

# **INDOOR AIR QUALITY ASSESSMENT**

**Swanson Road Intermediate School  
10 Swanson Road  
Auburn, MA**



Prepared by:  
Massachusetts Department of Public Health  
Bureau of Environmental Health  
Indoor Air Quality Program  
July 2016

## Background

<b>Building:</b>	Swanson Road Intermediate School
<b>Address:</b>	10 Swanson Road, Auburn, MA
<b>Assessment Requested by:</b>	Joe Fahey, Facilities Director, Auburn Public Schools
<b>Reason for Request:</b>	Health concerns and general indoor air quality (IAQ) concerns
<b>Date of Assessment:</b>	June 2, 2016
<b>Massachusetts Department of Public Health/Bureau of Environmental Health (MDPH/BEH) Staff Conducting Assessment:</b>	Ruth Alfasso, Environmental Engineer/Inspector and Cory Holmes, Environmental Analyst/Inspector, IAQ Program
<b>Date of Building Construction:</b>	1959, with additions in 1972 and 1998 and a renovation in 2014
<b>Building Description:</b>	Originally the Swanson Road Intermediate School, starting in fall of 2015 it houses elementary school students. The building is two-story brick construction with flat roofs.
<b>Building Population:</b>	550 students in grades 1 through 5 with a staff of approximately 60
<b>Windows:</b>	Mostly openable

## METHODS

Please refer to the IAQ Manual for methods, sampling procedures, and interpretation of results (MDPH, 2015).

## IAQ Testing Results

The following is a summary of indoor air testing results (Table 1).

- *Carbon dioxide levels* were above 800 parts per million (ppm) in 37 of 52 areas surveyed, indicating a lack of air exchange in two-thirds of the areas tested.
- *Temperature* was within the recommended range of 70°F to 78°F in all but one of the areas tested; one reading in an unoccupied modular classroom was 69°F.

- *Relative humidity* was within the recommended range of 40 to 60% in all but one of the areas tested.
- *Carbon monoxide* levels were non-detectable in all indoor areas tested.
- *Fine particulate matter (PM2.5)* concentrations measured were below the National Ambient Air Quality Standard (NAAQS) level of 35 µg/m<sup>3</sup> in approximately 80 percent of areas tested. Note that outdoor levels were measured at 31, which is close to the NAAQS levels.

This sampling indicates that the ventilation system in the building could provide more fresh air and filtration in most classrooms.

### **Ventilation**

A heating, ventilating and air conditioning (HVAC) system has several functions. First it provides heating and, if equipped, cooling. Second, it is a source of fresh air. Finally, an HVAC system will dilute and remove normally occurring indoor environmental pollutants by not only introducing fresh air, but by filtering the airstream and ejecting stale air to the outdoors via exhaust ventilation. Even if an HVAC system is operating as designed, point sources of respiratory irritation may exist and cause symptoms in sensitive individuals. The following analysis examines and identifies components of the HVAC system and likely sources of respiratory irritant/allergen exposure due to water damage, aerosolized dust and/or chemicals found in the indoor environment.

Fresh air is provided by a combination of unit ventilators (univents) located in individual classrooms along the outside wall (Picture 1) and air handling units (AHUs), which serve central areas. Unit ventilators draw fresh air through a vent on the exterior wall (Picture 2). Air is mixed with return air from the room, filtered, heated (if needed) and delivered back to the room. Air from the AHUs is filtered, heated/cooled and delivered to rooms via ducted supply vents (Picture 3). Most univents were off at the time of the visit, reducing the amount of fresh air being delivered to classrooms, and many were blocked on top or in front by items and furniture (Picture 4).

