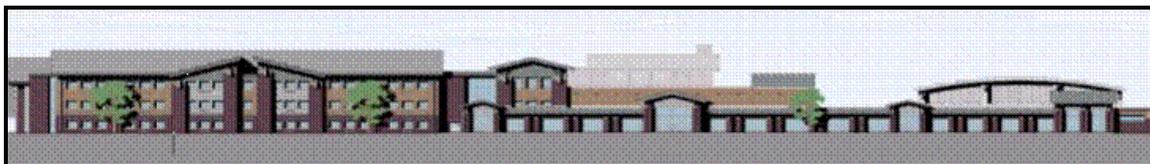


Sampling Results for the Keith Middle School Foundation Vent Stack and Indoor Air for Polychlorinated Biphenyls and Volatile Organic Compounds

December 2007 Monitoring Round



Prepared for:

Department of Environmental Stewardship
City of New Bedford
133 William Street
New Bedford, Massachusetts 02740

Prepared by:

TRC Environmental Corporation
Wannalancit Mills
650 Suffolk Street
Lowell, Massachusetts 01854
(978) 970-5600

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TRC Project No. 115058

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EXECUTIVE SUMMARY

TRC Environmental Corporation (TRC) of Lowell, Massachusetts was retained by the City of New Bedford (the City) to provide sampling support in conducting foundation vent stack and indoor air sampling for polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs) at the Keith Middle School (KMS) in New Bedford, Massachusetts. This report documents the indoor air and vent stack sampling performed by TRC during December 2007.

Sampling and analysis of vent stack and indoor air was conducted in accordance with the approved *Long-Term Monitoring and Maintenance Plan (LTMMIP)*, revision 4, dated October 20, 2006. The indoor air quality sampling program involved the collection of one indoor air quality sample from the ground floor of each of the three school building sections (Building A, Building B, and Building C). Concurrently with the indoor air quality sampling, air sampling of the sub-slab foundation ventilation system was performed during December 2007 from four selected rooftop vent stacks, including VS-1 and VS-4 which vent building Section A (classrooms), VS-9 which vents building Section B (near the kitchen), and VS-12 which vents building Section C (the Gymnasium). The passive sub-slab ventilation system was installed to allow any sub-slab soil gases to migrate from beneath the vapor barrier to the vent stacks, installed through the school building roof. Air samples were also collected immediately outside of the school during each round to provide comparative background results.

Following collection, the samples were analyzed for VOCs according to EPA Method TO-15 (VOCs in Air) by Alpha Woods Hole Labs of Westborough, Massachusetts and PCBs according to EPA Method 680 (PCB Homologues) by Northeast Analytical Labs of Schenectady, New York. Though this PCB method was not specified in the LTMMIP, the homolog analytical method is a reliable analytical method to quantify total PCBs. By quantifying PCB homologues, total PCB air data gathered at the KMS are directly comparable to total PCB air data gathered at the high school.

During the December 2007 sampling round, both PCBs and VOCs were detected in indoor air samples. In vent stack air samples, only VOCs were detected. However, the PCB detection limit for the vent stack samples was higher than the detected indoor air concentrations. Therefore, it can be inferred that concentrations of PCBs and VOCs in indoor air samples were lower than those observed in vent stack air samples during the December 2007 round, consistent with historical data observations. The presence of higher levels of VOCs and PCBs in vent stack air samples is an expected finding for a sub-slab ventilation system and indicates that the passive ventilation system is performing as designed. The presence of VOCs in vent stack air may also be indicative of off-gassing from the venting system components in addition to subsurface VOC release.

It is likely that VOCs are present in indoor air due to off-gassing from building materials and the storage and use of cleaners, adhesives, paints, and other VOC-containing products indoors at the school. Concentrations of PCBs detected in indoor air samples are consistent with background levels measured in outdoor ambient environments. Levels of PCBs and VOCs detected in indoor air demonstrate noticeable fluctuations in measured concentrations overtime due to: 1) the degree of building air exchange that occurs during normal school operation (i.e., open

conditions) versus vacation periods when the school is not in session (i.e., closed conditions); 2) changes in ambient temperatures that may increase or decrease the off-gassing of contaminants from indoor building materials, as well as fugitive releases from VOC-containing products in storage; 3) the degree to which activities within the school building (e.g., cleaning and repairs) are contributing to indoor air concentrations of contaminants; and 4) reductions in building material related VOC emission sources over time.

PCB indoor air and vent stack air sampling results were compared to site-specific outdoor air concentrations and risk-based air concentrations (RBACs). Two PCB RBACs have been developed for the KMS, assuming occupational exposures within the school (8 hours/day, 250 days/year, for 25 years). The first RBAC is the Action Level (AL; 0.05 ug/m^3) used as an initial indicator that PCB air concentrations above background levels have been detected. The second RBAC is the Acceptable Long-Term Average Exposure Concentration (ALTAEC; 0.3 ug/m^3), indicative of the maximum acceptable air concentration that should not be exceeded for an extended time period. No indoor air or vent stack air PCB concentrations exceed RBACs.

VOC data were compared to MassDEP Threshold Effects Exposure Limits (TELs) and Allowable Ambient Limits (AALs), published in December 1995, consistent with the LTMMIP. TELs are developed to be applicable to short-term exposure concentrations (average 24-hour levels) while AALs are developed to be protective of long-term exposure concentrations (average annual levels over 30 years). Because TELs and AALs have not been updated since 1995, VOC concentrations in excess of AALs and TELs were discussed relative to EPA screening levels (EPA SLs) developed by Oak Ridge National Laboratory (2008) to be protective of continuous long-term residential exposures and shorter-term commercial exposures, using the most current toxicity information available. Because AALs, TELs, and EPA SLs are set at risk levels that are only a portion of the MassDEP risk management criteria, concentrations that slightly exceed (i.e., less than 5-fold) one or more comparison criteria are unlikely cause for concern. VOC concentrations in excess of comparison criteria were also compared to MassDEP indoor air background values, used by MassDEP in the development of the Massachusetts Contingency Plan (MCP) numeric standards.

Among all indoor air samples, only one VOC (styrene in the Building C sample) exceeded one or more comparison criteria and the MassDEP indoor air background value. The LTMMIP specifies that the LSP-of-Record should submit the indoor air data to a toxicologist/risk assessor for further assessment if indoor air VOC concentrations exceed TELs, AALs, or 150% of outdoor air background concentrations. Further quantitative assessment of the indoor air data indicated that the maximum detected VOC concentrations were associated with a condition of no significant risk to potentially exposed individuals.

In vent stack air, two VOCs (2-butanone and methyl tert butyl ether) exceeded risk-based comparison criteria. Even though the LTMMIP specifies that both indoor air and vent stack air VOC concentrations are to be compared to comparison criteria, this comparison is not appropriate for vent stack air results. The vent system is designed to capture VOCs being released from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, limiting migration through the building slab and into indoor air. Little if any human exposure is occurring to air within the vent stack system itself. Air from the vent stack is

released to outdoor air where the VOCs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to comparison criteria developed assuming short-term (24-hour) and long-term exposure is highly conservative, if not conceptually irrelevant.

Temporal trends show that VOC concentrations have been decreasing in indoor air, suggesting that off-gassing from the newly constructed school building is diminishing over time. The sporadic detection of slightly higher VOC concentrations compared to those typically detected when the school is normally occupied is noted during the spring and summer school vacation periods. During the vacation periods the building is experiencing lower than normal air exchange and the indoor use of VOC-containing cleaning products and repair materials increases. Low level fluctuations in PCB concentrations in indoor air are representative of background conditions. Positive detections of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed. The fluctuations in PCB vent stack air concentrations and decreasing vent stack air VOC concentrations suggest that the range of measured concentrations is representative of typical conditions within the subsurface ventilation system and that off-gassing from the system is diminishing overtime. In addition, the human health risk calculations indicate that there is no significant risk associated with the occupancy of KMS.

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1.0 INTRODUCTION

1.1 Overview

TRC Environmental Corporation (TRC) of Lowell, Massachusetts was retained by the City of New Bedford (the City) to provide sampling support in conducting foundation vent stack and indoor air sampling for polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs) at the Keith Middle School (KMS) in New Bedford, Massachusetts. This report documents the indoor air and vent stack sampling performed by TRC during December 2007.

Soil gas sampling was performed under the location of the KMS building in December 2001. In addition to PCBs present in soil at this location, the primary VOCs detected in the soil gas samples included acetone, 2-butanone, cyclohexane, ethanol, heptane, n-hexane, and toluene. Lesser concentrations of benzene, carbon disulfide, ethylbenzene, methyl tert butyl ether, tetrachloroethene, 1,2,4-trimethylbenzene, and xylenes were also detected in soil gas samples. The results of the December 2001 soil gas sampling event were evaluated for potential adverse impacts on indoor air quality, assuming no vapor barrier was installed. Despite the conclusion that no significant risk to human health is posed by the measured soil gas concentrations, the City and School Department decided to install a vapor barrier on top of the soil beneath the school building concrete floor as an added layer of protection against intrusion of any gases that may accumulate under the building. Passive ventilation has been installed to allow any sub-slab soil gases to migrate from beneath the vapor barrier to the vent stacks, installed through the school building roof. Sampling of indoor air quality and vent stack air is conducted to confirm the proper functioning of the passive ventilation system.

PCBs and VOCs have historically been detected in both indoor air and vent stack air samples. However, concentrations of PCBs and VOCs in indoor air samples are consistently lower than those observed in vent stack air samples. It is likely that VOCs are present in indoor air due to off-gassing from building materials and the storage and use of cleaners, adhesives, paints, and other VOC-containing products indoors at the school. Concentrations of PCBs detected in indoor air samples are consistent with background levels measured in other outdoor ambient environments. Levels of PCBs and VOCs detected in indoor air fluctuate and demonstrate noticeable trends in measured concentrations overtime due to: 1) the degree of building air exchange that occurs during normal school operation (i.e., open conditions) versus vacation periods when the school is not in session (i.e., closed conditions); 2) changes in ambient temperatures that may increase or decrease the off-gassing of contaminants from indoor building materials, as well as fugitive releases from VOC-containing products in storage; 3) the degree to which activities within the school building (e.g., cleaning and repairs) are contributing to indoor air concentrations of contaminants; and 4) reductions in building material related VOC emission sources over time. The presence of higher levels of VOCs and PCBs in vent stack air samples is an expected finding for a sub-slab ventilation system and indicates that the passive ventilation system is performing as designed. The presence of VOCs in vent stack air may also be indicative of off-gassing from the venting system components in addition to subsurface VOC release.

Although there have been historical detections of both PCBs and VOCs in indoor air and vent stack air samples, the concentrations detected do not pose a significant risk to human health, based on the comparison of concentrations to both background concentrations and applicable risk-based criteria (TRC, 2008).

This report presents monitoring data collected during December 2007. The remaining sections of the report include Section 2 (Sampling Locations), Section 3 (Field Sampling Program), Section 4 (Analytical Program), Section 5 (Quality Assurance), Section 6 (Summary of Results), Section 7 (Comparison of PCB Results to Risk-Based Air Concentrations), Section 8 (Comparison of VOC Results to Comparison Criteria), Section 9 (Conclusions), and Section 10 (References). Supporting appendices include Appendix A (Field Sampling Data Sheets), Appendix B (Field Reduced Data), Appendix C (Equipment Calibration Sheets), Appendix D (Laboratory Data Reports), Appendix E (Laboratory Data Validation Memoranda), and Appendix F (Indoor Air Risk Calculation Spreadsheet – Commercial Worker).

1.2 Scope of Work

Sampling and analysis of vent stack and indoor air is required as part of United States Environmental Protection Agency (EPA) approved *Long-Term Monitoring and Maintenance Plan* (LTMMIP), revision 4, dated October 20, 2006. The LTMMIP was prepared by The BETA Group, Incorporated (BETA) in accordance with the August 31, 2005 *Approval for Risk-Based PCB Cleanup and Disposal under 40 CFR §761.6(c)* letter issued by EPA to the City. The LTMMIP set forth a vent stack and indoor air sampling schedule consisting of three monitoring events per year for the first year (July/August, December, April 2007), with the understanding that the City may submit a written request to EPA to reduce the indoor air sampling frequency after the first year of monitoring. However, per the order of the Mayor of the City, vent stack and indoor air monitoring took place monthly during the period of September 2006 to July/August 2007. Following the July/August sampling event, monitoring was reduced to once every four months. The December 2007 sampling event was the subsequent event following the July/August 2007 event. Monitoring from September 2006 through February 2007 was conducted by BETA and is reported elsewhere.

The indoor air quality sampling program involved the collection of samples over a 24-hour period. The sampling methodology consisted of the collection of high volume air samples using filters in tandem with polyurethane foam (PUF) cartridges for analysis of PCBs by EPA Method TO-4A and the collection of air samples using six-liter SUMMA™ canisters for the analysis of volatile organic compounds (VOCs) by EPA Method TO-15. The PUF and filter for TO-4A indoor air quality samples were analyzed separately. Concurrently with the indoor air quality sampling, air sampling of the sub-slab foundation ventilation system was performed. Vent sampling consisted of the collection of low volume air samples from four selected rooftop vent stacks. Vent stack samples were collected on PUF cartridges for PCBs analysis using EPA Method TO-10A and in 2.75-liter SUMMA™ canisters for VOCs analysis by Method TO-15. Sample collection procedures and analytical methods are described herein.

Following collection of the samples by TRC, the samples were analyzed for VOCs according to EPA Method TO-15 (VOCs in Air) by Alpha Woods Hole Labs of Westborough, Massachusetts

and PCBs according to EPA Method 680 (PCB Homologues) by Northeast Analytical Labs of Schenectady, New York. Though this PCB method was not specified in the LTMMIP, the homolog analytical method is a reliable analytical method to quantify total PCBs. By quantifying PCB homologues, total PCB air data gathered at the KMS are directly comparable to total PCB air data gathered at the high school.

2.0 SAMPLING LOCATIONS

2.1 Indoor Air Quality Sample Locations

During the sampling event, one indoor air quality sample was collected from the ground floor of each of the three school building sections (Building A, Building B, and Building C). Each sampling location was selected to be representative of portions of the school building normally occupied by students and teachers. The Building A sampling location is located within a hallway in an area of student classrooms. The Building B sampling location is located in the school cafeteria. The Building C sampling location is in a faculty dining area. One sample and a duplicate were also collected immediately outside of the school to provide comparative background results for ambient air.

Figure 2-1 presents the approximate locations of the indoor air quality sample locations. Table 2-1 summarizes the indoor air quality samples collected during the December 2007 sampling event. Indoor air quality samples collected during the December 2007 sampling event were designated with the letter A, B, or C to identify the building section from which the sample was collected and a unique sample identification suffix, indicating the sampling event number (e.g., A-15).

2.2 Foundation Vent Air Monitoring Sample Locations

The KMS foundation venting system is comprised of six sub-slab vapor collection zones, each vented by two or four vent stacks penetrating the roof. A total of four vent stacks are sampled during each round, including VS-1 and VS-4 which vent from the two collection zones located under building Section A (classrooms), and two other vent stacks which are rotated monthly to cover the remaining collection zones. One air sample is collected immediately outside of the school during each round to provide comparative background results.

Figure 2-2 presents the approximate locations of the vent stack sample locations. Table 2-1 summarizes the vent stack samples collected during the December 2007 sampling event. Vent stack samples collected during the December 2007 sampling event were designated with the vent stack number (e.g., VS-1) and a unique sample identification suffix indicating the sampling event number (e.g., VS-1-15).

3.0 FIELD SAMPLING PROGRAM

3.1 Overview

This section describes the procedures that TRC followed during the field sampling program.

3.2 Indoor Air Quality Sampling

Each of the indoor air quality field samples was collected by TRC over the course of one 24-hour test period. Indoor air quality samples were collected for analysis of PCBs by EPA Method TO-4A and VOCs by EPA Method TO-15.

3.2.1 Method TO-4A

Indoor air quality (IAQ) samples were collected for PCBs following the procedures described in the EPA Compendium Method TO-4A, *Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)*, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*, USEPA, January 1999.

TRC placed a high volume sampler at each PCB indoor air sampling location. A multi-point calibration was performed on each high volume sampler prior to sample collection using a calibrated orifice. A polyurethane foam (PUF) sampling cartridge was then unsealed and inserted into the high volume sampler and the sampler turned on. The start time, elapsed hours counter reading, and flow rate (magnehelic reading) were then recorded on a data sheet. After 24 hours of sampling, the elapsed hours counter reading and flow rate (magnehelic reading) were recorded on a data sheet along with the stop time. The PUF cartridge was then removed from the sampler, sealed, and labeled. A single-point post sampling calibration audit was performed to document that the high volume sampler remained calibrated.

Following the collection of the TO-4A samples, the total volume of ambient air sampled for each cartridge was calculated based on the duration of sampling and the average flow rate, as determined from the initial and final flow rates.

The data sheets are provided in Appendix A and the reduced data are presented in Appendix B. The calibration certifications of the critical orifice can be found in Appendix C.

3.2.2 Method TO-15

IAQ samples were collected for VOCs following the procedures described in the EPA Compendium Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)*, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*, USEPA, January 1999.

At each sampling location a six-liter evacuated SUMMA™ canister was set up with a flow-controller set to collect a sample over a 24-hour sampling period, and the canister valve opened. The flow controllers are pre-set by the laboratory performing the VOC analysis. The start time, SUMMA™ canister and flow-controller serial numbers, and SUMMA™ canister initial vacuum are then recorded on a data sheet. After 24 hours of sampling, the SUMMA™ canister valve was closed and the final SUMMA™ canister vacuum and stop time recorded.

The data sheets can be found in Appendix A and the reduced data can be found in Appendix B

3.3 Foundation Vent Air Sampling

Each of the vent air field samples was collected by TRC over the course of a 4-hour test period. Vent air samples were collected for analysis of PCBs by EPA Method TO-10A and VOCs by EPA Method TO-15. Prior to sampling, all of the foundation vents were temporarily capped for approximately 24 hours. Just prior to sampling, TRC removed the caps from all vent stacks that were not being sampled to allow for the inflow of air. This approach is a modification to the procedure outlined in the LTMMIP to improve representativeness by allowing sample air to be drawn from the entire vent stack zone without potential stagnation of flow impacted by capped vent stacks.

3.3.1 Method TO-10A

Vent stack air samples were collected for PCBs following the procedures described in the EPA Compendium Method TO-10A, *Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)*, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, USEPA, January 1999.

In order to sample each vent stack without collecting ambient air, a cap with Teflon™ tubing penetrating through it was placed over the vent stack. Prior to capping the stack, a PUF sampling cartridge was unsealed and connected to the length of tubing that would extend inside the vent stack. The tubing on the opposite side of the cap (that would be outside of the vent stack after the cap was installed) was attached to a Dawson® vacuum pump. A vacuum was applied to the tubing and cartridge using the pump and the vacuum was adjusted so that a flow rate of five liters per minute (LPM) of air was flowing through the PUF. The flow rate was confirmed using a Bios Defender™ 520 primary gas flow calibrator. The cap was then placed over the vent stack with the PUF cartridge suspended in the stack. The start time and flow rate was then recorded on a data sheet. After 4 hours of sampling, the flow rate was confirmed using the bubble meter. The final flow rate and stop time are then recorded on the data sheet. The PUF cartridge was then disconnected from the tubing, sealed with the supplied end caps, placed into a sample jar and labeled.

Following the collection of all the TO-10A samples, the total volume of ambient air sampled for each cartridge was calculated based on the duration of sampling and the average flow rate, as determined from the initial and final flow rates.

The data sheets can be found in Appendix A and the reduced data can be found in Appendix B. The calibration certifications of the Bios Defender™ 520 primary gas flow calibrator can be found in Appendix C.

3.3.2 Method TO-15

Foundation vent stack samples were collected for VOCs following the procedures described in the EPA Compendium Method TO-15, ***Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)***, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*, USEPA, January 1999.

At each sampling location a 2.75-liter evacuated SUMMA™ canister was set up (connected to the vent stack air space via Teflon™ tubing) with a flow-controller set to collect a sample over a 4-hour sampling period, and the canister valve opened. The flow controllers are pre-set by the laboratory performing the VOC analysis. The start time, SUMMA™ canister and flow-controller serial numbers, and SUMMA™ canister initial vacuum are then recorded on a data sheet. After 4 hours of sampling, the SUMMA™ canister valve was closed and the final SUMMA™ canister vacuum and stop time recorded

The data sheets can be found in Appendix A and the reduced data can be found in Appendix B

4.0 ANALYTICAL PROGRAM

Samples collected by EPA Method TO-10A and TO-4A were prepared by the Soxhlet Extraction Method (EPA Method 3540C/TO-4A) and analyzed by gas chromatography/mass spectroscopy (EPA Method 680) for PCB Homolog distribution. Though the LTMMIP specified that PCBs were to be analyzed by the congener analytical method, the homolog analytical method is as reliable as the congener analytical method in quantifying total PCBs which is the basis for the EPA Action Level ($0.05 \mu\text{g}/\text{m}^3$) and Acceptable Long-Term Average Exposure Concentration ($0.3 \mu\text{g}/\text{m}^3$) described in Section 7. In addition, by quantifying PCB homologues, total PCB air data gathered at the KMS are directly comparable to total PCB air data gathered at the high school since both are based on homologues rather than congeners, which greatly facilitates communication and discussion with the general public on the results of analyses.

Samples collected by EPA Method TO-15 were analyzed by gas chromatography/mass spectroscopy (EPA Method TO-15) for volatile organic compounds.

