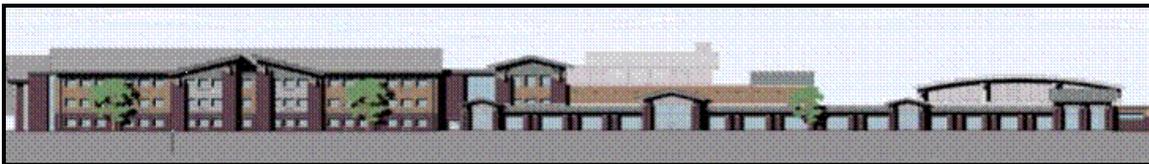


Sampling Results for the Keith Middle School Foundation Vent Stack and Indoor Air for Polychlorinated Biphenyls and Volatile Organic Compounds

April 2011 Monitoring Round



Prepared for:

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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 April 2011.

The sampling and analysis of vent stack and indoor air for KMS is described in 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 from four selected rooftop vent stacks, including VS-5 which vents building Section B (near the Cafeteria), VS-8 which vents building Section B (near the Auditorium), VS-12 which vents Section C (Gymnasium), and VS-16 which vents the area between Section A and Section B. 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 this 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 homologue 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 New Bedford High School.

During the April 2011 sampling round, VOCs were detected in indoor air and vent stack air samples, and PCBs were detected in the three indoor air samples and the duplicate outdoor air background sample. However, PCBs were not detected in any of the vent stack air samples or in the second outdoor air background sample. It should be noted that PCB vent stack air and outdoor air detection limits were well below applicable criteria. The presence of VOCs 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 VOCs entering the venting system.

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. Detected concentrations for PCBs in indoor air samples were generally consistent with urban ambient air background levels. Based on the total PCB indoor air results collected between August 2006 and April 2011, it appears that there is variability in indoor air concentrations and the higher concentrations detected in April 2009, August 2010 and April 2011 relative to previous sampling rounds are not part of a trend. Levels of PCBs and VOCs detected in indoor

air demonstrate fluctuations in measured 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 VOCs from indoor building materials, as well as fugitive emissions 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 VOCs; and 4) reductions in building material related VOC emission sources over time.

PCB indoor air concentrations and vent stack air detection limits 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), which is 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. PCB indoor air concentrations were also compared to EPA's Public Health Level (PHL) (USEPA, 2009; 0.45 ug/m^3) developed to be protective of indoor school air exposures for adult employees and 12 to <15 year-old students. Indoor air PCB concentrations and vent stack air PCB detection limits were lower than RBACs and EPA's PHL.

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 (2011) 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 (after adjustment to correspond to a lower noncancer threshold) 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 to be a 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, and residential and commercial Indoor Air Threshold Values (IATVs), developed by MassDEP considering typical indoor air background concentrations and MassDEP risk management criteria. MassDEP considers investigation of the vapor intrusion pathway to be unnecessary when measured indoor air concentrations are at or below IATVs, assuming that the indoor air results are consistent with other site information and that adequate sampling has been performed.

Among all indoor air samples, six VOCs (1,2,4-trimethylbenzene, benzene, chloroform, ethylbenzene, p/m-xylene and toluene) exceeded one or more comparison criteria. Five of these compounds (benzene, chloroform, ethylbenzene, p/m-xylene and toluene) were detected at concentrations below their corresponding MassDEP indoor air background value and IATVs.

No MassDEP indoor air background values or IATVs are available for the sixth compound (1,2,4-trimethylbenzene). 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 VOC concentrations were associated with a condition of no significant risk to potentially exposed individuals.

In vent stack air, seven VOCs (2-butanone, benzene, chloroform, ethylbenzene, methylene chloride, methyl tertbutyl ether, tetrachloroethene, and trichloroethene) 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 potentially migrating from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, mitigating migration through the building slab and into indoor air. Little if any human exposure to air within the vent stack system itself takes place. Air from the vent stack is vented to outdoor air on the roof of the building 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 winter, 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. Measured concentrations of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed. 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 over time. In addition, the human health risk calculations indicate that there is no significant risk associated with the occupancy of KMS.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION.....	1-1
1.1 Overview.....	1-1
1.2 Scope of Work	1-2
2.0 SAMPLING LOCATIONS	2-1
2.1 Indoor Air Quality Sample Locations.....	2-1
2.2 Foundation Vent Air Monitoring Sample Locations	2-1
3.0 QUALITY ASSURANCE	3-1
3.1 Data Validation Summary.....	3-1
3.2 TO-15 - Persistent Laboratory-Derived Contaminants.....	3-2
3.3 Collocated Sampler Precision.....	3-2
4.0 SUMMARY OF RESULTS	4-1
4.1 Indoor Air Quality Results.....	4-1
4.2 Vent Stack Air Results.....	4-2
5.0 COMPARISON OF PCB RESULTS TO RISK-BASED AIR CONCENTRATIONS	5-1
5.1 Indoor Air.....	5-1
5.2 Vent Stack Air.....	5-2
6.0 COMPARISON OF VOC RESULTS TO COMPARISON CRITERIA.....	6-1
6.1 Indoor Air.....	6-2
6.2 Vent Stack Air.....	6-3
6.3 Risk Characterization for Indoor Air	6-4
6.4 Trend Analysis for VOCs	6-4
6.5 Recommended Modifications to the LTMMIP.....	6-5
7.0 CONCLUSIONS	7-1
8.0 REFERENCES.....	8-1

TABLES

Table 2-1.	April 2011 Sample Summary
Table 3-1.	Comparison of VOC Indoor Air Sample Results - Collocated Sampler Precision
Table 3-2.	Comparison of VOC Vent Stack Air Sample Results - Collocated Sampler Precision
Table 4-1.	Indoor Air Quality Sample Results – April 2011
Table 4-2.	Vent Stack Sample Results – April 2011
Table 5-1.	Comparison of PCB Indoor Air Quality Samples Results to Risk-Based Air Concentrations – April 2011
Table 5-2.	Comparison of PCB Vent Stack Air Sample Results to Risk-Based Air Concentrations – April 2011
Table 6-1.	Comparison of VOC Indoor Air Quality Sample Results to Comparison Criteria – April 2011
Table 6-2.	Comparison of VOC Vent Stack Air Sample Results to Comparison Criteria – April 2011

FIGURES

Figure 2-1.	Indoor Air Sampling Locations
Figure 2-2.	Vent Stack Sample Locations
Figure 5-1.	Total PCB Trends in KMS Indoor Air Quality (IAQ) Samples – August 2006 through April 2011
Figure 5-2.	KMS Vent Stack PCB Trends – August 2006 through April 2011
Figure 6-1.	VOC Trends in KMS Building A (IAQ) – August 2006 through April 2011
Figure 6-2.	VOC Trends in KMS Building B (IAQ) – August 2006 through April 2011
Figure 6-3.	VOC Trends in KMS Building C (IAQ) – August 2006 through April 2011
Figure 6-4.	VOC Trends in KMS Vent Stack VS-1 – August 2006 through April 2011
Figure 6-5.	VOC Trends in KMS Vent Stack VS-4 – August 2006 through April 2011

APPENDICES

Appendix A	Summary of Field Sampling Program, Analytical Program, Quality Assurance, and Inventory of Cleaning Supplies used at KMS
Appendix B	Field Sampling Data Sheets
Appendix C	Field Reduced Data
Appendix D	Equipment Calibration Sheets
Appendix E	Laboratory Data Reports (on CD)
Appendix F	Laboratory Data Validation Memoranda
Appendix G	Discussion of Risk-Based Comparison Criteria
Appendix H	Indoor Air Risk Calculations – Commercial Worker

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 April 2011.

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. 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. An inventory of cleaning supplies used at KMS and their ingredients is provided in Appendix A. Concentrations of PCBs detected in indoor air samples are consistent with background levels measured in outdoor air samples collected simultaneously. Levels of PCBs and VOCs detected in indoor air fluctuate and demonstrate noticeable trends in measured 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 from indoor building materials, as well as fugitive emissions 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; 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 VOCs.

Although PCBs and VOCs have been measured historically 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, 2008a, 2008b, 2008c, 2008d, 2009a, 2009b, 2009c, 2010a, 2010b, 2011a and 2011b).

This report presents monitoring data collected during April 2011. The remaining sections of the report include Section 2 (Sampling Locations), Section 3 (Quality Assurance), Section 4 (Summary of Results), Section 5 (Comparison of PCB Results to Risk-Based Air Concentrations), Section 6 (Comparison of VOC Results to Comparison Criteria), Section 7 (Conclusions), and Section 8 (References). Supporting appendices include Appendix A (Summary of Field Sampling Program, Analytical Program and Quality Assurance), Appendix B (Field Sampling Data Sheets), Appendix C (Field Reduced Data), Appendix D (Equipment Calibration Sheets), Appendix E (Laboratory Data Reports), Appendix F (Laboratory Data Validation Memoranda), Appendix G (Discussion of Risk-Based Comparison Criteria) and Appendix H (Indoor Air Risk Calculations – Commercial Worker).

1.2 Scope of Work

Sampling and analysis of vent stack and indoor air is performed 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, consistent with the LTMMIP. The April 2011 sampling event was the eleventh subsequent event following the July/August 2007 event. Monitoring from September 2006 through February 2007 was conducted by BETA and is reported elsewhere.

The sampling program consisted of the collection of indoor air quality and vent stack samples for the analysis of PCBs and VOCs. Details concerning the sample collection procedures and analytical methods are described in Appendix A. Sampling data sheets are provided in Appendix B and the reduced data are presented in Appendix C. The calibration certifications can be found in Appendix D. Laboratory analytical results are presented in Appendix E.

Field sampling data were validated by the Field Team Leader and/or the Field Quality Control Coordinator based on their review of adherence to each approved sampling protocol and written sample collection procedure. Details concerning quality assurance procedures are described in Appendix A. The laboratory data validation memoranda can be found in Appendix F.

The following sections describe those features of the field sampling program, quality assurance/quality control (QA/QC) program, and data analysis that are specific to the April 2011 event. Generic information on the sampling and QA/QC programs and data analysis procedures can be found in Appendices A and G, respectively.

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 auditorium. The Building C sampling location is in a faculty dining area. These indoor air quality sampling locations have remained consistent throughout TRC's sampling program, with the exception of the December 2007 Building B sample which was collected in the school cafeteria at the request of the City. 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 April 2011 sampling event. Indoor air quality samples collected during the April 2011 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-26).

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 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 April 2011 sampling event. Vent stack samples collected during the April 2011 sampling event were designated with the vent stack number (e.g., VS-9) and a unique sample identification suffix indicating the sampling event number (e.g., VS-9-26).

3.0 QUALITY ASSURANCE

This section highlights the results of the QA/QC review for the April 2011 sampling event. Please refer to Appendix A for additional QA/QC details.

3.1 Data Validation Summary

Limited (Tier II) validation was performed on the data for 16 air samples and three trip blank samples collected at the Keith Middle School in New Bedford, Massachusetts. The samples were collected on April 21, 2011 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 11040360 and 11040361.

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. Potential low bias exists for sample TB-26 (PUF) due to low surrogate recovery. Potential uncertainty exists for the results for trichlorobiphenyl and total PCBs in samples BG-26 (PUF) and BG-26-DUP (PUF) due to high relative percent difference in the evaluation of the field duplicate pair. This issue has a minor impact on the data usability; all results are still usable for project objectives.

Limited (Tier II) validation was performed on the data for 11 air samples and two trip blank samples collected at the Keith Middle School, Massachusetts. The samples were collected on April 21, 2011 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. The positive and nondetect results for C-26 were estimated (J/UJ) due to high pre and post flow controller calibration check relative percent difference. The results for 2-hexanone, 1,2,4-trimethylbenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, n-butylbenzene, 1,2,4-trichlorobenzene, 1,2,3-trichlorobenzene, and hexachlorobutadiene in all samples should be qualified as estimated (J/UJ) due to calibration nonconformances. The results for acetone, 2-butanone, tetrachloroethene, and trichloroethene in samples VS-14-26 and VS-14-26 DUP should be qualified as estimated (J) due to field duplicate precision results. The

results for acetone in samples C-26, B-26, BG-26, BG-26-DUP, VS-4-26, and VS-14-26-DUP and chloromethane in samples C-26, B-26, A-26, and VS-BG-26 should be qualified as estimated (J) due to possible co-elution with non-target compounds. The direction of the bias cannot be determined from these nonconformances. Due to the interference of non-target compounds, the presence of chloromethane in samples VS-1-26, VS-4-26, VS-9-26, VS-14-26, and VS-14-26 DUP could not be confirmed. These affected nondetect results were qualified as estimated (UJ).

3.2 TO-15 - Persistent Laboratory-Derived Contaminants

Based upon review of quality control data, TRC has determined that the results for four compounds reported throughout this report (acetone, ethanol, isopropanol, and methylene chloride) 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.

3.3 Collocated Sampler Precision

The collocated sampler data for the two pairs collected at the KMS during the April 2011 sampling event are summarized in Tables 3-1 and 3-2 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 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). Method precision is expressed as the relative percent difference (RPD) value derived on a parameter specific basis.

EPA Method TO-15 identifies a data quality goal/objective of $\pm 25\%$ RPD for analytes measured in replicate or collocated samples with detected results greater than two times the reporting limit. RPDs were calculated for seven compounds detected in the indoor air samples, as shown on Table 3-1. 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) and RPDs are not calculated when one or both of the collocated results are non-detect. The collocated results for all samples were in good agreement and within all acceptance criteria. In the cases where RPDs could not be calculated, the collocated non-detects show good agreement, although values in both samples could not be quantified.

RPDs were calculated for eleven compounds detected in the vent stack samples, as shown on Table 3-2. The collocated results for acetone (55.8%), 2-butanone (100.2%), trichloroethene (59.4%), and tetrachloroethene (59.9%) exhibited RPDs greater than 25%. The positive results for acetone, 2-butanone, tetrachloroethene, and trichloroethene in samples VS-14-26 and VS-14-26 DUP were estimated (J).

