INDOOR AIR QUALITY ASSESSMENT

Memorial Elementary School
16 Pine Street
Rochester, Massachusetts

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

In response to a request by Ms. Karen Walega, Health Director, Marion Rochester Regional Health District, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality at the Memorial Elementary School (MES), 16 Pine Street, Rochester, Massachusetts. On August 24, 2010, Cory Holmes and Lisa Hébert, Environmental Analysts/Regional Inspectors in BEH's Indoor Air Quality (IAQ) Program visited the MES to conduct a preliminary assessment. The assessment was prompted by potential IAQ concerns related to renovation/construction activities at the school. BEH staff were accompanied by Bob Braga, Superintendant, Gilbane Building Company and Ms. Walaga. At the completion of the assessment, BEH staff gave a number of verbal recommendations to isolate construction areas from occupied areas prior to the start of school. These recommendations are reiterated later in this report. On August 27, 2010, Mr. Holmes returned to the MES to conduct a follow-up evaluation and to conduct air testing.

The MES is a one-story brick school building that was originally constructed in the 1950's. Additions were reportedly made in the 1970's and 1980's. A modular classroom wing (the date of which was unknown) is also attached to the school. The building/renovation project involves the construction of an addition to the northeast of the building (Pictures 1 and 2) and complete renovation of the existing building. The project began in April of 2010 and is scheduled for completion in September 2011.

It is important to note that in 2010, the Massachusetts School Building Authority (MSBA) amended their regulations 963 CMR 2.04 to address concerns associated with school renovation projects in Massachusetts. The regulations specifically state that "[e]ligible

Applicants shall implement containment procedures for dusts, gases, fumes, and other pollutants created during construction of an Approved Project if the building is occupied by students, teachers or school department staff while such renovation and construction is occurring. Such containment procedures shall be consistent with the *"IAQ Guidelines for Occupied Buildings Under Construction"* published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), in effect at time of project approval. All bids and proposals received for an Approved Project shall include the cost of planning and execution of containment of construction/renovation pollutants consistent with such SMACNA guidelines" (MSBA, 2010).

Methods

On August 24, 2010, BEH staff performed a visual inspection of the building for potential issues related to construction/renovation between work areas and occupied portions of the school. On August 27, 2010, BEH staff evaluated construction barriers and conducted air monitoring to assess whether construction/renovation generated contaminants were migrating into occupied areas of the building. Air tests for carbon monoxide were taken 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. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results and Discussion

Renovation activities can produce a number of pollutants, including dirt, dust, particulate matter, and combustion products such as carbon monoxide (from construction vehicles). Particles generated from construction activities can settle on horizontal surfaces in classrooms. Dusts can be irritating to the eyes, nose and respiratory tract.

During the August 24, 2010, assessment it was reported by Mr. Braga that the gymnasium hallway shares a wall with construction/renovation zone (Pictures 1 and 2). Two possible routes for migration of renovation generated pollutant s into occupied space were identified in this wall: an exterior door (Picture 3) and a set of interior double doors (Picture 4). Mr. Braga said plans were in place to seal the exterior door with a solid gypsum wall that will be sealed along its edges with caulking. The interior doors would reportedly be closed and sealed using plastic polyethylene sheeting and duct tape. BEH staff recommended sealing the door on the interior, as well as the exterior side of the doors to provide a dual barrier. BEH staff also recommended sealing all open utility holes in the wall above the double doors to eliminate potential pathways of pollutant migration (Picture 5). At the time of the August 27, 2010 assessment, the barriers were installed and utility holes were sealed (Pictures 6 through 8). However, the plastic barrier on the double doors had a hole (Picture 8) as well as a breach in the cinderblock wall above the exterior door (Picture 9). Mr. Braga stated that these breaches would be sealed prior to school occupancy.

