



September 14, 2017

Mr. Mark Waller
Coordinator of Property Services and Construction
South-Western City Schools
3805 Marlane Drive
Grove City, Ohio 43123

Re: Executive Summary Letter, Indoor Air Quality Assessment of Buckeye Woods Elementary School

Dear Mr. Waller,

Lawhon & Associates, Inc. (L&A) was contracted by South-Western City Schools to perform an indoor air quality (IAQ) assessment within Buckeye Woods Elementary School located at 2525 Holton Road in Grove City, Ohio. It is our understanding that occupants of the building continue to express concern regarding the air quality, specifically exposure to mold, upon return to the facility following the summer break. L&A completed IAQ studies at this school in 2016 to investigate similar concerns; the associated recommendations were implemented during the 2016-2017 school year and over the 2017 summer break.

To investigate current concerns, L&A performed a building-wide air quality assessment to document common indoor air quality contaminants and identify any unusual building conditions or occupant exposures. As part of this survey L&A completed a visual assessment of relevant physical conditions, documented general ventilation parameters and measured concentrations of airborne particulate, total volatile organic compounds (TVOCs) and non-culturable mold. L&A's findings, conclusions and recommendations are summarized in this document:

- 1. Building Conditions.** L&A observed the following building conditions that have the potential to affect the air quality of comfort of the environment.
 - L&A noted particulate accumulation / suspect discoloration on supply air diffusers and return air vents in all areas assessed.
 - Return air vents obstructed by classroom materials and/or furnishings. This can reduce fresh air ventilation rates necessary to maintain acceptable air quality.
 - Significant amounts of loose, stored materials, primarily books, paper and other teaching aids were noted in Rooms. If not routinely sorted and/or cleaned, these areas can become particulate/allergen reservoirs.
 - Live plants were observed in multiple rooms. Plants and the associated soil are the natural habitat of mold and other allergens.
 - Condensation was noted on windows in the modular classrooms. There was no evidence of water damage of fungal growth on adjacent building materials.

2. **Carbon Dioxide.** Carbon dioxide concentrations in the school ranged from 519 to 1,373 ppm. Although well below occupational exposure standards published by OSHA, NIOSH and ACGIH, CO₂ levels in the following locations were elevated when compared to guidelines published by ASHRAE (1,129 ppm) and USEPA (1,000 ppm)
 - Room 303 (1,373 ppm)
 - Modular 703 (1,113 ppm)

Both of these classrooms had a large volume of children in the room at the time of testing. These findings indicate that adequate amounts of fresh air are being supplied to the building to effectively ventilate occupied areas under normal occupancy rates.

3. **Carbon Monoxide.** Carbon monoxide concentrations ranged from not detected to 0.4 ppm. Exposures to CO were below ambient air quality standards mandated by the USEPA (9 ppm) and occupational safety and health standards published by ACGIH (25 ppm) and OSHA (50 ppm). These findings indicate combustion appliances are properly exhausted and the space is appropriately ventilated to control exposures to CO.
4. **Temperature.** Indoor temperatures in the building ranged from 54.8 to 75.5°F in the building; temperatures in the modular classrooms ranged from 54.8 to 72.5°F. Temperatures were within ASHRAE guidelines for cooling season (73-81°F) in the main school building. Readings in the modular units were below the lower limit prescribed, however this may be attributable to early morning hours and/or occupant set points. L&A will document temperatures in modular classrooms in September 2017 to verify conditions are attributable to sampling time.
5. **Relative Humidity.** Relative humidity levels averaged from 48.5 to 59.4% in the areas tested. Readings were comparable to the ranges specified by ASHRAE for summer months (20 - 60%) to maintain thermal comfort and below the range (>70%) that would create conditions favorable to the growth of mold on surfaces in the absence of active water leaks. Although, above the range specified by USEPA to minimize air quality concerns, this condition is common during summer months in Central Ohio, as interior relative humidity levels will be influenced by outdoor conditions (humidity ranged from 28.4% to 67.9% during the sampling events).
6. **Airborne Particulate.** Airborne particulate matter can be comprised of inorganic compounds (gypsum, fiberglass, and metals), microbial contaminants and other organic dust and debris. Airborne particle concentrations are a useful measure of the effectiveness of HVAC filtration systems and housekeeping/maintenance practices in removing particulate from air and surfaces indoors. As part of this assessment, L&A documented respirable (PM_{2.5}) and inhalable (PM₁₀) particulate levels in the building to evaluate occupant exposures. Concentrations of ≥0.5 micron particulate were also measured to evaluate the performance of the HVAC system.
 - a. Respirable Particulate (PM_{2.5}). Respirable particles, which can penetrate deep into the gas exchange region of the lungs, are defined as those with a mean diameter less than 2.5 microns (PM_{2.5}). PM_{2.5} concentrations ranged from 5 to 24 µg/m³ in the building. The levels recorded were well below the USEPA National Ambient Air Quality 24-Hour Standard (35 µg/m³). However, levels in Room 502 and Room 503 were above ranges detected outdoors on this date (15 - 23 µg/m³). Per L&A's recommendation, SWCS cleaned horizontal surfaces, replaced HVAC filtration media and installed MERV 8 temporary filters at supply

air vents. The latter will remain in place through September to capture any residual particulate that may remain from duct cleaning activities as the HVAC systems transition from cooling to heating functions.

