INDOOR AIR QUALITY
POST-FLOODING ASSESSMENT

Massachusetts Department of Developmental Services
100 Cummings Center
Suite 150B
Beverly, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
January 2012

Background/Introduction

In response to a request from Martha Goldsmith, Director of Leasing, Division of Capital Asset Management (DCAM) and Roger Tremblay, Human Resources Director, Office of Disabilities and Community Services, Executive Office of Health and Human Services (EOHHS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted indoor air quality (IAQ) testing at the Massachusetts Department of Developmental Services (DDS) area office located at 100 Cummings Center, Suite 150B, Beverly, Massachusetts. The office experienced storm-related flooding on October 4, 2011. On October 12, a visit to examine the flood remediation efforts was made by Cory Holmes, Environmental Analyst/Regional Inspector and Ruth Alfasso, Environmental Engineer/Inspector in BEH's IAQ Program. On October 27, 2011, Ms. Alfasso revisited the DDS office to conduct IAQ testing.

The DDS is located in the Cummings Center, which is a large office building complex that was originally built as a shoe machine manufacturing facility in the early 1900s. It was opened to its current use in the mid 1990s. The complex currently houses over 500 tenants in a variety of subdivided spaces. Current use of the space includes medical offices, spa/cosmetic salons, restaurants, other retail, business offices and research and development uses. The DDS office has approximately 10,000 square feet of space located along the eastern edge of the 100 Cummings Center building. The DDS space contains offices, open plan cubicles, conference/meeting rooms, and storage space for files and materials. Windows, found only along the eastern side of the office, are openable.

During the course of a few hours in the early morning of October 4, 2011, two and a half inches of rain fell in the North Shore region (Weather Underground, 2011). Flood water

reportedly infiltrated the entire 100 Cummings Center building to a depth of at least several inches, damaging nearly all the office space on the first floor. The occupants of the DDS office were relocated while their office space was remediated. During the October 12, 2011 visit, BEH staff observed the extent of removal of water-damaged wallboard, carpeting and other materials from the office. Wallboard was removed and replaced to a height of about 18 inches, well above the extent of the water damage and all the carpeting had been removed. By the time of the October 27, 2011 visit, remediation had been completed; the occupants had returned to the space only three days beforehand.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. BEH staff also performed visual inspection of building materials for water damage and/or microbial growth and for any other concerns regarding the flood remediation effort.

Results

Approximately 50 people work in the DDS office with up to 100 people visiting each day. The tests were taken during normal operations although unpacking activities were still in progress at the time of the BEH inspection. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all areas indicating optimal air exchange at the time of testing (Table 1). Mechanical ventilation is provided by a heating, ventilation and air conditioning (HVAC) system. Fresh air is drawn through a vent on the exterior of the building. Ductwork connects the air handling unit (AHU) to ceiling-mounted supply diffusers (Picture 1). By design, diffusers are equipped with fixed louvers that direct air along the ceiling to flow down the walls and create airflow. Air returns to the AHU through ceiling-mounted return vents via ductwork (Picture 2). Additional exhaust ventilation is provided in bathrooms, via vents activated when the bathroom light is on.

The HVAC system is controlled via wall-mounted thermostats located around the office (Picture 3). The thermostats examined at the DDS office were set in the *on* position which is the MDPH recommended setting to provide continuous air circulation.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of last balancing of the HVAC system was not available during the visit.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied.

Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

Indoor temperatures ranged from 69º F to 73º F, which were within or very close to the MDPH recommended comfort range (Table 1); the two readings below 70º F were in the computer server room (which has a separate air conditioning unit) and the closed/locked library room. The MDPH recommends that indoor air temperatures be maintained in a range of 70º F to 78º F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 33 to 46 percent (Table 1). With one exception (the computer room) relative humidity levels were within the MDPH recommended comfort range or slightly below (i.e. 39 percent) during the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

In order to support microbial growth, a source of water exposure is necessary. Remediation efforts in response to the flood appeared to have been thorough, and no remaining water-damaged wallboard, carpeting, ceiling tiles or other materials were noted during the MDPH visits. Materials that had been removed from and returned to the space, including files, books and personal items were examined for signs of water damage, and no visible signs or musty odors were noted from any of these materials. Most furniture and cubicle dividers were reported to be newly acquired since the flood remediation.