Note that the univents in each section of the building are original equipment, dating from 1959 and 1972, which makes them over 55 and over 40 years old respectively. Function of equipment of this age is difficult to maintain, since compatible replacement parts are often

unavailable. According to the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), the service life<sup>1</sup> for a unit heater, hot water or steam is 20 years, assuming routine maintenance of the equipment (ASHRAE, 1991). Despite attempts to maintain the univents, the operational lifespan of the equipment has been exceeded. Maintaining the balance of fresh air to exhaust air will become more difficult as the equipment ages and as replacement parts become increasingly difficult to obtain. Note that univents installed during the 1998 renovation are also approaching 20 years old.

It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). It was reported that systems in this building were last balanced in March of 2016.

Exhaust vents are located on the walls or ceilings of classrooms and offices (Picture 5) and are ducted to fans on the roof. Additional exhaust vents are located in toilet rooms and other areas. While all classroom exhaust vents checked were operational, many were blocked by furniture and items (Picture 6), reducing the ability of the exhaust system to remove stale air. Some restroom exhaust vents were examined and weak or no draw from them was observed; motors, belts and power for these should be examined/repared to ensure they are operational.

The AHU provides cooling as well as heating to areas it serves. Cooling in areas with univents is provided by ductless air conditioning units hung on walls (Picture 7). These units are connected to heat pumps using chilled refrigerant to provide cooling during the warmer months, and can also provide heating during the colder months.

### **Microbial/Moisture Concerns**

Stained ceiling tiles were observed in a few areas (Table 1). Some of the observed stained tiles were from roof leaks that have reportedly been repaired. Leaks were reported from windows/window areas in a few classrooms. No water staining or damaged materials were observed in these areas at the time of the visit. Leaks should be reported promptly to building maintenance staff to ensure they can be repaired and materials can be dried. The US EPA and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2008;

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<sup>1</sup> The service life is the median time during which a particular system or component of ...[an HVAC]... system remains in its original service application and then is replaced. Replacement may occur for any reason, including, but not limited to, failure, general obsolescence, reduced reliability, excessive maintenance cost, and changed system requirements due to such influences as building characteristics or energy prices (ASHRAE, 1991).

ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed and discarded.

Ductless air conditioners have condensate drains. Most of these are directed outside and drain by gravity, but some had pumps. These units should be checked periodically to ensure drainage hoses are intact, not clogged, and that pumps are operational to prevent stagnant water and leaks. A classroom sink had a gap in the backsplash (Picture 8; Table 1), which can allow for moistening of the wood material and potential microbial growth.

In the basement area, former locker rooms had been converted to occupied space. There are unused toilets in this area that could create stagnant water conditions that may lead to odors or pests. Floor drains are also present that can allow sewer gases into occupied spaces if not periodically moistened.

Plants were observed in a few areas including on univents (Picture 9; Table 1). Plants can be a source of pollen and mold, which can be respiratory irritants to some individuals. Plants should be properly maintained and equipped with drip pans and should be located away from air diffusers to prevent the aerosolization of dirt, pollen and mold.

There were several refrigerators in the building, and one was found to have mold on the gasket (Picture 10). Refrigerators should be cleaned regularly to prevent microbial growth and odors.

The outside of the building was examined for conditions that may impact IAQ. A bush was noted along the outside of the building (Picture 11) and some trees/shrubs in the courtyard were close to the foundation and overhanging the roof (Picture 12). Plants close to the exterior can prevent walls from drying and lead to drainage problems/deterioration of the building envelope. When near air intakes, they can also be a source of odors, pollen and debris to the inside of the building.

Some downspouts were missing or damaged (Picture 13), which can allow water to accumulate against the foundation. The north (shady) side of the building had moss/mold staining (Picture 14) that should be cleaned. The courtyard has a small water feature. These can be difficult to maintain and lead to stagnant water, odors, and pests including mosquitoes.

The vinyl skirting of the modular classrooms was damaged in several areas (Pictures 15 and 16) that could allow harborage for pests. Some exterior doors were missing weather-stripping (Table 1), which can allow moisture, unconditioned air and pests into the building.

