COMMITMENT & INTEGRITY
DRIVE RESULTS

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December 17, 2018

George Katinger
Senior Associate, Project Architect
Kenneth Boroson Architects
315 Peck Street
Building 3, Suite 2-B
New Haven, CT 06513

RE: Indoor Air Quality Screening and Consulting Support Services
Holland Hill Elementary School

Dear Mr. Katinger:

Woodard & Curran ha prepared this summary report of the indoor air quality (IAQ) screening results and review of means and methods being utilized to control dust and odors during ongoing construction activities at the Holland Hill School located at 105 Meadowcroft Road in Fairfield, Connecticut.

On December 8, 2018 Woodard & Curran representative, Mr. William Henderson performed the IAQ screening and observed ongoing electrical work. The site visit occurred on a Saturday when school was not in session; however, an electrical contractor was working at the school.

The renovations currently being conducted at the school include the construction of a building addition off the south side of the existing building as well as interior renovations and modifications to the existing building controls and heating, ventilation and air conditioning in the existing structure. This indoor air quality screening was conducted to establish baseline conditions regarding the potential entrainment of airborne construction-related particulates and odors into the occupied portions of the school. The site visit included the following tasks:

1. Real-time measurements for carbon monoxide, total volatile organic compounds (VOCs), and particulate matter (dust) throughout the school.
2. A visual inspection of areas throughout the school to determine if there were obvious construction-related dusts, odors, or migration pathways for construction related dusts and odors to become entrained in the occupied portions of the school.
3. Observation of air flow patterns between the occupied school and the construction areas using air flow visualization.
4. Discussions/interviews with representatives from the construction management team (Gilbane Building Company).

Woodard & Curran's scope of work was to include a limited evaluation of the school's heating ventilation and air conditioning (HVAC) system; however, Woodard & Curran did not have access to the HVAC systems at the time of our site visit.

Observations

Holland Hill School consists of a one-story building with a partial basement. The first floor of the school houses classrooms, administrative offices, library, gymnasium, multipurpose rooms, and kitchen. The boiler room is located in the basement. With the exception of the library, the acoustical ceiling tiles were reportedly removed during the summer when students were not in school.

The construction of a large building addition is ongoing on the south elevation of the building while a smaller building addition is being constructed on the north elevation. Within the existing school footprint, mechanical ventilation is being added to the classrooms. The south addition is connected to the school near the corridor outside the gymnasium on the west side and the vestibule outside the library on the east elevation. The north elevation addition is ongoing and is adjacent to the kitchen and the boiler room and the construction area is open to the boiler room.

On the day of the site visit, an electrical subcontractor was installing wires above the suspended ceiling grids in the existing classrooms and corridor outside classrooms 12 and 14 and in the boiler room. Wiring was also being installed in the south construction area. Approximately 10 people were working on the day of the site visit. No other subcontractors were observed conducting construction-related activities during the site visit.

The south construction area is separated from the existing building with double doors in two locations. On the day of the site visit, the boiler room door to the basement was open to the school's classroom corridor. There were no other temporary barriers separating the construction and occupied areas of the school. There were area mats at the entrances to the construction area which appeared to have construction related dust and debris. Gilbane reported that school personnel vacuum carpets and clean the occupied areas of the school. No school personnel were available to discuss cleaning means and methods.

Observations regarding air flow patterns were made during the site visit. Air was observed to move from the south elevation construction area into the occupied areas of the school. Air was also observed flowing into the boiler room (north elevation construction area) from the corridor. The boilers were operational at this time which can cause the room to be negatively pressurized.

According to Gilbane site representative, separate heating and air conditioning systems service the library and gymnasium. The air handling units (AHUs) that service these areas of the building are located on the roof. On the day of the survey, Woodard & Curran did not have access to inspect within these AHUs; however, the ceiling supply air diffusers in the library appeared clean. The acoustical ceiling tiles were in place in the library and no construction related activities were observed in this area while on site. The supply air ducts and diffusers in the gymnasium were approximately 25 to 30 feet above floor level and could not be inspected up close.