Laboratory analytical results are presented in Appendix D.

5.0 QUALITY ASSURANCE

5.1 Overview

TRC management is fully committed to an effective Quality Assurance/Quality Control (QA/QC) Program whose objective is the delivery of a quality product. For much of TRC's work, that product is data developed from field measurements, sampling and analysis activities, engineering assessments, and the analysis of gathered data for planning purposes. TRC's QA/QC Program works to provide complete, precise, accurate, representative data in a timely manner for each project, considering both the project's needs and budget.

This section highlights the specific QA/QC procedures that were followed during this sampling and analysis program.

5.2 Field Quality Control Summary

Calibrations of the field sampling equipment were performed prior to the field sampling effort. Copies of the calibration sheets were submitted to the Field Team Leader to take onsite and placed in the project file. Calibrations were performed as described in the EPA 40 CFR Part 50 Appendix B. All calibrations were available for review during the test program. Copies of the equipment calibration forms can be found in Appendix C. All instrument calibrations met the performance criteria defined in 40 CFR 50 Appendix B.

5.3 Data Reduction and Validation

Specific QC measures were used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in all projects.

5.3.1 Field Data Reduction

Appendix A of this document presents the standardized forms that were used to record field sampling data. The data collected was reviewed in the field by the Field Team Leader and at least one other field crewmember. Errors or discrepancies were noted in the field book.

5.3.2 Data Validation

TRC supervisory and QC personnel used validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records of all data were maintained, including that judged as an "outlying" or spurious value. The persons validating the data have sufficient knowledge of the technical work to identify questionable values.

Field sampling data was validated by the Field Team Leader and/or the Field QC Coordinator based on their review of adherence to each approved sampling protocol and written sample collection procedure.

The following criteria were used to evaluate the field sampling data:

- Use of approved test procedures;
- Proper operation of the process being tested;
- Use of properly operating and calibrated equipment;
- Proper chain-of-custody maintained.

Laboratory analytical data was validated by TRC chemists. The sample results were assessed using the EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analyses, revised December 1996. Modification of these guidelines was performed to accommodate the non-CLP methodology.

Sample data were reviewed for the following parameters:

- Agreement of analyses conducted with TRC requests
- Holding times and sample preservation
- Gas chromatography/mass spectrometry (GC/MS) tunes
- Initial and continuing calibrations
- Method blanks
- System Monitoring Compound recoveries
- Laboratory control sample (LCS) and LCS Duplicate (LCSD) results
- Internal standard performance
- Field duplicate results
- Quantitation limits and sample results

The laboratory data validation memoranda can be found in Appendix E. All data are reported in standard units depending on the measurement and the ultimate use of the data.

5.4 Data Validation Summary

In general, the TO-4A and TO-10A data appear to be valid as reported and may be used for decision-making purposes. No quality assurance issues were associated with this sample set.

The TO-15 data also appear to be valid as reported and may be used for decision-making purposes. All non-detect and positive cyclohexane results should be considered estimated (UJ/J) due to a low recovery in the laboratory control sample. All results for cyclohexane should be considered biased low.

5.5 TO-15 - Persistent Laboratory Contaminants

Based upon review of quality control data, TRC has determined that the results for three compounds reported throughout this report (acetone, ethanol, and isopropanol) were influenced by laboratory-derived contamination and hence do not reflect actual vent stack and indoor air concentrations at KMS. This conclusion is supported by: 1) the high concentrations of these compounds in contrast to other VOCs within samples; 2) TRC experience with these same

compounds when using EPA Method TO-15A on prior programs; and 3) concentrations over time do not follow trends observed for other VOCs known to be associated with products in storage and use at the KMS.

5.6 Collocated Sampler Precision

Single collocated sampler pairs were included for both indoor and vent stack air (PCBs and VOCs) during each sampling event. Collocated samplers were operated for the same duration at near identical flow rates and were in close proximity to each other so as to represent near identical air space. The data resulting from the analyses of the collocated sampler pairs were used to define the precision of the combined sample collection and analyses scheme.

Precision was determined by the collection and analysis of replicate samples and is expressed as the relative percent difference (RPD), which is determined according to the following equation:

$$RPD = \left[\frac{X_1 - X_2}{\frac{X_1 + X_2}{2}} \right] \times 100$$

where X_1 and X_2 are the measurement results of each replicate sample expressed as an absolute value (always positive).

The collocated sampler data for the two pairs collected at the KMS during the December 2007 sampling event are summarized in Tables 5-1 and 5-2 for the indoor air and vent stack air samples, respectively. Results are provided for each of the analytes measured in the sampler pair in units of $\mu\text{g}/\text{m}^3$. Method precision is expressed as the relative percent difference value derived from the above equation on a parameter specific basis.

EPA Method TO-15 identifies a data quality goal/objective of +/-25% for RPD for analytes measured in replicate or collocated samples. For the sampling event conducted in December 2007, RPDs were not calculated for most of the compounds analyzed since the majority of results were reported as non-detects (i.e., very few compounds were detected). RPDs are not calculated for non-detect results. Even though the RPD was greater than 25% for the one compound for which an RPD was calculated (methyl tert butyl ether in the VS-9-15 sample as shown on Table 5-2), the collocated non-detects show good agreement, although unquantifiable (analyte not detected in both samples of collocated pair). RPD data can be used to identify if differences in measured concentrations are attributable to actual concentration differences or if they are within the precision of the sampling and analytical procedure.

6.0 SUMMARY OF RESULTS

The following section describes the findings from the sampling events conducted by TRC at the KMS during December 2007. Table 2-1 provides a summary of the types, numbers, and locations of the samples collected. Appendices D and E contain the laboratory data reports and data validation memoranda, respectively. Along with the samples, TO-4A, TO-15, and TO-10A trip blanks were analyzed as a quality assurance measure. PCBs and VOCs were not detected in the trip blanks. Trip blanks are used as a check on shipping and laboratory-related sources of contamination.

TRC believes that the results for three compounds reported throughout this report (acetone, ethanol, and isopropanol) were influenced by laboratory derived contamination and hence do not reflect actual vent stack and indoor air concentrations at the KMS, as previously discussed in more detail in Section 5.5.

A trend analysis of VOC concentrations over time is presented in Section 8.4. VOCs detected in the indoor air samples are believed to be associated with the storage and use of cleaning and repair products as well as building construction materials. This finding is based upon sporadic detections of slightly higher VOC concentrations noted during the spring and summer school vacation periods when the building is experiencing lower than normal air exchange and the indoor use of VOC-containing cleaning products and repair materials increases. Overall, VOC concentrations are decreasing in indoor air suggesting that off-gassing from the newly constructed school building is diminishing over time. Low level fluctuations in PCB concentrations in indoor air are representative of background conditions. Positive detections of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed.

6.1 Indoor Air Quality Results

On December 27 and 28, 2007, TRC collected three indoor and one outdoor background (with duplicate) 24-hour TO-4A and TO-15 air samples at the KMS. Table 6-1 provides a summary of positive compound results for the indoor air quality samples.

It is possible that a positive detection of VOCs and PCBs in indoor air might indicate limited subsurface migration that is not entirely mitigated by the passive foundation ventilation system. However, it is more likely that VOCs are present in indoor air due to off-gassing from building materials and the use of cleaners, adhesives, paints, and other VOC-containing products indoors at the school. Levels of PCBs and VOCs detected in indoor air may fluctuate and demonstrate noticeable trends in concentrations over time due to: 1) the degree of building air exchange that occurs during normal school operation (i.e., open conditions) versus vacation periods when the school is not in session (i.e., closed conditions); 2) changes in ambient temperatures that may increase or decrease the off-gassing of contaminants from indoor building materials; 3) the degree to which activities within the school building (e.g., cleaning and repairs) are contributing to ambient levels of contaminants; and 4) reductions in building material related VOC emission sources over time.

PCBs were detected in all three indoor air samples collected. PCBs were not detected in the background outdoor air sample, but were detected in the duplicate background outdoor air sample at a concentration (0.000035 ug/m^3) 10- to 100-fold less than the concentrations observed in indoor air. The highest total PCB indoor air concentration (0.003 ug/m^3) was noted in the Building A sample, with the lowest concentration (0.00094 ug/m^3) noted in the Building B sample.

A total of seven VOCs were detected in the three indoor air quality samples collected during December 2007. One VOC (acetone) was detected in the outdoor air background sample, indicative of ambient conditions in the vicinity of the school unrelated to the Site. Ethanol was detected in the three indoor air samples collected, but not in the outdoor air background sample. The highest ethanol concentration was detected in the Building C sample, and the lowest ethanol concentration was detected in the Building B sample. Acetone was detected in two of the three indoor air samples collected and at the background location. Indoor air concentrations of acetone were up to six times the concentration detected in the background sample, with the highest detected concentration in the Building C sample and the lowest concentration observed in the Building A sample. 2-Butanone was also detected in two of the three indoor air samples collected, but not in the outdoor air background sample. Similar to acetone, the highest 2-butanone concentration was detected in the Building C sample with the lowest concentration detected in the Building A sample. Isopropanol, p/m-xylene, and toluene were each detected only in the Building A sample, while styrene was only detected in the Building C sample.

Acetone, isopropanol, and ethanol are common laboratory contaminants while all of the other VOCs detected in the indoor air samples are found in cleaning products, adhesives, paints and other VOC-containing products, and as components of building materials. Their presence in indoor air may not be representative of site conditions (i.e., soil, groundwater), but rather a result of off-gassing from building materials, the use of VOC-containing materials within the school, or partially contributed by ambient concentrations in the vicinity of the school.

6.2 Vent Stack Air Results

On December 28, 2007, TRC collected four vent stack air samples (plus one duplicate) and one ground level outdoor background 4-hour TO-10A and TO-15 samples at the KMS. Table 6-2 provides a summary of positive compound results for the vent stack samples.

As previously described, the primary compounds detected in the soil gas samples collected by BETA from beneath the location of the KMS in 2001 include acetone, 2-butanone, cyclohexane, ethanol, heptane, n-hexane, and toluene. Lesser concentrations of benzene, carbon disulfide, ethylbenzene, methyl tert butyl ether, tetrachloroethene, 1,2,4-trimethylbenzene, and xylenes were also detected in soil gas samples. A vapor barrier was installed on top of the soil beneath the school building concrete floor to protect against intrusion of any gases that may accumulate under the building. Passive ventilation has been installed to allow any sub-slab soil gases to migrate from beneath the vapor barrier to the vent stacks, the latter installed through the school building roof.

VOCs are consistently detected in the sub-slab passive vent stacks, while PCBs are sporadically detected in the vent stacks. Positive detections of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed. Vent stack air sampling occurs from the rooftop vent stacks after they have been sealed with temporary covers for 24 hours prior to sampling, maximizing the concentrations of VOCs and PCBs in the foundation venting system contributed from the soil beneath the building and VOCs released from the PVC piping and adhesives. Acetone, 2-butanone, and tetrahydrofuran are common components in PVC pipe cement and may leach into vent stack air overtime. Therefore, the presence of these compounds in vent stack air may be indicative of off-gassing from the venting system components rather than a site-related impact.

No PCB detections were noted in the vent stack samples collected or in the outdoor air background sample.

A total of six VOCs were detected in the vent stack air samples, including the common laboratory contaminants acetone and ethanol. No VOCs were detected at the outdoor air background sampling location. 2-Butanone was detected in three of the four vent stack air samples collected indicating that this compound is likely being released from the subsurface ventilation system and/or uniformly from the subsurface and vented by the system. The remaining VOCs were detected in one or two of the subsurface collection zones indicating a more localized subsurface release.

7.0 COMPARISON OF PCB RESULTS TO RISK-BASED AIR CONCENTRATIONS

This section of the report discusses the PCB indoor air and vent stack air sampling results, relative to site-specific outdoor air concentrations and risk-based air concentrations (RBACs). Air sampling results, background outdoor air results, and RBACs are presented in Tables 7-1 and 7-2 for the December 2007 sampling event. Compound-specific results exceeding RBACs are highlighted on these tables. The detected concentrations of compounds exceeding RBACs are discussed in Sections 7.1 and 7.2 for indoor air and vent stack air, respectively.

Two PCB RBACs have been developed for the KMS, assuming occupational exposures within the school (8 hours/day, 250 days/year, for 25 years). Both non-carcinogenic and carcinogenic health endpoints were considered in the calculation of the RBACs; however, RBACs are based on noncarcinogenic effects as the most sensitive endpoint. The first RBAC is the Action Level (AL; 0.05 ug/m^3) used as an initial indicator that PCB air concentrations above background levels have been detected. The risk basis for the AL is a noncarcinogenic hazard index of approximately 0.2. The second RBAC is the Acceptable Long-Term Average Exposure Concentration (ALTAEC; 0.3 ug/m^3), indicative of the maximum acceptable air concentration that should not be exceeded for an extended time period. The ALTAEC could be exceeded over the short-term and still result in acceptable risk levels. The risk basis for the ALTAEC is a noncarcinogenic hazard index of one.

Both RBACs were developed to be applied to a total PCB air concentration. PCB homologues have been quantified and summed to generate total PCB air concentrations. By quantifying PCB homologues, total PCB air data gathered at the KMS are directly comparable to total PCB air data gathered at the high school since both are based on homologues rather than congeners, which greatly facilitates communication and discussion with the general public on the results of analyses.

The LTMMIP specifies that both indoor air and vent stack air gas-phase total PCB concentrations are to be compared to RBACs. This comparison is appropriate for indoor air results since exposures to indoor air at the KMS are occurring over a similar duration and frequency as that assumed for RBAC development (8 hours/day, 250 days/year for 25 years). However, this comparison is less appropriate for vent stack air results. The vent system is designed to capture gas-phase PCBs being released from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, limiting migration through the building slab and into indoor air. Little if any exposure is occurring to air within the vent stack system itself. Air from the vent stack is released to outdoor air where the PCBs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to RBACs developed assuming exposures of 8 hours/day, 250 days/year for 25 years is highly conservative, if not conceptually irrelevant. The results of the comparison of vent stack air results to RBACs should be interpreted with caution due to the significantly reduced degree of exposure to vent stack air that can be experienced by individuals in comparison to indoor air.

7.1 Indoor Air

Indoor air sampling results, outdoor air background results, and RBACs are presented in Table 7-1. PCBs were detected at each indoor air sampling location (Buildings A, B, and C). Concentrations of PCBs in indoor air are consistent with levels associated with ambient conditions. All PCB indoor air detections are at least 10-fold less than the PCB AL. Because the PCB ALTAEC is approximately 10-fold greater than the PCB AL, all PCB indoor air detections are also approximately 100-fold less than the PCB ALTAEC. PCBs were also detected in the duplicate outdoor air background sample at a concentration more than 1000-fold less than the PCB AL and approximately 10,000-fold less than the PCB ALTAEC. Indoor air reporting limits ranged from $<0.00015 \text{ ug/m}^3$ to $<0.00038 \text{ ug/m}^3$, which allowed for the quantification and reporting of total PCB air concentrations at levels much lower than RBACs. Because there are no indoor air PCB concentrations in excess of the RBACs, no specific follow-up actions are recommended at this time.

Temporal trends for total PCB indoor air concentrations at the sampling location in Building A (classrooms), Building B (auditorium), and Building C (faculty dining area) are shown in Figure 7-1. Figure 7-1 also shows concentration trends at the outdoor air background sampling location. Data included on this figure are for the time period August 2006 to December 2007. The highest indoor air total PCB concentration was detected during the July/August 2007 sampling event when the school was likely experiencing lower than normal air exchange (summer use) and the potential for volatilization of PCBs from ambient sources is greatest due to the warmer weather. The lowest indoor air total PCB concentration was detected during the December 2006 sampling event when ambient temperatures were lower.

No clear trends are noted for total PCB concentrations in indoor air. Measured concentrations fluctuate over time, with slightly higher concentrations noted during the summer school vacation period when the building is experiencing lower than normal air exchange and the potential for volatilization of PCBs from ambient sources is greatest due to warmer weather. The low level PCB indoor air concentrations are representative of background conditions in outdoor ambient environments.

April 2007 is the date of the next (subsequent) sampling event.

7.2 Vent Stack Air

Vent stack air sampling results, outdoor air background results, and RBACs are presented in Table 7-2. PCBs were not detected in the four vent stack samples. PCBs were also not detected in the outdoor air background sample. Because there are no exceedances of the RBACs, no specific follow-up actions are recommended at this time.

Vent stack air reporting limits were higher than those for indoor air, ranging from $<0.021 \text{ ug/m}^3$ to $<0.028 \text{ ug/m}^3$. The higher reporting limit likely masked the presence of PCBs in the vent stack air system. However, reporting limits were 10-fold below the AL indicating that PCBs, even if not detected by the analytical method, were present at concentrations less than the RBACs.

Temporal trends for total PCB vent stack air concentrations are shown in Figure 7-2. Two vent stack locations were consistently sampled over the monthly program to establish a basis for concentration trends. The vents selected were VS-1 and VS-4 which were chosen because they both vent from the vapor collection zone in Building A which consists of classrooms where children spend most of the day. Figure 7-2 also shows concentration trends at the outdoor air background sampling location. Data included on this figure are for the time period August 2006 to December 2007. Many of the vent stack air samples collected during this time period displayed non-detect levels of total PCBs. Total PCB concentrations in VS-1 are consistent over time and similar to levels present at the outdoor air background location. Total PCB concentrations in VS-4 displayed greater variability with slightly higher concentrations noted during warmer ambient temperatures. The low PCB vent stack air concentrations are likely representative of typical conditions within the subsurface ventilation system.

April 2007 is the date of the next (subsequent) sampling event.

8.0 COMPARISON OF VOC RESULTS TO COMPARISON CRITERIA

This section of the report discusses the VOC indoor air and vent stack air sampling results, relative to site-specific outdoor air and generic indoor air background concentrations and available comparison criteria. Air sampling data, background data, and comparison criteria are presented in Tables 8-1 and 8-2. Compound-specific results exceeding comparison criteria are highlighted on these tables. The detected concentrations of compounds exceeding comparison criteria are discussed Section 8.1 for indoor air quality samples and Section 8.2 for vent stack air samples, followed by a discussion of observed trends in Section 8.4. Section 8.3 presents the findings of a risk characterization conducted to evaluate the significance of the comparison criteria exceedances.

Comparison criteria for VOC data include MassDEP Threshold Effects Exposure Limits (TELs) and Allowable Ambient Limits (AALs), published in December 1995, consistent with the LTMMIP. TELs are developed to be applicable to short-term exposure concentrations (average 24-hour levels) while AALs are developed to be protective of long-term exposure concentrations (average annual levels over 30 years). AALs and TELs are risk-based values, corresponding to the lower of a non-carcinogenic hazard of 0.2 or an excess lifetime cancer risk of one in one million (1×10^{-6}) for potentially carcinogenic compounds. Indoor air and vent stack air VOC concentrations are conservatively compared to both criteria even though it is unlikely that actual exposures to measured air concentrations would occur for either an entire 24-hour day or continually for 30 years. Short-term exposures at the KMS are likely to occur for approximately 8 hours per day, while long-term exposures are likely to occur for approximately 250 days/year for an exposure duration of 25 years.

Because TELs and AALs have not been revised since 1995 and may not include the most up-to-date toxicity information available, VOC concentrations in excess of AALs and TELs are discussed relative to alternate comparison criteria. The alternate comparison criteria are primarily residential and commercial EPA screening levels (EPA SLs) developed by Oak Ridge National Laboratory (June 2008) using the most current toxicity information available. Similar to AALs, residential EPA SLs are applicable to continuous long-term exposures. Commercial EPA SLs are more applicable to the actual exposures occurring at the KMS (8 hours/day, 250 days/year for 25 years). Residential and commercial EPA SLs are associated with the same cancer risk threshold used in establishing AALs and TELs. However, EPA SLs are based on a hazard of 1 for non-carcinogenic endpoints. Therefore, EPA SLs provided on Tables 8-1 and 8-2 have been adjusted to a non-carcinogenic hazard of 0.2 to be consistent with AALs and TELs based on non-carcinogenic effects. In interpreting concentrations in excess of residential EPA SLs, it is important to consider how the frequency and duration of actual exposures may differ from continuous long-term exposures assumed for residential EPA SL development.

Because AALs, TELs, and EPA SLs are set at risk levels (i.e., non-carcinogenic hazard of 0.2 and excess lifetime cancer risk of 1×10^{-6}) that are only a portion of the MassDEP risk management criteria of a non-carcinogenic hazard of 1 and an excess lifetime cancer risk of one in one-hundred thousand (1×10^{-5}), concentrations that slightly exceed (i.e., less than 5-fold) one or more comparison criteria may not be cause for concern, especially considering that actual

exposures may be of lesser duration and frequency than assumed in comparison criteria development.

For compounds lacking comparison criteria, detected concentrations are discussed relative to available comparison criteria for a surrogate compound, selected based on similarities in chemical structure and/or known toxicity. Compounds lacking comparison criteria are also discussed relative to site-specific outdoor and indoor air background concentrations, as available. Surrogate assignments are identified in footnotes on Tables 8-1 and 8-2.

Levels of VOCs in air present as a result of background or ambient conditions were not factored into the establishment of comparison criteria. Therefore, comparison criteria may be set at values that are below typical background levels of VOCs in indoor air, present as a result of off-gassing from building materials or indoor activities unrelated to site-specific releases. To account for anticipated background conditions at the KMS, VOC concentrations in excess of comparison criteria are framed relative to site-specific outdoor air background concentrations, indicating ambient conditions in the vicinity of site. To provide additional perspective, VOC concentrations in excess of comparison criteria are also discussed relative to MassDEP indoor air background values, used by MassDEP in the development of the Massachusetts Contingency Plan (MCP) numeric standards. Therefore, the presence of one or more VOCs at concentrations that exceed comparison criteria should be interpreted with caution and may not indicate the need for immediate action.