A window was found to be damaged in office 2 (i.e., it would not close completely). The occupant reported that this was a new condition and that the window had possibly been damaged during flood-related remediation activities. The outside east edge of the building near the DDS office was examined for breaches and potential water infiltration sources and none were observed; flooding had occurred down the interior hallway and not through windows into the DDS office.

The faucet in the kitchen/break room sink was dripping at the time of the inspection. No water leaks were noted underneath the sink and the backsplash behind the sink was intact and sealed. Water leaks from plumbing can provide a source of moisture for building materials and should be repaired promptly. Plants were noted in a few areas (Table 1). Overwatering of plants or keeping plants on porous materials can also provide a medium for mold growth and attract pests. Plants should be kept on washable non-porous drip pans, and the drip pans should be cleaned regularly.

The US Environmental Protection Agency (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, 2001; ACGIH, 1989). If 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.

Other Indoor Air Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor, and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the building environment, BEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health effects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect (ND) the day of the assessment (Table 1). No

measureable levels of carbon monoxide were detected in the building during the assessment (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

The outdoor PM2.5 concentration was measured at 5 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 7 to 32 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. The highest level was measured in the copy/mail room during continuous operation of a shredder. No exhaust vent was noted in the copy/mail room; additional exhaust ventilation can be helpful in areas which may produce particles, odors or other pollutants.

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 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.

Other Conditions

Several other conditions that can potentially affect indoor air quality were identified during the assessment. In a number of areas, items were observed on the floor, windowsills, tabletops, counters, bookcases and desks (Pictures 4 and 5). Many of these items were still being unpacked from boxes. The large number of items stored provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, dusts can accumulate on flat surfaces (e.g., desktops, windowsills and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation (Picture 6).

Most occupied areas of the office have wall-to-wall carpeting which was reported to be new. It was unknown if a regular carpet cleaning program is in place, apart from daily vacuuming. The Institute of Inspection, Cleaning and Restoration Certification (IICRC), recommends that carpeting be cleaned annually (or semi-annually in soiled high traffic areas) (IICRC, 2005).

A pipe of unknown use was found in one of the women's restrooms (Picture 7). Pipes or other breaches can provide a pathway for migration of odors and other pollutants from unconditioned areas to occupied areas. This pipe should be investigated to determine its purpose and/or ensure it is properly capped or removed.

New furnishings, carpeting and paint were present in all areas of the office. No significant odors related to these items were noted during the visit. However, furnishings, paint

and carpet may off-gas volatile organic compounds (VOCs) when they are new/newly applied. Ensuring continuous ventilation during and after paint or adhesive materials are applied will dilute these VOCs. Because construction activities continue in other parts of the Cummings Center, keeping the door closed to the DDS space will also help control migration of odors and dusts from these areas.

Conclusions/Recommendations

It appears that flooding remediation has been completed in a thorough manner and no ongoing problems relating to this event should be expected. In view of the findings at the time of the assessment, the following recommendations are made:

1. Continue operating the HVAC system in fan "on" mode during occupied hours to maximize air circulation and filtration.
2. Repair the leaking kitchen faucet and the broken window in office 2 to prevent any water infiltration and damage.
3. Use drip pans for plants and clean them regularly to prevent water damage and mold growth.
4. Determine the function and outlet for the pipe noted in the women's restroom and ensure it is properly capped or removed.
5. Consider adding exhaust ventilation to the copy/mail room to remove airborne pollutants/particulates caused by shredding and other activities.
6. Keep the front door to the office space closed to reduce impact from construction activities in other areas of the building.
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize

common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

8. Clean stored and personal items regularly to prevent excessive dust build-up.
9. Refrain from burning candles in building.
10. Clean carpeting annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC). Copies of the IICRC fact sheet can be downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)
11. While the conditions leading to the flood in 100 Cummings Center were unusual, another flooding event may occur in the future. It is advisable to keep items, particularly files and other important papers, off the floor as much as practical to prevent loss or damage due to another flood.
12. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH's website: http://mass.gov/dph/iaq.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air Conditioning Engineers. ANSI/ASHRAE 62-1989.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL.