Other observations include:

- Although subjective, transient odors from the construction area, including paint were detected in the classroom areas.
- The occupied areas of the building including classrooms and corridors, with the exception of the areas immediately outside the construction entrances, appeared clean and no excessive accumulation of settled dust was observed.
- The work observed on the day of the site visit would not be expected to cause elevated indoor airborne particulate or VOCs.

A photo log of the survey is included in Attachment A.

Indoor Air Quality

Carbon Monoxide

Common sources of carbon monoxide within indoor environments include internal combustion engines such as motor vehicle and forklift exhaust. Other sources may include tobacco smoke, space heaters, improperly adjusted oil or gas burners and other processes that result in incomplete combustion. The Environmental Protection Agency (EPA) has established a National Ambient Air Quality Standard of 9 ppm for carbon monoxide averaged over an 8-hour period. Typical average concentrations found in a commercial building range from 0 to 6 ppm.

Carbon monoxide readings throughout the school were made with a Ventis MX4 direct-reading instrument. Carbon monoxide readings were all less than the instrument limit of detection of 1 ppm in the occupied interior locations and therefore, were within the EPA's guideline for carbon monoxide.

A summary of the direct-reading measurements for carbon monoxide is provided in Table 1.

Airborne Particulate

Airborne particulate is a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope and can be irritating to the respiratory system. Various size particles were measured throughout the occupied areas of the building and in the construction areas. The US EPA NAAQS standard for airborne particulate PM-2.5 and PM-10 (airborne particulate matter with size diameters 2.5 and 10 micrometers) is 0.035 mg/m^3 and 0.150 mg/m^3 respectively, measured over a 24-hour period.

Airborne particulate was measured using a calibrated DustTrak DRX (model 8533) manufactured by TSI which can measure mass and size fraction of airborne particulate. The DustTrak DRX can measure airborne particulate with different size ranges including particles that are 1, 2.5, and 10 micrometers in diameter size as well as respirable sized particulate and total particulate. Particulate concentration was higher in the construction areas and directly outside the doors to the south construction area, then in the occupied areas of the building. Measurements of PM-2.5 and PM-10 were generally below reference levels in the classrooms, but in some areas close to construction, i.e. gymnasium, corridor outside gymnasium and vestibule outside library, particulate concentrations were slightly above reference standards.

A summary of the direct-reading measurements for airborne particulate is provided in Table 1.

Total Volatile Organic Compounds

VOCs comprise a broad category of chemicals that include components of many common office supplies and products such as paints, solvents, mothballs, some janitorial supplies, photocopiers, insecticides, and building materials such as construction adhesives. Although U. S. Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) have been established for many of these individual chemicals, concentrations in typical non-industrial indoor air seldom exceed these limits.

VOC measurements were made using a calibrated photo ionization detector (PID) MiniRae 2000 to indicate the levels of total VOCs that have an ionization potential below 10.6 electron volts. The PID is useful for detecting VOCs to a lower limit of one to two ppm calibration gas equivalent. Total VOC levels ranged from 0.2 and 0.5 ppm during the survey in the typically occupied areas of the school. In the construction areas, (South addition area and Boiler Room) the total VOC levels ranged from 0.7 to 1.1

ppm. There are currently no indoor air quality limits recommended by the EPA, however, indoor air concentrations are typically 2 – 5 times greater than the measured outdoor concentrations and can be over a thousand times higher during certain activities, such as painting. The measured concentrations during the site visit are expected with the observed amount of paint and primer being used in the construction area and with the observed air flow from the construction area to the occupied school.

A summary of the direct-reading measurements for VOCs is provided in Table 1.

Air Current Flow Test

Air current tubes, which generate a small amount of smoke, were used to visualize air flow around the double doors separating the construction area from the school. It was also used around the open door to the boiler room. The results of this evaluation indicated that the construction area, (South addition area) is positively pressurized (i.e. air was observed flowing from the construction area into the adjacent classroom area) relative to the adjacent classroom area. This was observed at the door near the vestibule at the library and at the door in corridor outside the gymnasium. Whether the door was open slightly or closed smoke was observed moving into the typically occupied classroom areas at the floor level. At the higher levels, such as shoulder height and at the top of the door, the air was more neutral.

