INDOOR AIR QUALITY ASSESSMENT

New Bedford Health Department
1213 Purchase Street
New Bedford, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
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Background/Introduction

At the request of Marianne De Souza, Director of Public Health, New Bedford Health Department (NBHD), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality (IAQ) concerns at the NBHD office located at 1213 Purchase Street, New Bedford, Massachusetts. The request was prompted by employee symptoms (i.e., skin and respiratory irritation) believed to be associated with the building, primarily a newly-acquired file room/storage area where NBHD file cabinets are located. On November 3, 2011, a site visit was made by Cory Holmes, Environmental Analyst/Regional IAQ Inspector for BEH's IAQ Program.

The NBHD is located on the first floor of a three-story red brick building that was originally constructed in 1898 as a textile manufacturer. The NBHD space is made up of offices, conference rooms, clinical rooms, storage and common areas. The majority of areas have wooden floors and a suspended ceiling system; however some areas contain wall-to-wall carpeting and open ceilings. The first floor also houses the city of New Bedford Veteran's Office, which was included as part of the assessment. A limited number of windows are openable throughout the first floor.

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.

Results

The NBHD office has an employee population of 10 to 15; the Veteran's Office has approximately 5 employees. Both areas are visited by varying numbers of members of the public daily. The tests were taken during normal operations and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 ppm (parts per million) in all areas surveyed, indicating adequate air exchange throughout the space at the time of the assessment. The heating, ventilation and air conditioning (HVAC) system consists of rooftop air handling units (AHU) that draw in outside air through air intakes and distribute it to occupied areas via ductwork. Conditioned air is distributed via ceiling-mounted air diffusers (Picture 1) and ducted back to the AHU via return vents (Picture 2).

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 ventilation systems be re-balanced every five years to ensure

adequate air systems function (SMACNA, 1994). The date of the last balancing of the HVAC system was not available at the time of the assessment.

The Massachusetts Building Code requires that each area 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 Department of Public Health 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, please see Appendix A.

Temperatures ranged from 70^{o} F to 75^{o} F, which were within the MDPH recommended comfort range. The MDPH recommends that indoor air temperatures be maintained in a range of

70° F to 78° 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.

Relative humidity ranged from 35 to 42 percent, which were within or close to the lower end of the MDPH recommended comfort guidelines. The MDPH recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. 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

Water-damaged ceiling tiles were seen in several areas throughout the NBHD and Veterans Office (Pictures 3 through 5). Water-damaged ceiling tiles indicate leaks from either the roof or plumbing system and can provide a source for mold growth. Active leaks were reported in the 1st floor hallway outside of the NBHD. These tiles should be replaced after a water leak is discovered and repaired.

Other IAQ 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 indoor 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 Refrigeration 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. On the day of the assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). No measureable levels of carbon monoxide were detected inside 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.

Outdoor PM2.5 was measured at 25 $\mu g/m^3$ (Table 1). Indoor PM2.5 levels ranged from 12 to 15 $\mu g/m^3$ (Table 1). Both indoor and outdoor PM 2.5 levels were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be

at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur indoors 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

Other conditions that can affect indoor air quality were observed during the assessment. Light could be seen penetrating beneath exterior doors (Pictures 6 and 7). These spaces can provide access for rodents and insects to enter the building. To penetrate the exterior of a building, rodents require a minimal breach of ¼ inch (MDFA, 1996). Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine contains a protein that is a known sensitizer (US EPA, 1992).

Although the office contains a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner, the filter was completely occluded with dust and debris (Pictures 8 and 9). If not periodically cleaned or changed as per the manufacture's instructions, a saturated filter can actually serve as a reservoir for dirt, dust and debris to be reaerosolized into occupied areas. A number of supply diffusers and return vents were observed to have accumulated dust/debris (Picture 10). Dust can be irritating to the eyes, nose and respiratory tract.

Fluorescent light fixtures were missing covers in several areas including the medical supply office (Picture 11). Fixtures should be equipped with access covers installed with bulbs

fully secured in their sockets. Breakage of glass can cause injuries and may release mercury and/or other hazardous compounds.

