Exponent
149 Commonwealth Drive
Menlo Park, CA 94025

telephone 650-326-9400
facsimile 650-326-8072
www.exponent.com

April 5, 2018

Mr. Jonathan Triebwasser
Board President
Woodbridge Township Board of Education
428 School Street
Woodbridge, NJ 07095

Subject: *Focused Evaluation of Asbestos Testing Performed at Indiana Avenue School #18, Iselin, New Jersey*

Dear Mr. Triebwasser:

Exponent was asked by the Woodbridge Township Board of Education ("Board") to evaluate results of asbestos air sampling and analysis performed following repair of a roof leak on January 27, 2018, at Indiana Avenue School, located at 256 Indiana Avenue in Iselin, New Jersey. The following testing data were provided to Exponent by the Board for our evaluation:

- RAMM Environmental Services, Inc. ("RAMM Environmental") report titled "*Indoor air / surface quality assessment report for Indiana Avenue School: Principal's Office, Main Office, Classroom No. 01, Iselin, New Jersey*" (dated January 27, 2018)

- RAMM Environmental report titled "*Asbestos air survey / monitoring at Indiana Avenue School No. 18: Principal's Office, Main Office, and Room No. 01 and adjacent areas, Iselin, New Jersey*" (dated February 26, 2018), including analytical report from EMSL Analytical, Inc. ("EMSL") (dated February 23, 2018)

- RAMM Environmental report titled "*Asbestos bulk sampling report for Indiana Avenue School No. 18: Principal's Office – 1' × 1' ceiling tile*" (dated February 26, 2018), including analytical report from EMSL (dated February 23, 2018)

- RAMM Environmental report titled "*Indoor air quality assessment report for Indiana Avenue School throughout school, Iselin, New Jersey*" (dated February 27, 2018)

- McCabe Environmental Services, LLC ("MES") report titled "*Woodbridge Township – Indiana Avenue School, limited asbestos sampling / investigation (MES # 18-03475),*" including analytical reports from EMSL (dated March 15 and 16, 2018)

- MES report titled "*Limited asbestos inspection report*" (dated April 4, 2018).

- Various analytical reports from EMSL addressed to AHERA Consultants, Inc. (dated February 24, 26, and 28, 2018; March 5–6, 21–22, 24, and 26–28, 2018; and April 3 and 5, 2018).

We were specifically asked to review the asbestos testing results performed to date at Indiana Avenue School and to provide context for the results obtained to date. This evaluation was limited to the information described herein as of the date of this report. If the Board is aware of additional reports, material or information not specified within this report that are relevant to the scope and evaluation outlined in this letter, then those materials should be evaluated as appropriate.

Exponent investigated specific issues relevant to the evaluation as provided by the Board. Therefore, the scope of services performed during this assessment may not adequately address the needs of others, and any re-use of or reliance upon this report or the findings, conclusions, or recommendations presented herein is at the sole risk of the user. If any errors in this report are discovered, please notify us so that we can respond to any concerns.

Summary of Findings

Several rounds of sampling, which included samples of air, surfaces, and building materials, and analyses were performed at Indiana Avenue School between late February and early April of 2018 following the discovery and repair of a roof leak. Samples have been taken by companies hired by both the Board and the Teachers' Association from nearly every classroom, office, and common space. The sample collection methods and analyses used followed industry standards and accepted methods required in regulations governing the assessment and control of asbestos-containing materials in schools to protect school children and school employees.

Based on the analysis of the available data and information, we conclude the following:

- Multiple entities, including consultants hired by the Board, consultants hired by the Teachers' Association, and the State of New Jersey, specifically the Public Employees Occupational Safety and Health (PEOSH) / New Jersey Department of Health, have concluded that the Indiana Avenue School buildings are appropriate for re-occupancy.

- The airborne concentrations reported in the data collected from the school are comparable to levels historically reported in school buildings in the scientific literature and within the recommended and acceptable criterion for building re-entry and occupancy.