EPA Method TO-4A identifies a data quality goal/objective of $\pm 25\%$ RPD for analytes measured in replicate or collocated samples with detected results greater than two times the reporting limit. RPDs were calculated for total PCBs detected in the indoor air samples, as

shown on Table 3-1. PCBs were detected in the background samples (BG) duplicate samples, collected in April 2011. As shown in Appendix F, collocated results for trichlorobiphenyl and Total PCB were above the acceptance criteria. The positive and nondetect results for trichlorobiphenyl and total PCBs in samples BG-26 and BG-26 DUP (PUF) were estimated (J/UJ).

4.0 SUMMARY OF RESULTS

The following section describes the findings from the sampling events conducted by TRC at the KMS during April 2011. The April 2011 sampling occurred during the school vacation time period. Table 2-1 provides a summary of the types, numbers, and locations of the samples collected. Appendices E and F 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 indoor air quality or vent stack trip blanks. Trip blanks are used as a check on shipping and laboratory-related sources of contamination.

TRC believes that the results for four compounds reported throughout this report (acetone, ethanol, methylene chloride 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 3.2.

A trend analysis of VOC concentrations over time is presented in Section 6.4. VOCs detected in the indoor air samples are believed to be associated with the storage and use of cleaners, adhesives, paint, and other VOC-containing products as well as building construction materials. This finding is based upon sporadic measurements of slightly higher VOC concentrations noted during the winter, 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 of PCB concentrations in indoor air are generally consistent with urban indoor background levels. Measured concentrations of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed.

4.1 Indoor Air Quality Results

On April 21, 2011, TRC collected three indoor and one (plus one duplicate) outdoor background 24-hour TO-4A and TO-15 air samples at the KMS. Table 4-1 provides a summary of results for all compounds that have been found one or more times within the indoor air quality samples.

PCBs were detected in the three indoor air samples and the duplicate outdoor background sample collected, but not in the background outdoor air sample. Total PCB detections ranged from 0.0115 ug/m³ in the Building C sample to 0.0036 ug/m³ in the Building A sample. The total PCB detection in the duplicate outdoor air background sample was 0.0002 ug/m³, and the total PCB detection limit in the background outdoor air sample was 0.0001 ug/m³.

A total of 16 VOCs were detected in the three indoor air quality samples and/or outdoor air background samples collected during April 2011. Three VOCs (chloromethane, difluorodichloromethane, and trichlorofluoromethane) were detected in the three indoor air samples and the background location samples. The indoor air concentrations of each of these VOCs were similar to those detected in the outdoor air background samples. Trichloroethene was detected in the Building B sample, but at a lower concentration than in the outdoor air

background sample. Chloroform was detected in the Building A and Building B samples at a lower concentration than that detected in the outdoor air background sample. Acetone was detected in the Building B and Building C samples at concentrations up to four-fold higher than detected in the outdoor air background samples. Methylene chloride was only detected in the outdoor air background sample.

2-Butanone, benzene, and toluene were detected in the three indoor air samples, but not in the background samples. The highest concentrations of 2-butanone, benzene, and toluene were observed in the Building A sample. Ethylbenzene, p/m-xylene and o-xylene were detected in the Building A and Building B samples with the highest concentration observed in the Building A sample. 1,2,4-Trimethylbenzene, 1,3,5-trimethylbenzene and propylene-propylbenzene were observed only in the Building A sample.

Acetone and methylene chloride 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.

4.2 Vent Stack Air Results

On April 21, 2011, TRC collected four (plus one duplicate) vent stack and one ground level outdoor background 4-hour TO-10A and TO-15 samples at the KMS. Table 4-2 provides a summary of results for the vent stack samples.

In April 2011, PCBs were not detected in the vent stack samples or in the outdoor air background sample.

A total of 13 VOCs were detected in the vent stack air samples and/or background sample, including the common laboratory contaminants acetone and methylene chloride. Three of the detected VOCs (acetone, difluorodichloromethane and trichlorofluoromethane) were detected in one or more of the vent stack air samples and at the outdoor air background sampling location. For these three VOCs, similar concentrations (i.e., less than 2-fold different) were observed in the vent stack air and outdoor air samples, except for acetone which displayed concentrations 3 to 20-fold the background concentration in the four vent stack air samples. Chloromethane was only detected at the outdoor air sampling location.

2-Butanone, benzene, carbon disulfide, chloroform, methylene chloride, methyl tert butyl ether, tetrachloroethene, tetrahydrofuran, toluene, and trichloroethene, were detected in one or more of the subsurface collection zones and not at the outdoor air background sampling location, indicating the localized presence of these compounds in the ventilation system or in the subsurface vented by the system.

5.0 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 5-1 and 5-2 for the April 2011 sampling event. Compound-specific results exceeding RBACs are highlighted on these tables. Measured concentrations of compounds exceeding RBACs are discussed in Sections 5.1 and 5.2 for indoor air and vent stack air, respectively. A detailed discussion of the RBACs can be found in Appendix G.

Two PCB RBACs have been developed for the KMS. 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. The ALTAEC could be exceeded over the short-term and still result in acceptable risk levels. In September 2009, EPA published Public Health Levels (PHLs) which are calculated indoor air concentrations that maintain PCB exposures below a level that EPA believes does not cause harm (USEPA, 2009). PHLs were calculated for all ages of children from toddlers in day care to adolescents in high school as well as for adult school employees. In this report, indoor air PCB concentrations are also compared to the PHL for adult school employees and children 12 to <15 years old, representative of the middle school age range.

The LTMMIP specifies that both indoor air and vent stack air 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. However, this comparison is less appropriate for vent stack air results since little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is vented to outdoor air where the PCBs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to RBACs 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.

5.1 Indoor Air

Indoor air sampling results, outdoor air background results, and RBACs are presented in Table 5-1. PCBs were detected at all three of the indoor air sampling locations (Buildings A, B, and C). PCBs were detected in the duplicate outdoor air background sample, but not in the outdoor air background sample. The highest indoor air total PCB concentration (Building C sample) was approximately 4-fold lower than the PCB AL and roughly 25-fold lower than the ALTAEC; the Building A and Building B samples displayed concentrations of PCBs approximately 12-fold lower than the AL and 75-fold lower than the ALTAEC. Because the PCB AL is used as an initial indicator that PCB air concentrations above background levels for indoor air have been detected and the detected concentrations of PCBs are significantly less than the AL,

concentrations of PCBs in indoor air are consistent with levels associated with ambient conditions. The indoor air samples were also between 40- and 125-fold lower than the EPA PHL. 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 locations in Building A (classrooms), Building B (auditorium), and Building C (faculty dining area) are shown in Figure 5-1. Figure 5-1 also shows concentration trends at the outdoor air background sampling location. Data included on this figure are for the time period August 2006 to April 2011. The highest indoor air total PCB concentration was detected during the April 2009 sampling event when the school was likely experiencing lower than normal air exchange (school vacation) and the potential for volatilization of PCBs from outdoor ambient sources is greater due to the warmer weather. The lowest indoor air total PCB concentration was detected during the November 2006 sampling event.

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 outdoor ambient sources is greatest due to warmer weather. The low level PCB indoor air concentrations are generally consistent with urban ambient background conditions. Based on the total PCB indoor air results collected between August 2006 and April 2011, it appears that there is variability in indoor air concentrations and the higher concentrations detected in April 2009, August 2010 and April 2011 relative to previous sampling rounds are not part of a trend.

5.2 Vent Stack Air

Vent stack air sampling results, outdoor air background results, and RBACs are presented in Table 5-2. PCBs were not detected at the four vent stack sampling locations. 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, ranging from 0.0192 ug/m³ to 0.0227 ug/m³, were higher than the detected indoor air total PCB concentrations. However, reporting limits were approximately 2-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 5-2. Two vent stack locations were consistently sampled on a monthly basis so as to establish concentration trends. The vents selected were VS-1 and VS-4 which were chosen because Building A consists of classrooms where children spend most of the day and both vent from the Building A vapor collection zone. Figure 5-2 also shows concentration trends at the outdoor air background sampling location. Data included on this figure are for the time period August 2006 to April 2011. Total PCB concentrations in VS-1 and VS-4 are consistent over time and similar to levels present at the outdoor air background location. The low level fluctuations in PCB vent stack air

concentrations suggest that the range of measured concentrations is representative of typical conditions within the subsurface ventilation system.

6.0 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 6-1 and 6-2. Compound-specific results exceeding comparison criteria are highlighted on these tables. The detected concentrations of compounds exceeding comparison criteria are discussed in Section 6.1 for indoor air quality samples and Section 6.2 for vent stack air samples, followed by a discussion in Section 6.3 of the findings of a risk characterization conducted to evaluate the significance of the comparison criteria exceedances. Risk-based comparison criteria are discussed below, with greater detail provided in Appendix G. Section 6.4 presents the observed trends in contaminant concentrations over time.

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). 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.

VOC concentrations in excess of AALs and TELs are discussed relative to alternate comparison criteria because TELs and AALs have not been revised since 1995 and may not include the most up-to-date toxicity information available. The alternate comparison criteria are primarily residential and commercial EPA screening levels (EPA SLs) developed by Oak Ridge National Laboratory (May 2011; USEPA, 2011) 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. 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 (after adjustment to correspond to a lower noncancer threshold) are set at risk levels that are only a portion of the MassDEP risk management criteria (see Appendix G for additional information on this), 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. Surrogate assignments are identified in footnotes on Tables 6-1 and 6-2.

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 the 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 (MassDEP, 2008a) and residential and commercial Indoor Air Threshold Values (IATVs; December 2010) developed by MassDEP considering typical indoor air background concentrations and MassDEP risk management criteria. The residential IATVs assume continuous exposure (24 hours per day, 365 days per year for 30 years) while the commercial IATVs were developed to be applicable to exposures of lesser duration and intensity (8 hours per day, 250 days per year for 30 years). MassDEP considers investigation of the vapor intrusion pathway to be unnecessary when measured indoor air concentrations are at or below IATVs, assuming that the indoor air results are consistent with other site information and that adequate sampling has been performed. 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 since little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is vented to outdoor air where the VOCs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to comparison criteria 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.

6.1 Indoor Air

As presented in Table 6-1, concentrations of six VOCs in the indoor air samples exceeded one or more comparison criteria. The compounds are 1,2,4-trimethylbenzene, benzene, chloroform, ethylbenzene, p/m-xylene and toluene. Benzene, chloroform, ethylbenzene, p/m-xylene and toluene were detected at concentrations below MassDEP IATVs, indicating that the presence of these compounds in indoor air is not a site-related finding. No MassDEP IATVs are available for 1,2,4-trimethylbenzene.

1,2,4-Trimethylbenzene, benzene, chloroform, ethylbenzene and toluene concentrations detected in one or more of the indoor air samples exceed comparison criteria developed assuming long-term continuous exposure. However, the concentrations do not exceed the TEL and commercial EPA SL, which are more applicable to actual exposures occurring at the KMS than the AAL or residential EPA SL, despite the “commercial” label. Therefore, the 1,2,4-trimethylbenzene, benzene, chloroform, ethylbenzene and toluene concentrations in the indoor air samples are unlikely to be of concern. This conclusion is supported by the risk characterization presented in Section 6.3.

The p/m-xylene concentration detected in one of the three indoor air samples exceeds its AAL and TEL. However, the concentration does not exceed the residential or commercial EPA SLs, which are based on more recent toxicity information and more applicable to actual exposures occurring at the KMS in the case of the commercial EPA SL. Therefore, the p/m-xylene concentration in the indoor air sample is unlikely to be of concern, as supported by the risk characterization presented in Section 6.3.

6.2 Vent Stack Air

As indicated on Table 6-2, concentrations of seven VOCs in vent stack air samples exceeded one or more comparison criteria. The compounds include 2-butanone, benzene, chloroform, methylene chloride, methyl tertbutyl ether, tetrachloroethene, and trichloroethene. 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 measured 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.

2-Butanone, benzene, methyl tertbutyl ether, and trichloroethene concentrations detected in vent stack air samples only exceed comparison criteria developed assuming continuous exposure (i.e., AALs and/or residential EPA SLs). Because the concentrations of these compounds do not exceed TELs and commercial EPA SLs, these concentrations in the vent stack air samples are unlikely to be of concern.

The chloroform and tetrachloroethene vent stack air concentrations do not exceed the TELs, applicable to short-term exposures, though the detected concentrations do exceed the AALs and residential/commercial EPA SLs. However, the detected concentrations only exceed the commercial EPA SL, most applicable to exposures occurring at the KMS, by approximately 5-fold at most. Therefore, these concentrations in the vent stack air samples are unlikely to be of concern.

The methylene chloride vent stack air concentration in one sample (27 ug/m^3) exceeds all four screening criteria, including the commercial EPA SL. However, the concentration in the vent stack air sample only slightly exceeds the commercial EPA SL (26 ug/m^3). Therefore, this compound is unlikely to be of concern because exposure to vent stack air is not occurring.

Seven of the 13 compounds present in vent stack air were detected in the December 2001 subsurface soil gas sampling event conducted by BETA, including 2-butanone, acetone, benzene, carbon disulfide, methyl tert butyl ether, tetrachloroethene and toluene. The presence of these compounds in vent stack air indicates that the passive foundation venting system is performing as designed and limiting or preventing the migration of subsurface VOCs to indoor air.

6.3 Risk Characterization for Indoor Air

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 to determine whether a condition of no significant risk exists within the school. All compounds detected in indoor air samples between March 2007 and April 2011 were included in the risk characterization. Exposure point concentrations are either maximum detected concentrations or 95 percent upper confidence limits (95% UCLs) on the arithmetic mean, using sampling data for Buildings A through C combined. Because the indoor air sampling locations were selected to provide representative VOC and total PCB data for the three buildings, students, faculty and staff move throughout the buildings, and VOC and total PCB concentrations vary throughout the buildings with no one building displaying consistently elevated concentrations relative to the other buildings, the use of maximum detected concentrations or 95% UCLs for all sampling data combined as exposure point concentrations provides a reasonable upper bound of the contaminant concentrations an individual may be exposed to, over the specified time period. 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 H contains a data summary table detailing the derivation of the exposure point concentrations and a calculation spreadsheet presenting the exposure assumptions and toxicity values used in the assessment.