IICRC. 2005. Carpet Cleaning FAQ 4 Institute of Inspection, Cleaning and Restoration Certification. Institute of Inspection Cleaning and Restoration, Vancouver, WA.

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2001. "Mold Remediation in Schools and Commercial Buildings". Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001. Available at: http://www.epa.gov/iaq/molds/mold_remediation.html

US EPA. 2006. National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html

Weather Underground, The. 2011. Weather History for Beverly, Massachusetts, October 4, 2011. Available at: http://www.wunderground.com/history/airport/KBVY/2011/10/4/DailyHistory.html?req_city=Beverly&req_state=MA&req_statename=Massachusetts

Picture 1

Ceiling-Mounted Supply Diffuser

Picture 2

Ceiling-Mounted Return Vent

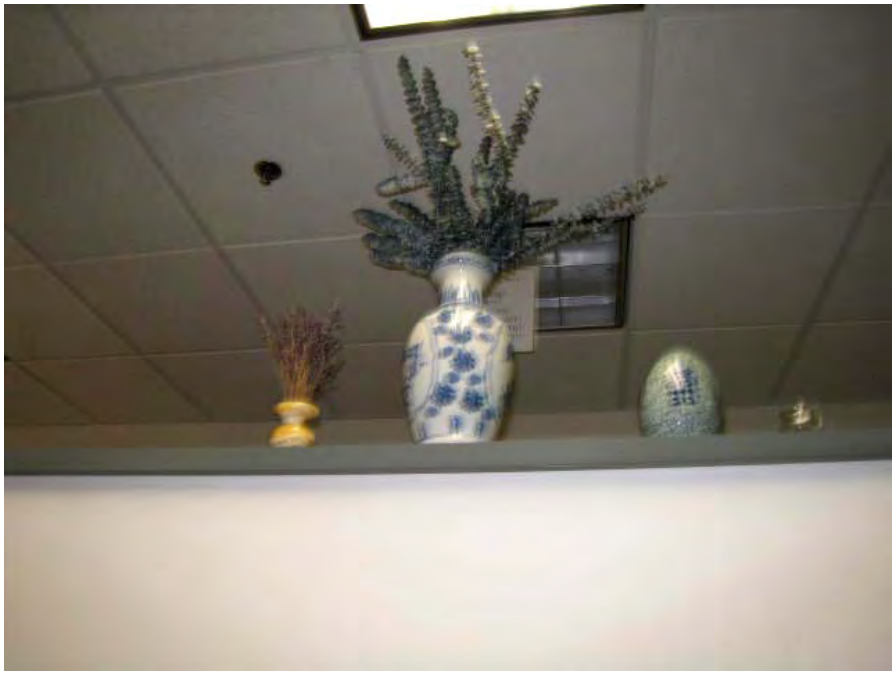
Picture 3

Thermostat, Fan set to "On" (arrow)

Picture 4

Still Packed Boxes and Items in Office

Picture 5



Decorative Items on Cubicle Divider

Picture 6

Dusty Bookshelf

Picture 7

Unknown Pipe in a Women's Restroom (Arrow)

Picture 8

Scented Candles

Location: Department of Developmental Services, Beverly Area Office **Indoor Air Results**

Address: 100 Cummings Center, Suite 150B

Table 1

Date: 10/27/2011

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m^3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background		55	40	389	ND	5				Rainy and cold, measurement taken in parking lot directly outside DDS office
4	1	71	42	649	ND	14	Y	Y	N	
5	0	71	41	615	ND	10	Y	Y	N	
7	0	72	39	559	ND	8	Y	Y	N	DO
8	0	71	40	556	ND	7	Y	Y	Y	
9	0	71	40	552	ND	7	N	Y	Y	PF
10	1	71	41	537	ND	7	N	Y	Y	
11	0	71	41	526	ND	7	N	Y	N	Room empty of furniture
13	1	71	42	737	ND	12	N	Y	N	

ppm = parts per million
µg/m^3 = micrograms per cubic meter
ND = non-detect

AC = air conditioner
AT = ajar ceiling tile
DEM = dry erase materials

DO = door open
HVAC = heating, ventilation and air conditioning
PC = photocopier

PF = personal fan

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

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

Location: Department of Developmental Services, Beverly Area Office **Indoor Air Results**