The LTMMIP specifies that both indoor air and vent stack air VOC concentrations are to be compared to comparison criteria. This comparison is appropriate for indoor air results since exposures to indoor air at the KMS are occurring over a similar though lesser duration and frequency as that assumed for comparison criteria development. However, this comparison is less appropriate for vent stack air results. The vent system is designed to capture VOCs being released from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, limiting migration through the building slab and into indoor air. Little if any exposure is occurring to air within the vent stack system itself. Air from the vent stack is released to outdoor air where the VOCs are quickly diluted and dispersed, similar to but to a greater degree than the dilution and dispersion that occurs in indoor air. Therefore, comparison of vent stack air results to comparison criteria developed assuming short-term (24-hour) and long-term exposure is highly conservative, if not conceptually irrelevant. The results of the comparison of vent stack air results to comparison criteria should be interpreted with caution due to the significantly reduced degree of exposure to vent stack air that can be experienced by individuals in comparison to indoor air.

There are a small number of compounds in indoor air, vent air, and outdoor air background samples for which reporting limits exceed comparison criteria set at very low values, which are not readily achievable with standard analytical methods. The comparison criteria for each of the affected compounds (i.e., benzene, chloroform, methylene chloride, styrene, tetrachloroethene, and trichloroethene) are based on an excess lifetime cancer risk of 1×10^{-6} for continuous lifetime exposure. For these compounds, the reporting limit typically exceeds the comparison criteria by 10-fold or less, indicating that the reporting limit is associated with an excess lifetime cancer risk of up to 1×10^{-5} for long-term exposures. However, because the development of

comparison criteria does not consider airborne levels present as a result of background or ambient activities, it is important to note that comparison criteria for these compounds are set at levels that are below typical indoor air background levels and cannot be distinguished from levels in site-specific outdoor air samples. Tables 8-1 and 8-2 provide the sample-specific detection limits for these compounds as well as the MassDEP indoor air background levels and site-specific outdoor air background sample results.

For three of the four vent stack air samples (VS-9-15, VS-1-15, and VS-12-15), reporting limits were elevated due to dilutions required for reliable analyses of the sample matrix due to one or more compounds that were present at elevated concentrations. For these samples, the compounds present at elevated concentrations include methyl tert butyl ether and 2-butanone. Elevated concentrations of these two VOCs may be related to their use as components of PVC pipe cement.

8.1 Indoor Air

As presented on Table 8-1, only the concentration of styrene in the Building C indoor air sample exceeds its AAL. The detected concentration is less than the TEL for styrene, indicating that short-term exposures are not of concern for this compound. In addition, the detected concentration is less than both the residential and commercial EPA SLs, suggesting that the most recent toxicity information indicates a lesser degree of toxicity for styrene than believed in 1995 when the AALs/TELS were developed. Because the detected styrene concentration does not exceed the EPA SLs, based on the most up-to-date toxicity information, and exceeds the AAL by less than 4-fold, the detected concentration is unlikely to be of concern.

Isopropanol, which lacks compound-specific comparison criteria, was also detected in the Building A indoor air sample at a concentration above the outdoor air background reporting limit. There is no published AAL/TEL for this compound. However, a comparison to the AAL/TEL for isobutyl alcohol can give some perspective on the significance of the detected isopropanol concentrations, based on similarities in chemical structure and toxicity. The detected indoor air concentration is below the AAL/TEL for isobutyl alcohol suggesting that the detected concentration is unlikely to be of concern. In addition, detections of isopropanol may be associated with laboratory contamination, as discussed in Section 5.5.

8.2 Vent Stack Air

As indicated on Table 8-2, concentrations of two VOCs (2-butanone and methyl tert butyl ether) in vent stack air samples exceed both the corresponding outdoor air background sample concentrations, which were all below reporting limits, and one or more comparison criteria. Comparison of vent stack air results to risk-based comparison criteria assumes that exposures to the air within the vent system are occurring at the same duration and intensity as indoor air, which is unlikely as previously noted. Therefore, VOC concentrations detected in excess of comparison criteria for VOCs in the vent stack system are unlikely to be indicative of a health concern since individuals are experiencing little, if any exposure to vent stack air.

Detected concentrations of 2-butanone do not exceed its TEL, applicable to short-term exposures, or its residential or commercial EPA SLs, based on the most current toxicity information available, indicating that this compounds is unlikely to be of concern. 2-Butanone is a component of PVC pipe cement and may be present in vent stack air due to off-gassing from vent system components.

The detected concentrations of methyl tert butyl ether exceed its residential EPA SL by up to 5-fold. Only one of the three detections slightly exceeds its commercial EPA SL. Therefore, long-term exposures are unlikely to be of concern, should they be occurring in the vent system.

Five of the six compounds detected in vent stack air were detected in the December 2001 subsurface soil gas sampling event conducted by BETA, including 2-butanone and methyl tert butyl ether. The presence of these compounds in vent stack air, but at lower or non-detect concentrations in indoor air, indicates that the passive foundation venting system is performing as designed and limiting or preventing the migration of subsurface VOCs to indoor air.

8.3 Risk Characterization for VOCs

The LTMMIP specifies that the LSP-of-Record should submit the indoor air data to a toxicologist/risk assessor for further assessment if indoor air VOC concentrations exceed TELs, AALs, or 150% of outdoor air background concentrations. Therefore, non-carcinogenic hazards and excess lifetime cancer risks have been estimated based on maximum indoor air concentrations to determine whether a condition of no significant risk exists within the school, assuming worst-case exposure conditions. All VOCs detected in indoor air samples between March 2007 and December 2007 were included in the risk characterization. A commercial worker scenario was used which assumed exposures for 8 hours/day, 250 days/year for 25 years, consistent with the assumptions used in the development of the site-specific PCB action levels. Appendix F contains the calculation spreadsheet presenting the VOC concentrations, exposure assumptions and toxicity values used in the assessment.

The results presented in Appendix F document that a condition of no significant risk exists associated with commercial worker indoor air exposures at the KMS. Because workers are the most highly exposed individuals at the KMS, exposures of school children and staff would also be associated with a condition of no significant risk. The risk and hazard to the commercial worker is overestimated due to the assumption that a worker would be continuously exposed to the maximum detected VOC concentrations over 25 years. VOC concentrations associated with off-gassing from building materials have been demonstrated to be trending downward (see discussion in Section 8.4).

The LTMMIP also specified that the LSP-of-Record should submit the vent stack air data to a toxicologist/risk assessor for further assessment if vent stack air VOC results exceed TELs and AALs. Because exposures to vent stack air are negligible or non-existent, further quantitative assessment of the vent stack air VOC results were not required.

8.4 Trend Analysis for VOCs

Temporal trends for VOC indoor air concentrations at the sampling location in Building A (classrooms), Building B (auditorium), and Building C (faculty dining area) are shown in Figures 8-1 through 8-3, respectively. Five VOCs were selected for data presentation including 2-butanone, methyl tert butyl ether, tetrahydrofuran, toluene, and total xylenes (the sum of m/p-xylene and o-xylene isomers). These VOCs were selected because they are not common laboratory contaminants, were frequently detected in indoor air samples, and were noted as exceeding one or more comparison criteria. Data included on these figures are for the time period August 2006 to December 2007. Bars on the figures outlined in black indicate that the compound was not detected during the specific sampling event, and the value presented on the figure is half the analytical detection limit. Though some degree of temporal fluctuation is observed, all five indicator VOCs display clearly decreasing concentration trends overtime in each building suggesting that off-gassing from the newly constructed school building is diminishing. In more recent months, most of the five selected compounds have not been detected. The sporadic detection of slightly higher VOC concentrations is noted during the spring and summer school vacation periods when the building is experiencing lower than normal air exchange and the indoor use of VOC-containing cleaning products and repair materials increases.

Temporal trends for VOC vent stack air concentrations are shown in Figures 8-4 and 8-5 for VS-1 and VS-4, respectively. The same five VOCs selected for presentation for indoor air were also used for data presentation purposes for vent stack air. Data included on these figure are for the time period August 2006 to December 2007. All five indicator VOCs display clearly decreasing trends overtime at both vent stack air sampling locations. Though some degree of temporal fluctuation is observed, the sporadic detection of slightly higher vent stack air VOC concentrations is noted during times of warmer ambient temperatures, increasing the subsurface release of VOCs or the off-gassing of VOCs from the ventilation system.

8.5 Recommended Modifications to the LTMMIP

The LTMMIP specifies follow-up actions to be taken if VOC air data exceed the comparison criteria. However, the response actions set forth in the LTMMIP are excessive and unnecessary for the December 2007 data set for the following reasons:

- Risk calculations presented herein and in prior TRC reports encompassing 7 months of monitoring data show that the maximum concentrations of detected VOCs do not pose a significant risk to human health and VOC concentrations are trending downward;
- Most of the VOCs detected in indoor air are associated with the storage and use of cleaners, adhesives, paints, and other VOC-containing products within the KMS; and
- The comparison of vent stack air to comparison criteria (e.g., TELs and AALs) is inappropriate because human exposure to air within the vent stack is a highly unlikely exposure scenario, rendering the comparison to such criteria conceptually irrelevant.

The LTMMIP will be revised to reflect TRC's detailed understanding of the site conceptual model (e.g., impacts from indoor use of commercially available cleaners, paints, adhesives, etc.), the relationship between vent measurements and historical soil gas measurements that illustrate the proper functioning of the passive sub-slab ventilation system, and long-term downward trends for indoor air and passive vent system concentrations for VOCs originating from building materials. The revised LTMMIP will also include more appropriate response actions and response action schedules that reflect TRC's comprehensive understanding of human health risk, sources, and air measurements. In addition, a new methodology for evaluation vent stack air concentrations is recommended for the proposed revised LTMMIP, which will be more appropriate than the presently required review against comparison criteria. A draft revision to the LTMMIP is planned for regulatory review in late summer/early fall 2008.

9.0 CONCLUSIONS

Indoor air quality and vent stack air sampling was conducted at the KMS during December 2007 for total PCBs and VOCs. Data were evaluated for quality and usability, discussed relative to risk-based air concentrations, and analyzed for concentration trends over the period of sampling from August 2006 to December 2007. The following summarizes the conclusions of the air sampling data evaluation.

In general, all TO-4A, TO-10A, and TO-15 data collected during December 2007 were determined to be valid as reported and usable for decision-making purposes.

No indoor air PCB concentrations exceed risk-based air concentrations, established to be protective of exposures occurring for 8 hours/day, 250 days/year for 25 years. Styrene was the only VOC that exceeded its MassDEP AAL, an ambient air risk-based concentration developed to be protective of continuous long-term exposures. Further assessment of the indoor air data indicated that the maximum detected VOC concentrations between March 2007 and December 2007 were associated with a condition of no significant risk to exposed individuals at the KMS.

No vent stack air PCB concentrations exceeded risk-based air concentrations. A greater number of VOCs in vent stack air exceeded comparison criteria as compared to VOCs in indoor air. However, the comparison to risk-based criteria is not appropriate for vent stack air results. The vent system is designed to capture VOCs being released from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, limiting migration through the building slab and into indoor air. Little if any exposure is occurring to air within the vent stack system itself. Air from the vent stack is released to outdoor air where the VOCs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to comparison criteria developed assuming short-term (24-hour) and long-term exposure is highly conservative, if not conceptually irrelevant.

Some VOCs are likely present in indoor air due to off-gassing from building materials and the storage and use of cleaners, adhesives, paints, and other VOC-containing products indoors at the school. Levels of PCBs and VOCs in indoor air were found to fluctuate overtime likely due to: 1) the degree of building air exchange that occurs during normal school operation (i.e., open conditions) versus vacation periods when the school is not in session (i.e., closed conditions); 2) changes in ambient temperatures that may increase or decrease the off-gassing of contaminants from indoor building materials; 3) the degree to which activities within the school building (e.g., cleaning and repairs) are contributing to indoor air concentrations of VOCs, and 4) reductions in building material related VOC emission sources over time. The PCB indoor air concentrations are representative of background conditions within outdoor ambient air. Overall, VOC concentrations are decreasing in indoor air suggesting that off-gassing from the aggregate of sources within the newly constructed school building is diminishing. The sporadic detection of slightly higher VOC concentrations noted during the spring and summer school vacation periods is likely attributable to the building experiencing lower than normal air exchange and the indoor use of VOC-containing cleaning products and repair materials increases.

VOCs are consistently detected in the sub-slab passive vent stacks, while PCBs are sporadically detected in the vent stacks. Positive detections of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed. VOCs detected in vent stack air samples may also have been released from the ventilation system. The low PCB vent stack air concentrations and decreasing vent stack air VOC concentrations are likely representative of typical conditions within the subsurface ventilation system and that off-gassing from the system is diminishing overtime.

It is recommended that the LTMMIP be revised to reflect TRC's detailed understanding of the site conceptual model (e.g., impacts from indoor use of commercially available cleaners, paints, adhesives, etc.), the relationship between vent measurements and historical soil gas measurements that illustrate the proper functioning of the passive sub-slab ventilation system, and long-term downward trends for indoor air and passive vent system concentrations for VOCs originating from building materials. The revised LTMMIP will also include more appropriate response actions and response action schedules that reflect TRC's comprehensive understanding of human health risk, sources, and air measurements. In addition, a new methodology for evaluation vent stack air concentrations is recommended for the proposed revised LTMMIP, which will be more appropriate than the presently required review against comparison criteria. A draft revision to the LTMMIP is planned for regulatory review in late summer/early fall 2008.

10.0 REFERENCES

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- TRC Environmental Corporation (TRC). 2008. Sampling Results for the Keith Middle School Foundation Vent Stack and Indoor Air for Polychlorinated Biphenyls and Volatile Organic Compounds – 2007 Monthly Monitoring Rounds: March, April, May, June, and July/August. May 2008.

TABLES

Table 2-1. December 2007 Sample Summary

**Keith Middle School
New Bedford, Massachusetts**

Sample ID	Sample Location	Sampling Events (suffix) December (-15)	Sample Type
A	Building A, center of west hallway	X	IAQ
B	Building B, Auditorium	X	IAQ
C	Building C, Faculty Dining Room	X	IAQ
BG	Background, flagpole area outside main entrance to Building A	XX	IAQ
VS-1	Building A, vent stack 1	X	Vent Stack
VS-4	Building A, vent stack 4	X	Vent Stack
VS-7	Building B, vent stack 7		Vent Stack
VS-8	Building B, vent stack 8		Vent Stack
VS-9	Building B, vent stack 9	XX	Vent Stack
VS-10	Building B, vent stack 10		Vent Stack
VS-11	Gymnasium , vent stack 11		Vent Stack
VS-12	Gymnasium, vent stack 12	X	Vent Stack
VS-14	Gymnasium, vent stack 14		Vent Stack
VS-16	Building A , vent stack 16		Vent Stack
VS-BG	On the ground at main entrance to Building A		Vent Stack

Notes:

IAQ = Indoor Air Quality

BG = Sample designation for background samples.

VS = Sample designation for vent stack samples.

XX = Designation indicating duplicate samples collected at specified location.

**Table 5-1. Comparison of VOC Indoor Air Sample Results - Collocated Sampler Precision
Keith Middle School
New Bedford, Massachusetts**

Analysis	Analyte	Dec-07		
		BG-15	BG-15 Dup	RPD (%)
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 3.71	< 3.71	NC
	1,2,4-trimethylbenzene	< 2.46	< 2.46	NC
	2,2,4-trimethylpentane	< 2.33	< 2.33	NC
	2-butanone	< 1.47	< 1.47	NC
	acetone	< 4.75	4.87	NC
	benzene	< 1.60	< 1.60	NC
	carbon disulfide	< 1.56	< 1.56	NC
	chloroform	< 2.44	< 2.44	NC
	chloromethane	< 1.03	< 1.03	NC
	cyclohexane	< 1.72	< 1.72	NC
	ethanol	< 3.76	< 3.76	NC
	ethylbenzene	< 2.17	< 2.17	NC
	isopropanol	< 1.23	< 1.23	NC
	methylene chloride	< 3.47	< 3.47	NC
	methyl tert butyl ether	< 1.80	< 1.80	NC
	p/m-xylene	< 4.34	< 4.34	NC
	o-xylene	< 2.17	< 2.17	NC
	n-heptane	< 2.05	< 2.05	NC
	n-hexane	< 3.52	< 3.52	NC
	styrene	< 2.13	< 2.13	NC
tetrachloroethene	< 3.39	< 3.39	NC	
tetrahydrofuran	< 1.47	< 1.47	NC	
toluene	< 1.88	< 1.88	NC	
trichloroethene	< 2.68	< 2.68	NC	
trichlorofluoromethane	< 2.81	< 2.81	NC	

RPD - Relative Percent Difference = $ABS(Dup-Sample)/((Dup+Sample)/2)*100$

NC - RPD could not be calculated due to a non-detect in one or both of the collocated samples

**Table 5-2. Comparison of VOC Vent Stack Air Sample Results - Collocated Sampler Precision
Keith Middle School
New Bedford, Massachusetts**

Analysis	Analyte	Dec-07		
		VS-9-15	VS-9-15 Dup	RPD (%)
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 37.1	< 37.1	NC
	1,2,4-trimethylbenzene	< 24.6	< 24.6	NC
	2,2,4-trimethylpentane	<23.3	< 23.3	NC
	2-butanone	17.6	< 14.7	NC
	acetone	< 47.5	< 47.5	NC
	benzene	< 16.0	< 16.0	NC
	carbon disulfide	< 15.6	< 15.6	NC
	chloroform	< 24.4	< 24.4	NC
	chloromethane	< 10.3	< 10.3	NC
	cyclohexane	< 17.2	< 17.2	NC
	ethanol	< 37.6	< 37.6	NC
	ethylbenzene	< 21.7	< 21.7	NC
	isopropanol	< 12.3	< 12.3	NC
	methylene chloride	< 34.7	< 34.7	NC
	methyl tert butyl ether	35.1	23.4	40.00
	p/m-xylene	< 43.4	< 43.4	NC
	o-xylene	< 21.7	<21.7	NC
	n-heptane	< 20.5	< 20.5	NC
	n-hexane	< 35.2	< 35.2	NC
	styrene	< 21.3	< 21.3	NC
tetrachloroethene	< 33.9	< 33.9	NC	
tetrahydrofuran	< 14.7	< 14.7	NC	
toluene	< 18.8	< 18.8	NC	
trichloroethene	< 26.8	< 26.8	NC	
trichlorofluoromethane	< 28.1	< 28.1	NC	

RPD - Relative Percent Difference = $ABS(Dup-Sample)/(Dup+Sample)/2*100$

NC - RPD could not be calculated due to a non-detect in one or both of the collocated samples

N/A - Not Available

Table 6-1. Indoor Air Quality Sample Results - December 2007
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations			Background Locations		QA/QC Trip Blank
		A-15	B-15	C-15	BG-15	BG-15 Dup	
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 3.71	< 3.71	< 3.71	< 3.71	< 3.71	< 3.71
	1,2,4-trimethylbenzene	< 2.45	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46
	2,2,4-trimethylpentane	< 2.33	< 2.33	< 2.33	< 2.33	< 2.33	< 2.33
	2-butanone	2.63	< 1.47	3.54	< 1.47	< 1.47	< 1.47
	acetone ⁽¹⁾	11.5	< 4.75	30	< 4.75	4.87	< 4.75
	benzene	< 1.60	< 1.60	< 1.60	< 1.60	< 1.60	< 1.60
	carbon disulfide	< 1.56	< 1.56	< 1.56	< 1.56	< 1.56	< 1.56
	chloroform	< 2.44	< 2.44	< 2.44	< 2.44	< 2.44	< 2.44
	chloromethane	< 1.03	< 1.03	< 1.03	< 1.03	< 1.03	< 1.03
	cyclohexane	< 1.72	< 1.72	< 1.72	< 1.72	< 1.72	< 1.72
	ethanol ⁽¹⁾	33.7	15.5	34.9	< 3.76	< 3.76	< 3.76
	ethylbenzene	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17
	isopropanol ⁽¹⁾	2.89	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23
	methylene chloride ⁽¹⁾	< 3.47	< 3.47	< 3.47	< 3.47	< 3.47	< 3.47
	methyl tert butyl ether	< 1.80	< 1.80	< 1.80	< 1.80	< 1.80	< 1.80
	p/m-xylene	5.06	< 4.34	< 4.34	< 4.34	< 4.34	< 4.34
	o-xylene	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17
	heptane	< 2.05	< 2.05	< 2.05	< 2.05	< 2.05	< 2.05
	n-hexane	< 3.52	< 3.52	< 3.52	< 3.52	< 3.52	< 3.52
	styrene	< 2.13	< 2.13	7.18	< 2.13	< 2.13	< 2.13
tetrachloroethene	< 3.39	< 3.39	< 3.39	< 3.39	< 3.39	< 3.39	
tetrahydrofuran	< 1.47	< 1.47	< 1.47	< 1.47	< 1.47	< 1.47	
toluene	5.07	< 1.88	< 1.88	< 1.88	< 1.88	< 1.88	
trichloroethene	< 2.68	< 2.68	< 2.68	< 2.68	< 2.68	< 2.68	
trichlorofluoromethane	< 2.81	< 2.81	< 2.81	< 2.81	< 2.81	< 2.81	
PCBs (ug/m ³)							
	Total PCBs	0.003	0.00094	0.0011	< 0.00037	0.000035	< 0.025

Notes:

J - Concentration should be considered estimated.