The results presented in Appendix H 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. VOC concentrations associated with off-gassing from building materials have been demonstrated to be trending downward (see discussion in Section 6.4).

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 was not conducted.

6.4 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 6-1 through 6-3, 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 April 2011. 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.

Although some degree of temporal fluctuation is observed, there are clearly decreasing concentration trends for 2-butanone, toluene, and total xylenes over time in the Building B and C indoor air quality samples. The other two indicator compounds, tetrahydrofuran and methyl tert butyl ether, were only detected once in the samples collected from the Building B and C samples, respectively. For the Building A samples, most concentrations for the selected compounds have been consistently low, with the sporadic detection 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. These sporadic higher concentrations were also observed within the Building B and C samples. Overall, the decreasing trends in Buildings B and C suggest that off-gassing from the newly constructed school building is diminishing. The trend is less apparent in Building A since concentrations have been consistently low over time with some fluctuations.

Temporal trends for VOC vent stack air concentrations are shown in Figures 6-4 and 6-5 for VS-1 and VS-4, respectively. The same five VOCs selected for trend analysis in indoor air were also used for vent stack air. Data included on these figures are for the time period August 2006 to April 2011. All five indicator VOCs display clearly decreasing trends over time at both vent stack air sampling locations. Though some degree of temporal fluctuation is observed, the sporadic presence of slightly higher vent stack air VOC concentrations is noted during times of warmer ambient temperatures, potentially associated with the subsurface migration of VOCs or the off-gassing of VOCs from the ventilation system. For example, increases in concentrations of 2-butanone and tetrahydrofuran in VS-1 and VS-4 were observed in April 2010.

6.5 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 April 2011 data set for the following reasons:

- Risk calculations presented herein and in prior TRC reports (encompassing fourteen sampling events of monitoring data collected over 42 months) show that the maximum or 95% UCL on the arithmetic mean concentrations of detected VOCs do not pose a significant risk to human health and further that 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 highly unlikely, rendering the comparison to such criteria conceptually irrelevant.

The LTMMIP is under revision 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 revised 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 of vent stack air concentrations is recommended for the proposed revised LTMMIP that is more appropriate than the presently called for review against comparison criteria. A draft revision to the LTMMIP is planned for regulatory review in 2011.

7.0 CONCLUSIONS

Indoor air quality and vent stack air sampling was conducted at the KMS during April 2011 for total PCBs and VOCs. Data were evaluated for quality and reliability, discussed relative to risk-based air concentrations, and analyzed for concentration trends over the period of sampling from August 2006 to April 2011. The following summarizes the conclusions of the air sampling data evaluation.

In general, all TO-10A and TO-15 data collected during April 2011 were determined to be valid as reported and usable for decision-making purposes.

PCBs were detected in the three indoor air samples collected in April 2011. The detected PCB concentrations for these samples were below risk-based action levels. Detected concentrations of 1,2,4-trimethylbenzene, benzene, chloroform, ethylbenzene, p/m-xylene and toluene in indoor air samples exceeded one or more risk-based comparison criteria. However, further assessment of the indoor air data indicated that the 95% UCL on the arithmetic mean or maximum VOC concentrations measured between March 2007 and April 2011 were associated with a condition of no significant risk to exposed individuals at the KMS.

PCBs were not detected in the four vent stack air samples collected in April 2011. There were more VOC exceedances of comparison criteria in vent stack samples as compared to indoor air samples. However, the comparison to risk-based criteria is not appropriate for vent stack air results. The vent system is designed to capture VOCs from the subsurface beneath the KMS and convey the gases through PVC piping to outdoor air, preventing migration through the building slab and into indoor air. Little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is vented to outdoor air on the roof of KMS 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 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 low level fluctuations of PCB indoor air concentrations are generally consistent with concentrations found in urban ambient air background. Based on the total PCB indoor air results collected between August 2006 and April 2011, it appears that there is variability in indoor air concentrations and the higher concentrations detected in April 2009, August 2010 and April 2011 relative to previous sampling rounds are not part of a trend. 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 presence 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 in combination with increased use of VOC-containing cleaning products and repair materials indoors.

VOCs are consistently detected in the sub-slab passive vent stacks, while PCBs are sporadically detected in the vent stacks. The presence of PCBs and VOCs in vent stack air is expected, and indicates that the passive ventilation system is performing as designed. VOCs detected in vent stack air samples may also have been emitted by the ventilation system itself. 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 indicate 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 of vent stack air concentrations is recommended for the proposed revised LTMMIP, which will be more appropriate than the presently called for review against comparison criteria. A draft revision to the LTMMIP is planned for regulatory review in 2011.

August 2011 is the date for the next sampling event.

8.0 REFERENCES

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TABLES

**Table 2-1. April 2011 Sample Summary
Keith Middle School
New Bedford, Massachusetts**

Sample ID	Sample Location	Sample Collected	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-5	Building B, vent stack 5		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	X	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		Vent Stack
VS-13	Gymnasium, vent stack 13		Vent Stack
VS-14	Gymnasium, vent stack 14	XX	Vent Stack
VS-16	Building A , vent stack 16		Vent Stack
VS-BG	On the ground at main entrance to Building A	X	Vent Stack

X - Sample collected at this location during this sampling round.

XX - Sample and duplicate collected at this location during this sampling round.

**Table 3-1. Comparison of VOC Indoor Air Sample Results - Collocated Sampler Precision
Keith Middle School
New Bedford, Massachusetts**

Analysis	Analyte	Apr-11		
		BG-26	BG-26 Dup	RPD (%)
VOCs (µg/m ³)	1,2,4-trichlorobenzene	< 1.48	< 1.48	NC
	1,2,4-trimethylbenzene	< 0.982	< 0.982	NC
	1,2-dichloroethane	< 0.809	< 0.809	NC
	1,3-dichlorobenzene	< 1.20	< 1.20	NC
	1,4-dioxane	< 0.720	< 0.720	NC
	2-butanone	< 0.589	< 0.589	NC
	2-hexanone	< 0.819	UJ	UJ
	acetone ⁽¹⁾	3.38	J	3.34
	benzene	< 0.319	< 0.319	NC
	carbon disulfide	< 0.622	< 0.622	NC
	chloroform	0.132	< 0.098	NC
	chloromethane	0.898	0.891	0.78%
	cis-1,2-dichloroethene	< 0.792	< 0.792	NC
	difluorodichloromethane	2.34	2.20	6.17%
	ethylbenzene	< 0.868	< 0.868	NC
	freon-113	< 1.53	< 1.53	NC
	methylene chloride ⁽¹⁾	11.1	< 4.86	NC
	methyl tert butyl ether	< 0.720	< 0.720	NC
	p/m-xylene	< 1.74	< 1.74	NC
	o-xylene	< 0.868	< 0.868	NC
	propylene	< 0.344	< 0.344	NC
	styrene	< 0.851	< 0.851	NC
	tetrachloroethene	< 0.136	< 0.136	NC
	tetrahydrofuran	< 0.589	< 0.589	NC
	toluene	< 0.753	< 0.753	NC
	trichloroethene	< 0.107	0.145	NC
	trichlorofluoromethane	1.40	1.30	7.41%
	PCBs (µg/m ³)			
Total PCBs		0.000207	< 0.000015	NC

Notes:

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

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

Detected values are shown in bold

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

**Table 3-2. Comparison of VOC Vent Stack Air Sample Results - Collocated Sampler Precision
Keith Middle School
New Bedford, Massachusetts**

Analysis	Analyte	Apr-11				
		VS-14-26		VS-14-26 DUP		RPD (%)
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 1.48	UJ	< 1.48	UJ	NC
	1,2,4-trimethylbenzene	< 0.982	UJ	< 0.982	UJ	NC
	1,2-dichloroethane	< 0.89		< 0.89		NC
	1,3-dichlorobenzene	< 1.20	UJ	< 1.20	UJ	NC
	1,4-dioxane	< 0.720		< 0.720		NC
	2-butanone	35.5	J	11.8	J	100.21%
	2-hexanone	< 0.819	UJ	< 0.819	UJ	NC
	acetone ⁽¹⁾	74.9	J	42.2	J	55.85%
	benzene	0.555		0.412		29.58%
	carbon disulfide	< 0.622		< 0.622		NC
	chloroform	2.49		2.86		13.83%
	chloromethane	< 0.413	UJ	< 0.413		NC
	cis-1,2-dichloroethene	< 0.792		< 0.792		NC
	difluorodichloromethane	2.15		2.23		3.65%
	ethylbenzene	< 0.868		< 0.868		NC
	freon-113	< 1.53		< 1.53		NC
	methylene chloride ⁽¹⁾	< 4.86		< 4.86		NC
	methyl tert butyl ether	27.2		29.9		9.46%
	p/m-xylene	< 1.74		< 1.74		NC
	o-xylene	< 0.868		< 0.868		NC
	styrene	< 0.851		< 0.851		NC
	tetrachloroethene	2.61	J	4.84	J	59.87%
	tetrahydrofuran	2.68		3.19		17.38%
	toluene	1.02		1.05		2.90%
trichloroethene	0.553	J	1.02	J	59.38%	
trichlorofluoromethane	3.57		3.63		1.67%	
PCBs (ug/m ³)						
	Total PCBs	< 0.0208		< 0.0208		NC

Notes:

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

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

Detected values are shown in bold

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

Table 4-1. Indoor Air Quality Sample Results - April 2011
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations			Background		QA/QC
		A-26	B-26	C-26	BG-26	BG-26 Dup	Trip Blank
VOCs (µg/m ³)	1,2,4-trichlorobenzene	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ
	1,2,4-trimethylbenzene	4.97 J	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809 UJ	< 0.809	< 0.809	< 0.809
	1,3-dichlorobenzene	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ
	1,4-dioxane	< 0.720	< 0.720	< 0.720 UJ	< 0.720	< 0.720	< 0.720
	2-butanone	2.27	1.66	0.966 J	< 0.589	< 0.589	< 0.589
	2-hexanone	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ
	acetone ⁽¹⁾	< 2.37	12.3 J	6.07 J	3.38 J	3.34 J	< 2.37
	benzene	1.56	0.616	0.450 J	< 0.319	< 0.319	< 0.319
	carbon disulfide	< 0.622	< 0.622	< 0.622 UJ	< 0.622	< 0.622	< 0.622
	chloroform	0.098	0.098	< 0.098 UJ	0.132	< 0.098	< 0.098
	chloromethane	1.01 J	1.57 J	0.687 J	0.898	0.891	< 0.413
	cis-1,2-dichloroethene	< 0.792	< 0.792	< 0.792 UJ	< 0.792	< 0.792	< 0.792
	difluorodichloromethane	3.00	2.47	2.27 J	2.34	2.2	< 0.988
	ethylbenzene	4.30	1.62	< 0.868 UJ	< 0.868	< 0.868	< 0.868
	methylene chloride ⁽¹⁾	< 4.86	< 4.86	< 4.86 UJ	11.1	< 4.86	< 4.86
	methyl isobutyl ketone (MIBK)	< 0.819	< 0.819	< 0.819 UJ	< 0.819	< 0.819	< 0.819
	methyl tert butyl ether	< 0.720	< 0.720	< 0.720 UJ	< 0.720	< 0.720	< 0.720
	p/m-xylene	12.0	5.06	< 1.74 UJ	< 1.74	< 1.74	< 1.74
	o-xylene	4.15	1.97	< 0.868 UJ	< 0.868	< 0.868	< 0.868
	styrene	< 0.851	< 0.851	< 0.851 UJ	< 0.851	< 0.851	< 0.851
	tetrachloroethene	< 0.136	< 0.136	< 0.136 UJ	< 0.136	< 0.136	< 0.136
	tetrahydrofuran	< 0.589	< 0.589	< 0.589 UJ	< 0.589	< 0.589	< 0.589
toluene	22.1	4.57	1.84 J	< 0.753	< 0.753	< 0.753	
trichloroethene	< 0.107	0.107	< 0.107 UJ	< 0.107	0.145	< 0.107	
trichlorofluoromethane	1.63	1.56	1.36 J	1.4	1.3	< 1.12	
n-propylbenzene	1.06	< 0.982	< 0.982 UJ	< 0.982	< 0.982	< 0.982	
1,3,5-trimethylbenzene	1.96	< 0.982	< 0.982 UJ	< 0.982	< 0.982	< 0.982	
PCBs (µg/m ³)	Total PCBs	0.0036	0.0040	0.0115 J	< 0.0001	0.0002 J	< 0.025 ug UJ

Notes:

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

PCBs - polychlorinated biphenyls

µg - micrograms; trip blank results are presented in micrograms (µg) due to no air volume being collected during analysis.

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

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

Values in **Bold** indicate the compound was detected.