Address: 100 Cummings Center, Suite 150B **Date: 10/27/2011**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m^3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
14	0	71	41	673	ND	18	N	Y	N	
16	1	71	42	721	ND	21	N	Y	N	PF
17	0	72	41	551	ND		N	Y	N	Storage, dusty PF
18	0	72	41	585	ND	9-10	N	Y	N	Clutter, plants
19	0	72	41	558	ND	9-10	N	Y	N	
2	0	71	41	631	ND	11	Y (cracked open)	Y	N	Window seemed to be stuck/broken ajar
20	1	72	41	555	ND	9-10	N	Y	N	
21	2	72	41	574	ND	9	N	Y	N	
22	0	72	41	590	ND	8	N	Y	N	PF on

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Location: Department of Developmental Services, Beverly Area Office **Indoor Air Results**

Address: 100 Cummings Center, Suite 150B **Date: 10/27/2011**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m^3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
24	0	71	42	588	ND	10	N	Y	N	Scented candles on desk (cubicle not currently occupied)
25	0	71	41	585	ND	10	N	Y	N	
26	0	71	40	541	ND	9	N	Y	N	Office, sanitizer, candy on table
27	0	70	39	535	ND	8	N	Y	N	Empty and locked, HVAC fan noise
28	2	71	42	647	ND	9	N	Y	N	
31	1	72	39	624	ND	9	N	Y	N	
34	1	73	40	760	ND	10	N	Y	N	
35 fax/typing	0	73	39	718	ND	9	N	Y	N	Markers, items/paper

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Table 1 (continued)

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								Supply	Exhaust	
36	1	73	39	614	ND	10	N	Y	N	Clutter
37	1	73	39	605	ND	9	N	N	N	
38	2	73	39	634	ND	10	N	N	N	
39	0	71	41	567	ND	9	N	Y	N	Empty, HVAC fan noise
40	0	71	41	576	ND	9	N	Y	N	
41	0	71	40	590	ND	9	N	Y	N	Paper cutter in use here, dusty shelves
43	0	72	41	600	ND	9	N	Y	Y	
45/44	0	72	40	594	ND	10	N	Y	Y	
46	1	72	41	500	ND	9	N	Y	N	

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m^3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
47	0	72	40	592	ND	9	N	N	N	Curtain rod over entrance (no curtain at this time)
48	1	72	41	592	ND	9	N	Y	N	PF on
Break room/kitchen	0	71	41	522	ND	7	N	Y	N	AT, fridge, microwave, toasters, sink backsplash unitary (no break).
Conference room A	0	71	41	528	ND	9-10	N	Y	Y	Large room, contains stored furniture and files
Conference room B	2	70	46	539	ND	9	N	Y	N	Hand sanitizer dispenser, DEM
Conference room C	0	71	41	614	ND	8	Y	Y	N	DO
Copy/mail room	0	70	42	530	ND	9	Y	Y	N	PC, shredders Note that during shredder operations, PM2.5 measured 32 µg/m3.
Front file storage	0	72	42	560	ND	9-10	N	N	N	No odor, no water damage, one loose floor tile, shelves appear in good condition

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								Supply	Exhaust	
Library	0	69	41	594	ND	9	N	Y	N	Cleaning chemical, table fountain (not in use), books in boxes do not appear/smell water damaged
Reception area	0	71	42	539	ND	9	N	Y	Y	Next to door to hall, painting/plastering ongoing in hall
Server room	0	69	33	517	ND	7	N	Y	Y	Room has special AC, original flooring (floor tile)
Storage						10				No water damage, filing neat, no odors
Supply and fax area	0	71	40	574	ND	9	N	N	N	
Supply room						7				DEM, slight "new carpet" odor. no water-damaged materials/supplies noted
Women's restroom							N	N	Y	Exhaust only on when light is on, original floor tile, pipe in wall (see Picture 8)

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