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October 6, 2011

Mr. James Scully  
Superintendent of Schools  
City of Haverhill  
4 Summer Street  
Haverhill, Massachusetts 01830

**Subject: Hunking School Preliminary Review**

Dear Mr. Scully:

Per your request AECOM has performed a preliminary structural assessment on October 5 and 6, 2011 at the City owned Hunking Middle School. Recent cracking of the floor system and masonry walls reported by Tom Geary, City of Haverhill Facilities Manager, prompted the City to request this inspection. A previous inspection of the timber framed roof system was completed by AECOM February 4, 2011 in response to the heavy snowfall.

On October 6, 2011, Bob Hajar, PE and Bill Blue, PE of AECOM, with the assistance of Tom Geary, City of Haverhill Facilities Manager, visited the Hunking School to observe the condition of the ground floor of the school. The following is based on a brief inspection of the facility and representative analysis of typical floor members. The findings and analyses results are not the result of extensive field investigations and structural analysis, but as preliminary findings intended to make the city aware of the conditions that exist and to make the city aware of the need to conduct further investigations and to make them aware of the potential hazards which exists.

The Hunking School was constructed in the late 1950s. The school has two classroom wings, a north wing adjacent to the gymnasium and a south wing. Both wings are of similar size and construction. The classrooms were constructed of a concrete joist system supported by concrete beams and exterior concrete walls. The concrete support beams along the corridors are supported on concrete circular columns that are supported by concrete spread footings. There is a crawl space below each of the wings.

#### **North Wing - Column Lines 31N to 51U**

At the north wing it was observed that the concrete on the underside of the joist webs and beam webs have been spalling and reinforcing bars in the concrete joists and beams have been exposed to view due to the loss of concrete cover. In many cases the rebar in the bottom of the concrete members have fully delaminated from the concrete resulting in the rebar falling to the ground in the crawl space below. The spalling of the concrete has occurred due to rusting of the reinforcing steel due to excessive humidity in the crawl space, likely resulting from failures in the roof drainage piping. This condition appears to have been ongoing for many years.

It was also observed that there are splits in the concrete columns. These splits occur over most of the column height. The splits appear to be in line with the vertical reinforcing of the columns and appear to have been caused by the rusting of the reinforcing bars. The depth of the split appears to extend to the outer face of the vertical reinforcing and does not appear to extend further into the core, but this

could not be conclusively verified. It appears that large areas of the concrete cover over the column reinforcing could be easily dislodged by striking with a hammer or similar object.

The spalling and cracking of the concrete is a common occurrence in beams and columns when the steel reinforcing bars rust due to prolonged exposure to moisture. The rusting of the rebar causes very large expansive forces in the concrete members as the rebar expands. Eventually, concrete splits and over time the concrete cover can spall and fall off of the concrete member. Once the concrete cover is lost, the reinforcing loses its protection afforded by the concrete chemistry and the rebar corrosion accelerates. As the corrosion continues, either significant loss of rebar section occurs or the rebar delaminates from the concrete member.

#### **South Wing - Column Lines 1A to T29**

The south wing was inspected and appears to be in good shape. There were no significant signs of concrete and rebar deterioration. The crawl space in this wing was dry and indicated no signs of having been wet over any extended period of time as was observed in the north wing.

#### **Analysis**

The original contract drawings were reviewed and calculations were performed to determine how the floor design matched up to the intended use of the structure. It was hoped that there might be additional capacity in the floor system that might offset the loss in floor capacity due to the loss of rebar section in the floor joists and beams. Unfortunately it was determined that the design of the floor was sufficient to carry the intended floor loads but without significant reserve that might help to offset the loss in rebar cross sectional area that has occurred in the north wing.

In large areas of the north wing most of the floor joists have lost over half of the cross sectional area of the original rebar due to corrosion and delamination. Based on the analysis it appears that large areas of the floor do not have sufficient rebar remaining that can be relied on to safely support the intended use of the school.

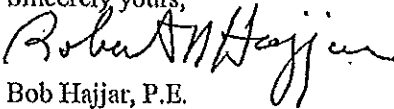
AECOM recommends the following actions be taken by the City in regard to this inspection.

1. **The north wing adjacent to the gymnasium is unsafe for occupancy due to the structural deficiencies stated above. The South wing is safe for occupancy.**
2. In order for the City to reoccupy the north wing of the school the concrete floor system will need to be shored (supported) down to the earth subgrade. The mechanical deficiencies will need to be corrected including, roof drainage, heating steam lines, sewage lines, and other affected piping and wiring. This is only a temporary measure to reoccupy the north wing.
3. A permanent fix for the structural deficiencies will involve substantial structural investigation, quantification of deficiencies, and preparation of structural shoring plans and specifications. Reconstruction of the concrete floor system will be required and could involve complete removal of the floor system. The roof system could be supported while this work is completed, however, the roof system is not in line with current design standards. Snow drifting was likely not accounted for in the original design. The design code did not require snow drift loading and the plans do not indicate increased loading at high/low roof locations. Drift loads can be two to three times the stated 40 psf design load.

Should the School Department desire, AECOM can perform a more detailed inspection of the Hunking School evaluating the structural condition and design validity under current design codes. It should be noted that further detailed structural evaluation below the floor system would most likely require shoring of the floor system before this could be performed. AECOM can also perform Architectural and HVAC assessments of the building in addition to structural review and design should this be desired.

Please contact me if you have any questions.

Sincerely yours,



Bob Hajjar, P.E.  
Project Manager