< - less than laboratory reporting limit

J - Detected result reported is estimated

UJ - Non-Detect result reported is estimated

Table 4-2. Vent Stack Sample Results - April 2011
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background	QA/QC
		VS-1-26	VS-4-26	VS-9-26	VS-14-26	VS-14-26-DUP	VS-BG-26	Trip Blank-VS
VOCs ($\mu\text{g}/\text{m}^3$)	1,2,4-trichlorobenzene	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ
	1,2,4-trimethylbenzene	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809	< 0.809	< 0.809	< 0.809	< 0.809
	1,3-dichlorobenzene	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ
	1,4-dioxane	< 0.720	< 0.720	< 0.720	< 0.720	< 0.720	< 0.720	< 0.720
	2-butanone	26.9	34.7	8.26	35.5 J	11.80 J	< 0.589	< 0.589
	2-hexanone	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ
	acetone ⁽¹⁾	29.8	128 J	17.4	74.9 J	42.2 J	5.98	< 2.37
	benzene	0.776	0.830	< 0.319	0.555	0.412	< 0.319	< 0.319
	carbon disulfide	< 0.622	1.32	< 0.622	< 0.622	< 0.622	< 0.622	< 0.622
	chloroform	2.76	1.03	3.98	2.49	2.86	< 0.098	< 0.098
	chloromethane	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	0.536 J	< 0.413 UJ
	cis-1,2-dichloroethene	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792
	difluorodichloromethane	2.34	2.61	2.48	2.15	2.23	2.46	< 0.988
	ethylbenzene	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868
	methylene chloride ⁽¹⁾	27.0	< 4.86	< 4.86	< 4.86	< 4.86	< 4.86	< 4.86
	methyl isobutyl ketone (MIBK)	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819
	methyl tert butyl ether	< 0.720	< 0.720	2.57	27.2	29.9	< 0.720	< 0.720
	p/m-xylene	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74
	o-xylene	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868
	styrene	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851
	tetrachloroethene	2.26	0.427	2.96	2.61 J	4.84 J	< 0.136	< 0.136
	tetrahydrofuran	2.96	1.07	2.22	2.68	3.19	< 0.589	< 0.589
	toluene	1.02	0.858	1.20	1.02	1.05	< 0.753	< 0.753
	trichloroethene	0.161	1.140	< 0.107	2.61 J	1.02 J	< 0.107	< 0.107
	trichlorofluoromethane	2.00	1.73	2.56	3.57	3.63	1.44	< 1.12
	n-propylbenzene	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982
	1,3,5-trimethylbenzene	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982
PCBs ₃ ($\mu\text{g}/\text{m}^3$)	Total PCBs	< 0.0208	< 0.0227	< 0.0208	< 0.0208	< 0.0208	< 0.0192	< 0.0250 μg

Notes:

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

VOCs - volatile organic compounds

PCBs - polychlorinated biphenyls

μg - micrograms; trip blank results are presented in micrograms (μg) due to no air volume being collected during analysis.

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

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

Values in **Bold** indicate the compound was detected.

< - less than laboratory reporting limit

J - Detected result reported is estimated

UJ - Non-Detect result reported is estimated

FP - Reported result is a false positive as a result of data validation

Table 5-1. Comparison of PCB Indoor Air Quality Sample Results to Risk-Based Air Concentrations - April 2011
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations			Background Location		QA/QC Trip Blank	MassDEP Background	Comparison Values		
		A-26	B-26	C-26	BG-26	BG-26 Dup			AL*	ALTAEC*	PHL**
PCBs ($\mu\text{g}/\text{m}^3$)	Total PCBs	0.0036	0.0040	0.0115	<0.0001	< 0.0002	< 0.025 ug	--	0.05	0.3	0.45

Notes:

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

PCBs - polychlorinated biphenyls

NA - not analyzed

ug - micrograms; trip blank results are presented in micrograms (ug) since no air volume is collected for the trip blank

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).

** PCBs are compared to the lowest of the EPA Public Health Level for PCBs in School Indoor Air (September 2009) for adult employees and children 12-<15 year olds (<http://www.epa.gov/pcbsincaulk/>)

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

Table 5-2. Comparison of PCB Vent Stack Sample Results to Risk-Based Air Concentrations - April 2011
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background	QA/QC	Comparison Values		
		VS-1-26	VS-4-26	VS-9-26	VS-14-26	VS-14-26 Dup	VS-BG-26	Trip Blank-VS			
PCBs ($\mu\text{g}/\text{m}^3$)	Total PCBs	< 0.0208	< 0.0227	< 0.0208	< 0.0208	< 0.0208	< 0.0192	< 0.025 ug	AL*	ALTAEC*	PHL**
									0.05	0.3	0.45

Notes:

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

PCBs - polychlorinated biphenyls

ug - micrograms; trip blank results are presented in micrograms (ug) since no air volume is collected for the trip blank

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).

** PCBs are compared to the lowest of the EPA Public Health Level for PCBs in School Indoor Air (September 2009) for adult employees and children 12-<15 year olds (<http://www.epa.gov/pcbsincaulk/>)
 Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 6-1. Comparison of VOC Indoor Air Quality Sample Results to Comparison Criteria - April 2011
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations			Background Location		QA/QC	MassDEP	MassDEP	MassDEP	Comparison Values			
		A-26	B-26	C-26	BG-26	BG-26 Dup	Trip Blank	Background	IATV (residential)	IATV (commercial)	TEL*	AAL*	EPA SL (residential)	EPA SL (commercial)
VOCs (µg/m ³)	1,2,4-trichlorobenzene	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	0.59	3.4	175	--	--	0.42 (a)	1.76 (a)
	1,2,4-trimethylbenzene	4.97 J	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	--	--	--	--	--	1.46 (a)	6.2 (a)
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809 UJ	< 0.809 UJ	< 0.809 UJ	< 0.809 UJ	--	0.09	0.39	11.01	0.04	0.094 (a)	0.47 (a)
	1,3-dichlorobenzene	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	--	0.6	180	--	--	0.22 (e)	1.1 (e)
	1,4-dioxane	< 0.720	< 0.720	< 0.720 UJ	< 0.720 UJ	< 0.720 UJ	< 0.720 UJ	--	0.59	2.5	24.49	0.24	0.32 (a)	1.6 (a)
	2-butanone	2.27	1.66	0.966 J	< 0.589	< 0.589	< 0.589	42.18	12	4200	200	10	1040 (a)	4400 (a)
	2-hexanone	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	--	--	--	10.88	10.88	6.2 (a)	26 (a)
	acetone ⁽¹⁾	< 2.37	12.3 J	6.07 J	3.38 J	3.34 J	< 2.37	27.04	91	700	160.54	160.54	6400 (a)	28000 (a)
	benzene	1.56	0.616	0.450 J	< 0.319	< 0.319	< 0.319	21	2.3	11	1.74	0.12	0.31 (a)	1.6 (a)
	carbon disulfide	< 0.622	< 0.622	< 0.622 UJ	< 0.622 UJ	< 0.622 UJ	< 0.622 UJ	--	--	--	0.1	0.1	146 (a)	620 (a)
	chloroform	0.098	0.098	< 0.098 UJ	0.132	< 0.098	< 0.098	3.36	1.9	3	132.76	0.04	0.11 (a)	0.53 (a)
	chloromethane	1.01 J	1.57 J	0.687 J	0.898	0.891	< 0.413	--	--	--	--	--	18.8 (a)	78 (a)
	cis-1,2-dichloroethene	< 0.792	< 0.792	< 0.792 UJ	< 0.792 UJ	< 0.792 UJ	< 0.792 UJ	--	0.8	31	215.62	107.81	12.6 (f)	52 (f)
	difluorodichloromethane	3.00	2.47	2.27 J	2.34	2.2	< 0.988	--	--	--	--	--	20 (a)	88 (a)
	ethylbenzene	4.30	1.62	< 0.868 UJ	< 0.868 UJ	< 0.868 UJ	< 0.868 UJ	9.62	7.4	880	300	300	0.97 (a)	4.9 (a)
	methylene chloride ⁽¹⁾	< 4.86	< 4.86	< 4.86 UJ	11.1	< 4.86	< 4.86	600	5	22	9.45	0.24	5.2 (a)	26 (a)
	methyl isobutyl ketone (MIBK)	< 0.819	< 0.819	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	--	2.2	2600	55.7	55.7	620 (a)	2600 (a)
	methyl tert butyl ether	< 0.720	< 0.720	< 0.720 UJ	< 0.720 UJ	< 0.720 UJ	< 0.720 UJ	--	39	2600	--	--	9.4 (a)	47 (a)
	p-m-xylene	12.0	5.06	< 1.74 UJ	< 1.74 UJ	< 1.74 UJ	< 1.74 UJ	72.41**	20	88	11.8**	11.8**	20 (a)	88 (a)
	o-xylene	4.15	1.97	< 0.868 UJ	< 0.868 UJ	< 0.868 UJ	< 0.868 UJ	72.41**	20	88	11.8**	11.8**	20 (a)	88 (a)
	styrene	< 0.851	< 0.851	< 0.851 UJ	< 0.851 UJ	< 0.851 UJ	< 0.851 UJ	2.79	1.4	18	200	2	200 (a)	880 (a)
	tetrachloroethene	< 0.136	< 0.136	< 0.136 UJ	< 0.136 UJ	< 0.136 UJ	< 0.136 UJ	11.01	1.4	4.1	922.18	0.2	0.41 (a)	2.1 (a)
	tetrahydrofuran	< 0.589	< 0.589	< 0.589 UJ	< 0.589 UJ	< 0.589 UJ	< 0.589 UJ	--	--	--	160.35	80.18	--	--
	toluene	22.1	4.57	1.84 J	< 0.753	< 0.753	< 0.753	28.65	54	4400	80	20	1040 (a)	4400 (a)
	trichloroethene	< 0.107	0.107	< 0.107 UJ	< 0.107 UJ	0.145	< 0.107	4.49	0.8	6	36.52	0.61	1.2 (a)	6.1 (a)
	trichlorofluoromethane	1.63	1.56	1.36 J	1.4	1.3	< 1.12	--	--	--	--	--	146 (a)	620 (a)
	n-propylbenzene	1.06	< 0.982	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	--	--	--	--	--	200 (a)	880 (a)
1,3,5-trimethylbenzene	1.96	< 0.982	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	--	--	--	--	--	1.46 (h)	6.2 (h)	

Notes:

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

IATV - Indoor Air Threshold Value; Mass DEP interim draft December 2010

EPA SL - EPA Screening Level; May 2011

- (a) EPA Screening Level (ELCR of 1E-06 for carcinogens; hazard of 0.2 for noncarcinogens)
- (b) EPA SL for n-hexane used as surrogate for 2,2,4-trimethylpentane
- (c) AAL/TEL for isobutyl alcohol used as surrogate for isopropanol
- (d) EPA SL for n-hexane used as surrogate for heptane
- (e) EPA SL for 1,4-dichlorobenzene used as surrogate for 1,3-dichlorobenzene
- (f) EPA SL for trans-1,2-dichloroethene used as surrogate for cis-1,2-dichloroethene
- (g) AAL/TEL for alkanes/alkenes used as surrogate for propylene
- (h) EPA SL for 1,2,4-trimethylbenzene used as surrogate for 1,3,5-trimethylbenzene

Highlighted values show exceedances of comparison values and the value which was exceeded

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

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)

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

-- - No corresponding comparison criterion.

J - Concentration should be considered estimated.

R - Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

Table 6-2. Comparison of VOC Vent Stack Sample Results to Comparison Criteria - April 2011
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background VS-BG-26	QA/QC Trip Blank-VS	Comparison Values			
		VS-1-26	VS-4-26	VS-9-26	VS-14-26	VS-14-26 Dup			TEL*	AAL*	EPA SL (residential)	EPA SL (commercial)
VOCs (µg/m ³)	1,2,4-trichlorobenzene	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	--	--	0.42 (a)	1.76 (a)
	1,2,4-trimethylbenzene	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	< 0.982 UJ	--	--	1.46 (a)	6.2 (a)
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809	< 0.809	< 0.809	< 0.809	< 0.809	11.01	0.04	0.094 (a)	0.47 (a)
	1,3-dichlorobenzene	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	< 1.20 UJ	--	--	0.22 (e)	1.1 (e)
	1,4-dioxane	< 0.720	< 0.720	< 0.720	< 0.720	< 0.720	< 0.720	< 0.720	24.49	0.24	0.32 (a)	1.6 (a)
	2-butanone	26.9	34.7	8.26	35.5 J	11.80 J	< 0.589	< 0.589	200	10	1040 (a)	4400 (a)
	2-hexanone	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	10.88	10.88	6.2 (a)	26 (a)
	acetone ⁽¹⁾	29.8	128 J	17.4	74.9 J	42.2 J	5.98	< 2.37	160.54	160.54	6400 (a)	28000 (a)
	benzene	0.776	0.830	< 0.319	0.555	0.412	< 0.319	< 0.319	1.74	0.12	0.31 (a)	1.6 (a)
	carbon disulfide	< 0.622	1.32	< 0.622	< 0.622	< 0.622	< 0.622	< 0.622	0.1	0.1	146 (a)	620 (a)
	chloroform	2.76	1.030	3.98	2.49	2.86	< 0.098	< 0.098	132.76	0.04	0.11 (a)	0.53 (a)
	chloromethane	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	0.536 J	< 0.413 UJ	--	--	18.8 (a)	78 (a)
	cis-1,2-dichloroethene	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792	< 0.792	215.62	107.81	12.6 (f)	52 (f)
	difluorodichloromethane	2.34	2.61	2.48	2.15	2.23	2.46	< 0.988	--	--	20 (a)	88 (a)
	ethylbenzene	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	300	300	0.97 (a)	4.9 (a)
	methylene chloride ⁽¹⁾	27.0	< 4.86	< 4.86	< 4.86	< 4.86	< 4.86	< 4.86	9.45	0.24	5.2 (a)	26 (a)
	methyl isobutyl ketone (MIBK)	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819	55.7	55.7	620 (a)	2600 (a)
	methyl tert butyl ether	< 0.720	< 0.720	2.57	27.2	29.9	< 0.720	< 0.720	--	--	9.4 (a)	47 (a)
	p/m-xylene	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74	11.8**	11.8**	20 (a)	88 (a)
	o-xylene	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	< 0.868	11.8**	11.8**	20 (a)	88 (a)
styrene	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851	200	2	200 (a)	880 (a)	
tetrachloroethene	2.26	0.427	2.96	2.61 J	4.84 J	< 0.136	< 0.136	922.18	0.02	0.41 (a)	2.1 (a)	
tetrahydrofuran	2.96	1.07	2.22	2.68	3.19	< 0.589	< 0.589	160.35	80.18	--	--	
toluene	1.02	0.858	1.2	1.02	1.05	< 0.753	< 0.753	80	20	1040 (a)	4400 (a)	
trichloroethene	0.161	1.140	< 0.107	2.61 J	1.02 J	< 0.107	< 0.107	36.52	0.61	1.2 (a)	6.1 (a)	
trichlorofluoromethane	2.00	1.73	2.56	3.57	3.63	1.44	< 1.12	--	--	146 (a)	620 (a)	
n-propylbenzene	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	--	--	200 (a)	880 (a)	
1,3,5-trimethylbenzene	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	--	--	1.46 (h)	6.2 (h)	

Notes:

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

EPA SL - EPA Screening Level; May 2011

- (a) EPA Screening Level (ELCR of 1E-06 for carcinogens; hazard of 0.2 for noncarcinogens)
- (b) EPA SL for n-hexane used as surrogate for 2,2,4-trimethylpentane
- (c) AAL/TEL for isobutyl alcohol used as surrogate for isopropanol
- (d) EPA SL for n-hexane used as surrogate for heptane
- (e) EPA SL for 1,4-dichlorobenzene used as surrogate for 1,3-dichlorobenzene
- (f) EPA SL for trans-1,2-dichloroethene used as surrogate for cis-1,2-dichloroethene
- (g) AAL/TEL for alkanes/alkenes used as surrogate for propylene
- (h) EPA SL for 1,2,4-trimethylbenzene used as surrogate for 1,3,5-trimethylbenzene

Highlighted values show exceedances of comparison values and the value which was exceeded

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

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

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

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

-- - No corresponding comparison criterion.