## **Other IAQ Evaluations**

### *Particulate Matter*

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter includes airborne solids that can be irritating to the eyes, nose and throat. This PM2.5 standard requires outdoor air particle levels be maintained below 35  $\mu\text{g}/\text{m}^3$  over a 24-hour average (US EPA, 2006). As mentioned, outdoor PM2.5 concentrations were measured at 31  $\mu\text{g}/\text{m}^3$  (Table 1). PM2.5 levels indoors ranged from 5 to 66  $\mu\text{g}/\text{m}^3$  (Table 1), which were above the NAAQS PM2.5 level of 35  $\mu\text{g}/\text{m}^3$  in approximately 20% of the areas tested, most likely due to classroom activities, outside conditions and lack of ventilation/filtration. Carpeting in classrooms (Table 1) may contribute to elevated particulate levels in some areas. The usable life of carpeting is approximately 10-11 years (IICRC, 2002) and carpeting older than that may contribute particulates to the indoor environment due to wearing of fibers. Carpeting, including wall-to-wall and area rugs, also should be cleaned annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC, 2012). Plush and upholstered items should also be cleaned regularly. Carpeting, area rugs and plush/upholstered items that are worn and/or have become hard to clean should be discarded.

Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of activities that occur indoors and/or mechanical devices can generate particulate matter during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of stoves and/or microwave ovens in kitchen areas; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

## *TVOCs*

Exposure to low levels of total volatile organic compounds (TVOCs) may produce eye, nose, throat, and/or respiratory irritation in some sensitive individuals. To determine if VOCs were present, BEH/IAQ staff examined rooms for products containing VOCs. BEH/IAQ staff noted air fresheners, hand sanitizers, cleaners, and dry erase materials in use within the building (Table 1). All of these products have the potential to be irritants to the eyes, nose, throat, and respiratory system of sensitive individuals.

Laminators and copy machines were observed in several areas (Table 1). These can emit odors and VOCs, and copy machines can also emit ozone, which is a respiratory irritant. When possible, they should be placed in areas with direct-vented exhaust to remove the pollutants generated during operation.

A kiln in the art room had no exhaust ventilation and was located directly inside the classroom. Exhaust ventilation for kilns is necessary to remove heat and odors during operation. Consider installing a direct exhaust vent for the kiln and ensure it is used every time the kiln is in operation.

Additionally, no exhaust ventilation was observed in janitorial closets, which contain mops and cleaning chemicals, which can be sources of odors. Janitorial closets also had missing ceiling tiles (Picture 17) that can allow odors from the closets to traverse into occupied spaces. Missing/ajar tiles were also observed in occupied areas; tiles should be replaced flush with the ceilings to provide a barrier to dusts and odors between areas.

Filters were examined from a univent (Picture 18). It appeared recently changed/clean and well-fitted, but of a mesh type that provides minimal filtration. A pleated filter with a Minimum Efficiency Reporting Value (MERV) value of at least 9 is recommended. Because of the age of the univents, use of a higher-efficiency filter may reduce flow or cause mechanical stress, so univents should be evaluated to ensure higher-efficiency filters can be used. Filters should be changed 2 to 4 times a year. Having univents turned on and equipped with good filtration should help reduce levels of particulate matter in the building.

Some personal fans, supply and exhaust vents were observed to be dusty (Picture 19; Table 1). Univent cabinets had dust and debris in them as well (Table 1). In some areas, items were observed on the floor, windowsills, tabletops, counters, bookcases, and desks (e.g., Picture 3; Table 1). The numerous items/irregular surfaces make it difficult for custodial staff to clean.