Damaged and/or missing floor tiles were observed in the electrical room where the water heater is located (Pictures 12 and 13). These floor tiles may contain asbestos. Intact asbestos-containing materials (ACM) do not pose a health hazard. If damaged, ACM can be rendered friable and become aerosolized. Friable asbestos is a chronic (long-term) health hazard, but will not produce acute (short-term) health effects (e.g., headaches) typically associated with buildings believed to have indoor air quality problems. Where asbestos-containing materials are found damaged, these materials should be removed or remediated in a manner consistent with Massachusetts asbestos remediation laws (MDLI, 1993).

In several areas, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in offices and common areas 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, dust can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

Many of the floor surfaces are covered by wall-to-wall carpeting. It was not clear if the building had a carpet cleaning program in place. 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).

File/storeroom Conditions

The file/storeroom is located in an unfinished room outside of the NBHD office. The storeroom has interior wooden walls, an unfinished wooden floor and an open ceiling system (Pictures 14 through 15). Although ductwork traverses the room, there is no ventilation provided to this room. At the time of the assessment the floor was covered with dust/debris and appeared not to have been cleaned for some time. The room contains file cabinets and wall shelving with pamphlets, cardboard boxes, books and other materials. The amount of stored materials and lack of finish on the floor make it prone to dust/debris accumulation, which can be a source of eye and respiratory irritation. In addition, the hallway/adjacent areas outside of the file/storeroom had piles of accumulated dust and debris.

On the other side of the file/storeroom is a larger area that is also used for storage. This area was dirty/dusty and had exposed fiberglass insulation (Pictures 16 and 17), which can be a source of eye and respiratory irritation. Breaches in the wall separating these two areas were observed (Pictures 18 and 19). These breaches can serve as pathways for dirt, dust and other airborne pollutants into the file/storeroom.

To improve IAQ, NBHD staff have stationed an air purifier equipped with a high efficiency particulate arrestance (HEPA) filter in the storage room (Picture 20). However, because there is no outlet in this room the door is kept open to accommodate an extension cord. In this condition, the air purifier is actually drawing in airborne particulates into the storeroom through the open door (Picture 21). The previously mentioned breaches in walls and spaces around the door exacerbate this problem.

Conclusions/Recommendations

In view of the findings at the time of the assessment, recommendations to improve indoor air quality are separated into two categories; those specifically related to the storeroom and general IAQ recommendations for the remainder of NBHD and Veteran's Office space:

Storeroom

1. Clean file/storeroom regularly.
2. Install supply vent in file/storeroom. This will provide fresh/outside air to the space as well as positively pressurize the room, preventing the infiltration of dirt, dust and pollutants from adjacent areas.
3. Remove/discard out of date materials to reduce clutter. Obtain plastic storage totes to seal materials in.
4. Seal all wall penetrations and breaches between file/storeroom and adjacent areas with an appropriate fire-rated sealant. Ensure tightness of doors by monitoring for light penetration and drafts
5. Ensure door fits flush with threshold. Seal doors on all sides with foam tape and/or weather-stripping. Installing weather-stripping/door sweeps on bottom of door. Ensure tightness of doors by monitoring for light penetration and drafts around doorframes.
6. Install outlet to accommodate HEPA filter. Keep door shut during HEPA filter operation.
7. If preceding recommendations are not feasible or prove ineffective, consider relocating frequently accessed file cabinets within the NBHD office space.

NBHD and Veteran's Office

1. Ensure leaks are repaired and remove/replace water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
2. Eliminate spaces around exterior doors. Ensure door fits flush with threshold. Seal doors on all sides with foam tape and/or weather-stripping. Ensure tightness of doors by monitoring for light penetration and drafts around doorframes.
3. Clean/change filters for vacuum cleaner as per the manufacturer's instructions or more frequently if needed. If filters cannot be adequately cleaned/maintained consider replacing vacuum.
4. 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 HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
5. Clean supply diffusers and return vents periodically of accumulated dust/debris.
6. Relocate or consider reducing the amount of stored materials to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
7. 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).