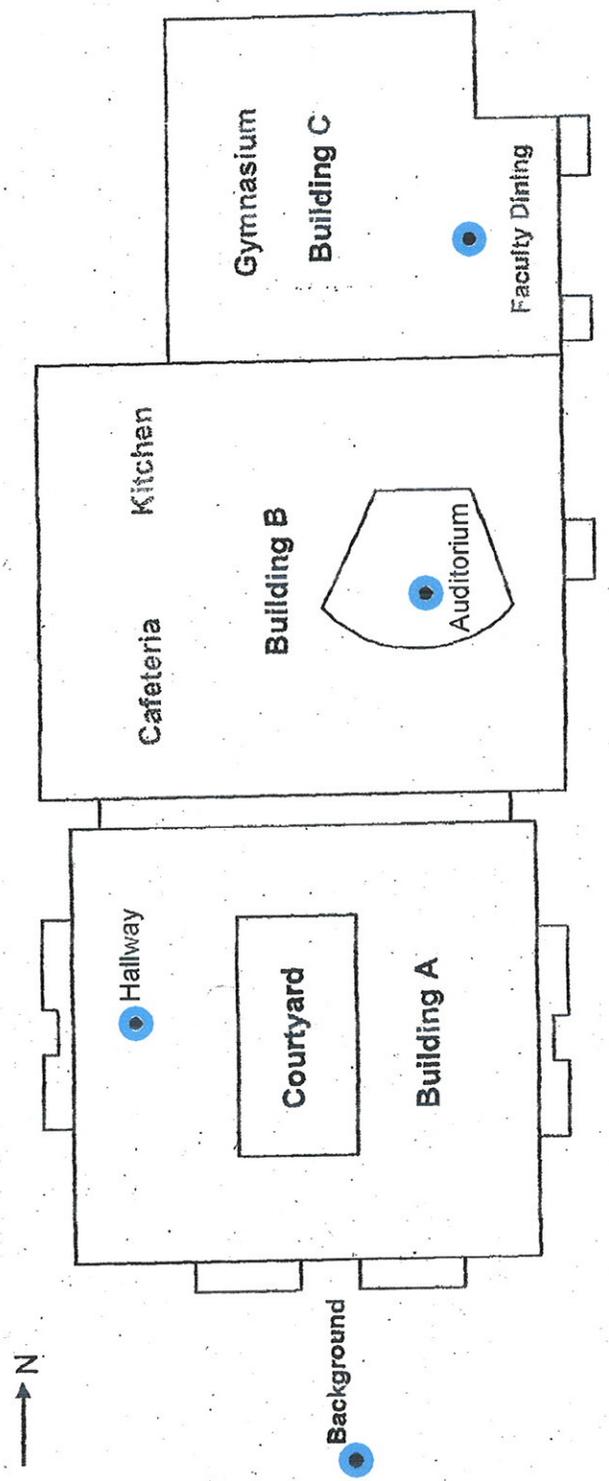
J - Concentration should be considered estimated.

R- Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

FIGURES

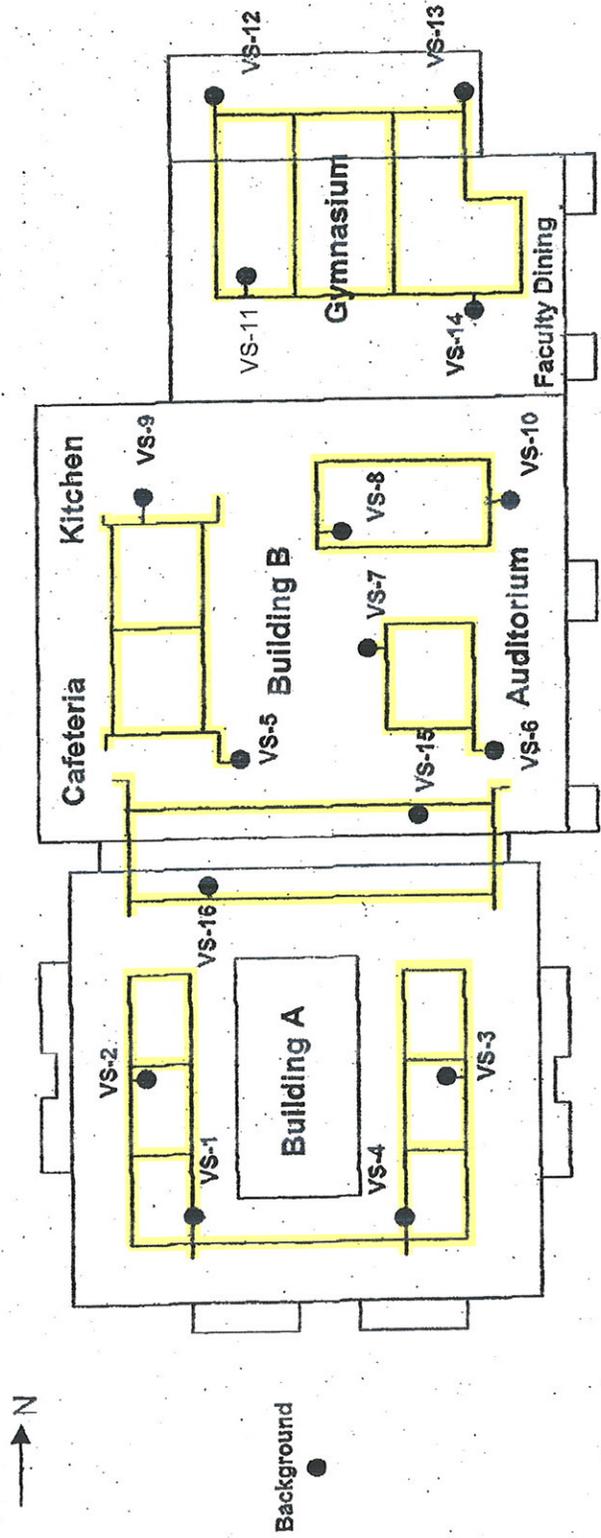
Keith Middle School Indoor Air Sampling Locations



- = Indoor Air Sampling Point
- = Sample Locations

KEITH MIDDLE SCHOOL NEW BEDFORD, MASSACHUSETTS	
INDOOR AIR SAMPLING LOCATIONS	
<small>Wannancott Mills 650 Suffolk Street Lowell, MA 01854 (978) 970-5600</small>	
<small>DRAWN BY: ---</small>	<small>DATE: MAY 2008</small>
<small>CHECKED BY: DMS</small>	
FIGURE 2-1	

Keith Middle School Foundation Venting System



Hathaway Boulevard

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

KEITH MIDDLE SCHOOL
NEW BEDFORD, MASSACHUSETTS

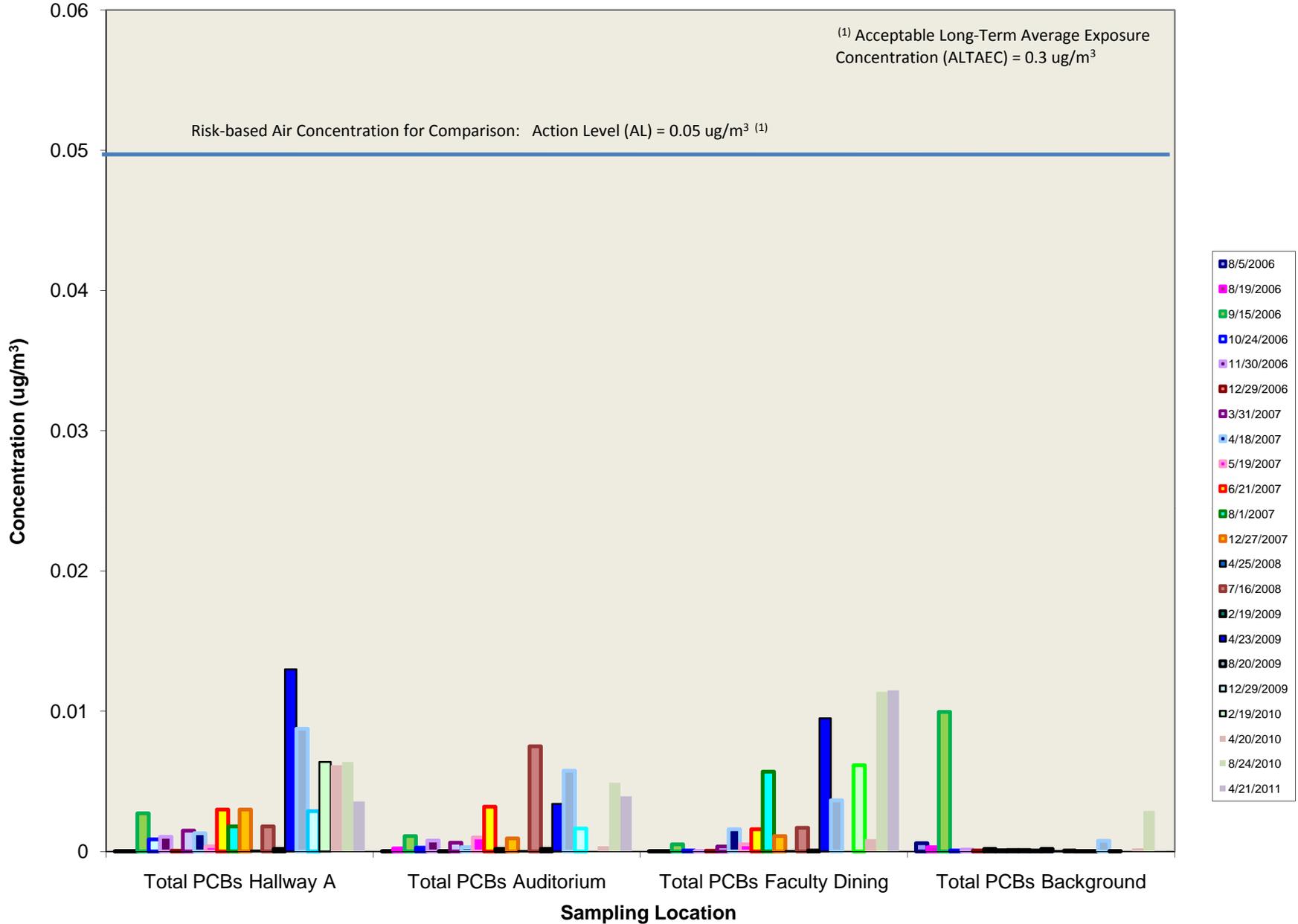
VENT STACK SAMPLE LOCATIONS

CTRC
Wannalancit Mills
650 Suffolk Street
Lowell, MA 01854
(978) 970-5600

FIGURE 2-2

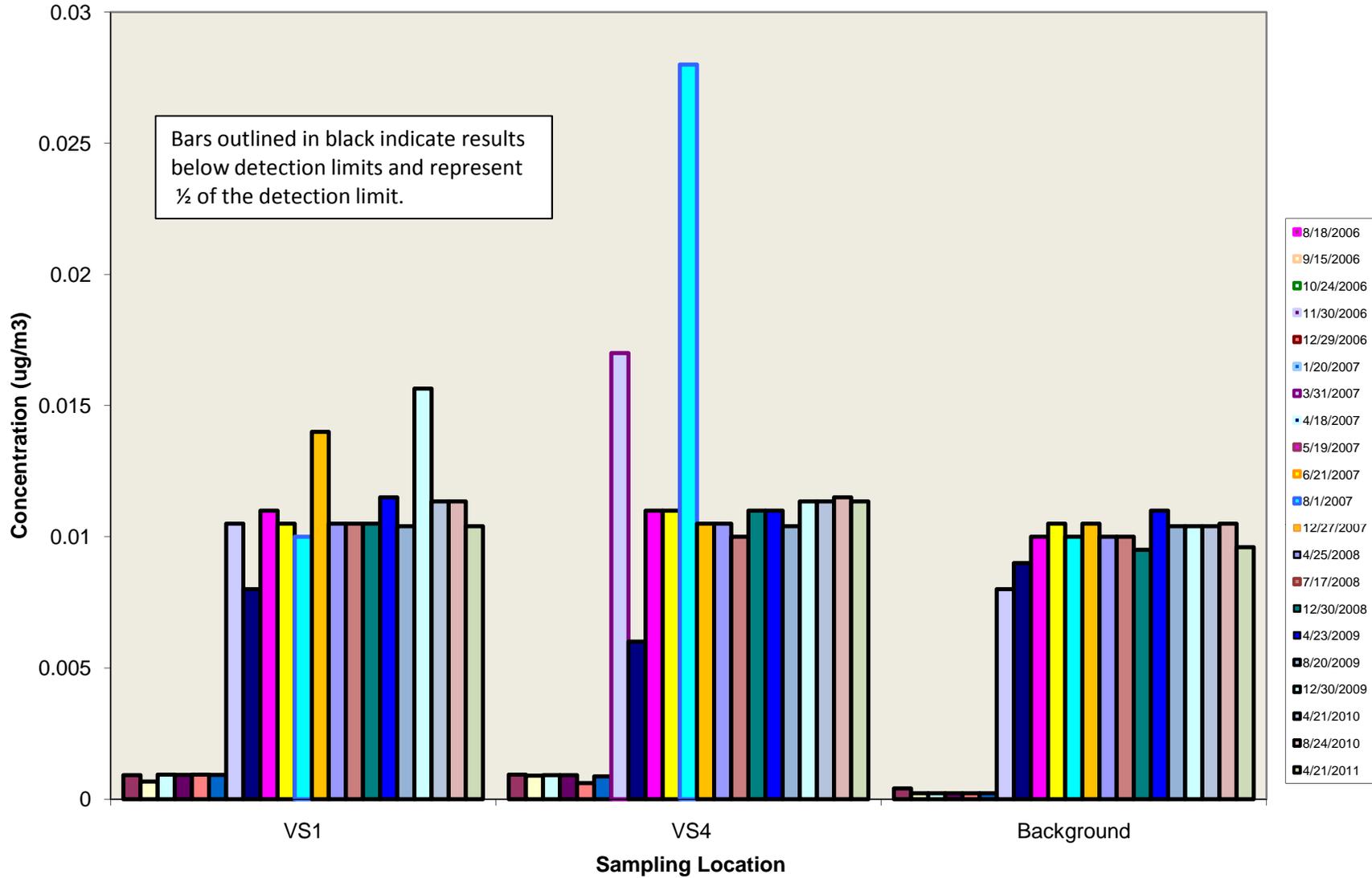
DRAWN BY: --- DATE: MAY 2008
CHECKED BY: DMS