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

PCBs - polychlorinated biphenyls

⁽¹⁾ Compound is a common laboratory contaminant and detects may be associated with laboratory contamination, as discussed in Section 5.

* - Results for indoor air are compared to contemporary outdoor air (background) sample

Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 6-2. Vent Stack Sample Results - December 2007
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background	QA/QC
		VS-9-15	VS-9-15 Dup	VS-1-15	VS-12-15	VS-4-15	VS-BG-15	Trip Blank-VS
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 37.1	< 37.1	< 37.1	< 37.1	< 3.71	< 3.71	< 3.71
	1,2,4-trimethylbenzene	< 24.6	< 24.6	< 24.6	< 24.6	< 2.46	< 2.46	< 2.46
	2,2,4-trimethylpentane	< 23.3	< 23.3	< 23.3	< 23.3	< 2.33	< 2.33	< 2.33
	2-butanone	17.6	< 14.7	15.6	< 14.7	6.72	< 1.47	< 1.47
	acetone ⁽¹⁾	< 47.5	< 47.5	< 47.5	< 47.5	18.3	< 4.75	< 4.75
	benzene	< 16.0	< 16.0	< 16.0	< 16.0	< 1.60	< 1.60	< 1.60
	carbon disulfide	< 15.6	< 15.6	< 15.6	< 15.6	< 1.56	< 1.56	< 1.56
	chloroform	< 24.4	< 24.4	< 24.4	< 24.4	< 2.44	< 2.44	< 2.44
	chloromethane	< 10.3	< 10.3	< 10.3	< 10.3	< 1.03	< 1.03	< 1.03
	cyclohexane	< 17.2	< 17.2	< 17.2	< 17.2	< 1.72	< 1.72	< 1.72
	ethanol ⁽¹⁾	< 37.6	< 37.6	< 37.6	< 37.6	4.84	< 3.76	< 3.76
	ethylbenzene	< 21.7	< 21.7	< 21.7	< 21.7	< 2.17	< 2.17	< 2.17
	isopropanol ⁽¹⁾	< 12.3	< 12.3	< 12.3	< 12.3	< 1.23	< 1.23	< 1.23
	methylene chloride ⁽¹⁾	< 34.7	< 34.7	< 34.7	< 34.7	< 3.47	< 3.47	< 3.47
	methyl tert butyl ether	35.1	23.4	< 18.0	53.5	< 1.80	< 1.80	< 1.80
	p/m-xylene	< 43.4	< 43.4	< 43.4	< 43.4	< 4.34	< 4.34	< 4.34
	o-xylene	< 21.7	< 21.7	< 21.7	< 21.7	< 2.17	< 2.17	< 2.17
	heptane	< 20.5	< 20.5	< 20.5	< 20.5	< 2.05	< 2.05	< 2.05
	n-hexane	< 35.2	< 35.2	< 35.2	< 35.2	< 3.52	< 3.52	< 3.52
	styrene	< 21.3	< 21.3	< 21.3	< 21.3	< 2.13	< 2.13	< 2.13
tetrachloroethene	< 33.9	< 33.9	< 33.9	< 33.9	< 3.39	< 3.39	< 3.39	
tetrahydrofuran	< 14.7	< 14.7	16.3	< 14.7	45.7	< 1.47	< 1.47	
toluene	< 18.8	< 18.8	< 18.8	< 18.8	1.91	< 1.88	< 1.88	
trichloroethene	< 26.8	< 26.8	< 26.8	< 26.8	< 2.68	< 2.68	< 2.68	
trichlorofluoromethane	< 28.1	< 28.1	< 28.1	< 28.1	< 2.81	< 2.81	< 2.81	
PCBs (ug/m ³)								
	Total PCBs	< 0.024	< 0.022	< 0.028	< 0.022	< 0.021	< 0.021	< 0.025

Notes:

J - Concentration should be considered estimated.

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

PCBs - polychlorinated biphenyls

⁽¹⁾ Compound is a common laboratory contaminant and detects may be associated with laboratory contamination, as discussed in Section 5.

* - Results for vent stack air are compared to contemporary outdoor air (background) sample

Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 7-1. Comparison of PCB Indoor Air Quality Sample Results to Risk-Based Air Concentrations - December 2007
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations			Background Locations		QA/QC Trip Blank	MassDEP Background	Comparison Values	
		A-15	B-15	C-15	BG-15	BG-15 Dup			AL*	ALTAEC*
PCBs ($\mu\text{g}/\text{m}^3$)	Total PCBs	0.003	0.00094	0.0011	< 0.00037	0.000035	< 0.025	--	0.05	0.3

Notes:

$\mu\text{g}/\text{m}^3$ - micrograms per cubic meter

PCBs - polychlorinated biphenyls

PCB results for indoor air are compared to contemporary outdoor air (background) sample and MassDEP indoor air background values.

* PCBs are compared to the EPA site specific Action Level (AL) and the Acceptable Long-Term Average Exposure Concentration (ALTAEC).

Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 7-2. Comparison of PCB Vent Stack Sample Results to Risk-Based Air Concentrations - December 2007
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background	QA/QC	Comparison Values	
		VS-9-15	VS-9-15 Dup	VS-1-15	VS-12-15	VS-4-15	VS-BG-15	Trip Blank-VS	AL*	ALTAEC*
PCBs ($\mu\text{g}/\text{m}^3$)										
	Total PCBs	< 0.024	< 0.022	< 0.028	< 0.022	< 0.021	< 0.021	< 0.025	0.05	0.3

Notes:

$\mu\text{g}/\text{m}^3$ - micrograms per cubic meter

PCBs - polychlorinated biphenyls

PCB results for vent stack air are compared to contemporary outdoor air (background) sample.

* PCBs are compared to the EPA site specific Action Level (AL) and the Acceptable Long-Term Average Exposure Concentration (ALTAEC).

Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 8-1. Comparison of VOC Indoor Air Quality Sample Results to Comparison Criteria - December 2007
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations			Background Locations		QA/QC Trip Blank	MassDEP Background	Comparison Values			
		A-15	B-15	C-15	BG-15	BG-15 Dup			TEL*	AAL*	Alternate Value (residential)	Alternate Value (commercial)
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 3.71	< 3.71	< 3.71	< 3.71	< 3.71	< 3.71	0.59	--	--	0.22 (e)	1.1 (e)
	1,2,4-trimethylbenzene	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	< 2.46	--	--	--	1.46 (a)	6.2 (a)
	2,2,4-trimethylpentane	< 2.33	< 2.33	< 2.33	< 2.33	< 2.33	< 2.33	--	--	--	146 (b)	620 (b)
	2-butanone	2.63	< 1.47	3.54	< 1.47	< 1.47	< 1.47	42.18	200	10	1040 (a)	4400 (a)
	acetone ⁽¹⁾	11.5	< 4.75	30	< 4.75	4.87	< 4.75	27.04	160.54	160.54	6400 (a)	28000 (a)
	benzene	< 1.60	< 1.60	< 1.60	< 1.60	< 1.60	< 1.60	21	1.74	0.12	0.31 (a)	1.6 (a)
	carbon disulfide	< 1.56	< 1.56	< 1.56	< 1.56	< 1.56	< 1.56	--	0.1	0.1	146 (a)	620 (a)
	chloroform	< 2.44	< 2.44	< 2.44	< 2.44	< 2.44	< 2.44	3.36	132.76	0.04	0.11 (a)	0.53 (a)
	chloromethane	< 1.03	< 1.03	< 1.03	< 1.03	< 1.03	< 1.03	--	--	--	1.4 (a)	6.8 (a)
	cyclohexane	< 1.72	< 1.72	< 1.72	< 1.72	< 1.72	< 1.72	--	280.82	280.82	1260 (a)	5200 (a)
	ethanol ⁽¹⁾	33.7	15.5	34.9	< 3.76	< 3.76	< 3.76	--	51.24	51.24	--	--
	ethylbenzene	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17	9.62	300	300	0.97 (a)	4.9 (a)
	isopropanol ⁽¹⁾	2.89	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	--	--	--	41.22 (c)	41.22 (c)
	methylene chloride ⁽¹⁾	< 3.47	< 3.47	< 3.47	< 3.47	< 3.47	< 3.47	600	9.45	0.24	5.2 (a)	26 (a)
	methyl tert butyl ether	< 1.80	< 1.80	< 1.80	< 1.80	< 1.80	< 1.80	--	--	--	9.4 (a)	47 (a)
	p/m-xylene	5.06	< 4.34	< 4.34	< 4.34	< 4.34	< 4.34	72.41**	11.8**	11.8**	146 (a)	620 (a)
	o-xylene	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17	< 2.17	72.41**	11.8**	11.8**	146 (a)	620 (a)
	heptane	< 2.05	< 2.05	< 2.05	< 2.05	< 2.05	< 2.05	--	--	--	146 (d)	620 (d)
	n-hexane	< 3.52	< 3.52	< 3.52	< 3.52	< 3.52	< 3.52	--	--	--	146 (a)	620 (a)
	styrene	< 2.13	< 2.13	7.18	< 2.13	< 2.13	< 2.13	2.79	200	2	200 (a)	880 (a)
	tetrachloroethene	< 3.39	< 3.39	< 3.39	< 3.39	< 3.39	< 3.39	11.01	922.18	0.02	0.41 (a)	2.1 (a)
	tetrahydrofuran	< 1.47	< 1.47	< 1.47	< 1.47	< 1.47	< 1.47	--	160.35	80.18	--	--
	toluene	5.07	< 1.88	< 1.88	< 1.88	< 1.88	< 1.88	28.65	80	20	1040 (a)	4400 (a)
trichloroethene	< 2.68	< 2.68	< 2.68	< 2.68	< 2.68	< 2.68	4.49	36.52	0.61	1.2 (a)	6.1 (a)	
trichlorofluoromethane	< 2.81	< 2.81	< 2.81	< 2.81	< 2.81	< 2.81	--	--	--	146 (a)	620 (a)	

Notes:

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

RSL - Regional Screening Level; June 20, 2008

⁽¹⁾ Compound is a common laboratory contaminant and detects may be associated with laboratory contamination, as discussed in Section 5.

VOC results for indoor air are compared to contemporary outdoor air (background) sample and MassDEP indoor air background values.

* Threshold Effects Exposure Limits (TELs) and Allowable Ambient Limits (AALs) for ambient air currently in effect (December, 1995)

Alternate Value: (a) Regional Screening Level (ELCR of 1E-06 for carcinogens; hazard of 0.2 for noncarcinogens)

(b) RSL for n-hexane used as surrogate for 2,2,4-trimethylpentane

(c) AAL/TEL for isobutyl alcohol used as surrogate for isopropanol

(d) RSL for n-hexane used as surrogate for n-heptane

(e) RSL for 1,4-dichlorobenzene used as surrogate for 1,2,4-trichlorobenzene

** - Value for xylenes (m-, o-, and p-isomers)

-- - No corresponding comparison criterion.

Table 8-2. Comparison of VOC Vent Stack Sample Results to Comparison Criteria - December 2007
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background	QA/QC	Comparison Values			
		VS-9-15	VS-9-15 Dup	VS-1-15	VS-12-15	VS-4-15	VS-BG-15	Trip Blank-VS	TEL*	AAL*	Alternate Value (residential)	Alternate Value (commercial)
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 37.1	< 37.1	< 37.1	< 37.1	< 3.71	< 3.71	< 3.71	--	--	0.22 (e)	1.1 (e)
	1,2,4-trimethylbenzene	< 24.6	< 24.6	< 24.6	< 24.6	< 2.46	< 2.46	< 2.46	--	--	1.46 (a)	6.2 (a)
	2,2,4-trimethylpentane	<23.3	< 23.3	< 23.3	< 23.3	< 2.33	< 2.33	< 2.33	--	--	146 (b)	620 (b)
	2-butanone	17.6	< 14.7	15.6	< 14.7	6.72	< 1.47	< 1.47	200	10	1040 (a)	4400 (a)
	acetone ⁽¹⁾	< 47.5	< 47.5	< 47.5	< 47.5	18.3	< 4.75	< 4.75	160.54	160.54	6400 (a)	28000 (a)
	benzene	< 16.0	< 16.0	< 16.0	< 16.0	< 1.60	< 1.60	< 1.60	1.74	0.12	0.31 (a)	1.6 (a)
	carbon disulfide	< 15.6	< 15.6	< 15.6	< 15.6	< 1.56	< 1.56	< 1.56	0.1	0.1	146 (a)	620 (a)
	chloroform	< 24.4	< 24.4	< 24.4	< 24.4	< 2.44	< 2.44	< 2.44	132.76	0.04	0.11 (a)	0.53 (a)
	chloromethane	< 10.3	< 10.3	< 10.3	< 10.3	< 1.03	< 1.03	< 1.03	--	--	1.4 (a)	6.8 (a)
	cyclohexane	< 17.2	< 17.2	< 17.2	< 17.2	< 1.72	< 1.72	< 1.72	280.82	280.82	1260 (a)	5200 (a)
	ethanol ⁽¹⁾	< 37.6	< 37.6	< 37.6	< 37.6	4.84	< 3.76	< 3.76	51.24	51.24	--	--
	ethylbenzene	< 21.7	< 21.7	< 21.7	< 21.7	< 2.17	< 2.17	< 2.17	300	300	0.97 (a)	4.9 (a)
	isopropanol ⁽¹⁾	< 12.3	< 12.3	< 12.3	< 12.3	< 1.23	< 1.23	< 1.23	--	--	41.22 (c)	41.22 (c)
	methylene chloride ⁽¹⁾	< 34.7	< 34.7	< 34.7	< 34.7	< 3.47	< 3.47	< 3.47	9.45	0.24	5.2 (a)	26 (a)
	methyl tert butyl ether	35.1	23.4	< 18.0	53.5	< 1.80	< 1.80	< 1.80	--	--	9.4 (a)	47 (a)
	p/m-xylene	< 43.4	< 43.4	< 43.4	< 43.4	< 4.34	< 4.34	< 4.34	11.8**	11.8**	146 (a)	620 (a)
	o-xylene	< 21.7	< 21.7	< 21.7	< 21.7	< 2.17	< 2.17	< 2.17	11.8**	11.8**	146 (a)	620 (a)
	heptane	< 20.5	< 20.5	< 20.5	< 20.5	< 2.05	< 2.05	< 2.05	--	--	146 (d)	620 (d)
	n-hexane	< 35.2	< 35.2	< 35.2	< 35.2	< 3.52	< 3.52	< 3.52	--	--	146 (a)	620 (a)
	styrene	< 21.3	< 21.3	< 21.3	< 21.3	< 2.13	< 2.13	< 2.13	200	2	200 (a)	880 (a)
tetrachloroethene	< 33.9	< 33.9	< 33.9	< 33.9	< 3.39	< 3.39	< 3.39	922.18	0.02	0.41 (a)	2.1 (a)	
tetrahydrofuran	< 14.7	< 14.7	16.3	< 14.7	45.7	< 1.47	< 1.47	160.35	80.18	--	--	
toluene	< 18.8	< 18.8	< 18.8	< 18.8	1.91	< 1.88	< 1.88	80	20	1040 (a)	4400 (a)	
trichloroethene	< 26.8	< 26.8	< 26.8	< 26.8	< 2.68	< 2.68	< 2.68	36.52	0.61	1.2 (a)	6.1 (a)	
trichlorofluoromethane	< 28.1	< 28.1	< 28.1	< 28.1	< 2.81	< 2.81	< 2.81	--	--	146 (a)	620 (a)	

Notes:

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

RSL - Regional Screening Level; June 20, 2008

⁽¹⁾ Compound is a common laboratory contaminant and detects may be associated with laboratory contamination, as discussed in Section 5.

VOC results for indoor air are compared to contemporary outdoor air (background) sample and MassDEP indoor air background values.

* Threshold Effects Exposure Limits (TELEs) and Allowable Ambient Limits (AALs) for ambient air currently in effect (December, 1995)

Alternate Value: (a) Regional Screening Level (ELCR of 1E-06 for carcinogens; hazard of 0.2 for noncarcinogens)

(b) RSL for n-hexane used as surrogate for 2,2,4-trimethylpentane

(c) AAL/TEL for isobutyl alcohol used as surrogate for isopropanol

(d) RSL for n-hexane used as surrogate for heptane

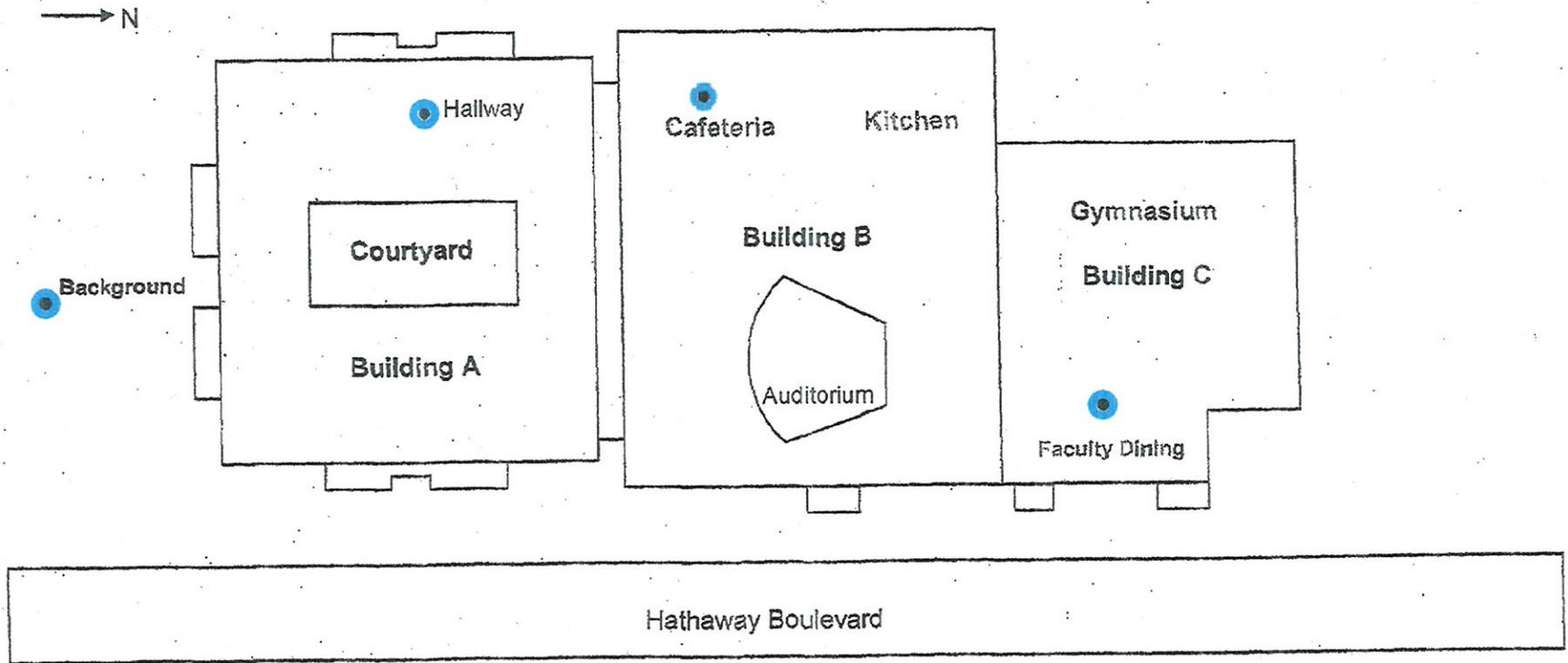
(e) RSL for 1,4-dichlorobenzene used as surrogate for 1,2,4-trichlorobenzene

** - Value for xylenes (m-, o-, and p-isomers)

-- - No corresponding comparison criterion.