At the door to the Boiler Room, air was observed flowing into the Boiler Room.

Visual HVAC System Evaluation

Although Woodard & Curran did not have access within the HVAC ducts at the time of our assessment, or to the rooftop air handling units, the supply air diffusers in the library were observed. They appeared clean as did the area above the acoustical ceiling tiles. The other areas of the currently occupied areas of the school do not currently have mechanical HVAC. The supply air ducts and diffusers in the gymnasium were approximately 25 to 30 feet above floor level and could not be inspected.

Conclusions

The airborne particulate concentrations in the typically occupied classrooms were generally within the guidelines recommended by the US EPA NAAQS. Areas in the corridor outside the gymnasium and corridor outside the library were higher as compared to the occupied areas of the school and were greater than recommended indoor air quality levels. The recommended IAQ levels are 24-hour averages that were compared to the measured concentrations in the school. The levels of particulate in these areas were likely drawn in from the south construction area, where higher concentrations of airborne particulate were measured.

The concentration of VOCs was measured higher in the south construction area compared to the occupied classroom area. Five-gallon cans of paint and primer were stored in the corridor of the south construction area and could be the source of VOCs measured in the school. A janitor's closet with various cleaning products was observed during the survey.

Given that the observed electrical work is not likely to cause elevated concentrations of airborne particulate or VOCs, the levels may be expected to be greater during activities that generate more dust and vibration or that generate VOCs, like painting.

Recommendations

Better isolation and separation of occupied and construction area are recommended to minimize entrainment of construction dust in occupied areas of the school. Consider implementing the following engineering controls and work practices to minimize the migration of construction related-particulates and odors into occupied areas of the school:

- Construct a temporary wall should be between the occupied areas of the school and the construction areas. This wall should be constructed to separate the two areas and should extend from floor to ceiling.
- Minimize passage between construction and occupied areas.
- Construct an anteroom around the doors to minimize the migration of particulates and odors.
- Maintain the doors in a closed position and maintain sweeps and gaskets to maintain tight seal. Maintain the construction area at a negative pressure differential relative to the adjacent occupied areas. Air filtering devices equipped with HEPA filters can help control air flow. Filtered air should be exhausted to the outdoors away from windows, doors and pedestrian walkways. A differential pressure gauge or manometer can show the difference in pressure between the work and occupied areas. Dust mitigation techniques such as local exhaust ventilation with High Efficiency Particulate Air (HEPA) shrouded tools or the use of water will capture or minimize dusts as they are generated.

Outside the construction zone, sticky mats could be placed to collect dust from the bottom of work boots as workers leave the construction zones and enter the school. These mats should be changed frequently. The areas around the entrance to construction should also be cleaned with vacuum equipped with a HEPA filter and mopped frequently. A log should be kept and displayed to indicate when cleanings occur.

Going forward, Woodard & Curran also recommends:

- Inspect HVAC systems, when accessible;
- Repeat direct reading measurements as construction activities change; and
- Review construction schedule to make recommendations regarding additional screening events.

Limitations

The services performed by Woodard & Curran were conducted in a manner consistent with standard industry practices for indoor air quality screening assessments and Woodard & Curran's proposal dated November 5, 2018.

If you have any questions, or require additional information, please contact us via email or at the number listed above.

Sincerely,

WOODARD & CURRAN

William Henderson, CIH
Project Scientist II

George J. Franklin, CHMM
Technical Manager

Attachments: Table 1: Direct Reading Measurements December 8, 2018
Attachment A: Photo Log