Figure 5-1. Total PCB Trends in KMS Indoor Air Quality (IAQ) Samples - August 2006 through April 2011



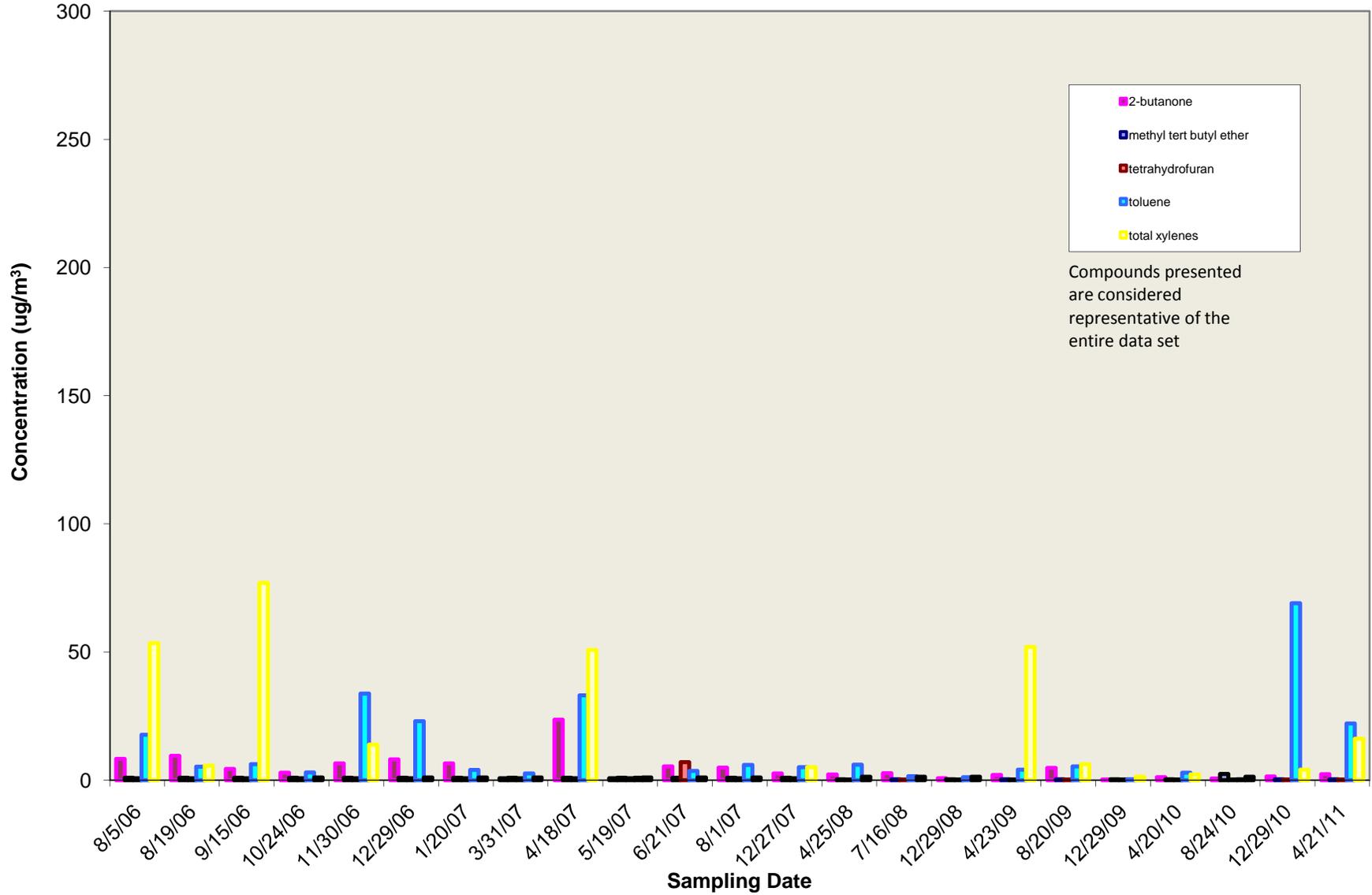
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 5-2. KMS Vent Stack PCB Trends - August 2006 through April 2011



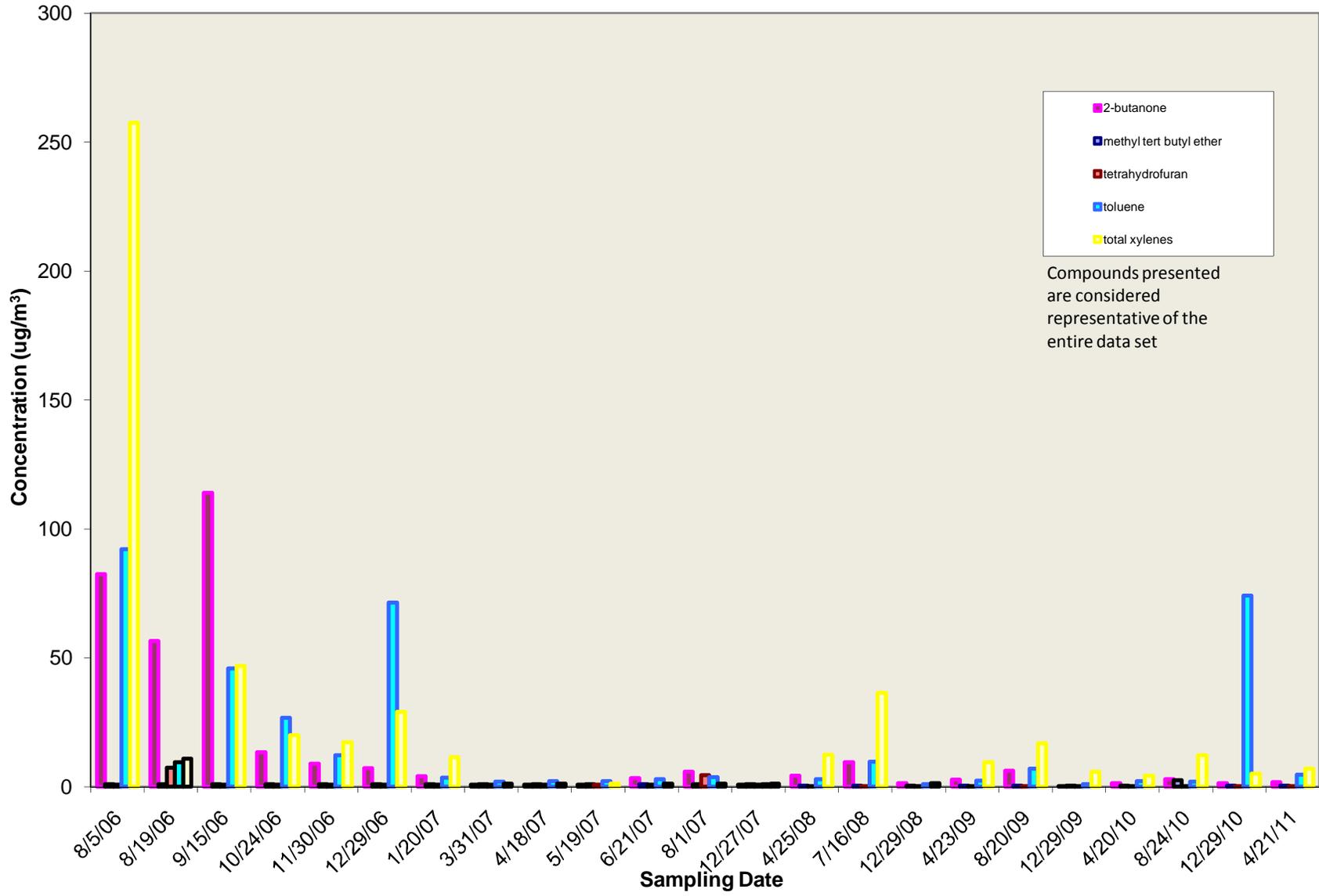
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-1. VOC Trends in KMS Building A (IAQ) - August 2006 through April 2011



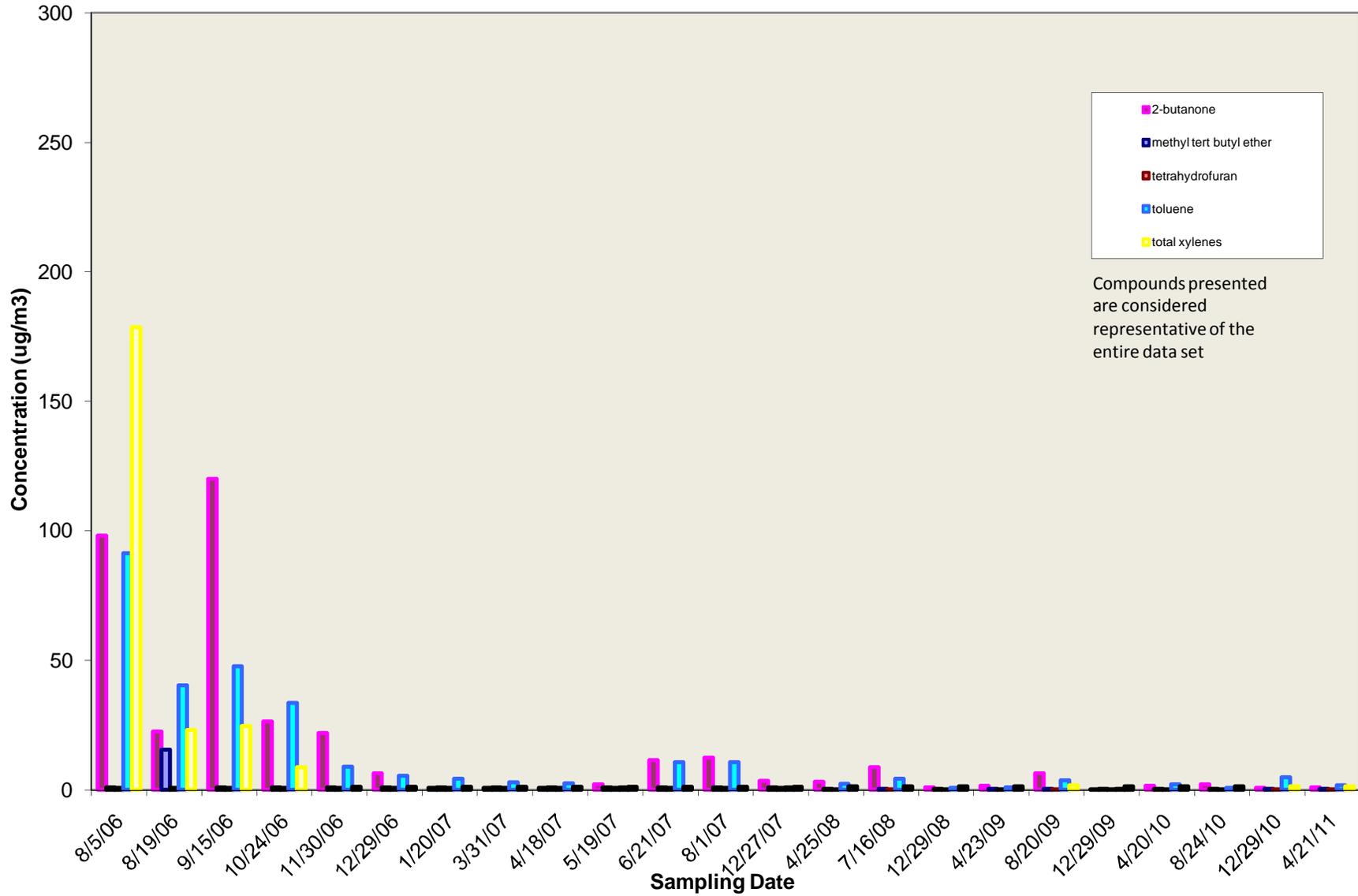
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-2. VOC Trends in KMS Building B (IAQ) - August 2006 through April 2011