FIGURES

Keith Middle School Indoor Air Sampling Locations

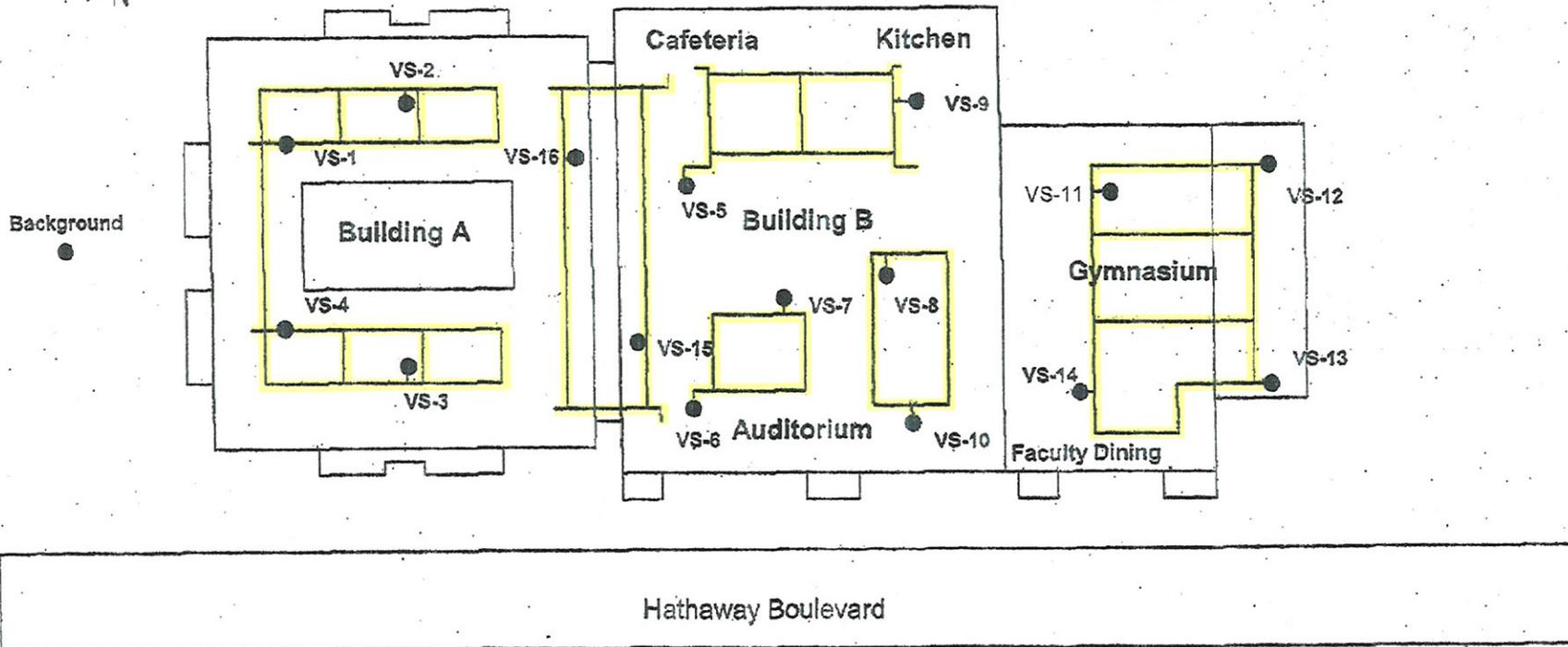
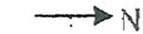


- = Indoor Air Sampling Point
- = Sample Locations

KEITH MIDDLE SCHOOL NEW BEDFORD, MASSACHUSETTS	
INDOOR AIR SAMPLING LOCATIONS	
	Wannanett Mills 650 Suffolk Street Lowell, MA 01854 (978) 970-5500
DRAWN BY: --- CHECKED BY: DMS	DATE: MAY 2008
FIGURE 2-1	

FILE: F:\E_CAD\115058\indoorventsys1.dwg

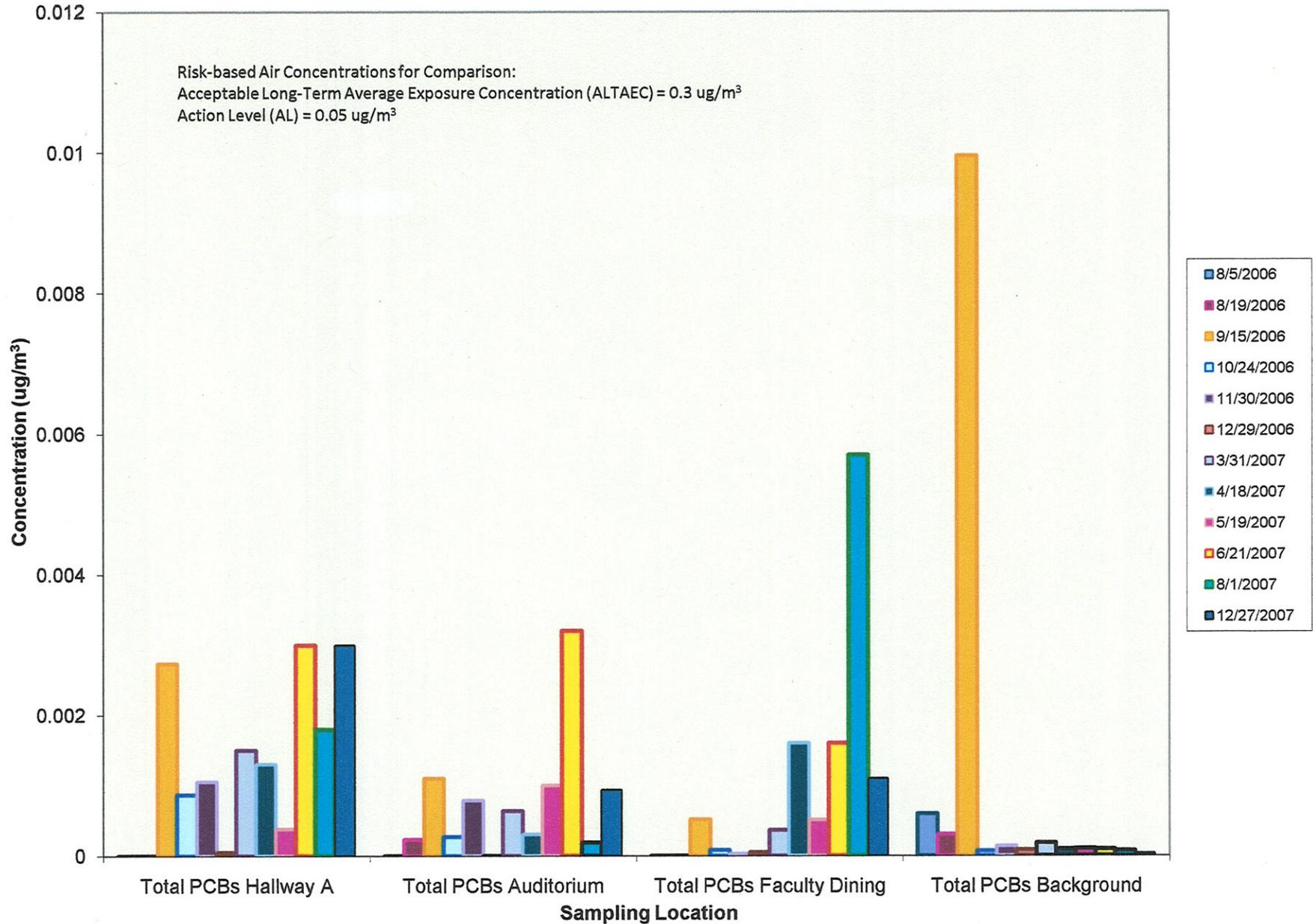
Keith Middle School Foundation Venting System



- = Vent Riser / Vent Stack Sampling location
- = Passive Venting and Collection System

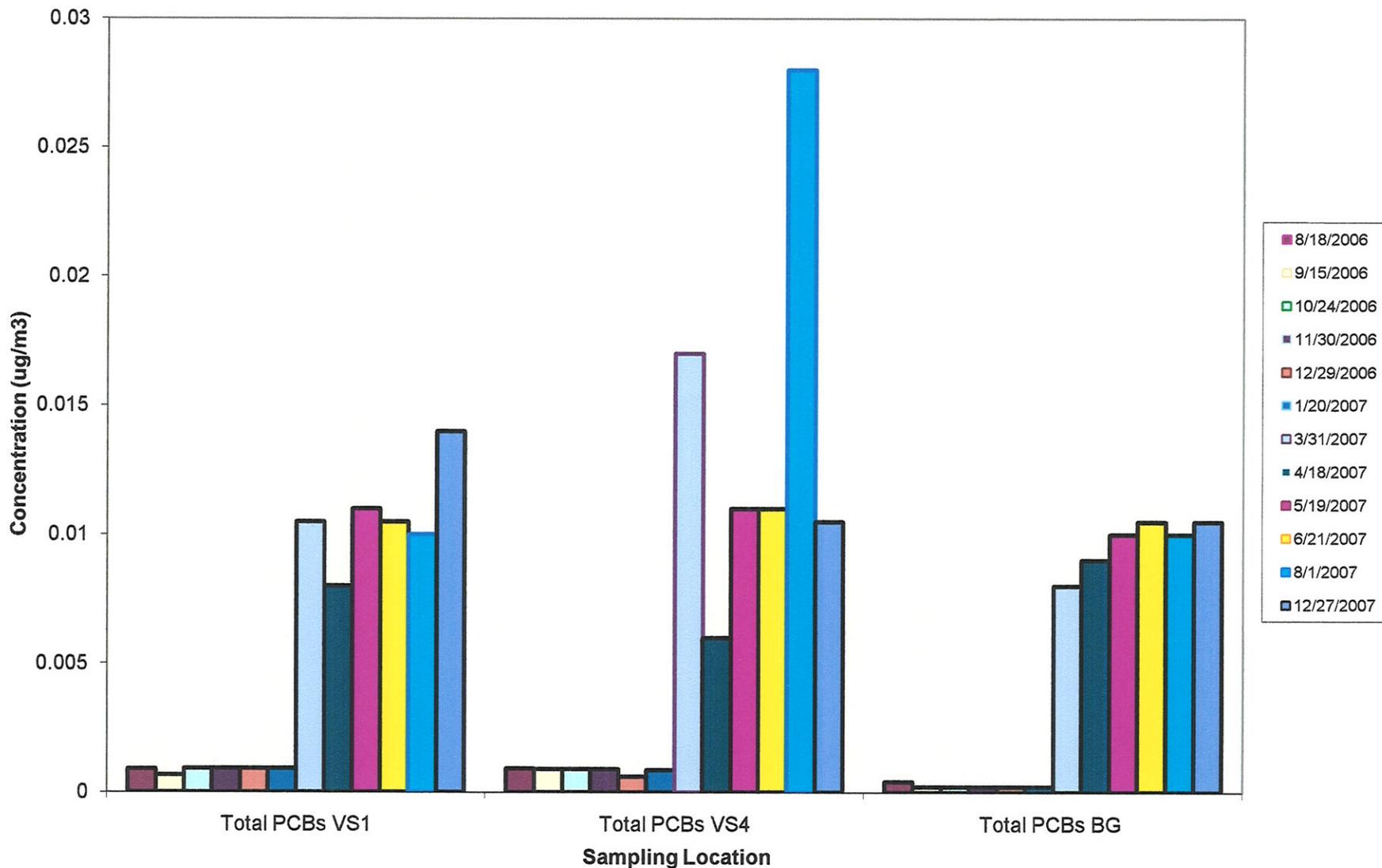
KEITH MIDDLE SCHOOL NEW BEDFORD, MASSACHUSETTS	
VENT STACK SAMPLE LOCATIONS	
	Wannancit Mills 650 Suffolk Street Lowell, MA 01854 (978) 970-5600
DRAWN BY: —	DATE:
CHECKED BY: DMS	MAY 2008
FIGURE 2-2	

Figure 7-1. Total PCB Trends in KMS Indoor Air Quality (IAQ) Samples - August 2006 through December 2007



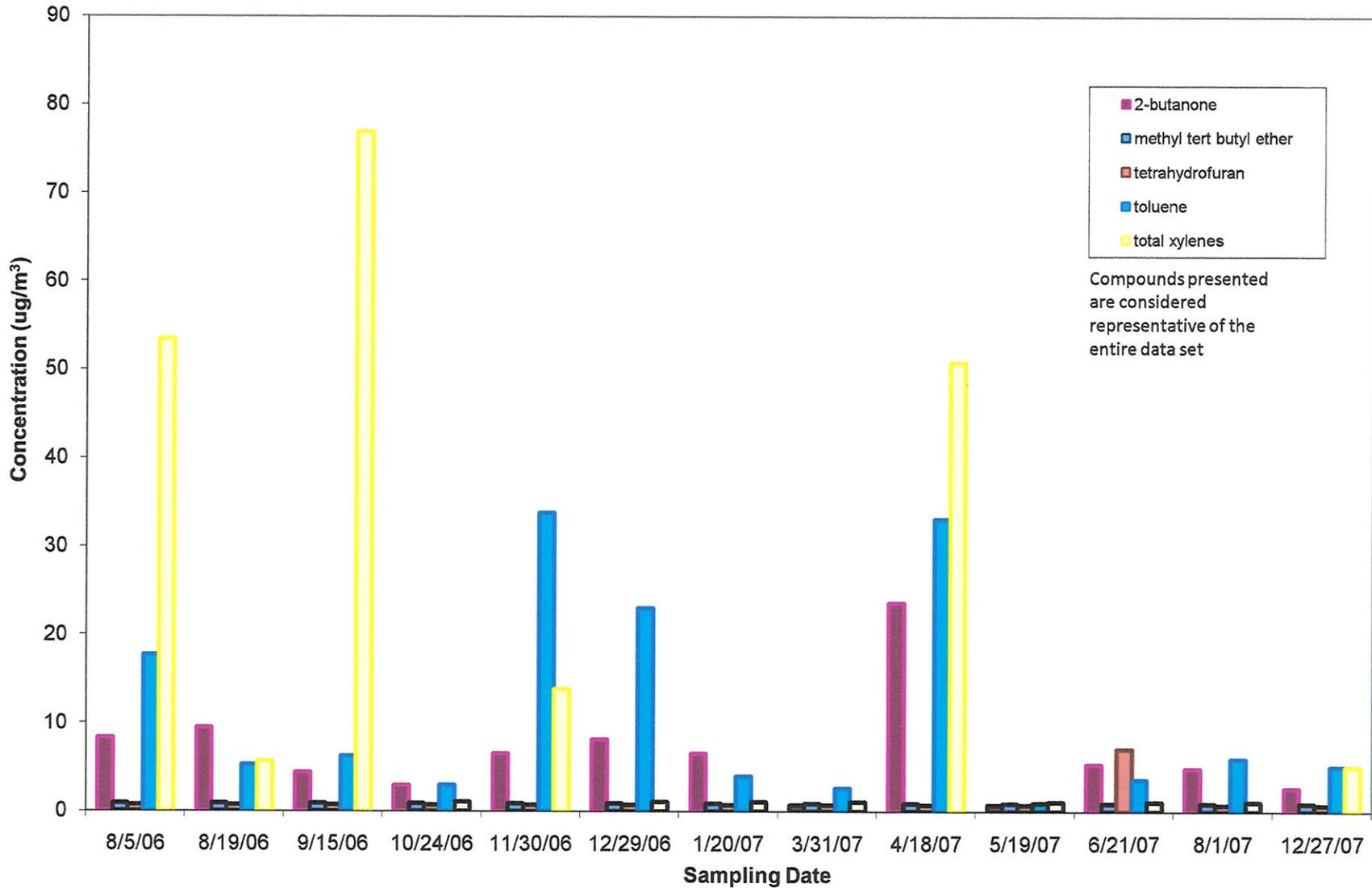
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 7-2. KMS Vent Stack PCB Trends - August 2006 through December 2007



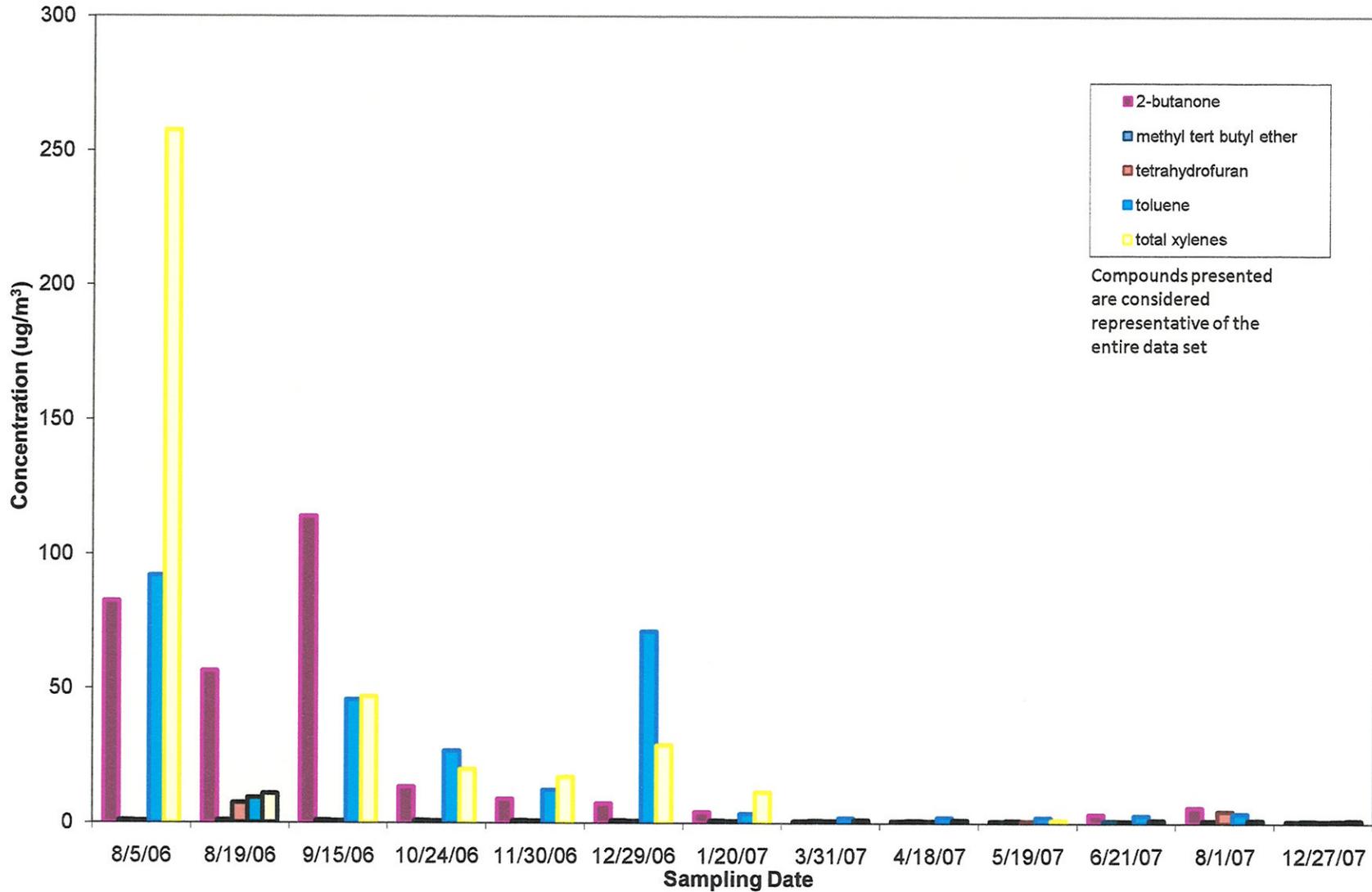
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 8-1. VOC Trends in KMS Building A (IAQ) - August 2006 through December 2007



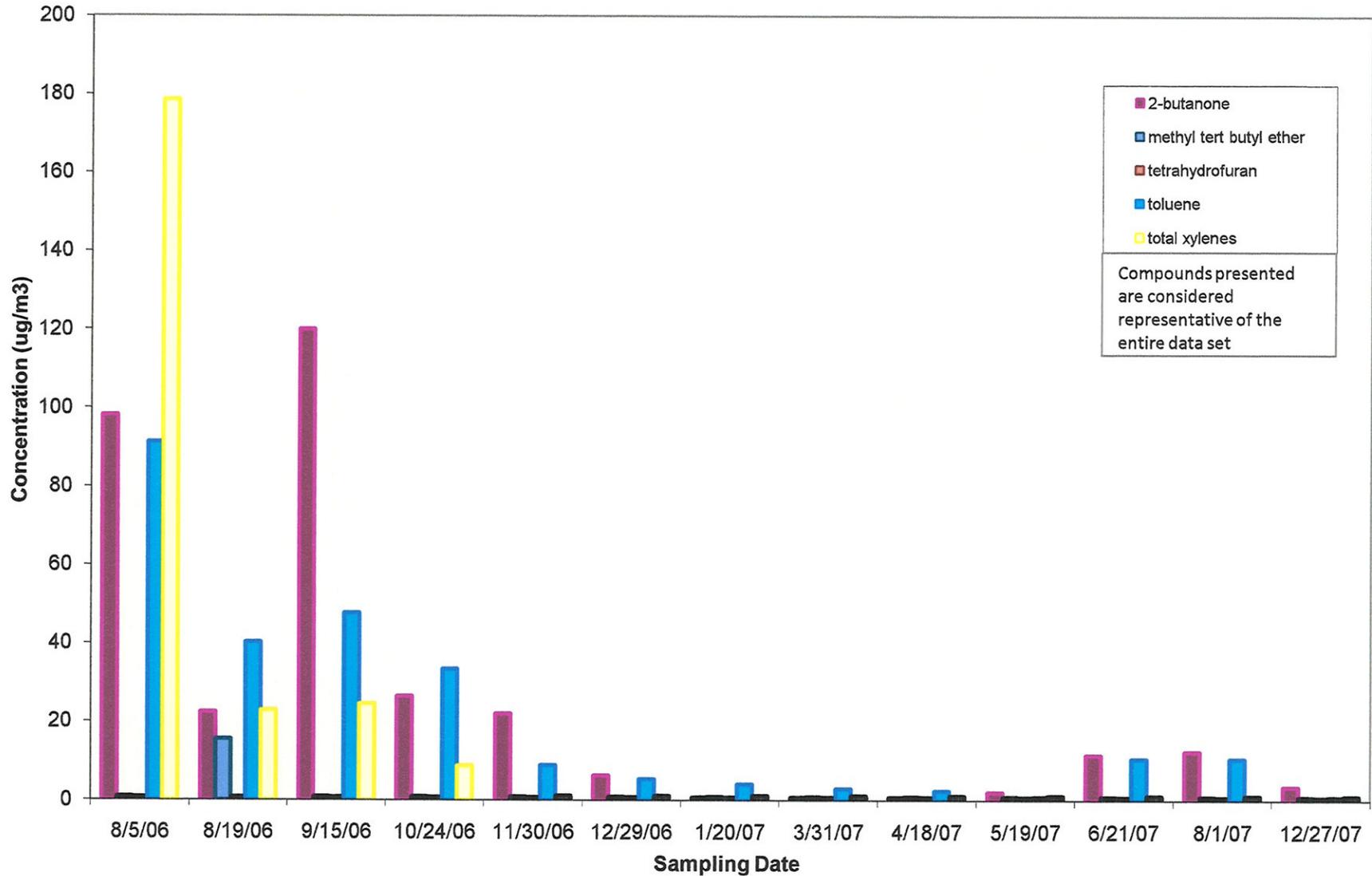
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 8-2. VOC Trends in KMS Building B (IAQ) - August 2006 through December 2007