Classrooms adjacent to construction of the new addition may be subject to several potential pollutant sources. BEH staff observed a number of construction vehicles and large areas of dirt/construction debris along the northeast portion of the building (Pictures 1 and 2). This activity should be closely monitored to prevent the entrainment of vehicle exhaust and other fugitive dust/debris from construction entering the building via univent air intakes, open doors or windows. A number of classrooms adjacent to the construction zone had open windows during the assessment (Picture 2). The opening of windows allows for unfiltered air to enter the classroom environment carrying with it airborne dirt, dust and particulates. Thus, opening windows during this construction/renovation project should be done with caution. Dusts can be irritating to the eyes, nose and respiratory tract. At the time of the assessment, Mr. Braga reported that final cleaning was scheduled to be conducted prior to occupancy for the 2010-2011 school year. BEH staff recommended that the interior of univents be thoroughly cleaned prior to activation. At the time of the August 27, 2010, assessment univents had been cleaned. In addition, it was recommended that filter media be installed on the exterior of univent air intakes to help reduce/prevent the entrainment of construction related pollutants generated from activities adjacent to the building.

The type of filters installed in univents (particulary along the construction zone) provides minimal filtration of respirable dusts (Picture 10). In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop), which can subsequently reduce the efficiency of the unit due to increased resistance. Prior to any increase of filtration, each univent should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

IAQ Evaluations/Air Testing

The primary purpose of air testing at the school was *to identify and reduce/prevent pollutant pathways*. Air monitoring was conducted in areas that may be directly impacted due to close proximity to renovation sites and other areas for comparison. Please note, air measurements are only reflective of the indoor air concentrations present at the time of testing.

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 affects. 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 measurable levels of carbon monoxide were detected inside the building (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 μg/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 concentrations ranged from 19 to 28 μg/m^3 (Table 1). PM2.5 levels measured indoors ranged from 2 to 26 μg/m^3 (Table 1), which were below the NAAQS PM2.5 level of 35 μg/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.

Volatile Organic Compounds

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether construction/renovation generated VOCs were migrating into occupied areas of the building, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND. No measurable levels of TVOCs were detected in the building during the assessment (Table 1).

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made. Also included as Appendix A is MDPH guidance "Methods Used to Reduce/Prevent Exposure to Construction/Renovation Generated Pollutants in Occupied Buildings". The MDPH has prepared this guidance document in order to prevent/reduce the migration of renovation-generated pollutants into occupied areas.

1. Comply with 963 CMR 2.04(2) (2) Design and Construction Standards: Indoor Air Quality – Massachusetts School Building Authority. "Eligible Applicants shall implement containment procedures for dusts, gases, fumes, and other pollutants created during construction of an Approved Project if the building is occupied by students, teachers or school department staff while such renovation and construction is occurring. Such containment procedures shall be consistent with the *"IAQ Guidelines for Occupied Buildings Under Construction"* published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), in effect at time of project approval. All bids and proposals received for an Approved Project shall include the cost of planning and execution of containment of construction/renovation pollutants consistent with such SMACNA guidelines" (MSBA, 2010).
2. Seal construction barriers on all sides with polyethylene plastic and duct tape. Seal these barriers on the construction, as well as the occupied side to provide a dual barrier. Ensure

integrity of barriers by monitoring for light penetration and drafts around seams. Seal hole in barrier shown in Picture 6.

3. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the *re-entrainment* of these materials into the building's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).
4. Consider changing HVAC filters more regularly in areas impacted by construction/renovation activities.
5. Consider increasing the dust-spot efficiency of univent filters, particularly adjacent to the construction zone. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.
6. Develop a notification system to provide building occupants immediately adjacent to construction activities a means to report construction/renovation related odors and/or dusts problems to the building administrator. Have these concerns relayed to the contractor in a manner to allow for a timely remediation of the problem.
7. If possible, schedule projects that produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.

8. Cover dirt/debris piles with tarps or wet down to decrease aerosolization of particulates, when possible.

9. Ensure that faculty is aware of construction activities that may be conducted in close proximity to their classrooms. In certain cases, HVAC equipment may need to be deactivated periodically and windows in classrooms adjacent to construction activities closed to prevent unfiltered air and vehicle exhaust from entering the building. For this reason, prior notification(s) should be made.

10. Disseminate scheduling itinerary to all affected parties through meetings, newsletters and/or weekly bulletins.

11. Continue to monitor Material Safety Data Sheets (MSDS) for all construction materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983). Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.

12. Relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from areas of renovations, if possible.

13. Implement prudent housekeeping and work site practices to minimize exposure to renovation pollutants. Consider increasing the number of full-time equivalents or work hours for existing staff (e.g., before school) to accommodate increase in dirt, dust accumulation due to construction/renovation activities. To control for dusts, a high efficiency particulate air filter (HEPA) equipped vacuum cleaner in conjunction with wet wiping/mopping of all surfaces is recommended.

References

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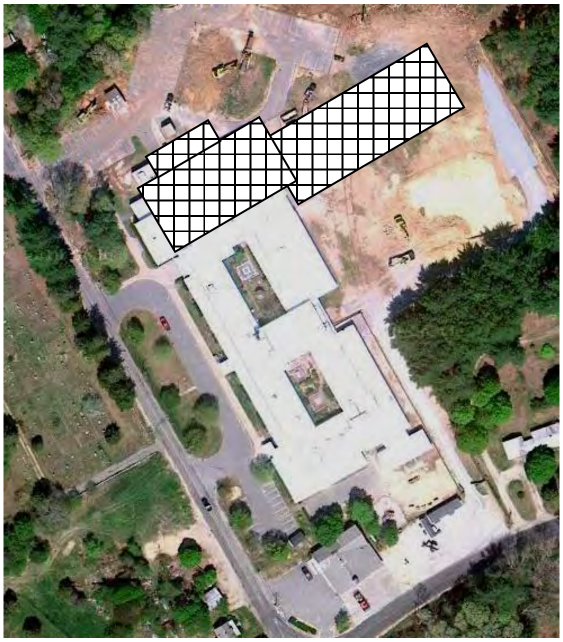
Picture 1



Aerial View of Memorial Elementary School, Hatched Areas Indicate Approximate Location of Construction/Renovation Areas

Picture 2

New Addition (Right) Attached to Northeast of Existing Building, Note Dirt/Construction Area Adjacent to Classroom Windows/Univent Air Intakes (Indicated by Arrows)

Picture 3

Exterior Door to Construction Zone in Gymnasium Hallway

Picture 4

Interior Doors to Renovation Zone in Gymnasium Hallway

Picture 5

Utilities Passing Through Wall above Interior Doors to Renovation Zone in Gymnasium Hallway

Picture 6

Exterior Door to Construction Zone (Shown in Picture 3) Sealed with Gypsum Wallboard and Caulking

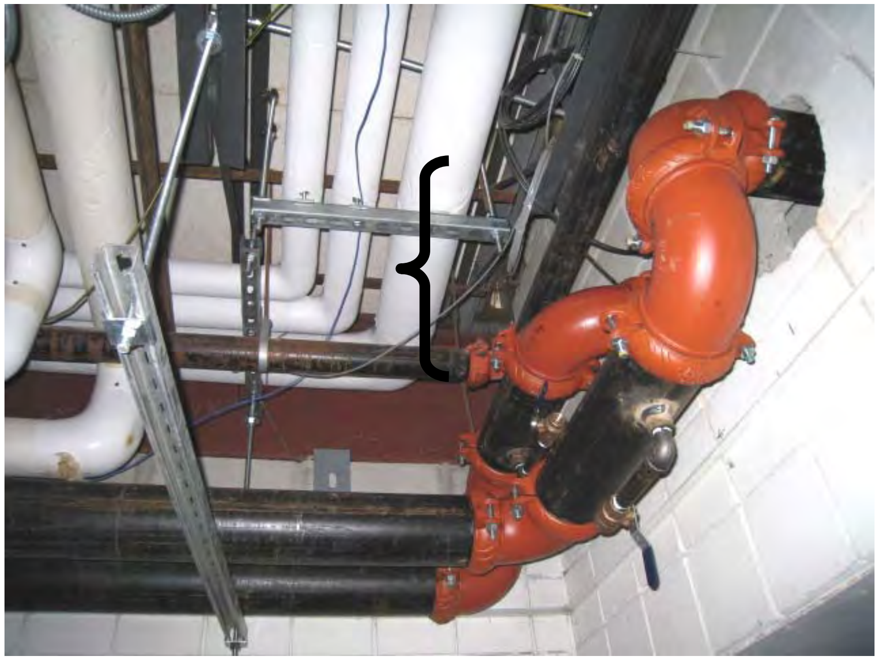
Picture 7

Interior Double Doors (Shown in Picture 4) Sealed With Plastic and Duct Tape, Arrow Indicates Hole in Plastic