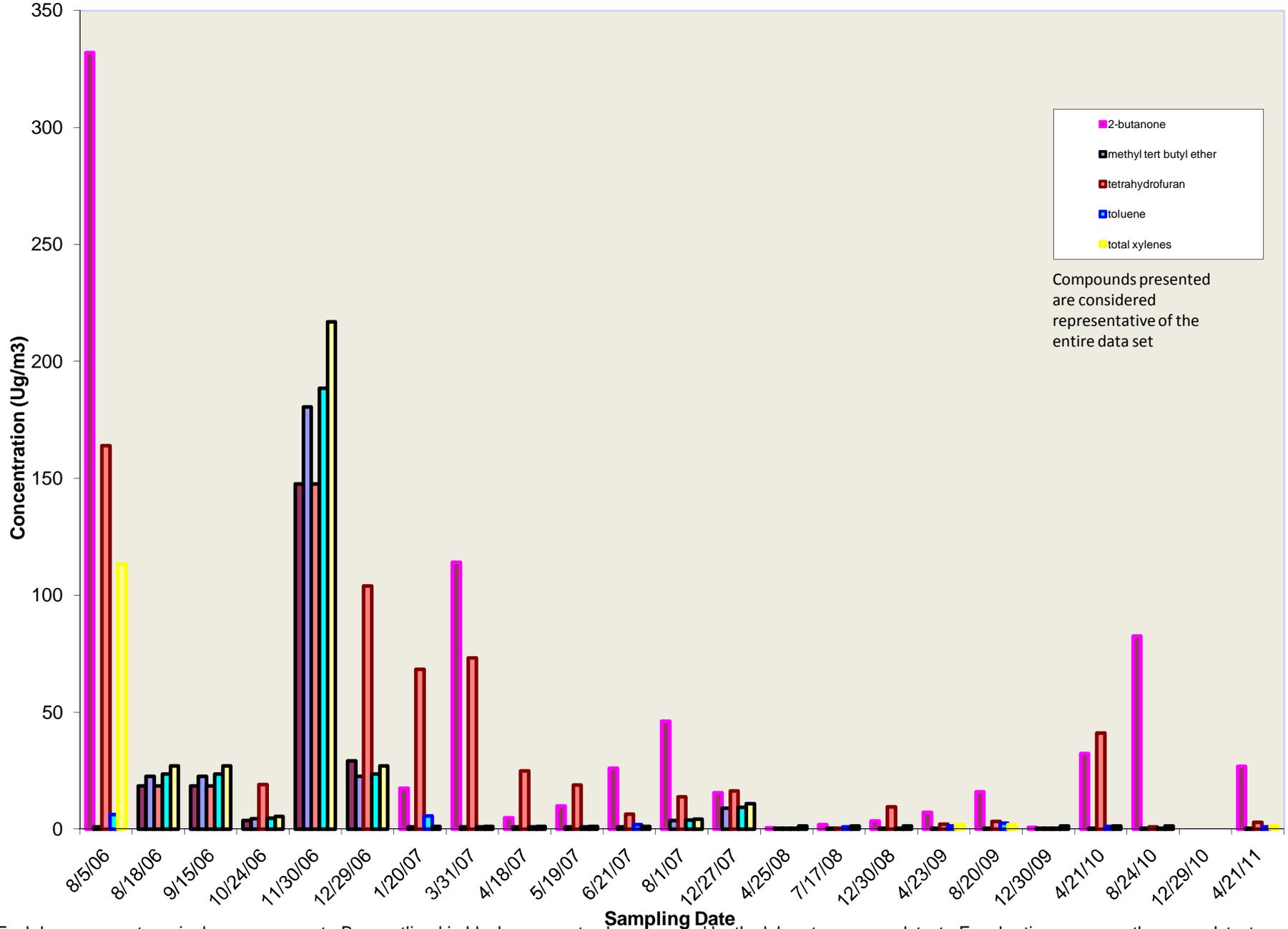
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-3. VOC Trends in KMS Building C (IAQ) - August 2006 through April 2011



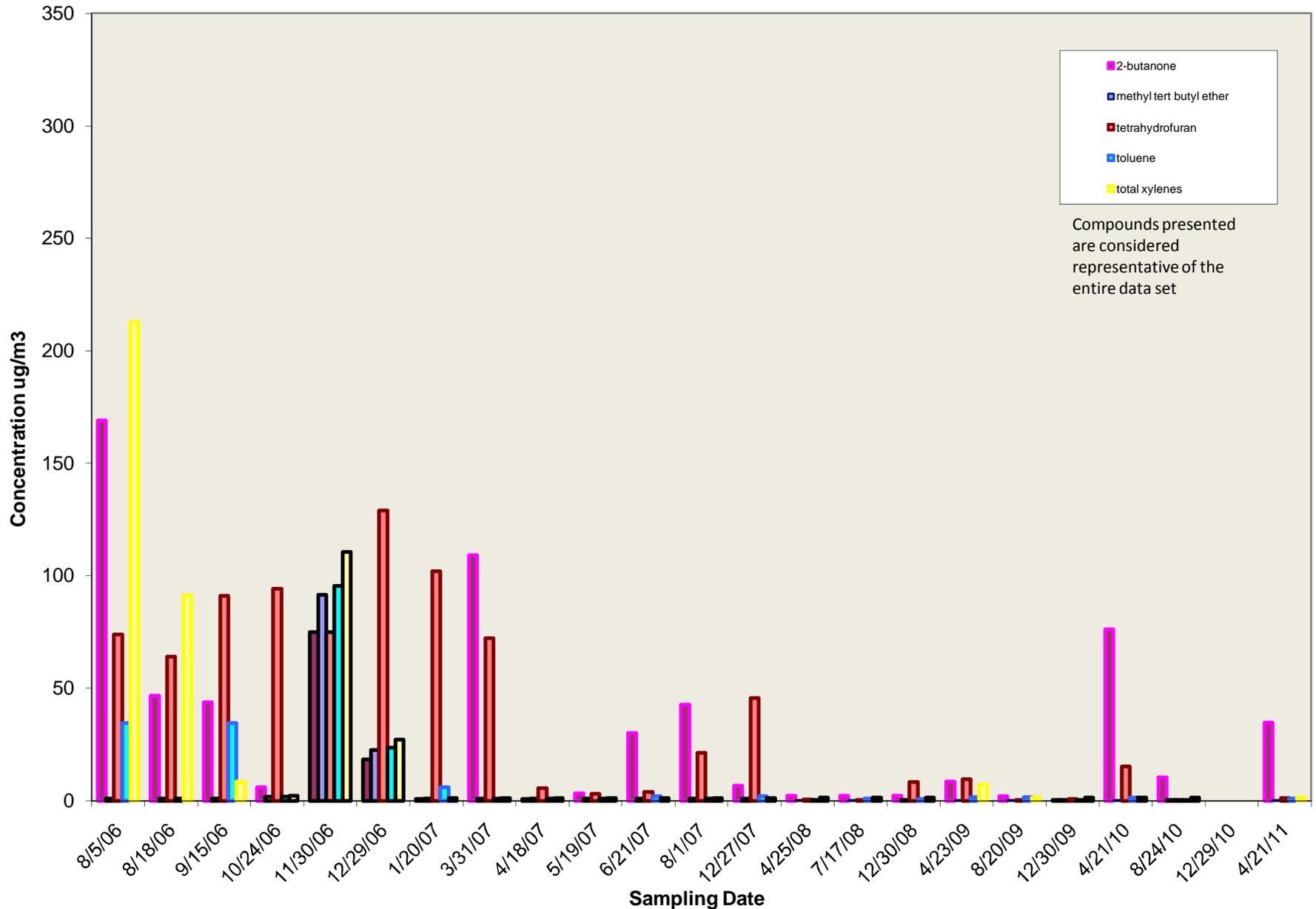
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-4. VOC Trends in KMS Vent Stack VS-1 - August 2006 through April 2011



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 6-5. VOC Trends in KMS Vent Stack VS-4 - August 2006 through April 2011



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

SUMMARY OF FIELD SAMPLING PROGRAM, ANALYTICAL PROGRAM, AND QUALITY ASSURANCE

1.0 FIELD SAMPLING PROGRAM

1.1 Overview

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

1.2 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.

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

1.2.2 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 B and the reduced data can be found in Appendix C.

1.3 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.

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

1.3.2 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 B and the reduced data can be found in Appendix C.

2.0 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 Homologue distribution. Though the LTMMIP specified that PCBs were to be analyzed by the congener analytical method, the homologue 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 5 and Appendix G. 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 E.

3.0 QUALITY ASSURANCE

3.1 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.

3.2 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 D. All instrument calibrations met the performance criteria defined in 40 CFR 50 Appendix B.

3.3 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.

3.3.1 Field Data Reduction

Appendix B 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.

3.3.2 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 F. All data are reported in standard units depending on the measurement and the ultimate use of the data.

3.4 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).

4.0 INVENTORY OF CLEANING SUPPLIES AND INGREDIENTS

The following bulleted list provides an inventory of cleaning supplies and their ingredients which are likely contributing to the detection of VOCs in the indoor air quality samples:

- Butchers Heptagon Disinfectant Spray
 - Active ingredients:
 - n-alkyl(60% C₁₄, 30% C₁₆, 5% C₁₂, 5% C₁₈)dimethylbenzyl ammonium chlorides
 - n-alkyl(68% C₁₂, 32% C₁₄)dimethylbenzyl ammonium chlorides
- Eclipse Neutral All Purpose Cleaner
 - Water
 - modified amine condensate
 - tetrapotassium
 - pyrophosphate
- Rebound Cleaner/Enhancer
 - Water
 - Polyethylene glycol
 - Nonionic surfactant
 - Monoethanol amine
- Concentrate 117 – oxidizing multipurpose cleaner
 - Active ingredient:
 - Hydrogen Peroxide – 3.95%
- Misco Disinfectant cleaner -- mint -- HI-Con 64
 - Active ingredients:
 - Didecyldimethyl ammonium chloride (2.54%)
 - N-alkyl(C₁₄ 50%, C₁₂ 40%, C₁₆ 10%)dimethyldibenzyl ammonium chloride
- Butchers Command Center Breakdown
 - Water
 - Alcohol ethoilate
 - Sodium xylene sulfonate
 - Bacillus spores
- Butchers Command Center Look
 - “see MSDS MS040015”
- Butchers Major Max Spray Buff
 - Water
 - Triethylene glycol
 - Dipropylene glycol

- First Step Sealer Acrylic Floor Sealer
 - Water
 - Aqueous acrylic emulsion
 - Ethanol 2-(2-methoxy ethoxy)
 - Ethanol 2-(2-ethoxy ethoxy)
 - Tributoxo ethyl phosphate
- Simplex Shine Up
 - Water
 - Petroleum distillates
 - Isobutene/propane blend
 - Petroleum solvent

APPENDIX B

SAMPLING DATA

Keith Middle School Sampling Data Sheet

- Ambient Air Sampling

Setup Date: 4/12/10
 Recovery Date: 4/12/10

Sampler(s): Dell / S. Morris
 Sampler(s):

Location	Time		Vacuum (in Hg)		SUMMA Serial No.:	Flow Controller Serial No.:
	Start	Stop	Start	Finish		
V5-1	935	1325	29.9	5.9	258	44
V5-4	937	1330	29.9	5.9	1718	495
V5-14	943	1346	29.8	5.6	131	375
V5-14 Dup	943	1346	30.0	5.70	462	484
V5-9	956	1352	29.9	6.0	530	118
BSG	1006	1417	29.9	4.5	179	159

8.7
8.5
8.6
9.0
8.7
8.6

TO-4A

Location	Time		PUF Number	Serial Number	Counter (Hrs)		Flow Rate (Mag Reading)	
	Start	Stop			Start	Finish	Initial	Final
V5-1	935	1326					5.15	5.02
V5-4	937	1330					5.11	4.75
V5-14	943	1346					5.17	5.01
V5-14 Dup	943	1346					5.04	4.93
V5-9	956	1352					5.02	5.16
BSG	1006	1417					5.11	5.09

SMP 4/25/11



Keith Middle School Sampling Data Sheet

Ambient Air Sampling

Setup Date: 4/26/11
 Recovery Date: 5/11/11

Sampler(s): D6/SMORRIS
 Sampler(s): D6/SMORRIS

3.0
 3.1
 3.3
 3.0
 3.3

Location	Time		Vacuum (in Hg)		SUMMA Serial No.:	Flow Controller Serial No.:
	Start	Stop	Start	Finish		
BG	1410	1448	28.81	5.5	1628	281
BG Dup	1410	1448	29.64	4.8	1550	286
A	1445	1457	29.84	5.9	936	41
B	1449	1447	29.83	5.74	1552	319
C	1453	1455	30.01	11.22	953	459

TO-4A									
Location	Time		PUF Number	Serial Number	Counter (Hrs)		Sampler		Flow Rate (Mag Reading)
	Start	Stop			Start	Finish	Initial	Final	
BG	1440	1448	/	820	97.78	121.55	50	48	
BG Dup	1440	1448		822	51081	534.66	58	57	
A	1445	1447		825	507.80	507.80	56	55	
B	1449	1447		823	487.76	511.73	61	60	
C	1453	1455		821	487.94	512.00	58	55	

SMORRIS



APPENDIX C

FIELD REDUCED DATA

INDOOR SAMPLING LOCATIONS

Average Temp (oF/ K): **68.0** 293.0

Average Baro. Press ("Hg / mmHg): **30.01** 762.3

Thursday, April 21, 2011

Location	Serial #	m _s	b _s	Start Reading ("H2O)	Start Reading (lpm)	Stop Reading ("H2O)	Stop Reading (lpm)	Avg. Reading ("H2O)	RPD of Start and Stop Readings	Avg. Flow (lpm)	Start time (hr)	Stop Time (hr)	Total Sample Time (min)	Total Actual Sample Volume (m ³)
A-26, (Hallway outside rm 169)	TO-4A 825	0.031	-0.698	56		55		55.5	1.80	260	14:45	14:37	1432	372.4
B-26 (Auditorium)	TO-4A 823	0.036	-1.660	61		60		60.5	1.65	259	487.76	511.73	1438	372.7
C-26 (faculty lounge)	TO-4A 821	0.036	-1.660	58		55		56.5	5.31	252	487.94	512	1444	363.7