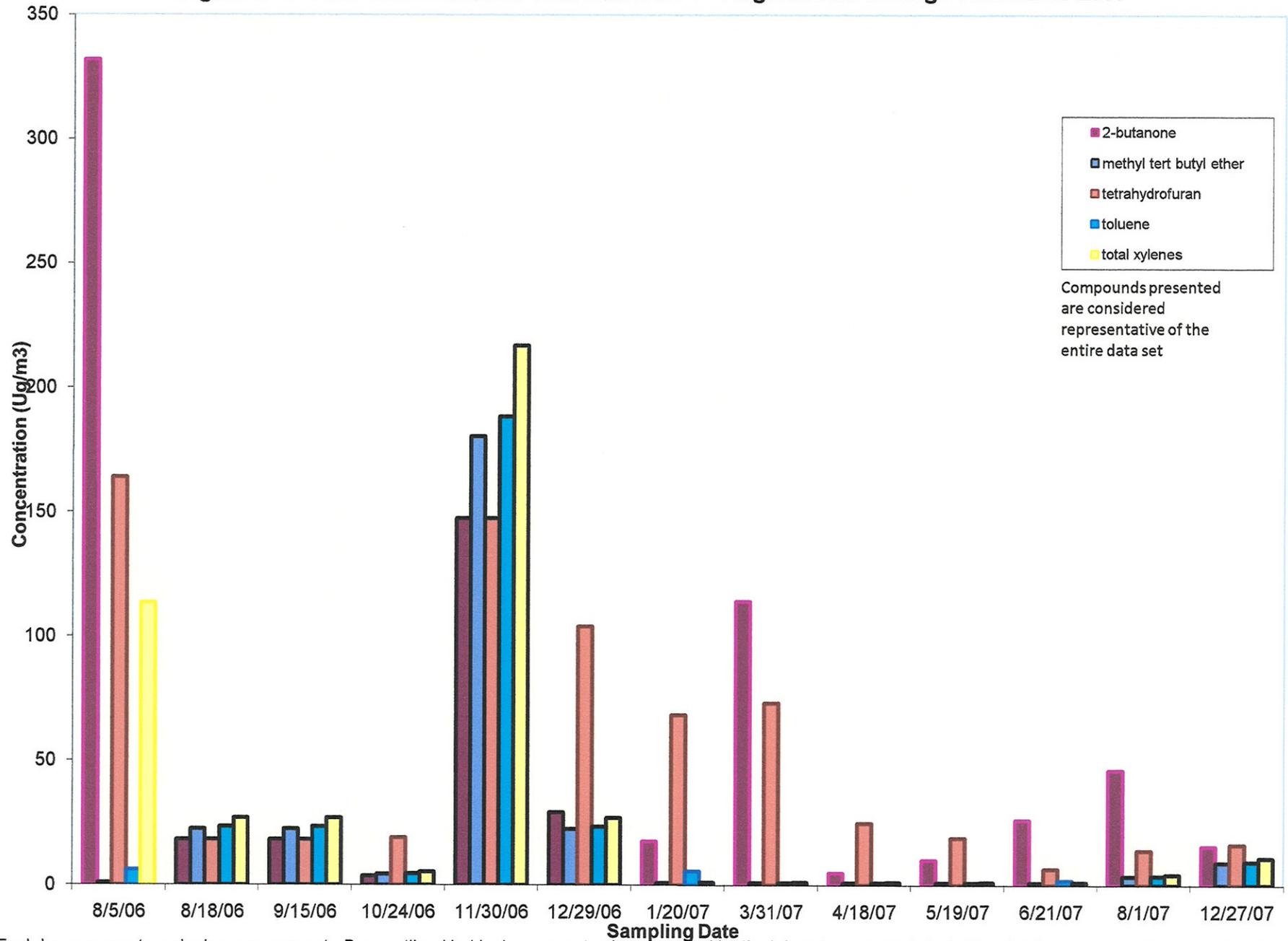
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 8-3. VOC Trends in KMS Building C (IAQ) - August 2006 through December 2007



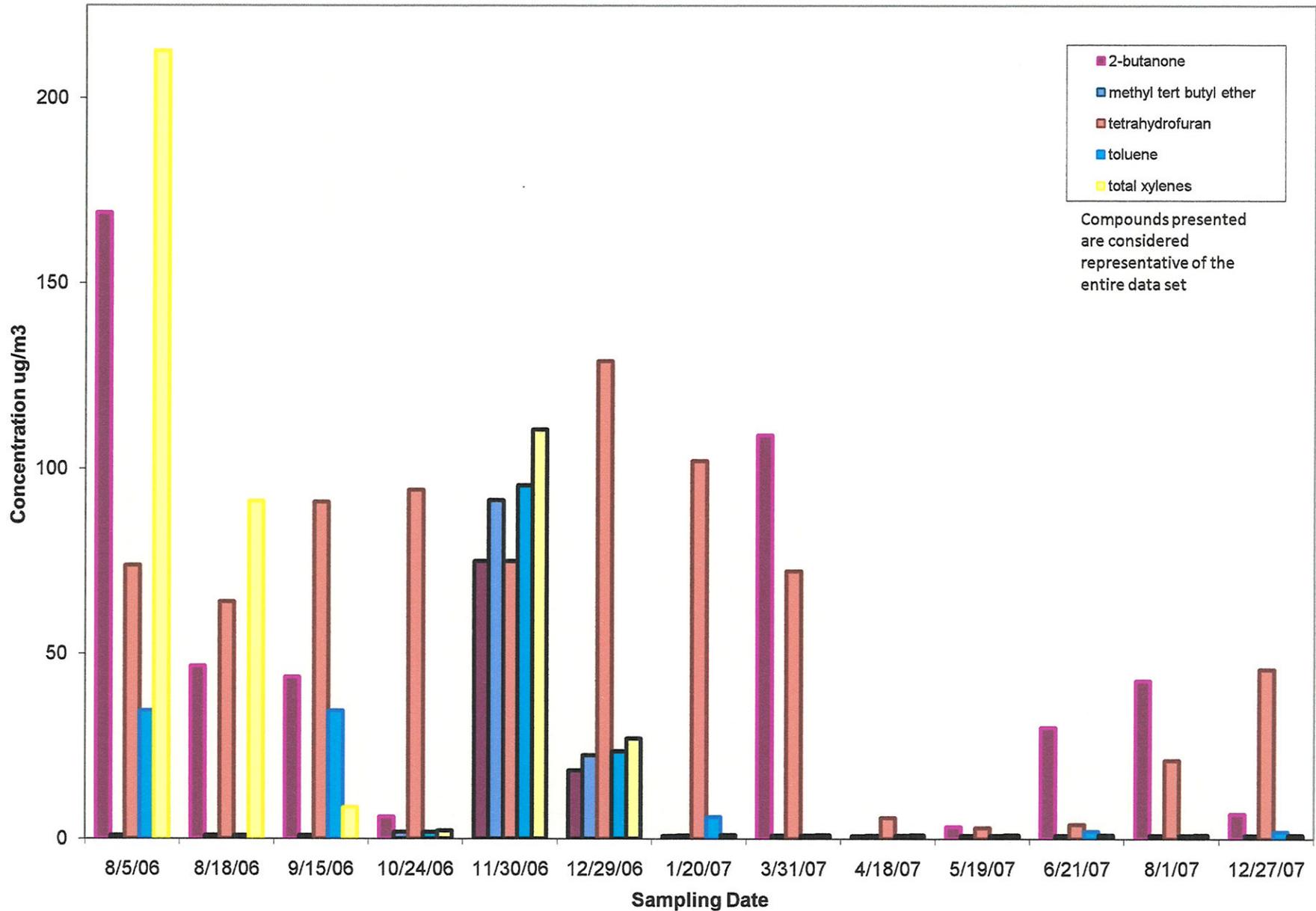
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 8-4. VOC Trends in KMS Vent Stack VS-1 - August 2006 through December 2007



Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 8-5. VOC Trends in KMS Vent Stack VS-4 - August 2006 through December 2007



Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

APPENDIX A

FIELD SAMPLING DATA SHEETS

Keith Middle School Sampling Data Sheet

Vent Air Sampling

Setup Date: 12/28/07
 Recovery Date: 12/28/07

Sampler(s): MLE EM
 Sampler(s): MLE EM

TO-15						
Location	Time		Vacuum (in Hg)		SUMMA Serial No.:	Flow Controller Serial No.:
	Start	Stop	Start	Finish		
VS-9	8:45	12:45	>-30	-4	451	0237
BG VS-9 DWP	9:30	13:26	-29.5	-0.08	380	0398
VS-9 DWP	8:45	12:45	>-30	0	383	0212
VS-1	9:05	12:56	-29.5	-4.5	477	0200
VS-12	8:50	12:50	>-30	0	190	0283
VS-4	9:21	13:10	-29.0	-12	387	0241

TO-10A				
Location	Time		Flow Rate (LPM)	
	Start	Stop	Start	Finish
VS-9	8:45	12:45	5.38	3.48
VS-9 DWP	8:45	12:45	5.01	4.48
VS-12	8:50	12:50	5.06	4.36
VS-1	9:05	12:56	5.11	2.40
VS-4	9:21	13:10	5.20	5.19
BG	9:30	13:26	5.16	4.90



Keith Middle School Sampling Data Sheet Ambient Air Sampling

Setup Date: 12/27/07
Recovery Date: _____

Sampler(s): EM & ML
Sampler(s): _____

TO-15							
Location	Time		Vacuum (in Hg)		SUMMA Serial No.:	Flow Controller Serial No.:	
	Start	Stop	Start	Finish			
A-15 B-15 Hallway 119 BG-15 C-15 BG-Dup	Cafeteria	1405	1125	-27	-6.5	7662	0061
	Teacher Lounge	1400	1325	>-30	-8	7674	0126
	B6	1402	030	-23	0	7314	0199
	Teacher Lounge	1356	1206	>-30	-5	2875	0060
	B6 Dup	1402	1328	>-30	-4.5	7128	0088

→ 0 = -5.5
→ 0 = -2.5

TO-4A								
Location	Time		PUF Number	Serial Number	Sampler Counter (Hrs)		Flow Rate (Mag Reading)	
	Start	Stop			Start	Finish	Initial	Final
Cafeteria	1405	1354	5	0820	235.32	259.13	56	53
Teacher Lounge	1356	1340	1	0825	245.57	264.87	56	51
Hallway 119	1406	1348	2	0821	226.33	245.13	56	51
B6 Dup	1402	1350	4	0823	220.92	244.73	56	53
B6	1402	1350	3	0822	220.49	244.29	56	54



APPENDIX B

FIELD REDUCED DATA

INDOOR SAMPLING LOCATIONS

Average Temp (oF/ K): 60.4 288.8

Average Baro. Press ("Hg / mmHg): 30.07 763.8

Friday, December 28, 2007

Location	Serial #	m _s	b _s	Start Reading ("H2O)	Start Reading (µm)	Stop Reading ("H2O)	Stop Reading (µm)	Avg. Reading ("H2O)	RPD of Start and Stop Readings	Avg. Flow (µm)	Start time (hr)	Stop Time (hr)	Total Sample Time (min)	Total Actual Sample Volume (m ³)
A-15, Hallway Rn	TO-4A 821	0.036	-1.32206	56		51		53.5	9.35	236	197.24	221.26	1441	340.3
B-15, Cafeteria	TO-4A 825	0.036	-1.53953	56		53		54.5	5.50	245	195.66	219.65	1439	352.3
C-15, Faculty lo	TO-4A 820	0.035	-1.21581	56		51		53.5	9.35	237	186.85	210.85	1440	342.0

OUTDOOR SAMPLING LOCATIONS

Average Temp (°F/ K): 37.8 275.2

Average Baro. Press ("Hg / mmHg): 30.07 763.3

Friday, December 28, 2007

Location	Serial #	m _s	b _s	Start Reading ("H2O)	Start Reading (µm)	Stop Reading ("H2O)	Stop Reading (µm)	Avg. Reading ("H2O)	RPD of Start and Stop Readings	Avg. Flow (µm)	Start time (hr)	Start time (clock)	Stop Time (hr)	Stop Time (clock)	Total Sample Time (min)	Total Actual Sample Volume (m ³)
VS-9-15	TO-10A	-	-		5.38		3.48	-	42.89	4.43		8:45		12:45	240	1.08
VS-9-15-DUP	TO-10A	-	-		5.01		4.48	-	11.17	4.745		8:45		12:45	240	1.14
VS-12-15	TO-10A	-	-		5.06		4.36	-	14.86	4.71		8:50		12:50	240	1.13
VS-1-15	TO-10A	-	-		5.11		2.6	-	65.11	3.855		9:05		12:56	231	0.89
VS-4-15	TO-10A	-	-		5.2		5.19	-	0.19	5.195		9:21		13:10	229	1.19
VS-BG-15	TO-10A	-	-		5.16		4.9	-	5.17	5.03		9:30		13:26	236	1.19
	TO-10A	-	-					-		0					0	0.00

Location	Serial #	m _s	b _s	Start Reading ("H2O)	Start Reading (µm)	Stop Reading ("H2O)	Stop Reading (µm)	Avg. Reading ("H2O)	RPD of Start and Stop Readings	Avg. Flow (µm)	Start time (hr)	Stop Time (hr)	Total Sample Time (min)	Total Actual Sample Volume (m ³)
BG-15	TO-4A	822	0.036	-1.57393	56	54	55	55	3.64	237	196.3	220.33	1442	341.9
BG-15-DUP	TO-4A	823	0.037	-1.66839	56	53	54.5	54.5	5.50	231	196.73	220.76	1442	333.5

APPENDIX C

EQUIPMENT CALIBRATION SHEETS

PS1 Calibration Data Sheet

A-15

Network: Keith Middle School Site: New Bedford, MA Serial #: 0821 Station # Hallway 119
 Technician: Q.M., L.M. Date: 12/27/07 Calibration Orifice S/N: 1125 Orif. Cal. Data: 12/3/07

Reason for Calibration (Circle One): New Instrument Brush Change Motor Change Quarterly Recal

Amb. Temp, T1 (°C): 17.2 Bar. press (in Hg): 29.7
 Thermometer Serial #: L001246

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelec
3.7	3.5	7.2	80.00
3.3	3.2	6.5	70.00
2.95	2.8	5.75	60.00
2.5	2.4	4.9	50.00
2.0	1.9	3.9	40.00



A-15

PS1 Post-Sampling Flow Audit

Network: Keith Middle School
Technician: ML

Site: New Bedford, MA
Date: 12/28/07

Serial #: 6821
Calibration Orifice
S/N: 1125

Station # A119 hallway
Orif. Cal. Data: 12/31/07

Amb. Temp, T1 (°C): 19.6
Thermometer Serial #: L001246

Bar.press (in Hg): 30.2

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.55	2.45	5.00	50.00



PS1 Calibration Data Sheet

B-15

Network: Keith Middle School Site: New Bedford, MA Serial #: 0820 Station # Cafeteria
 Technician: ML & EM Date: 12/27/07 Calibration Orifice S/N: 1125 Orif. Cal. Data: 12/03/07

Reason for Calibration (Circle One): New Instrument Brush Change Motor Change Quarterly Recal

Amb. Temp, T1 (°C): 15.6 Bar.press (in Hg): 29.7
 Thermometer Serial #: 2001246

ΔH_o ("H₂O) Calibration Orifice

Left	Right	Total	I ("H ₂ O) Magnahelic
3.7	3.6	7.3	80.00
3.4	3.3	6.7	70.00
2.9	2.85	5.75	60.00
2.45	2.4	4.85	50.00
2.0	2.0	4.0	40.00



PS1 Post-Sampling Flow Audit

B-15

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 0820

Station # cafeteria

Technician: ML

Date: 12/28/07

Calibration Orifice
S/N: 1125

Orif. Cal. Data: 12/3/07

Amb. Temp, T1 (°C): 17.6

Bar. press (in Hg): 30.2

Thermometer Serial #: L001246

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.5	2.35	4.85	50.00

TRC

PS1 Calibration Data Sheet

C-15

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 0825

Station # Teachers Lounge

Technician: EM, LM

Date: 12/27/07

Calibration Orifice
S/N: 1125

Orif. Cal. Data: 12/3/07

Reason for Calibration (Circle One): New Instrument Brush Change Motor Change Quarterly Recal

Amb. Temp, T1 (°C): 15.5

Bar. press (in Hg): 29.7

Thermometer Serial #: 4001246

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
3.9	3.8	7.7	80.00
3.5	3.4	6.9	70.00
2.95	2.9	5.85	60.00
2.6	2.5	5.1	50.00
2.2	2.1	4.3	40.00

C-15

PS1 Post-Sampling Flow Audit

Network: Keith Middle School
Technician: ML

Site: New Bedford, MA
Date: 12/28/07

Serial #: 0825
Calibration Orifice S/N: 1125

Station # teacher's lounge
Orif. Cal. Data: 12/3/07

Amb. Temp, T1 (°C): 16.1
Thermometer Serial #: LOG1246

Bar.press (in Hg): 30.2

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.6	2.5	5.1	50.00



PS1 Calibration Data Sheet

B6-15

Network: Keith Middle School Site: New Bedford, MA Serial #: 0822 Station # B6
 Technician: EM, LM Date: 12/27/07 Calibration Orifice S/N: 1125 Orif. Cal. Data: 12/3/07

Reason for Calibration (Circle One): New Instrument Brush Change Motor Change Quarterly Recal

Amb. Temp, T1 (°C): 4.2 Bar.press (in Hg): 29.7
 Thermometer Serial #: _____

ΔH , ("H₂O) Calibration Orifice

Left	Right	Total	I ("H ₂ O) Magnahelec
3.7	3.6	7.4	80.00
3.4	3.3	6.7	70.00
3.0	2.9	5.9	60.00
2.5	2.5	5.0	50.00
2.0	2.1	4.1	40.00



BG-15

PS1 Post-Sampling Flow Audit

Network: Keith Middle School Site: New Bedford, MA Serial #: 0822 Station # BG
Technician: ML Date: 12/28/07 Calibration Orifice S/N: 1125 Orif. Cal. Data: 12/3/07

Amb. Temp, T1 (°C): 9.6 Bar.press (in Hg): 30.2
Thermometer Serial #: L001246

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.6	2.4	5.0	50.00



PS1 Calibration Data Sheet

BG-DUP-15

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 0823

Station # BG Dup

Technician: GM, LM

Date: 12/27/07

Calibration Orifice

S/N: 1125

Orif. Cal. Data: 12/18/07

Reason for Calibration (Circle One):

New Instrument

Brush Change

Motor Change

Quarterly Recal

Amb. Temp, T1 (°C): 4.2

Bar. press (in Hg): 29.7

Thermometer Serial #: _____

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
3.6	3.5	7.1	80.00
3.25	3.1	6.35	70.00
2.8	2.8	5.6	60.00
2.4	2.5	4.9	50.00
1.9	2.0	3.9	40.00

BG-DUP-15

PS1 Post-Sampling Flow Audit

Network: Keith Middle School Site: New Bedford, MA Serial #: 0823 Station # BG-DUP
Technician: ML Date: 12/28/07 Calibration Orifice S/N: 1125 Orif. Cal. Data: 12/3/07

Amb. Temp, T1 (°C): 9.6 Bar. press (in Hg): 30.2
Thermometer Serial #: L001246

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.6	2.4	5.0	50.00



Network: New Bedford Site: Keith Middle Serial #: 821 Station #: A-15
 Technician: E.M. L.M. Date: 12/27/2007 OrificeS/N: 1125 Orif. Cal. Date: 3-Dec-07

Reason for Puff Sampler Calibration: *Monthly Recal*

Amb. Temp, Ta (°C) 17.2 Bar. Press., Pa (in Hg) 29.70
 Amb. Temp, Ta (K) 290.2 Bar. Press., Pa (mmHg) 754.4