8. Contact a licensed asbestos remediation firm to determine if damaged floor tiles in the electrical room contain ACM. Remediate damaged ACMs in conformance with Massachusetts asbestos remediation and hazardous waste disposal laws and regulations.
9. Replace all covers for fluorescent light fixtures.
10. 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://www.mass.gov/dph/iaq.

References

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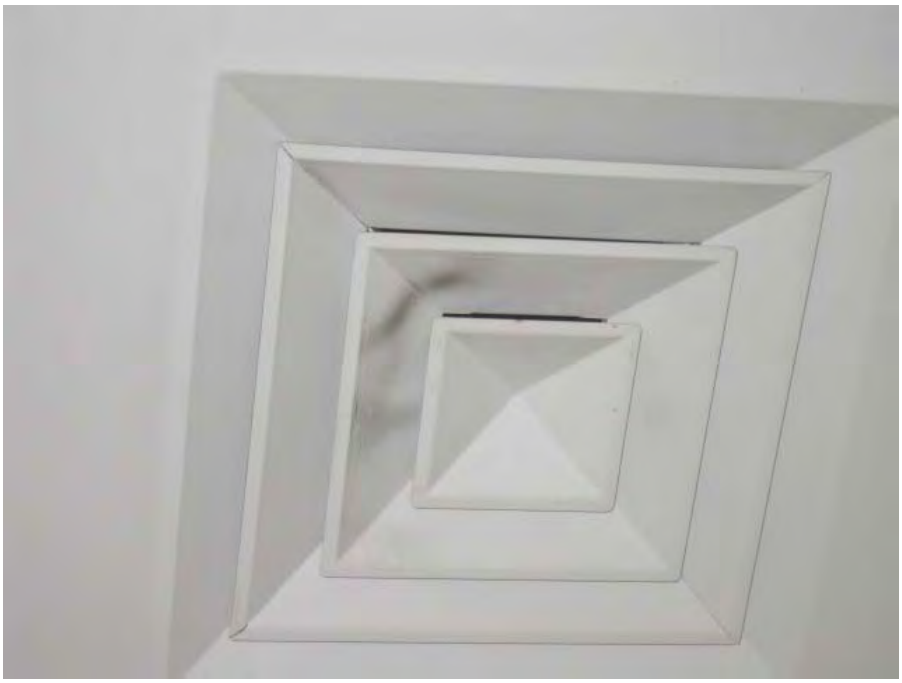
Picture 1