TABLE

Table 1: Direct Reading Measurements
December 8, 2018

Location	Time	VOCs (ppm)	CO (ppm)	Airborne Particulate (mg/m³)				
				PM-1	PM-2.5	Respirable	PM-10	Total
Outdoors	8:34	< 0.1	< 1	0.010	0.010	0.010	0.011	0.014
Corridor outside Gymnasium	8:37	0.4	< 1	0.027	0.040	0.046	0.055	0.065
Gymnasium	8:39	0.5	< 1	0.032	0.045	0.046	0.081	0.084
Classroom 20	8:44	0.3	< 1	0.014	0.016	0.017	0.021	0.023
Classroom 19	8:46	0.2	< 1	0.008	0.009	0.009	0.010	0.017
Classroom 17	8:48	0.4	< 1	0.014	0.017	0.020	0.029	0.030
Classroom 16	8:49	0.2	< 1	0.007	0.007	0.008	0.008	0.009
Classroom 13	8:51	0.3	< 1	0.012	0.015	0.016	0.021	0.046
Corridor Outside Boys and Girls Restrooms	8:53	0.3	< 1	0.024	0.034	0.057	0.065	0.081
Instrument Storage Room	8:55	0.3	< 1	0.028	0.028	0.035	0.049	0.060
Classroom 14	8:57	0.4	< 1	0.015	0.020	0.021	0.039	0.064
*Boiler Room**	8:59	0.9	< 1	0.106	0.132	0.121	0.304	0.053
*Addition area, adjacent to Boiler room**	9:02	0.7	< 1	0.042	0.046	0.072	0.154	0.224
Library	9:05	0.3	< 1	0.005	0.006	0.006	0.007	0.008
Multipurpose Room	9:07	0.2	< 1	0.008	0.011	0.014	0.015	0.019
Classroom 9	9:10	0.2	< 1	0.006	0.007	0.007	0.010	0.019
Administrative Office	9:12	0.2	< 1	0.004	0.004	0.004	0.004	0.004
Ms. Farrell's Room	9:12	0.3	< 1	0.005	0.005	0.005	0.005	0.005
Corridor outside Classroom 10	9:14	0.2	< 1	0.005	0.005	0.006	0.007	0.007
Classroom 6	9:15	0.2	< 1	0.005	0.005	0.006	0.006	0.006
Classroom 5	9:17	0.2	< 1	0.005	0.005	0.005	0.005	0.005
Classroom K1	9:18	0.3	< 1	0.005	0.005	0.007	0.008	0.008
*Corridor Outside Room 142**	9:22	1.0	< 1	0.145	0.165	0.185	0.246	0.310
*Room 140**	9:24	1.0	< 1	0.239	0.388	0.488	0.505	0.511
Outdoors	10:15	0.1	< 1	0.005	0.005	0.005	0.005	0.005

Location	Time	VOCs (ppm)	CO (ppm)	Airborne Particulate (mg/m³)				
				PM-1	PM-2.5	Respirable	PM-10	Total
Corridor outside Gymnasium	10:17	0.4	< 1	0.082	0.082	0.084	0.092	0.123
Gymnasium	10:19	0.5	< 1	0.034	0.037	0.042	0.053	0.075
Classroom 20	10:21	0.5	< 1	0.027	0.029	0.030	0.048	0.056
Classroom 19	10:23	0.4	< 1	0.025	0.025	0.031	0.035	0.037
Classroom 17	10:25	0.4	< 1	0.027	0.030	0.033	0.043	0.043
Classroom 16	10:27	0.4	< 1	0.019	0.021	0.024	0.025	0.027
Corridor Outside Boiler Room	10:29	0.3	< 1	0.023	0.026	0.034	0.036	0.039
Classroom 18	10:34	0.4	< 1	0.035	0.040	0.041	0.042	0.053
Instrument Storage Room	10:38	0.3	< 1	0.029	0.026	0.029	0.031	0.036
Classroom 14	10:39	0.4	< 1	0.019	0.019	0.020	0.032	0.036
*Boiler Room**	10:41	0.9	< 1	0.119	0.119	0.128	0.166	0.205
*Addition area, adjacent to Boiler room**	10:43	0.8	< 1	0.017	0.017	0.021	0.036	0.042
Corridor outside Library	10:45	0.3	< 1	0.072	0.099	0.129	0.296	0.386
Library	10:46	0.2	< 1	0.001	0.001	0.002	0.002	0.003
Multipurpose Room	10:48	0.2	< 1	0.009	0.012	0.018	0.021	0.023
Classroom 9	10:49	0.3	< 1	0.005	0.005	0.010	0.014	0.014
Administrative Office	10:51	0.3	< 1	0.003	0.005	0.005	0.007	0.010
Ms. Farrell's Room	10:52	0.3	< 1	0.001	0.001	0.002	0.002	0.003
Corridor outside Classroom 10	10:54	0.2	< 1	0.002	0.002	0.003	0.003	0.004
Classroom 6	10:56	0.2	< 1	0.002	0.002	0.002	0.002	0.002
Classroom 5	10:58	0.2	< 1	0.001	0.001	0.002	0.002	0.002
Classroom K1	11:00	0.2	< 1	0.002	0.005	0.005	0.008	0.008
Classroom K2	11:02	0.2	< 1	0.001	0.001	0.001	0.001	0.001
*Corridor Outside Room 138**	11:05	1.1	< 1	0.120	0.123	0.131	0.295	0.413
*Corridors Outside Room 144 (Boys Rooms)**	11:07	1.1	< 1	0.124	0.181	0.190	0.201	0.220
Kitchen	11:32	0.3	< 1	0.003	0.003	0.004	0.004	0.004
Outdoors	11:35	0.1	< 1	0.004	0.004	0.005	0.005	0.005
* Indicates construction area measurement								