Picture 8

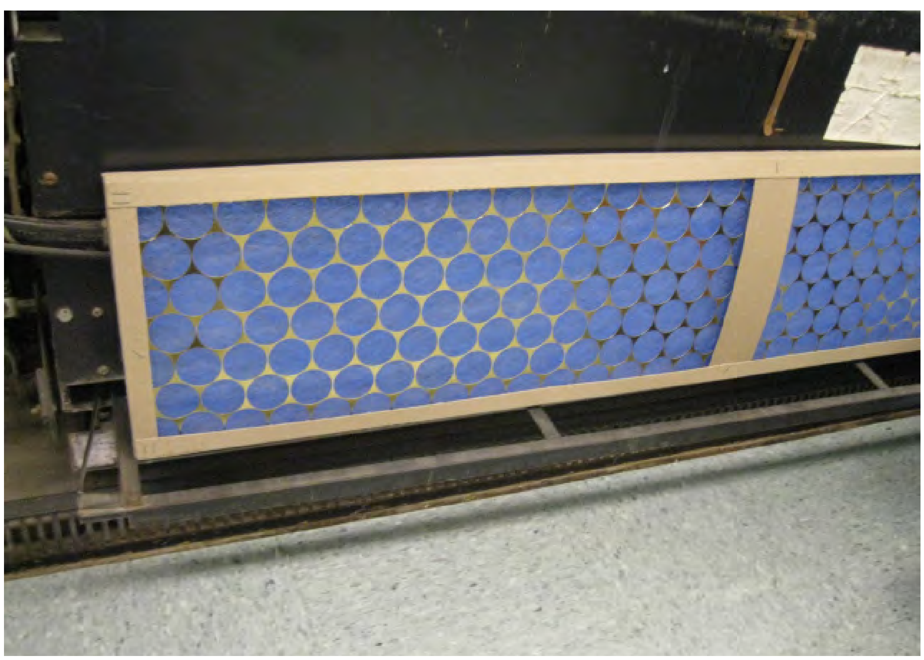
Close up of Hole in Plastic Poly Construction Barrier on Interior Double Doors (Preceding Picture)

Picture 9



Breach in Cinderblock Wall above Gypsum Wallboard Construction Barrier (Shown in Picture 6)

Picture 10



Fibrous Mesh Filters in Univents Adjacent to Construction Zone

Memorial Elementary School **Indoor Air Results**

16 Pine Street, Rochester, MA **August 27, 2010**

Table 1

Location/ Room	**Carbon Monoxide (*ppm)**	**TVOCs (*ppm)**	**PM2.5 (µg/m3)**	**Windows Openable**	**Ventilation**		**Remarks**
					Supply	**Exhaust**	
Background (outdoors)	ND	ND	19-28	-	-	-	Atmospheric Conditions: mostly sunny, warm, NW winds 5-8 MPH, gusts up to 17 MPH, moderate construction traffic
Cafeteria	ND	ND	2	Y	Y	Y	
Main Office Hallway	ND	ND	2	N	N	N	
Classroom 34/36	ND	ND	26	Y Open	Y	Y	Univent – fibrous mesh filters, clean
Classroom 35	ND	ND	10	Y Open	Y	Y	
Hallway/Construction Barriers outside Classrooms 51-53	ND	ND	4	N	N	N	Exterior door – sheet rocked and caulked/sealed –breach in cinder block wall near ceiling, interior doors sealed with plastic and duct tape (inside and out/dual barrier) – hole in plastic (door closer arm)

ppm = parts per million parts of air **µg/m3 = microgram per cubic meter** **ND = non-detect**