- Extensive air sampling has shown that, with the exception of one sample, none of the samples collected at Indiana Avenue School had asbestos concentrations that are of concern related to potential health impacts ("biologically relevant") to humans; this one reported result was not confirmed in subsequent sampling events. The one sample collected on February 23, 2018 (~1% of the 101 total samples collected), was reported as having detectable concentrations of biologically relevant asbestos fibers (longer than 5 microns [µm] in length). In this single sample, collected in Classroom #1 on February 23, 2018, a total of four structures of biological relevance were reported. All samples collected in and around Classroom #1 in the weeks following this initial finding (21 total samples in and around Classroom #1, Principal's Office, and Main Office) were below detection limits.

- With regard to the surface samples, the fact that some fibers were found in some surface samples is expected, but it is difficult to interpret these data as there are no established industry standards or regulations for asbestos fibers on surfaces. Surface sampling is not usually conducted nor is it required as part of regulations governing the assessment and control of asbestos-containing materials in schools. Importantly, the presence of fibers in surface samples does not equate to airborne levels and is not relevant for assessing potential biologically health impacts. Certain textbooks note "background" surface levels as <10,000 structures per square centimeter (s/cm^2) and "low" concentrations of <1,000 s/cm^2 when using the micro-vacuum sampling technique.

- The few samples with reportable concentrations in s/cm^2 were collected from surface dust samples obtained above the suspended ceiling in non-accessible areas. Due to the finding of asbestos fibers above the suspended ceiling in certain classrooms, MES recommended that an Operations and Maintenance (O&M) Plan be put in place. Based on our current understanding, the areas where surface dust was collected are not accessible by students nor teachers as they are covered by ceiling tiles and/or other ceiling covering. As recommended by MES, the existing O&M Plan for Indiana Avenue School was amended by the Woodbridge Township School District to specifically address this material in an ongoing manner moving forward.

Brief Background on Asbestos and Health Consequences

The term "asbestos" is a generic one that refers to a number of fibrous mineral silicates that occur naturally in the environment. There are two basic forms of asbestos: serpentine (chrysotile) and amphibole. Chrysotile, or "white" asbestos, accounts for between 90–95% of the asbestos that was used commercially in the United States. The amphibole fiber type is made up of several forms of asbestos, of which amosite ("brown" asbestos) and crocidolite ("blue" asbestos) are the two of commercial importance. The two main forms of asbestos (chrysotile and amphibole) vary widely in their potency to cause disease, due in part to the physicochemical properties of each fiber type.

The primary pathway for asbestos exposure, and potential for development of subsequent health consequences, is through inhalation. Asbestos can get into the air from naturally occurring sources of asbestos (e.g., erosion of asbestos-bearing rock) or from the deterioration or disturbance of manufactured products, such as insulation. When inhaled in sufficient quantities, asbestos is known to pose various health effects. The understanding of the nature and magnitude of the potential harm relies on evaluation of the level or quantity needed to pose a risk (toxicity) and the level and duration of exposure, which describes the specific circumstances and nature of an individual's contact with this material. When combined, these allow for evaluation of whether the magnitude of this risk or harm is acceptable (or not) in relevant exposure scenarios.

In evaluating the toxicity of asbestos, fiber type and fiber dimension are extremely important. With regard to asbestos, evaluation of fiber type is critical when evaluating potential health risk resulting from asbestos exposures. Various forms of asbestos fibers have been commercially

used in the United States, including serpentine asbestos (chrysotile) and amphibole asbestos. Published scientific studies have consistently demonstrated that the amphibole forms of asbestos are more potent (toxic) in causing asbestos-related disease than chrysotile asbestos by two orders of magnitude (100 times or more). These differences are due to various physical factors, such as fiber length, as well as chemical composition, which imparts different properties affecting biopersistence, a factor that determines durability in the body. Amphibole fibers are more durable, hence biopersistent, and are retained in the body longer than chrysotile fibers.