ATTACHMENT A: PHOTO LOG

APPENDIX A: PHOTO LOG

Photo Number: 1	Date: 12/08/2018
Description: Entrance to construction, corridor outside gymnasium	

Photo Number: 2	Date: 12/08/2018
Description: Entrance to construction, vestibule outside Library	

APPENDIX A: PHOTO LOG

Photo Number: 3	Date: 12/08/2018
Description: Corridor outside Boiler Room, wires being installed above ceiling	

Photo Number: 4	Date: 12/08/2018
Description: Entrance to construction area, carpet	

Photo Number: 5	Date: 12/08/2018
Description: Library, supply air diffusers	

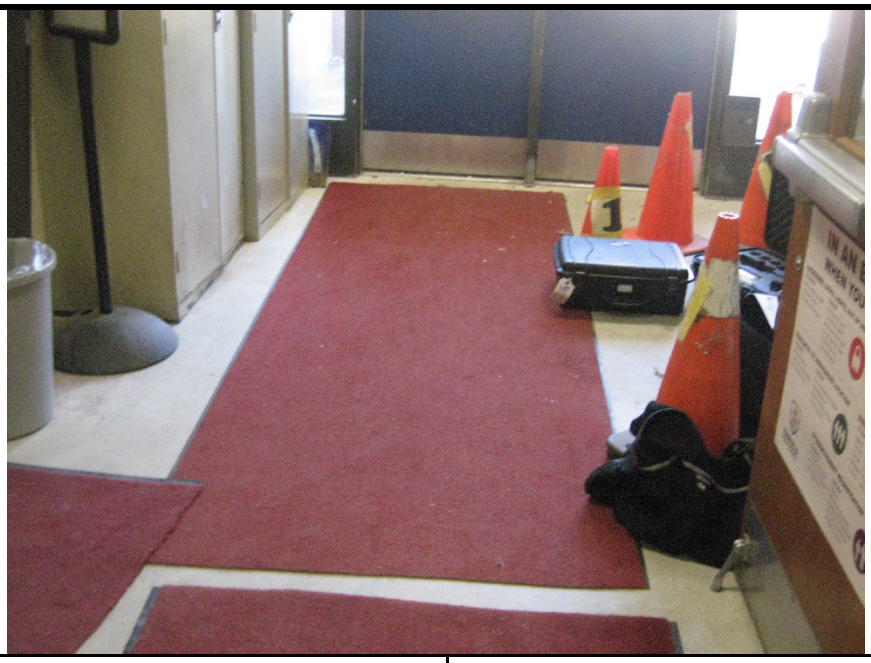

Photo Number: 6	Date: 12/08/2018
Description: Corridor outside gymnasium	

Photo Number: 7	Date: 12/08/2018
Description: Paints stored in south construction area	