Orifice Data

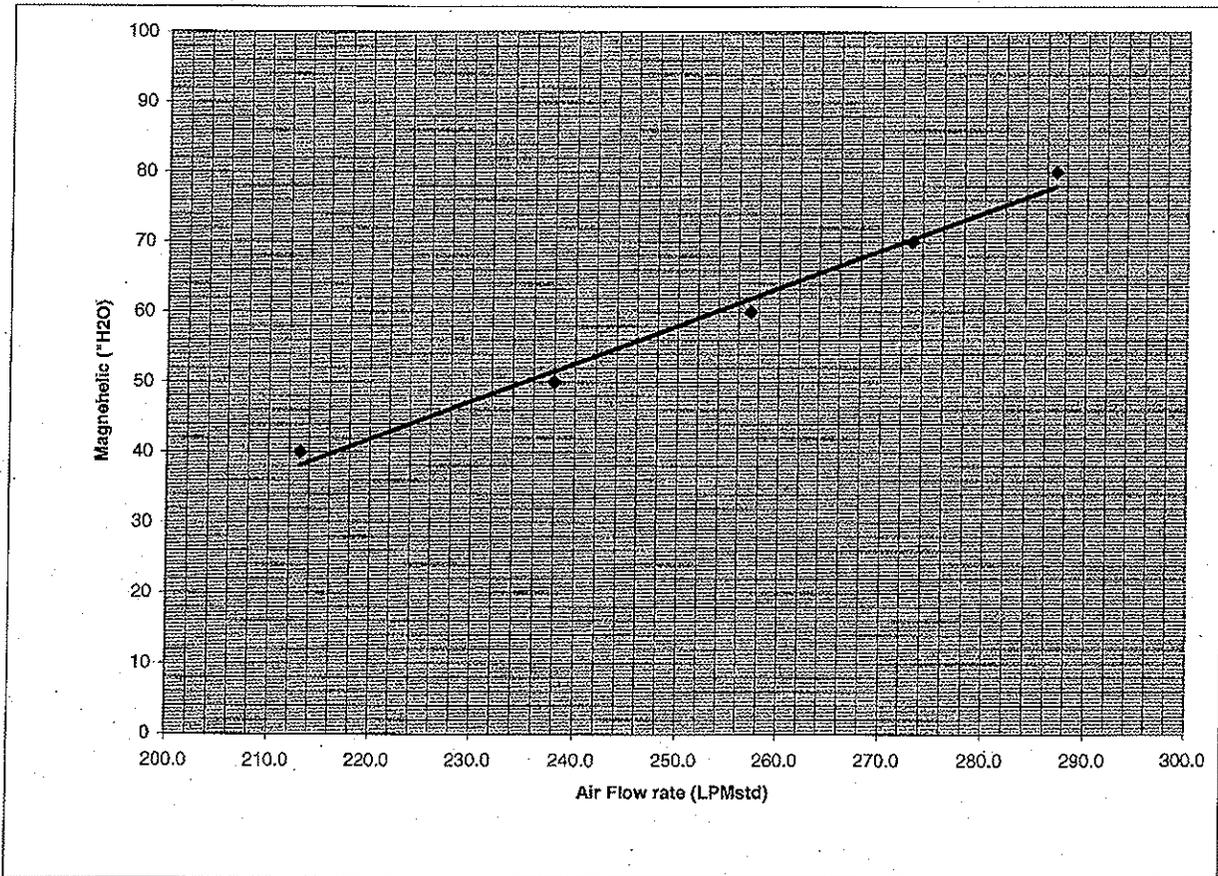
Qstd (m_o) = 9.68572 Qstd (b_o) = -0.07030 Qstd (r_o) = 0.99992

ΔH	Q _{std}	I	I _c
7.20	286.951	80	9.03
6.50	273.008	70	8.45
5.75	257.206	60	7.82
4.90	237.993	50	7.14
3.90	213.107	40	6.38

$I_c = \text{sqrt}[I \times 0.392 \times (Pa/Ta)]$

$Q_{std} = \{(1/m_o) \times \text{sqrt}[DH \times (Pa/760) \times (298/Ta) - b_o]\} \times 1000$

m_s = 0.036 b_s = -1.32206 r_s = 0.99770



Desired Flow Rate (lpm): 250 Sampler Setting: 58.0

m_{mag} = 0.540 b_{mag} = -76.89853 r_{mag} = 0.99301

Network: New Bedford Site: Keith Middle Serial #: 820 Station #: B-15
 Technician: E.M. L.M. Date: 12/27/2007 OrificeS/N: 1125 Orif. Cal. Date: 3-Dec-07

Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 15.6 Bar. Press., Pa (in Hg) 29.70
 Amb. Temp, Ta (K) 288.6 Bar. Press., Pa (mmHg) 754.4

Orifice Data

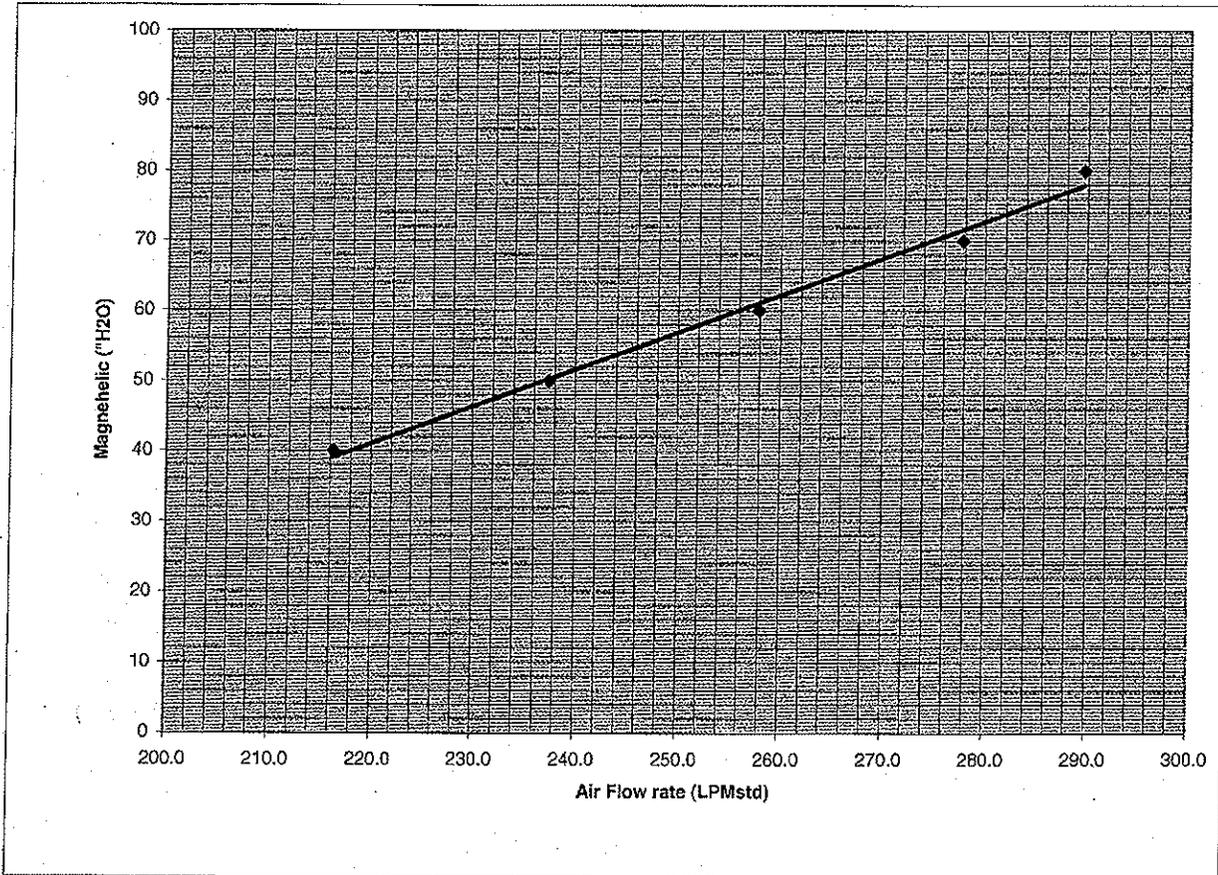
Qstd (m_o) = 9.68572 Qstd (b_o) = -0.07030 Qstd (r_o) = 0.99992

ΔH	Q _{std}	l	l _c
7.30	289.667	80	9.05
6.70	277.812	70	8.47
5.75	257.898	60	7.84
4.85	237.449	50	7.16
4.00	216.306	40	6.40

$l_c = \sqrt{l \times 0.392 \times (Pa/Ta)}$

$Q_{std} = \{ (1/m_o) \times \sqrt{DH \times (Pa/760) \times (298/Ta) - b_o} \} \times 1000$

m_s = 0.035 b_s = -1.21581 r_s = 0.99831



Desired Flow Rate (lpm): 250 Sampler Setting: 56.9

m_{mag} = 0.530 b_{mag} = -75.49138 r_{mag} = 0.99541

Network: New Bedford Site: Keith Middle Serial #: 825 Station #: C-15
 Technician: E.M. L.M. Date: 12/27/2007 OrificeS/N: 1125 Orif. Cal. Date: 3-Dec-07

Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 15.5 Bar. Press., Pa (in Hg) 29.70
 Amb. Temp, Ta (K) 288.5 Bar. Press., Pa (mmHg) 754.4

Orifice Data

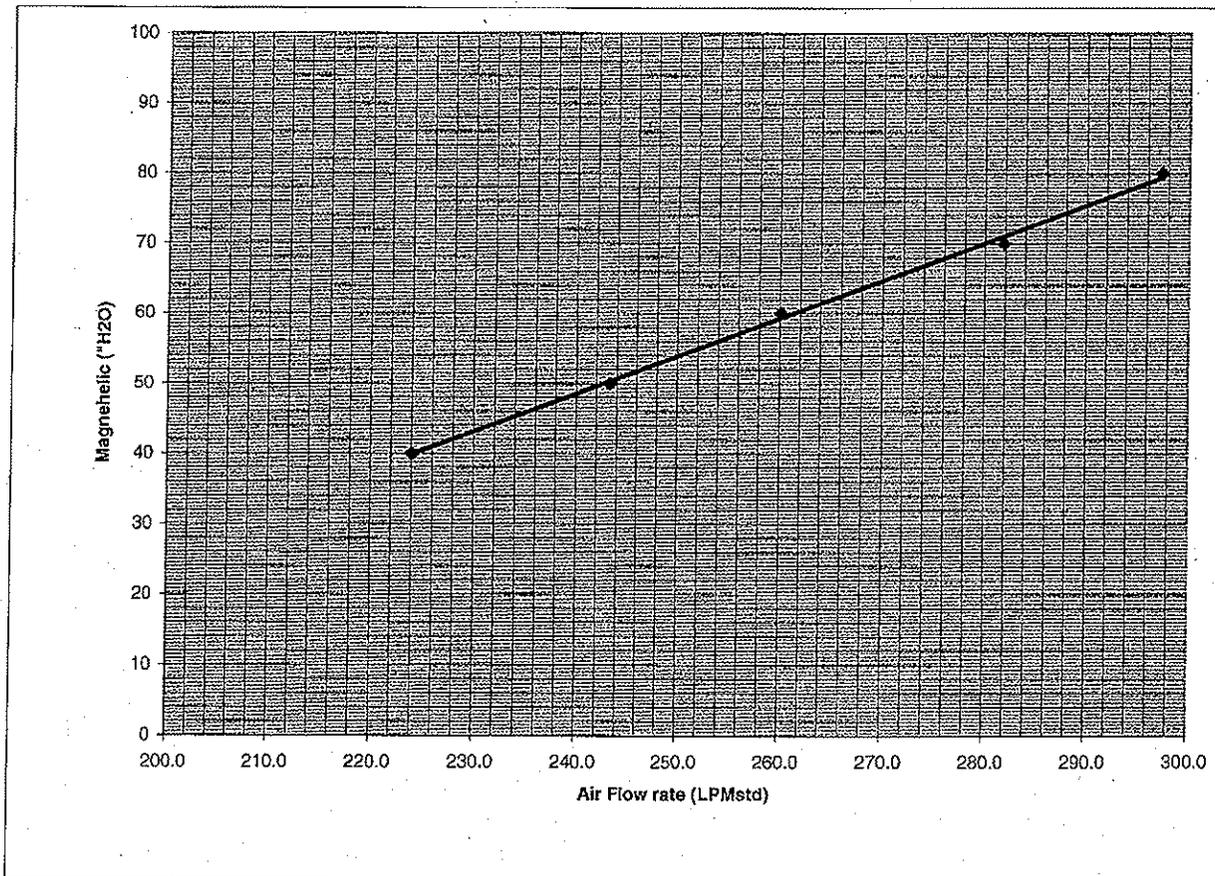
Qstd (m_o) = 9.68572 Qstd (b_o) = -0.07030 Qstd (r_o) = 0.99992

ΔH	Q _{std}	l	l _c
7.70	297.351	80	9.06
6.90	281.868	70	8.47
5.85	260.112	60	7.84
5.10	243.348	50	7.16
4.30	224.041	40	6.40

$l_c = \sqrt{l \times 0.392 \times (Pa/Ta)}$

$Q_{std} = \{(1/m_o) \times \sqrt{DH \times (Pa/760) \times (298/Ta) - b_o}\} \times 1000$

m_s = 0.036 b_s = -1.53953 r_s = 0.99824



Desired Flow Rate (lpm): 250 Sampler Setting: 53.9

m_{mag} = 0.539 b_{mag} = -80.87527 r_{mag} = 0.99899

Network: New Bedford Site: Keith Middle Serial #: 822 Station #: BG-15
 Technician: E.M. L.M. Date: 12/27/2007 OrificeS/N: 1125 Orif. Cal. Date: 3-Dec-07
 Reason for Puff Sampler Calibration: Monthly Recal

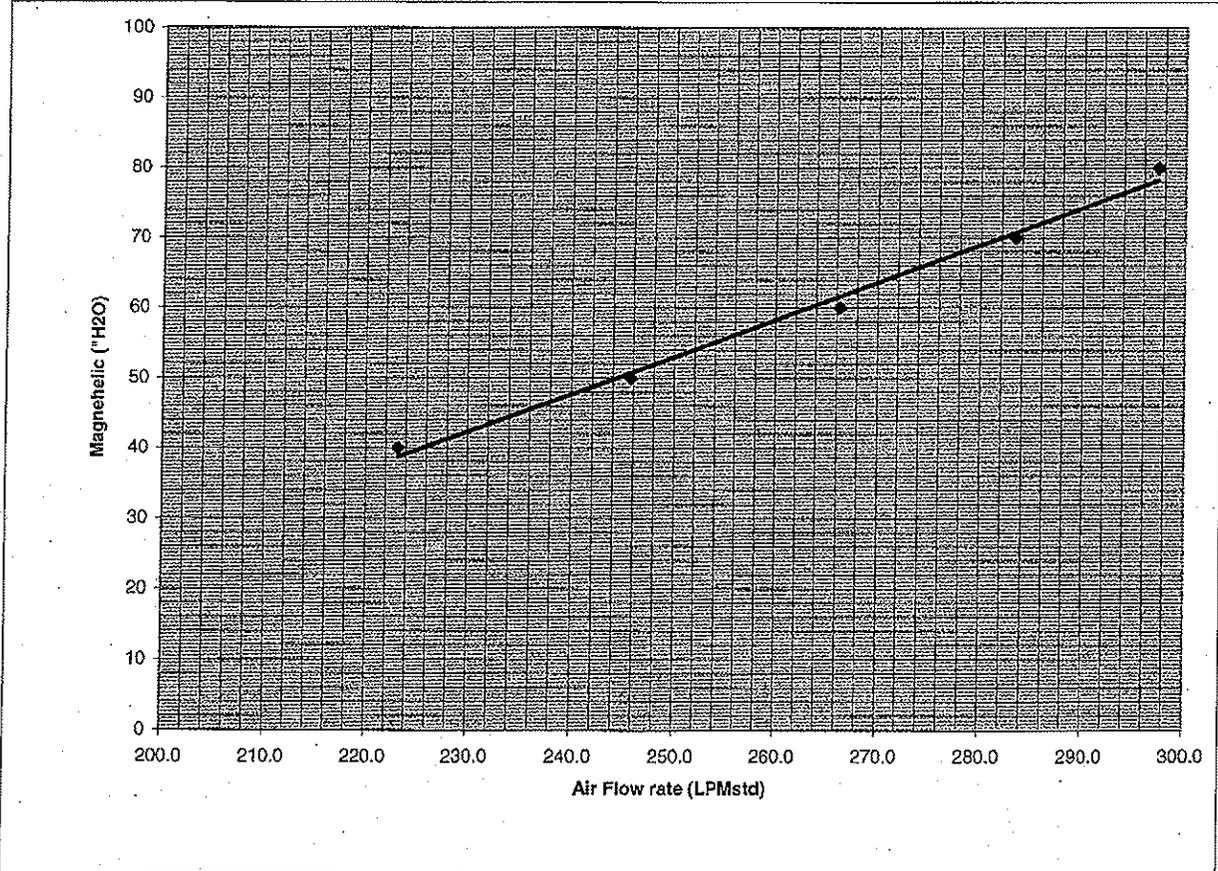
Amb. Temp, Ta (°C) 4.2 Bar. Press., Pa (in Hg) 29.70
 Amb. Temp, Ta (K) 277.2 Bar. Press., Pa (mmHg) 754.4

Orifice Data

Qstd (m_o) = 9.68572 Qstd (b_o) = -0.07030 Qstd (r_o) = 0.99992

ΔH	Q _{std}	l	l _c
7.40	297.382	80	9.24
6.70	283.319	70	8.64
5.90	266.314	60	8.00
5.00	245.739	50	7.30
4.10	223.211	40	6.53

$l_c = \text{sqrt}[l \times 0.392 \times (\text{Pa}/\text{Ta})]$ $Q_{std} = \{[(1/m_o) \times \text{sqrt}[\text{DH} \times (\text{Pa}/760) \times (298/\text{Ta}) - b_o]] \times 1000$
 $m_s = \underline{0.036}$ $b_s = \underline{-1.57353}$ $r_s = \underline{0.99905}$



Desired Flow Rate (lpm): 250 Sampler Setting: 53.0

$m_{mag} = \underline{0.533}$ $b_{mag} = \underline{-80.33542}$ $r_{mag} = \underline{0.99566}$

Network: New Bedford Site: Keith Middle Serial #: 823 Station #: BG-DUP-15
 Technician: E.M. L.M. Date: 12/27/2007 OrificeS/N: 1125 Orif. Cal. Date: 3-Dec-07

Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 4.2 Bar. Press., Pa (in Hg) 29.70
 Amb. Temp, Ta (K) 277.2 Bar. Press., Pa (mmHg) 754.4

Orifice Data

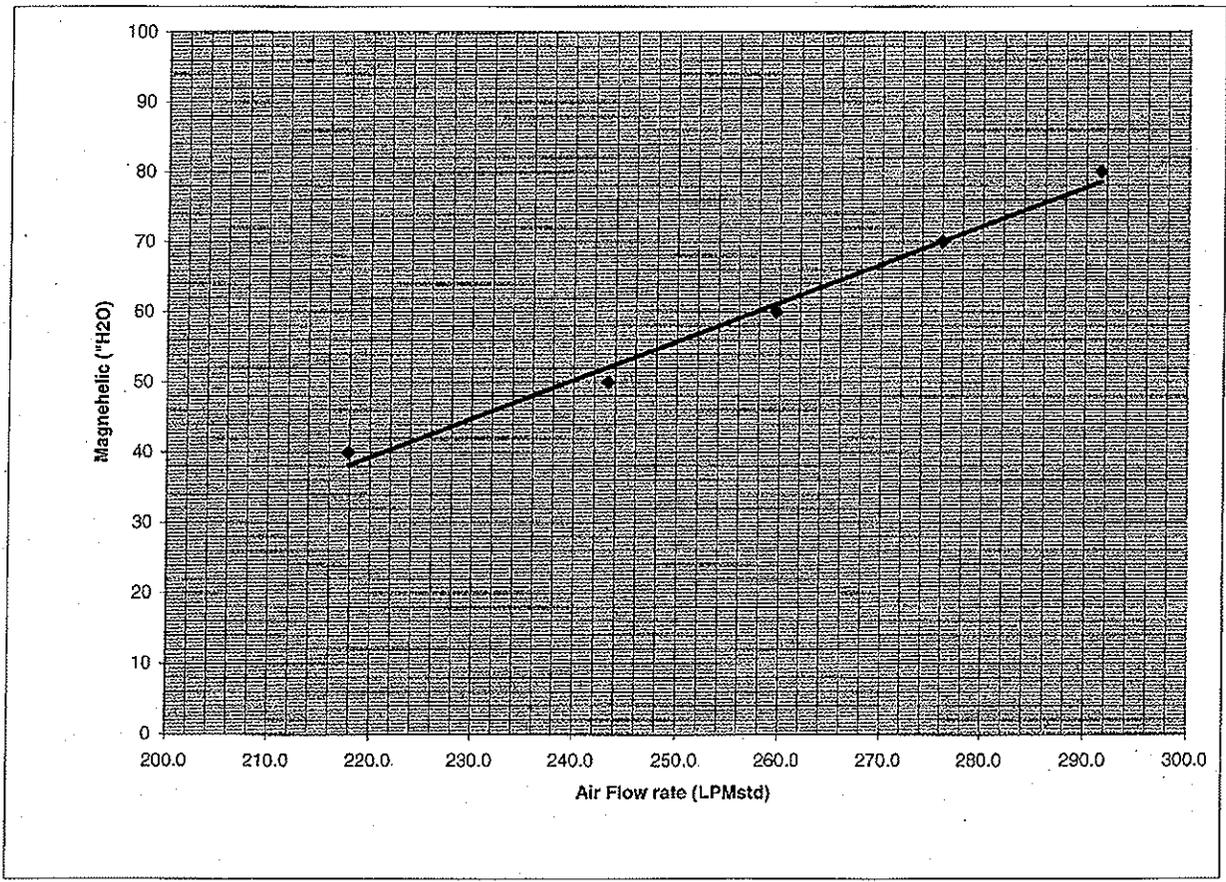
Qstd (m_o) = 9.68572 Qstd (b_o) = -0.07030 Qstd (r_o) = 0.99992

ΔH	Q _{std}	l	l _c
7.10	291.440	80	9.24
6.35	276.012	70	8.64
5.60	259.642	60	8.00
4.90	243.342	50	7.30
3.90	217.878	40	6.53