## **Conclusions/Recommendations**

Based on observations made at the time of the assessment, the following recommendations are made:

1. Operate supply and exhaust ventilation in all areas during occupied periods. During temperate weather, use windows to supplement fresh air. Ensure all windows are closed at the end of the day and during the cooling season/AC operation.
2. Work with building occupants to resolve comfort/noise concerns without reducing fresh air supply (e.g., repairing noisy univents, relocating desks away from vents).
3. Remove blockages from the top and front of univents and from exhaust vents.
4. Consider plans for overhaul or replacement of univents that are at/near the end of their useful life.
5. Have the HVAC system balanced every 5 years in accordance with SMACNA recommendations.
6. Install a direct-vented exhaust for the kiln and ensure it is used whenever the kiln is on and until the cycle has finished/kiln cooled down. Operate the kiln only when the classroom in which it is located is not occupied.
7. Consider installing direct vented exhaust in other areas where odors and pollutants may be generated such as copy/lamination rooms and janitorial closets.
8. Replace stained ceiling tiles. Monitor areas for leaks.
9. Ensure that procedures are in place for occupants to report leaks, wet tiles, and other maintenance conditions so that they can be logged and repaired promptly.
10. Monitor ductless air conditioning condensate drains to ensure they do not have clogs or standing water and that pumps are operational.
11. Repair sink backsplashes to render them watertight. Refrain from storing porous or significant amounts of materials under sinks.
12. Pour water down unused drain traps and flush unused toilets periodically to prevent stagnant water and dry drain traps. Consider removing unwanted fixtures and properly capping unused drains.
13. Keep plants in good condition, avoid overwatering, and remove from the airstream of univents and other air sources.

14. Ensure refrigerators are cleaned out regularly and that spills are cleaned promptly to prevent odors. Clean stained gaskets with an antimicrobial solution or, if they cannot be cleaned, replace.
15. Remove plants to about five feet away from exterior walls/foundation, including in the courtyard.
16. Clean moss from the south side of the building.
17. Consider removing the water feature in the courtyard.
18. Repair any breaks in the skirt/undercarriage of the modular classrooms to exclude pests.
19. Repair/replace weather-stripping on exterior doors and monitor for light and drafts.
20. Reduce the use of cleaning products, sanitizers, air fresheners, and other products containing VOCs. Use only school-issued products, ensure they are properly labeled, and keep material safety sheets on file for each product at the school.
21. Ensure the ceiling tile system is intact with all tiles in place to prevent migration of dusts and odors to occupied areas.
22. Change filters regularly in univents (2 to 4 times a year), and vacuum the cabinets of debris each time the filters are changed. Consider upgrading to a MERV 9 filter if current univents are capable of operating with the higher-efficiency filters.
23. Clean supply and exhaust vents and personal fans regularly to prevent aerosolization of debris.
24. Clean carpeting, area rugs and plush/upholstered items regularly in accordance with IICRC recommendations (IICRC 2012). If carpeting is too old and worn to be effectively cleaned, consider replacement.
25. Consider reducing the amount of items stored in classrooms to make cleaning easier. Periodically move items to clean flat surfaces.
26. Consider adopting the US EPA (2000) document, “Tools for Schools”, as an instrument for maintaining a good IAQ environment in the building. This document is available at: <http://www.epa.gov/iaq/schools/index.html>.
27. Refer to resource manual and other related IAQ documents located on the MDPH’s website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: <http://mass.gov/dph/iaq>.

## References

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- US EPA. 2008. “Mold Remediation in Schools and Commercial Buildings”. Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. September 2008. Available at: <http://www.epa.gov/mold/mold-remediation-schools-and-commercial-buildings-guide>.