Ceiling-Mounted Supply Diffuser

Picture 2

Ceiling-Mounted Return Vent

Picture 3

Water-Damaged Ceiling Tiles

Picture 4

Water-Damaged Ceiling Tiles

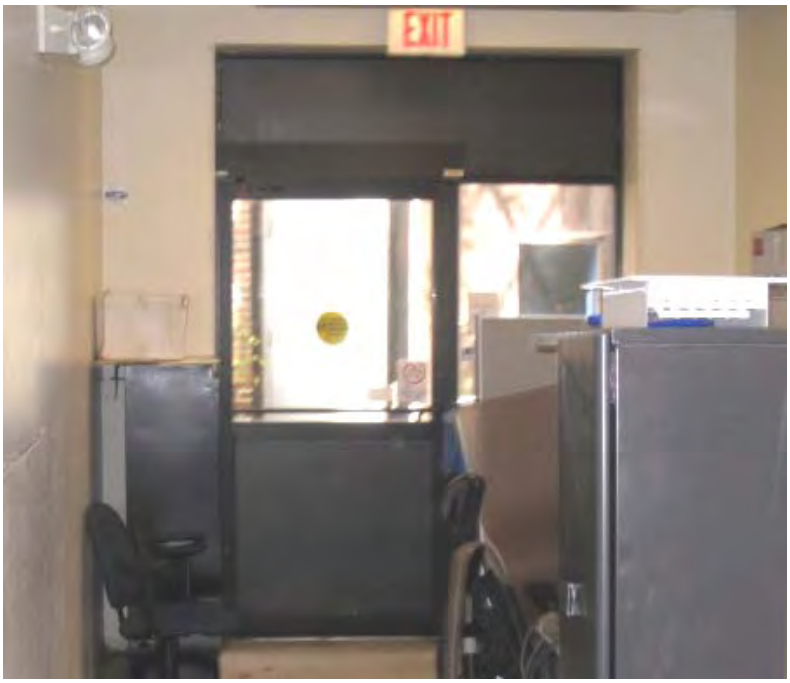
Picture 5

Water-Damaged Ceiling Tiles and Fluorescent Light Panel

Picture 6

Light Penetrating between Exterior Doors

Picture 7

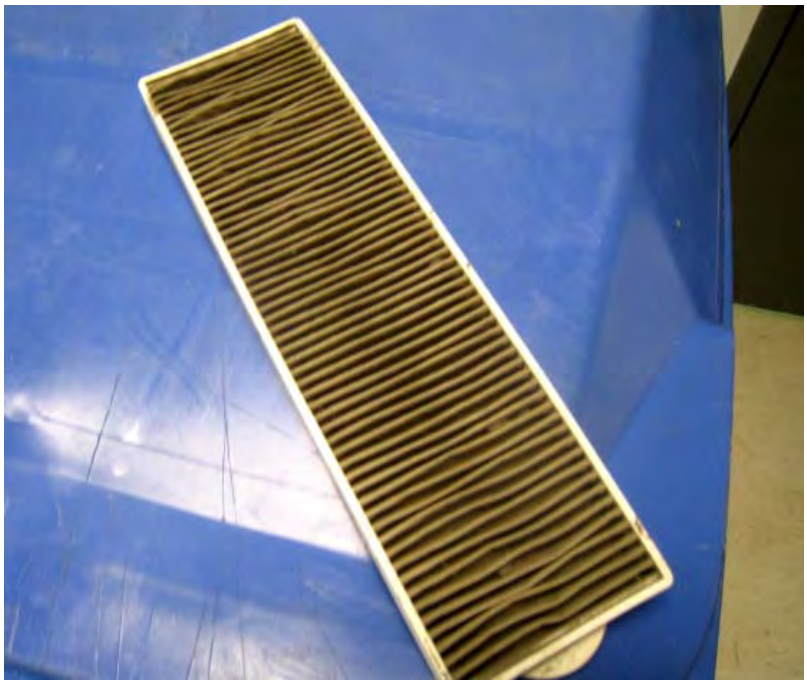


Light Penetrating beneath Exterior Door

Picture 8

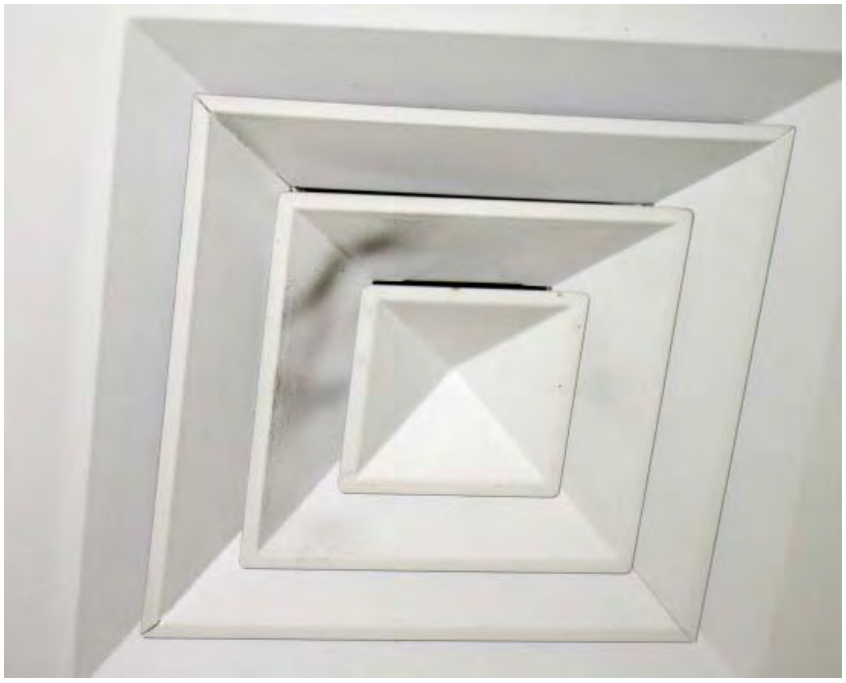
HEPA Filtered Vacuum Cleaner

Picture 9



Dirty Filter for HEPA Vacuum Occluded with Dust/Debris

Picture 10



Dust/Debris Accumulation on Supply Diffuser

Picture 11

Missing Fluorescent Light Cover in Medical Supply Office

Picture 12

Damaged Floor Tiles in Electrical Room

Picture 13

Damaged Floor Tiles in Electrical Room

Picture 14

Open Ceiling Exposing Ductwork and Fixtures

Picture 15

Unfinished Flooring in File/Storeroom

Picture 16

Various Dust/Debris-Covered Stored Items in Larger Storeroom

Picture 17

Damaged/Dust-Covered Duct Insulation Exposing Fiberglass

Picture 18

Breaches in Wall and around Ductwork

Picture 19

Breaches in Walls around Ductwork

Picture 20

HEPA-Filtered Air Purifier in File/Storeroom

Picture 21

Ill-Fitting Storeroom Door, Note Light Penetration at top of Door

Location: New Bedford Health Department
Address: 1213 Purchase Street, New Bedford, MA

Table 1

Indoor Air Results
Date: 11/3/2011

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		65	37	329	ND	25				Warm, mostly sunny, moderate traffic conditions
Main Work Area	3	74	36	431	ND	13	N	Y	Y	3 WD CT adjacent to exam room
Small Storage Room	0	70	42	389	ND	15	N	N	N	Air purifier, file cabinets, storage of paper items,/cardboard boxes, breaches in walls, space around door