$l_c = \sqrt{l} \times 0.392 \times (\text{Pa}/\text{Ta})$

$Q_{std} = \{[(1/m_o) \times \sqrt{DH \times (\text{Pa}/760) \times (298/\text{Ta})} - b_o]\} \times 1000$

m_s = 0.037 b_s = -1.66839 r_s = 0.99801



Desired Flow Rate (lpm): 250 Sampler Setting: 55.8

m_{mag} = 0.550 b_{mag} = -81.69542 r_{mag} = 0.99435

PS-1 Post-Sampling Flow Audit

$$Q_{std \text{ Orifice}} (m^3/min) = (1/m_o) * (\text{SQRT}(H_o * (T_{std}/P_{std})) - b_o)$$

$$Q_{std \text{ Sampler}} (m^3/min) = (1/m_s) * (\text{SQRT}(H_s * (T_{std}/P_{std})) - b_s) / 1000$$

$$\% \text{ Difference} = ((Q_{act \text{ Orifice}} - Q_{act \text{ Sampler}}) / Q_{act \text{ Orifice}}) * 100$$

12/28/2007														
			Press (°Hg): 30.2					Press - P _s (mmHg): 767.1						
	Temp (°C):	Temp - T _a (K):	Sampler Serial #	Sampler Reading - H _s (°h ₂ O)	Orifice Reading - H _o (°h ₂ O)	Orifice #	Orifice Slope - m _o	Orifice Intercept - b _o	Qstd Orifice	Sampler #	Sampler Slope - m _s	Sampler Intercept - b _s	Qstd Sampler	% Difference
BG-15	9.6	282.6	822	50	5.00	1125	9.68572	-0.07030	0.245	822	0.036	-1.57353	0.245	0.07
C-15	16.1	289.1	825	50	5.10	1125	9.68572	-0.07030	0.245	825	0.036	-1.53953	0.245	-0.08
B-15	17.6	290.6	820	50	4.85	1125	9.68572	-0.07030	0.239	820	0.035	-1.21581	0.239	-0.19
BG-DUP-15	9.6	282.6	823	50	5.00	1125	9.68572	-0.07030	0.245	823	0.037	-1.66839	0.240	2.10
A-15	19.6	292.6	821	50	5.00	1125	9.68572	-0.07030	0.241	821	0.036	-1.32206	0.237	1.76

822	12/27/2007	m _s =	0.036	b _s =	-1.57353
825	12/27/2007	m _s =	0.036	b _s =	-1.53953
820	12/27/2007	m _s =	0.035	b _s =	-1.21581
823	12/27/2007	m _s =	0.037	b _s =	-1.66839
821	12/27/2007	m _s =	0.036	b _s =	-1.32206

Acceptance Limit <= 10% Difference



TISCH ENVIRONMENTAL, INC.
 145 SOUTH MIAMI AVE.
 VILLAGE OF CLEVELAND, OH 45002
 513.467.9000
 877.263.7610 TOLL FREE
 513.467.9009 FAX
 WWW.TISCH-ENV.COM

AIR POLLUTION MONITORING EQUIPMENT

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5040A

Date - Dec 03, 2007 Rootsmeter S/N 9833620 Ta (K) - 292
 Operator Jim Tisch Orifice I.D. - 1125 Pa (mm) - 758.19

PLATE OR VDC #	VOLUME START (m3)	VOLUME STOP (m3)	DIFF VOLUME (m3)	DIFF TIME (min)	METER DIFF Hg (mm)	ORFICE DIFF H2O (in.)
1	NA	NA	1.00	6.5980	3.6	2.00
2	NA	NA	1.00	3.9670	10.0	5.50
3	NA	NA	1.00	3.2100	15.3	8.50
4	NA	NA	1.00	2.7450	20.7	11.50
5	NA	NA	1.00	2.4350	26.1	14.50
6	NA	NA	1.00	2.2750	29.7	16.50

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)	Va	(x axis) Qa	(y axis)
1.0132	0.1535	1.4270	0.9951	0.1508	0.8776
1.0047	0.2532	2.3664	0.9868	0.2487	1.4554
0.9975	0.3107	2.9418	0.9798	0.3052	1.8093
0.9902	0.3607	3.4217	0.9726	0.3543	2.1045
0.9830	0.4036	3.8422	0.9655	0.3965	2.3631
0.9782	0.4299	4.0987	0.9608	0.4223	2.5208
Qstd slope (m) =		9.68572	Qa slope (m) =		6.06503
intercept (b) =		-0.07030	intercept (b) =		-0.04324
coefficient (r) =		0.99992	coefficient (r) =		0.99992

y axis = $\text{SQRT}[\text{H2O}(\text{Pa}/760)(298/\text{Ta})]$

y axis = $\text{SQRT}[\text{H2O}(\text{Ta}/\text{Pa})]$

CALCULATIONS

$V_{std} = \text{Diff. Vol}[(\text{Pa} - \text{Diff. Hg})/760](298/\text{Ta})$
 $Q_{std} = V_{std}/\text{Time}$

$V_a = \text{Diff Vol}[(\text{Pa} - \text{Diff Hg})/\text{Pa}]$
 $Q_a = V_a/\text{Time}$

For subsequent flow rate calculations:

$Q_{std} = 1/m\{[\text{SQRT}(\text{H2O}(\text{Pa}/760)(298/\text{Ta}))] - b\}$
 $Q_a = 1/m\{[\text{SQRT}(\text{H2O}(\text{Ta}/\text{Pa}))] - b\}$

Bios International Calibration Certificate

Cert No. 102823
Product Defender 520-H
Serial No. 112218
Cal. Date 15 August 2007
Sale Date 25 September 2007
Cal. Due 23 September 2008

TRC Environmental Corporation
650 Suffolk Street
Lowell MA 01852



As Shipped Temperature and Pressure data:

All units tested in accordance with Bios International Corporation test number PR17-12 and PR17-11 using high-purity bottled nitrogen or dry filtered laboratory air.

Technician Zenaída Ortiz

Precision Thermometer	22.6 °C	Defender Temperature	22.5 °C	Allowable Deviation	±0.8 °C
Precision Barometer	749 mmHg	Defender Pressure	749 mmHg	Allowable Deviation	±3.5 mmHg

Asset Number	Cal Date	Due Date	Description
300907	4/9/2007	4/9/2008	Precision Thermometer
431/98-07	4/13/2007	4/13/2008	Precision Barometer

As Shipped Flow Test Data

All units tested in accordance with Bios International Corporation test number PR17-13 Rev A using high-purity bottled nitrogen or dry filtered laboratory air.

Asset Number	Description	Cal Date	Due Date
ML-500-24 101114	ML-500 Medium Flow Cell	10/18/2006	10/18/2007
ML-500-44 102677	ML-500 High Flow Cell	10/12/2006	10/12/2007

Technician Zenaída Ortiz

Lab. Temperature 22.6 °C Lab. Pressure 749 mmHg

Instrument Reading (ml/min)	Lab Standard Reading (ml/min)	Lab Standard Unit No.	Deviation	Allowable Deviation	Condition Shipped
300.46	300.335	101114	0.04 %	1.00%	in tolerance
4999.1	5008.25	102677	-0.18%	1.00%	in tolerance
30023	30003.5	102677	0.06 %	1.00%	in tolerance

Calibration Notes

Bios is an ISO 17025-accredited metrology laboratory. Each Bios primary gas flow standard is dynamically verified by comparing it to one of our laboratory standards, which is a Proven DryCal® Technology volumetric piston prover of much higher accuracy (±0.25% or better) but of similar operating principles. For this purpose, a flow generator of ±0.03% stability is used. Throughout testing, the stability of the flow generator is maintained due to the similar operating principles and construction of our laboratory standards and the devices under test (DUT), assuring the flow generator's validity as a transfer standard. Our laboratory standards are qualified by direct measurement of their dimensions (diameter, length of measured path, time base) using NIST-traceable precision gauges and instruments, such as depth micrometers and laser micrometers. NIST numbers for these gauges and instruments are available upon request. Rigorous analyses of our laboratory standards' uncertainties have been performed, in accordance with The Guide to the Expression of Uncertainty in Measurement (the GUM), assuring their traceable accuracy.

Harvey Padden, President

Bios International Corporation
10 Park Place, Butler, NJ 07405 USA
www.biosint.com

Printed 25 September 2007
Page 1 of 1

APPENDIX D

LABORATORY DATA REPORTS

APPENDIX E

LABORATORY DATA VALIDATION
MEMORANDA



Memo

To: David Sullivan
From: Edward MacKinnon
CC:
Date: 1/31/08
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDG L0800106

SUMMARY

Limited (Tier II) validation was performed on the data for 13 air samples collected at the Keith Middle School, Massachusetts. The samples were collected on December 27 & 28, 2007 and submitted to Alpha Woods Hole Labs (Alpha) in Westborough, MA for analysis. All air vent samples were collected in 2 liter SUMMA® canisters in accordance with EPA method TO-15A; all ambient air samples were collected in 6 liter SUMMA® canisters in accordance with EPA method TO-15A. The samples were analyzed for volatile organic compounds using EPA method TO-15A.

The sample results were assessed using the *EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analyses*, revised December 1996. Modification of these guidelines was performed to accommodate the non-CLP methodology.

In general, the data appear to be valid as reported and may be used for decision-making purposes. Cyclohexane field sample results should be qualified as estimated (UJ) due to low LCS recovery

SAMPLES

Samples included in this review are listed below:

VS-9-15	VS-1-15	BG-15
VS-9-15-DUP (a)	VS-BG-15	B-15
VS-12-15	VENT-TB	BG-15-DUP (b)
VS-4-15	A-15	TRIP BLANK

- a) Field duplicate of VS-9-15
- b) Field duplicate of BG-15

REVIEW ELEMENTS

Sample data were reviewed for the following parameters:

- Agreement of analyses conducted with TRC requests
- Holding times and sample preservation
- Gas chromatography/mass spectrometry (GC/MS) tunes
- Initial and continuing calibrations
- Method blanks
- System Monitoring Compound recoveries
- Laboratory control sample (LCS) results
- Internal standard performance
- Field duplicate results
- Quantitation limits and sample results

DISCUSSION

Agreement of Analyses Conducted with TRC Requests

Sample reports were checked to verify that the results corresponded to analytical requests as designated on the chain-of-custody and any correspondence between TRC and the laboratory. There were no discrepancies noted.

Holding Times and Sample Preservation

All samples were extracted and analyzed within the method-specified holding time.

GC/MS Tunes

The frequency and abundance of all bromofluorobenzene (BFB) tunes were within the acceptance criteria. The samples were analyzed within 12 hours from the BFB tunes.

Initial and Continuing Calibrations

The %RSDs of all target volatile organic compounds (VOCs) used in the initial calibration were within the acceptance criteria ($\leq 30\%$).

The %Ds of all target volatile organic compounds (VOCs) used in the continuing calibrations were within the acceptance criteria.

Method Blanks

Target compounds were not detected in the laboratory method blanks or field blanks associated with the volatile organic compound analyses.

System Monitoring Compound Recoveries

System monitoring compounds were not introduced to these samples. Evaluation of the samples based on system monitoring compound recovery was not performed.

LCS Results

A LCS, WG308038-2, was analyzed along with the field samples. The recoveries of the spiked target VOCs were within the acceptance criteria (70–130%) with the exception of the following:

Compound	Analysis Date	True Value (ppbv)	Found Concentration (ppbv)	% Recovery
Cyclohexane	1/9/08	10	6.76	68

Cyclohexane field sample results be qualified as estimated (UJ/J) with detected results considered possibly biased low due to low LCS recovery.

Internal Standard Performance

Internal standards were within the acceptance criteria in all sample analyses.

Field Duplicate Results

Samples VS-9-15/VIS-9-15-DUP and BG-15/BG-15-DUP were submitted as the field duplicate (collocated) pairs with this sample set. The following table summarizes the relative percent differences (RPDs) of the target VOCs detected in either sample.

VOCs	VS-9-15 ($\mu\text{g}/\text{m}^3$)	VS-9-15 ($\mu\text{g}/\text{m}^3$)	RPD (%)
2-Butanone	17.8	<14.7	< 2 x reporting limit
Methyl tetr butyl ether	36.1	23.4	< 2 x reporting limit

VOCs	BG-15 ($\mu\text{g}/\text{m}^3$)	BG-15-DUP ($\mu\text{g}/\text{m}^3$)	RPD (%)
Acetone	<4.75	4.87	< 2 x reporting limit

All compounds met the duplicate acceptance criteria of 20%RPD or the difference of <2 times the reporting limit for both duplicate pairs (BG-15/BG-15-DUP and VS-9-15/VIS-9-15-DUP).

Quantitation Limits and Sample Results

The quantitation limits met the requirements in the Sampling Plan for this program.



Memo

To: David Sullivan
From: Edward MacKinnon
CC:
Date: 2/6/08
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDG 07080018

SUMMARY

Limited (Tier II) validation was performed on the data for 19 air samples collected at the Keith Middle School, Massachusetts. The samples were collected on December 27 and 28, 2007 and submitted to Northeast Analytical, Inc. (NEA) in Schenectady, New York for analysis. All air vent samples were collected on polyurethane foam (PUF) cartridges in accordance with EPA method TO-10A; all ambient air samples were collected on particulate filters and PUF cartridges in accordance with EPA method TO-4A. The samples were analyzed for polychlorinated biphenyl (PCB) homologues using EPA method 680. NEA reported the results under job numbers 07120194A, 07120194B, and 07120194C.

The sample results were assessed using the *EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analyses*, revised December 1996. Modification of these guidelines was performed to accommodate the non-CLP methodology.

In general, the data appear to be valid as reported and may be used for decision-making purposes.

SAMPLES

Samples included in this review are listed below:

VS-9-15	B-15-PUF	BG-15-PF
VS-9-15-DUP (1)	A-15-PUF	BG-15-DUP-PF (3)
VS-1-15	BG-15-PUF	TRIP BLANK-PF
VS-12-15	BG-15-DUP-PUF (2)	A-15-PF
VS-4-15	TRIP BLANK-PUF	B-15-PF
VS-BG-15	C-15-PUF	C-15-PF
TRIP BLANK		

(1) Field duplicate of VS-9-15

- (2) Field duplicate of BG-15-PUF
- (3) Field duplicate of BG-15-PF

REVIEW ELEMENTS

Sample data were reviewed for the following parameters:

- Agreement of analyses conducted with TRC requests
- Holding times and sample preservation
- Gas chromatography/mass spectrometry (GC/MS) tunes
- Initial and continuing calibrations
- Method blanks
- Surrogate spike recoveries
- Laboratory control sample (LCS) results
- Internal standard performance
- Field duplicate results
- Quantitation limits and sample results

DISCUSSION

Agreement of Analyses Conducted with TRC Requests

Sample reports were checked to verify that the results corresponded to analytical requests as designated on the chain-of-custody and any correspondence between TRC and the laboratory. There were no discrepancies noted.

Holding Times and Sample Preservation

All samples were extracted and analyzed within the method-specified holding time. The cooler temperature was reported at 6.3°C upon receipt at the laboratory. The cooler temperature was slightly higher than the recommended temperature of 4°C ± 2°C. No data qualification was required due to the slightly elevated receipt temperature.

GC/MS Tunes

The frequency and abundance of all decafluorotriphenylphosphine (DFTPP) tunes were within the acceptance criteria. The samples were analyzed within 12 hours from the DFTPP tunes. Window defining mixtures were analyzed following each DFTPP tune.

Initial and Continuing Calibrations

The %RSDs and %Ds of all PCB congeners used in the initial and continuing calibrations were within the acceptance criteria.

Method Blanks

Target compounds were not detected in the laboratory method blanks or trip blanks associated with the PCB homologue analyses.

Surrogate Spike Recoveries

Select samples exhibited recoveries of the surrogate tetrachloro-m-xylene (TCMX) and/or surrogate (decachloro-C13 biphenyl [DCB]) which were outside the acceptance criteria of 40-140% for TCMX

and 44-110% for DCMP. The following table summarizes the surrogate recoveries in the affected samples.

Sample ID	SDG Package	TCMX	DCB
Method Blank (AK22241B)	07120194A	26%	31%
B-14-PUF	07120194B	0%	88%
A-15-PUF	07120194B	0%	41%
BG-15-PUF	07120194B	0%	73%

It is in the opinion of the validator that qualification of the data is not required due to the recovery nonconformances listed above when one of the two surrogate recoveries meet acceptance criteria.

LCS Results

An LCS and LCSD was extracted and analyzed with each extraction batch. Laboratory control samples AK22241L and AK22241S are associated with the preparation and analysis of TO-10A samples. Laboratory control samples AK22248L/AK22248S and AK22254L/AK22254S are associated with the preparation and analysis of PUF fraction and filter fraction of the TO-4A samples respectively.

All LCS/LCSD recoveries were within acceptance criteria.

Internal Standard Performance

In SDG 07120194B, the percent difference for the internal standard Phenanthrene-d10 was below the laboratory established limits for sample BG-15-DUP-PUF. The Chrysene-d12 internal standard was used for quantitation.

Field Duplicate Results

Samples VS-9-15/VS-9-15-DUP, BG-15-PUF/BG-15-PUF-DUP, and BG-15-PF/BG-15-PF-DUP were submitted as the field duplicate (collocated) pairs with this sample set. No PCBs were detected in any sample with the exception of 0.000035 ug/m3 of Dichlorobiphenyl in sample BG-15-DUP-PUF. Dichlorobiphenyl was not detected in sample BG-15-PUF at 0.000073 ug/m3. No data qualification is required.

Quantitation Limits and Sample Results

The quantitation limits met the requirements in the Sampling Plan for this program.

APPENDIX F

INDOOR AIR RISK CALCULATION SPREADSHEET – COMMERCIAL WORKER

Table 1
Commercial Worker Risk Evaluation
Inhalation of Air Exposure Pathway
Keith Middle School
New Bedford, MA

Constituent	EPC	Estimated Dose		Toxicity Values		Risk Estimates	
	Indoor Air Concentration $\mu\text{g}/\text{m}^3$	ADEcancer (Cancer) $\mu\text{g}/\text{m}^3$	ADEnon-cancer (Non-cancer) $\mu\text{g}/\text{m}^3$	Unit Risk $\mu\text{g}/\text{m}^3$	Chronic Noncancer Reference Concentration $\mu\text{g}/\text{m}^3$	Cancer Risk (--)	Hazard Quotient (--)
1,2,4-Trichlorobenzene	1.2E+01	1.0E+00	2.8E+00	NA	2.0E+02	NA	1.E-02
2-Butanone	2.4E+01	1.9E+00	5.4E+00	NA	5.0E+03	NA	1.E-03
Acetone	1.3E+02	1.1E+01	3.1E+01	NA	8.0E+02	NA	4.E-02
Chloromethane	1.5E+01	1.2E+00	3.5E+00	NA	9.0E+01	NA	4.E-02
Ethylbenzene	9.9E+00	8.2E-01	2.3E+00	NA	1.0E+03	NA	2.E-03
Methylene chloride	3.2E+02	2.6E+01	7.3E+01	4.7E-07	3.0E+03	1.E-05	2.E-02
Styrene	7.3E+00	6.0E-01	1.7E+00	5.7E-07	1.0E+03	3.E-07	2.E-03
Tetrahydrofuran	7.1E+00	5.8E-01	1.6E+00	1.9E-06	3.0E+02	1.E-06	5.E-03
Toluene	3.3E+01	2.7E+00	7.6E+00	NA	5.0E+03	NA	2.E-03
Trichlorofluoromethane	3.1E+00	2.5E-01	7.1E-01	NA	7.0E+02	NA	1.E-03
Xylenes	5.1E+01	4.2E+00	1.2E+01	NA	1.0E+02	NA	1.E-01
n-Hexane	1.5E+02	1.2E+01	3.3E+01	NA	2.0E+02	NA	2.E-01
n-Heptane	1.7E+01	1.4E+00	3.8E+00	NA	2.0E+02	NA	2.E-02
Cyclohexane	7.4E+00	6.0E-01	1.7E+00	NA	2.0E+02	NA	8.E-03
1,2,4-Trimethylbenzene	4.9E+00	4.0E-01	1.1E+00	NA	5.0E+01	NA	2.E-02
Ethanol	1.6E+02	1.3E+01	3.7E+01	NA	NA	NA	NA
Isopropanol	1.3E+01	1.1E+00	3.1E+00	NA	NA	NA	NA

Where:

LADEcancer = IAC x EF x ED x EP/APcancer

ADEnon-cancer = IAC x EF x ED x EP / APhon-cancer

Cancer Risk = LADEcancer x UR

Hazard Quotient = ADEnon-cancer / Inhalation Reference Concentration

LADE = Life Time Average Daily Exposure

ADE = Average Daily Exposure

EPC = Exposure Point Concentration

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

And where:

Exposure Frequency (EF) = 250 days/year (5 days a week for 50 weeks of exposure)

Exposure Duration (ED) = 8 hrs/event [1]

Exposure Period (EP) = 25 yr [1]

Unit Conversion (UC) = 0.042 days/hr

Averaging Period (APcancer) = 25550 days [1]

Averaging Period (APnon-cancer) = 9125 days [1]

[1] MADEP, 2008

Risk and hazard for PCBs in indoor air was not quantified because concentrations are associated with background conditions and contribute negligibly to risk and hazard. Risk and hazard is overestimated since continuous worker exposure to the maximum detected VOC concentrations for 25 years is not expected due to downward trends in concentrations.

	Cancer Risk	Hazard Index
TOTAL:	1.E-05	5.E-01

Bold = Cancer Risk > 1.0E-05 or Hazard Quotient > 1.0E+01