**Picture 1**



**Unit ventilator (univent)**

**Picture 2**



**Univent fresh air intake**

**Picture 3**



**Typical supply vent**

**Picture 4**



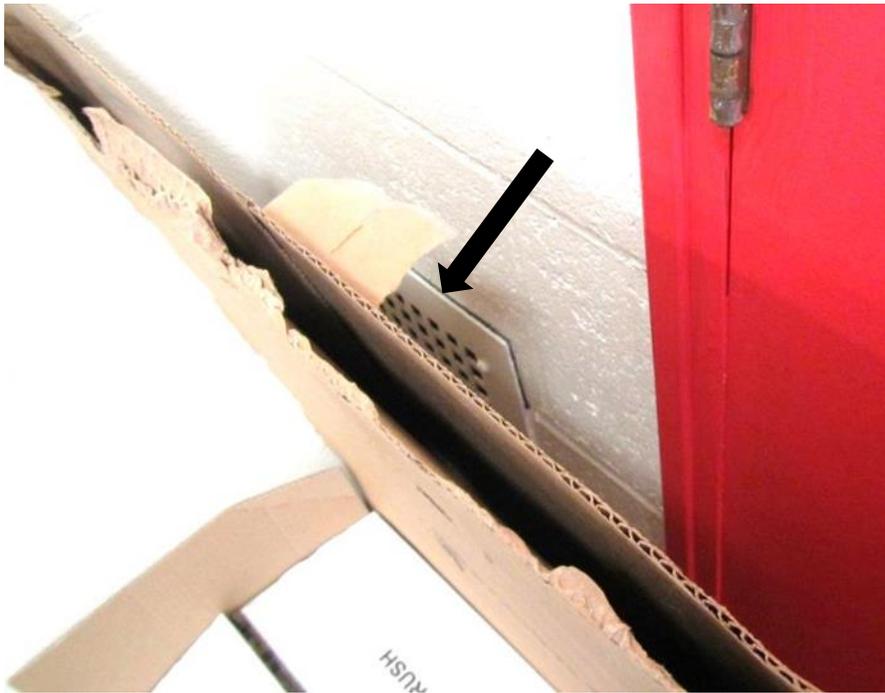
**Top of univent blocked by items**

**Picture 5**



**Ceiling-mounted exhaust vent in classroom**

**Picture 6**



**Wall-mounted exhaust vent (arrow) blocked by cardboard**

**Picture 7**



**Wall-mounted ductless air conditioning unit**

**Picture 8**



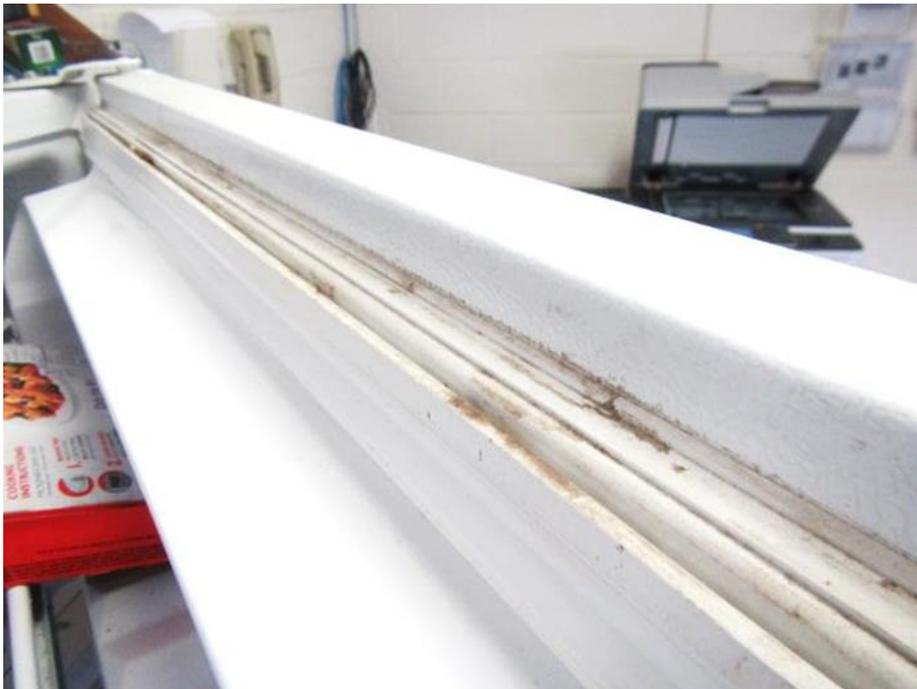
**Damaged sink backsplash**

**Picture 9**



**Plants on univent**

**Picture 10**



**Stained refrigerator gasket**

**Picture 11**



**Shrub near side of building**

**Picture 12**



**Plants and trees in the courtyard**

**Picture 13**



**Broken downspouts and siding**

**Picture 14**



**Moss/mold accumulations on north side of modular building**

**Picture 15**



**Deterioration at base of modular classroom**

**Picture 16**



**Hole/potential harborage under skirt of modular classroom**

**Picture 17**



**Missing tiles in janitorial closet**

**Picture 18**



**Mesh-type univalent filter**

**Picture 19**



**Dusty fan**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m <sup>3</sup> )	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background	421	0.6	65	56	31					Cloudy/foggy and cool
B 108	524	ND	73	55	21	2	N	Y	Y	Former locker room, abandoned shower drain
Main Office	911	ND	73	54	16	0	Y	Y	Y	PC, carpet, laminator
Principal's Office	703	ND	73	54	27	2	Y	Y	Y	Carpet
Staff food and MDF area	599	ND	73	53	15	0	N	N	N	Fridge and toaster, MT, NC, AI
Custodial Closet										Mops, CP, MT/AT and holes in ceiling
Maintenance Office	503	ND	75	52	21	1	N	Y	Y	Toilets, fridge, NC, DEM
Nurse Suite	890	ND	73	56	12	4	Y	Y	Y	
