:***
Kindergarten	$HQ = \dfrac{0.55\,\frac{\mu g}{m^3}\ x\ 0.12}{9.6\,\frac{\mu g}{m^3}} = \mathbf{0.007}$	$\text{Increased Cancer Risk} = 7.8E-06\,\frac{\mu g}{m^3}\ x\ 0.55\,\frac{\mu g}{m^3}\ x\ 0.002 = \mathbf{6.5E-09}$
1st to 5th grades	$HQ = \dfrac{0.55\,\frac{\mu g}{m^3}\ x\ 0.15}{9.6\,\frac{\mu g}{m^3}} = \mathbf{0.008}$	$\text{Increased Cancer Risk} = 7.8E-06\,\frac{\mu g}{m^3}\ x\ 0.55\,\frac{\mu g}{m^3}\ x\ 0.009 = \mathbf{4.04E-08}$
	Adjusted Lifetime Cancer Risk	$\text{Lifetime Increased Cancer Risk} = 6.49E-09\ + 4.04E-08 = \mathbf{4.69E-08}$

Non-Cancer Risk:

HQ < 1 = No increased development of non-cancer health effects is expected.

Increased Cancer Risk:

< 1E-06 = The estimated increased cancer risk via inhalation of contaminated air is less than one in a million, which in general, is considered extremely low.