- b. **Inhalable Particulate (PM10).** Inhalable particles, which can be inhaled and settle into the upper airways, are defined as particles with a mean diameter less than 10 microns (PM10). PM10 concentrations in the building also ranged from 5 to 24 $\mu\text{g}/\text{m}^3$. The levels recorded were well below the USEPA National Ambient Air Quality 24-Hour Standard (150 $\mu\text{g}/\text{m}^3$) and the USGBC guideline (50 $\mu\text{g}/\text{m}^3$) for newly constructed buildings. Inhalable particulate levels in Room 502 and Room 503 were above the outdoor average, but within ranges detected outdoors on this date (15 - 23 $\mu\text{g}/\text{m}^3$). As stated previously, SWCS took corrective action to reduce airborne particulate concentrations in these classrooms.
7. **Total Volatile Organic Compounds.** TVOC concentrations in the building ranged from 0 to 79 $\mu\text{g}/\text{m}^3$. TVOC levels in all locations sampled were well below the USGBC guideline of 500 ppm and the State of Washington guideline of 200 – 500 ppm.
8. **Non-Culturable Mold.** Airborne mold concentrations in the building ranged from 14 spores/ m^3 to 30,723 spores/ m^3 . There were three rooms – Mrs. Bennett’s Office (outside Room 103), Room 103 and Room 207 – that had significantly elevated concentrations of *Aspergillus/Penicillium* spores when compared to historical data for this geographical area.

There were also six classrooms (Room 104, Room 107, Room 200, Room 204, Room 206 and Room 501) where *Aspergillus/Penicillium* concentrations were within ranges occupants could encounter outdoors, but were notably higher than other rooms in the building. Given there was minimal surface growth observed during the walkthrough, it was L&A’s professional opinion that the source of these spores was mold-laden dust in the rooms or the HVAC systems that service these areas.

Immediately upon receipt of the results L&A notified SWCS personnel and provided the following recommendations to reduce airborne mold concentrations:

- Replace the filter media for the air handling units servicing these spaces.
- Remove particulate accumulation from supply air diffusers and return air vents.
- Install MERV 8 filter media over supply air diffusers.
- Clean horizontal surfaces using HEPA vacuums and/or a detergent solution.

These corrective actions were implemented in the aforementioned nine classrooms, as well as Rooms 502 and Rooms 503 where PM2.5/PM10 levels exceeded outdoor concentrations, between August 28, 2017 and August 31, 2017. L&A returned to the site on August 29, 2017 and September 1, 2017 to validate corrective actions effectively reduced airborne concentrations of this mold. The results are summarized in the following table:

Location	<i>Aspergillus/Penicillium</i> Concentration (spores/ m^3)	
	Baseline Assessment	Post-Cleaning
Office at Room 103	3,724	182
Room 103	12,104	91
Room 104	1,841	49
Room 107	2,121	21
Room 200	2,023	28

Room 204	1,841	63
Room 206	2,184	119
Room 207	30,723	518
Room 501	1,414	None detected
Room 502	77	None detected
Room 503	245	None detected

As illustrated above, analytical data indicate airborne concentrations of *Aspergillus/Penicillium* were significantly reduced following the completion of this work and well within ranges occupants would encounter outdoors in Central Ohio. Furthermore, the types and concentrations of all other fungal species on this date and identified during the August 25, 2017 sampling event were comparable to levels outdoors at the site and historical data for this geographical area.

In summary, concentrations of carbon dioxide, carbon monoxide, temperature, relative humidity, respirable particulate (PM2.5), inhalable particulate (PM10), total volatile organic compounds and non-culturable mold were within occupational safety and health standards and indoor air quality guidelines after the implementation of recommended corrective actions. L&A has recommended the temporary filter media at supply air vents remain in place through September to capture any residual particulate that may remain from duct cleaning activities as the HVAC systems transition from cooling to heating functions; these locations will be resampled following their removal at the end of September 2017 to validate airborne mold concentrations remain at acceptable levels.

CLOSURE

L&A has prepared this report in accordance with generally accepted inspection and testing practices. The information obtained in this report is site, data and time specific and pertains to this project only. The opinions expressed in this report are based on L&A's experience and available information. This inspection evaluated the conditions that existed at the time of the investigation of the subject property and does not warrant against future alteration of conditions at the subject site or subsequent changes in regulations. In summary, there are no unusual conditions or exposures that would explain the health effects reported by occupants.

This report was prepared for the exclusive use of South Western City Schools. No other party may rely on this report unless expressly designated by the Client and L&A in writing. The use of the report is subject to the limitations and exceptions set forth in this report, as well as the terms and conditions contained in the original contract documents. L&A will not distribute or publish this report without the Client's consent, except as required by law or court order.

Thank you once again for allowing Lawhon & Associates, Inc. to assist you in this important matter. If you have any questions concerning this document, please contact Ms. Karrie Bontrager at (614) 481-8600, ext.136.

Sincerely,



Karrie A. Bontrager, LEED AP
Principal, Director of Environmental Services