Faculty Lounge	640	ND	72	57	16	7	Y	N	N	Restroom exhaust off, laminator, PC-no local exhaust vent

ppm = parts per million

µg/m<sup>3</sup> = micrograms per cubic meter

ND = non detect

AC = air conditioner

AF = air freshener

AI = accumulated items

AT = ajar tile

CP = cleaning products

CT = ceiling tile

DEM = dry erase materials

DO = door open

HS = hand sanitizer

MT = missing tiles

NC = not carpeted

PC = photocopier

PF = personal fan

UV = univent

WD = water-damaged

**Comfort Guidelines**

Carbon Dioxide: < 800 ppm = preferred  
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F  
Relative Humidity: 40 - 60%

Table 1 (continued)

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m <sup>3</sup> )	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Reception	615	ND	74	53	19	1	Y	Y	Y	
Assistant Principal	632	ND	73	53	16	0	N	Y	Y	Carpet
Auditorium	490	ND	73	51	13	0	N	Y	Y	Carpet, PF on
Gym 1	599	ND	73	52	23	3	N	Y	Y	
Gym 2	610	ND	73	53	25	0	n	Y	Y	
Courtyard										Plants and trees near windows, water feature
Cafeteria	683	ND	71	63	66	~200	Y	Y	Y	NC
101 A Science Storage							N	N	N	PF, door blocked open by items
102	1509	ND	74	59	14	23	Y	Y	Y	UV off

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								Supply	Exhaust	
103	1539	ND	73	58	13	21	Y	Y	Y	UV off, MT, WD CT
105	816	ND	73	57	14	7	Y	Y	Y	
108 Custodial Closet							N	N	N	No exhaust vent
109 Art	1053	ND	73	58	15	21	Y	Y	Y	UV off, kiln local exhaust not installed
110	915	ND	73	56	12	1	Y	Y	Y	UV off, exhaust obstructed, 23 occupants gone 20 mins, DO
112	1495	ND	74	58	20	23	Y	Y	Y	UV off
113	1079	ND	73	54	21	1 class just left	Y	Y	Y	2 ductless AC, half carpeted, DEM, CP, sink backsplash open, plant
114	905	ND	72	53	28	1 class just left	Y	Y	Y	Ductless AC, DEM, carpet, AI
115	914	ND	71	55	17	1	Y	Y	Y	Ductless AC, carpet, DEM