First floor Hallway										Chronic rain leaks
Rear Hallway										Spaces under exterior door
Exam Room	0	73	38	413	ND	13	N	Y	Y	1 WD CT
Nursing Office	0	73	36	437	ND	13	N	Y	Y	
Small Conference Room	0	74	35	423	ND	13	N	Y	Y	1 WD CT

ppm = parts per million
µg/m^3 = micrograms per cubic meter
WD = water-damaged
CT = ceiling tile
ND = non-detect

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: New Bedford Health Department

Address: 1213 Purchase Street, New Bedford, MA

Indoor Air Results

Date: 11/3/2011

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	
Director's Office	1	73	35	404	ND	13	N	Y	Y	7 WD CTs
Medical Supply Office										Flickering fluorescent lights, missing cover on fluorescent light fixture
Office Manager	1	75	37	460	ND	14	N	Y	Y	1 WD CT
Interview Room	0	74	35	413	ND	12	N	Y	Y	
Large Conference Room	3	73	36	454	ND	14	Y	Y	Y	Dusty odors
Electrical Room/Water Heater					ND					WD cardboard box, debris on floor, broken/damaged floor tiles
Housing Inspector's Office	2	74	35	445	ND	15	N	Y	Y	
Lead Inspector's Office	0	73	35	431	ND	14	N	Y	N	

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Table 1 (continued)

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								Supply	Exhaust	
Chief Sanitarian	0	72	35	397	ND	14	N	Y	N	
Tobacco Control	2	73	36	477	ND	14	N	Y	N	
Veteran's Office	1	73	38	526	ND	12	N	Y	Y	
Main Reception Area	3	74	37	492	ND	13	N	Y	Y	6 WD CT (reportedly from bathroom leak above)
Investigator's Office	1	74	36	479	ND	12	N	Y	N	1 WD CT
File Room	0	74	36	455	ND	13	N	Y	Y	
Copy Area	0	74	37	479	ND	13	N	Y	N	

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