In addition to fiber type, fiber size is an important consideration when considering fiber potency (toxicity). In general, short fibers, including short asbestos fibers, have little to no disease-producing potential. In particular, available scientific and governmental literature pertaining to short fibers concludes that short fibers (that is, fibers less than 5µm in length), are not associated with asbestos-related health consequences. The most biologically important fibers for asbestos-related health hazards are those that are at least 5 µm in length and 3 µm or less in diameter.

Benchmarks of Asbestos Exposure

To place exposures in context, benchmarks are often used, including reported concentrations in similar environments (i.e., other schools) and/or ambient concentrations (i.e., natural outdoor concentrations) or other reference concentrations. Further, as noted by the Agency for Toxic Substances and Disease Registry (ATSDR), which is a part of the U.S. Center for Disease Control (CDC), "Low levels of asbestos that present little, if any, risk to health can be detected in almost any air sample." The ATSDR states that "small quantities of asbestos fibers are ubiquitous in air." They further state that the general U.S. population is exposed to asbestos in air both indoors and outdoors and provide estimates of typical lifetime exposures.

In an evaluation published in 1991 of indoor and outdoor samples taken from 71 schools scheduled for abatement, including schools in Texas, Michigan, Pennsylvania, Ohio, Florida, Colorado, Tennessee, and Massachusetts, reported an average concentration of 0.020 asbestos structures per cubic centimeter (s/cc) in indoor air, up to approximately 0.086 s/cc.[1] In outdoor air, average concentrations were 0.002 s/cc up to 0.0086 s/cc.[2]

Regulatory standards are generally used to assess compliance and as benchmarks to evaluate the potential for harm. The AHERA Act of 1986 has been part of the regulations governing the assessment and control of asbestos-containing materials in schools to protect school children and school employees. This method is published in the Code of Federal Regulations (CFR) and provides specific instructions on how to collect and analyze samples, methods for evaluation, criteria for evaluation of results, and requirements for addressing any issues uncovered during the testing process. This method calls for use of transmission electron microscopy (TEM), a method that allows for specific identification of asbestos fibers in collected samples when viewed through a microscope, with an analytical sensitivity of no greater than 0.005 s/cc. AHERA specifically requires an airborne clearance concentration or clearance level be met

[1] Higher value reported is the upper 95% confidence interval.
[2] Ibid.

prior to allowing for re-entry into a building following abatement of asbestos-containing materials. The basis for this value is based on background levels found on filters used for the sampling and is not based on potential health impacts in humans.

There are no established industry standards or regulations for asbestos fibers on surfaces; however, "background" surface levels of less than 10,000 asbestos s/cm^2 in settled dust have been noted in textbooks using the micro-vacuum sampling technique. MES reported "background" levels of 1,000 s/cm^2. The presence of fibers in surface samples does not equate to airborne levels and is not relevant for assessing potential biologically health impacts.

Summary of Asbestos Sampling and Analysis at Indiana Avenue School

Several rounds of sampling, which included samples of air, surfaces, and building materials, and analyses were performed at Indiana Avenue School between late February and early April of 2018 following the discovery and repair of a roof leak. Samples have been taken by companies hired by both the Board and Teachers' Association from nearly every classroom at the school, hallways adjacent to several classrooms, gymnasium, Multi-Purpose Room, Media Center, music room, copy room, and various offices spaces (Principal's Office, Main Office, Nurse's Office, Guidance Office, and Custodial Office). In certain areas (including classrooms and offices), multiple samples were taken. These sample collection methods and analyses followed industry standards and accepted methods required in regulations governing the assessment and control of asbestos-containing materials in schools to protect school children and school employees.

Three general types of samples were taken: airborne (i.e., evaluation of asbestos fibers in air), surface or wipe (i.e., evaluation of asbestos fibers in debris or settled dust on surfaces), and bulk (i.e., evaluation of asbestos content of certain building materials). The following sections include the evaluation of results of airborne testing and surface samples.