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								Supply	Exhaust	
116	1088	ND	72	58	37	18	Y	Y	Y	DEM, carpet, ductless AC
Reading Room	910	ND	72	53	26	1	Y	Y	Y	NC, DEM
118	1470	ND	73	58	31	18	Y	Y	Y	NC, DEM
Copy Room	870	ND	73	54	19	0	N	N	N	DO, carpet, PC, ductless AC
121	1321	ND	73	58	44	21	Y	Y	Y	Carpet, DEM, ductless AC
122	1178	ND	73	56	24	24	Y	Y	Y	PF, ductless AC, area rug
203	960	ND	73	54	13	27	Y	Y	Y	Spaces around exterior door, PF dusty
208 Modular	625	ND	72	56	7	2	Y	Y	Y	Dust/debris vents, WD CTs
209 Modular	643	ND	69	51	5	0	Y	Y	Y	Dust/debris vents, holes in CTs, WD CTs-painted

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								Supply	Exhaust	
210 Modular	588	ND	70	55	13	1	Y	Y	Y	Dusty vents, carpet (new), DEM
211 Music Modular	986	ND	70	50	11	0	Y	Y	Y	Dusty vents, DEM, carpet (new)
214	989	ND	73	58	14	5	Y	N	N	Window in inner office, DO
301	644	ND	72	53	44	22	Y	Y	Y	Carpet, UV obstructed
302	960	ND	72	58	23	25	Y	Y	Y	Carpet, DEM
305	1257	ND	73	57	18	0	Y	Y	Y	UV-off
Math	944	ND	72	55	42	2	Y	Y	Y	Ductless AC, carpet, DO
OTPT	945	ND	73	54	27	4	Y	Y	Y	Ductless AC, wall-mount exhaust vent, carpet
312	1112	ND	72	54	13	0	Y	N	N	Laminator, PC (2), no exhaust vent, refrigerator-moldy gasket

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313 Storage	1342	ND	74	50	21	0	N	N	N	AT/MT, NC, flashing light, communication equipment
314	1538	ND	72	57	14	25	Y	Y	Y	Exhaust vent obstructed by cabinet, UV-off
315	1822	ND	72	52	14	26	Y	Y	Y	Exhaust vent obstructed, DO, AF
317	1351	ND	73	55	39	21	Y	Y	Y	Ductless AC, carpet, DEM, plants, UV off
318	1714	ND	72	53	27	23	Y	Y	Y	Obstructed exhaust, 2 ductless AC units, NC, DEM, HS
319	1768	ND	73	54	36	21	Y	Y	Y	Obstructed exhaust, ductless AC, carpet, DEM
320	1358	ND	73	52	31	21	Y	Y	Y	Ductless AC, carpet, DO, HS, obstructed exhaust
321	1675	ND	74	56	55	21	Y	Y	Y	Ductless AC, plants on UV, carpet, concerns about allergies

ppm = parts per million

µg/m<sup>3</sup> = micrograms per cubic meter

ND = non detect

AC = air conditioner

AF = air freshener

AI = accumulated items

AT = ajar tile

CP = cleaning products

CT = ceiling tile

DEM = dry erase materials

DO = door open

HS = hand sanitizer

MT = missing tiles

NC = not carpeted

PC = photocopier

PF = personal fan

UV = univent

WD = water-damaged

**Comfort Guidelines**

Carbon Dioxide: < 800 ppm = preferred  
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F  
Relative Humidity: 40 - 60%

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m <sup>3</sup> )	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
322	1345	ND	74	54	71	20	Y	Y	Y	Plants, carpet, DO
323	1467	ND	73	57	45	21	Y	Y	Y	DEM, NC, DO, ductless AC
327	1120	ND	71	51	11	27	Y	Y	Y	Exhaust vent partially obstructed, UV-off, WD CTs
328	965	ND	71	50	13	25	Y	Y	Y	UV off, plug-in AF

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