RAMM Environmental (hired by the Board) and MES (hired by the Teachers' Association), both of whom performed independent analyses of airborne asbestos at Indiana Avenue School, reported that all airborne concentrations were within the recommended and acceptable criterion for building re-entry and occupancy in their reports dated February 26, 2018, and March 16 and April 4, 2018, respectively. It is our understanding from verbal discussion with Board members that this was also confirmed by the PEOSH, a division of the State of New Jersey Department of Health, on March 9, 2018, during a call in which both Board and teacher representatives were present.

Summary of Airborne Asbestos Samples

Between February 23 and April 3, 2018, a total of 101 airborne samples were collected and analyzed for asbestos by multiple parties. The air sampling was conducted using methods written in regulations that are specific to schools. All samples were collected by either RAMM Environmental or MES, and analyzed by EMSL. For the airborne samples, the analysis method used was TEM, according to the method published by the EPA in the Code of Federal Regulations (CFR) as part of AHERA. Specifically, 40 CFR Part 73, Appendix A to Subpart E

was used. The flow rate, volume, area analyzed, and analytical sensitivity were all reported by EMSL, per AHERA guidelines, and met all of the requirements for the method.

In the 101 samples collected, all but one indicated non-detectable concentrations of asbestos. In this single sample (~1% of total samples collected), TEM-02 (051800828-0002), collected on February 23, 2018, inside Classroom #1, a total of four structures with length greater than or equal to 5 µm were reported. As noted above, only fibers with lengths longer than 5 µm are considered relevant in evaluating asbestos-related disease potential. The equivalent concentration of this sample was 0.08 s/cc. This concentration is within the range of concentrations published for concentrations of asbestos structures in indoor air of U.S. schools. RAMM Environmental and MES, both of whom performed independent analyses of airborne asbestos at Indiana Avenue School, reported that all airborne concentrations were within the recommended and acceptable criterion for building re-entry and occupancy.

Surface Samples

Between March 14 and April 5, 2018, a total of 50 surface samples were collected using either a wipe sample technique or a "micro-vacuum" technique. Samples were collected and analyzed using one or more of three different methods, two of which are published by the American Society for Testing and Materials (ASTM): "Micro-vacuum" technique using ASTM Method D5755 and "Wipe" technique using ASTM Method 6480. This third method was described as a qualitative TEM and filtration technique, which is not interpretable, as results are indicative of a "yes" or "no" finding, with no further quantification provided.

Ten samples were collected using published ASTM standards. Only one of these samples was collected from an accessible surface. The one sample collected from an accessible surface was obtained from the "Media Center bookshelf" on March 16, 2018 (sample D-01), and was not found to contain asbestos. There are no established industry standards or regulations for asbestos fibers on surfaces; however, "background" surface levels of less than 10,000 asbestos s/cm^2 in settled dust have been have been noted in textbooks when using the micro-vacuum sampling technique. Publications have characterized "low" concentrations as <1,000 s/cm^2. The remaining nine samples were collected from surfaces above the suspended ceiling, an area that is not accessed or touched by students or teachers. Of these samples, four were sampled using the micro-vacuum technique, and five were collected using wipes. For the micro-vacuum samples, three were found to contain asbestos; however, the reported concentrations were well below the reported background level in the literature. In the five wipe samples, no asbestos was identified.

The remaining 40 samples were collected and analyzed using the qualitative TEM and filtration technique; that is, the analytical laboratory reports whether or not they find asbestos in the sample under a microscope (essentially a "yes" or "no" finding). Of these 39 samples, six (15%) reported the presence of asbestos fibers, some of which were reported as present on accessible surfaces that could possibly be contacted by building occupants (e.g., students, teachers, etc.). Simply reporting of the presence of asbestos does not indicate that exposure occurs, and reporting of asbestos in these types of samples does not mean people are exposed to elevated levels of asbestos. There are currently no published standards or background criteria to

allow for an interpretation of these types of results. Given that asbestos has been reported on surfaces under background or typical conditions, the findings of asbestos in some of these samples is not unexpected.

Fionna S. Mowat

Fionna S. Mowat, Ph.D.
Principal Scientist,
Director of Health Sciences Center

Michael Posson, CIH
Managing Scientist

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