OUTDOOR SAMPLING LOCATIONS

Average Temp (oF/ K): **51.0** 283.6

Average Baro. Press ("Hg / mmHg): **30.01** 762.3

Thursday, April 21, 2011

Location	Serial #	m _s	b _s	Start Reading ("H2O)	Start Reading (lpm)	Stop Reading ("H2O)	Stop Reading (lpm)	Avg. Reading ("H2O)	RPD of Start and Stop Readings	Avg. Flow (lpm)	Start time (hr)	Stop Time (hr)	Total Sample Time (min)	Total Actual Sample Volume (m ³)
BG-26	TO-4A	820	0.033	-0.869	50		48	49	4.08	232	97.78	121.55	1426	330.3
BG-26-DUP	TO-4A	822	0.034	-1.176	58		57	57.5	1.74	250	510.89	534.66	1426	356.6
VS-1-26	TO-10A				5.15		5.02		2.56	5.09	9:35	13:26	231	1.2
VS-4-26	TO-10A				5.11		4.75		7.30	4.93	9:37	13:30	233	1.1
VS-9-26	TO-10A				5.02		5.16		2.75	5.09	9:56	13:52	236	1.2
VS-14-26	TO-10A				5.17		5.01		3.14	5.09	9:45	13:46	241	1.2
VS-14-26-DUP	TO-10A				5.04		4.93		2.21	4.99	9:45	13:46	241	1.2
VS-BG-26	TO-10A				5.11		5.08		0.59	5.10	10:06	14:17	251	1.3

APPENDIX D

EQUIPMENT CALIBRATION SHEETS

Network: New Bedford Site: Keith Middle Serial #: 821 Station #: C-26
 Technician: DG/sm Date: 4/20/2011 Orifice S/N: 1125 Orif. Cal. Date: 5-Jan-11

Reason for Puff Sampler Calibration: *Monthly Recal*

Amb. Temp, Ta (°C) 20 Bar. Press., Pa (in Hg) 30.01
 Amb. Temp, Ta (K) 293.0 Bar. Press., Pa (mmHg) 762.2

Orifice Data

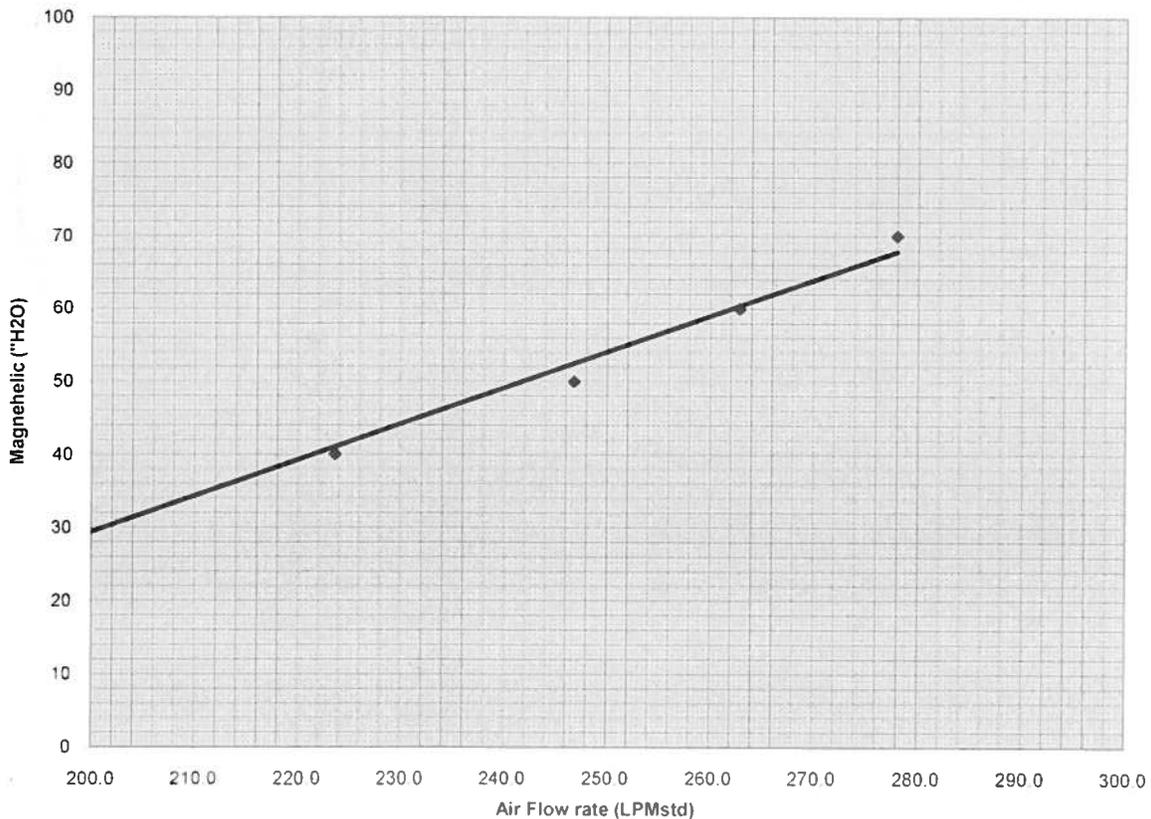
Qstd (m_o) = 8.71544 Qstd (b_o) = -0.03240 Qstd (r_o) = 0.99993

ΔH	Q _{std}	I	I _c
5.60	277.942	70	8.45
5.00	262.836	60	7.82
4.40	246.792	50	7.14
3.60	223.587	40	6.39
2.80	197.624	30	5.53

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

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

m_s = 0.036 b_s = -1.66035 r_s = 0.99799



Desired Flow Rate (lpm): 250

Sampler Setting: 54.1

m_{mag} = 0.493

b_{mag} = -69.11350

r_{mag} = 0.99239

[Signature]

4/25/11

Network: New Bedford Site: Keith Middle Serial #: 822 Station #: BG-26 - Dup
 Technician: DG/sm Date: 4/20/2011 Orifice S/N: 1125 Orif. Cal. Date: 5-Jan-11

Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 20 Bar. Press., Pa (in Hg) 30.01
 Amb. Temp, Ta (K) 293.0 Bar. Press., Pa (mmHg) 762.2

Orifice Data

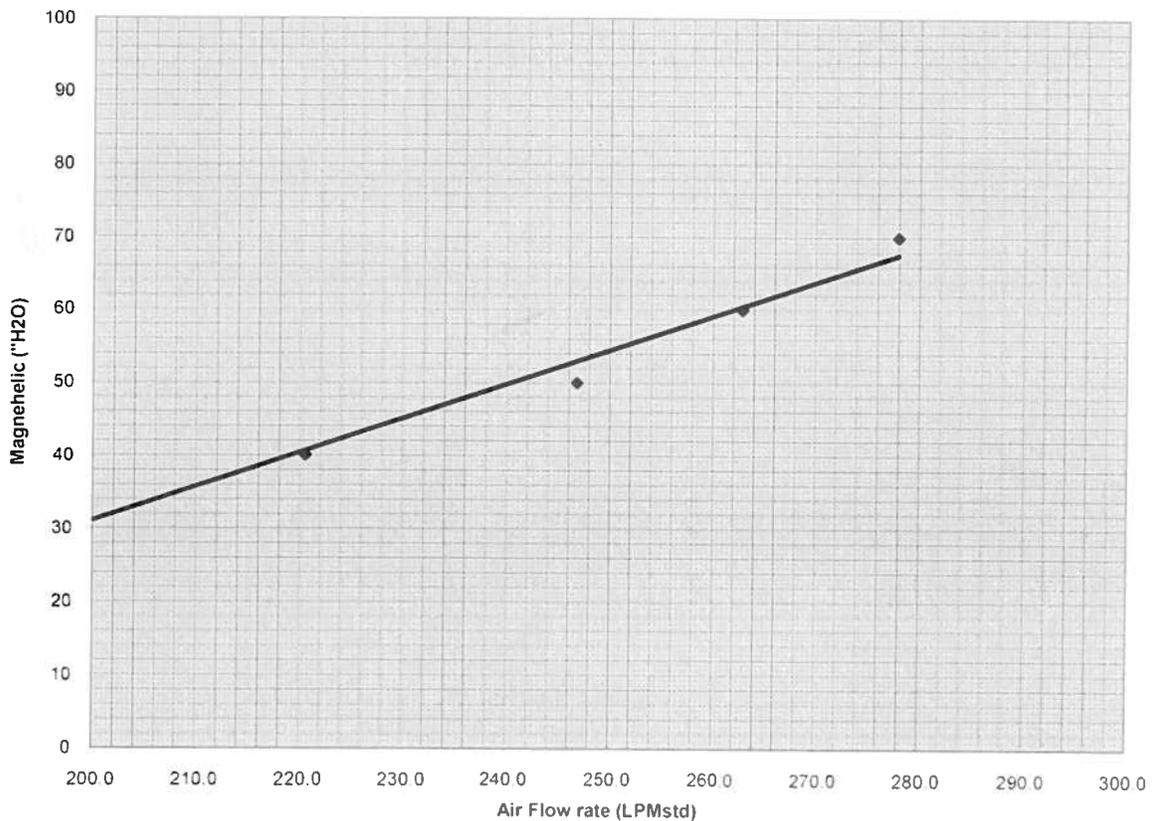
Qstd (m_o) = 8.71544 Qstd (b_o) = -0.03240 Qstd (r_o) = 0.99993

ΔH	Q _{std}	l	l _c
5.60	277.942	70	8.45
5.00	262.836	60	7.82
4.40	246.792	50	7.14
3.50	220.511	40	6.39
2.70	194.130	30	5.53

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

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

m_s = 0.034 b_s = -1.17464 r_s = 0.99690



Desired Flow Rate (lpm): 250

Sampler Setting: 54.5

m_{mag} = 0.468

b_{mag} = -62.42589

r_{mag} = 0.99080

ZAM

4/25/11

PS-1 Post-Sampling Flow Audit

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

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

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

4/21/2011

	Temp (°C)	Temp - T _s (K)	Sampler Reading - H _s (“h ₂ O)	Sampler Serial #	Orifice Reading - H _o (“h ₂ O)	Orifice #	Orifice Slope - m _o	Orifice Intercept - b _o	Qstd Orifice	Sampler # Stops - m _s	Sampler Intercept - b _s	Qstd Sampler	% Difference
A-26	20	293.0	50	825	4.50	1125	8.71544	-0.03240	0.250	0.031	-0.69829	0.253	-1.34
B-26	20	293.0	50	823	4.40	1125	8.71544	-0.03240	0.247	0.036	-1.66035	0.245	0.93
C-26	20	293.0	50	821	4.50	1125	8.71544	-0.03240	0.250	0.036	-1.66035	0.245	2.02
BG-26	20	293.0	50	820	4.40	1125	8.71544	-0.03240	0.247	0.033	-0.86903	0.243	1.64
BG-26-DUP	10.5	283.5	50	822	4.40	1125	8.71544	-0.03240	0.251	0.034	-1.17464	0.248	1.10

Press (Hg) 30.01 Press - P_s (mmHg) 762.3

Acceptance Limit \leq 10% Difference

Handwritten signature and date:
4/25/11

OFFICE 1125
CAL = 1/5/11

BG - 002
820

70 =	2.8 + 2.8	5.6
60 =	2.4 + 2.6	5.0
50 =	2.1 + 2.2	4.3
40 =	1.8 + 1.7	3.5
30 =	1.3 + 1.3	2.6
Post check	50 = 2.2 + 2.2	4.4

BGDUP - 004
822

70 =	2.8 + 2.8	5.6
60 =	2.5 + 2.5	5.0
50 =	2.2 + 2.2	4.4
40 =	1.8 + 1.7	3.5
30 =	1.4 + 1.3	2.7
Post check	50 = 2.2 + 2.2	4.4

Press 3001 INHs

= 762.2

A - 001
825

70	3.0 + 3.0	6.0
60	2.7 + 2.7	5.4
50	2.3 + 2.3	4.6
40	1.8 + 1.8	3.6
30	1.4 + 1.4	2.8
Post check	50 = 2.3 + 2.2	4.5

B - 003
823

70	2.8 + 2.8	5.6
60	2.5 + 2.5	5.0
50	2.2 + 2.2	4.4
40	1.8 + 1.8	3.6
30	1.4 + 1.4	2.8
Post check	2.2 + 2.2	4.4

Pos cal Temp
51°F

C - 005
821

70	2.8 + 2.8	5.6
60	2.5 + 2.5	5.0
50	2.2 + 2.2	4.4
40	1.8 + 1.8	3.6
30	1.4 + 1.4	2.8
Post check	2.2 + 2.3	4.5

Handwritten signature in red ink

APPENDIX E

LABORATORY DATA REPORTS (ON CD)

APPENDIX F

LABORATORY DATA VALIDATION
MEMORANDA



Memo

To: David Sullivan
From: Lorie MacKinnon
CC:
Date: 05/26/11
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDGs 11040360 and 11040361

SUMMARY

Limited (Tier II) validation was performed on the data for 16 air samples and three trip blank samples collected at the Keith Middle School in New Bedford, Massachusetts. The samples were collected on April 21, 2011 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 11040360 and 11040361.

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. Potential low bias exists for sample TB-26 (PUF) due to low surrogate recovery. Potential uncertainty exists for the results for trichlorobiphenyl and total PCBs in samples BG-26 (PUF) and BG-26-DUP (PUF) due to high relative percent difference in the evaluation of the field duplicate pair. This issue has a minor impact on the data usability; all results are still usable for project objectives.

SAMPLES

Samples included in this review are listed below:

11040360

VS-1-26

VS-4-26

VS-9-26

VS-14-26
VS-TB-26
C-26
TB-26

VS-14-26 DUP (1)
A-26
BG-26

VS-BG-26
B-26
BG-26 DUP (2)

11040361

A-26 (filter)
BG-26 (filter)

B-26 (filter)
BG-26 DUP (filter) (3)

C-26 (filter)
TB-26 (filter)

- (1) Field duplicate of VS-14-26
- (2) Field duplicate of BG-26
- (3) Field duplicate of BG-26 (filter)

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
- 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.

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 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.

Blanks

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

Target compounds were not detected in the verification filter Lot# 040411-4 and verification PUF Lot# 040411-3, which were reported under job 11040123.

Surrogate Spike Recoveries

Select samples exhibited surrogate recoveries outside the acceptance criteria. The following table summarizes the surrogate recoveries in the affected samples.

Sample ID Control Limit	TCMX 17.9-137	DCB 42.5-134	Validation Actions
TB-26 (PUF)	Criteria Met	36.1%	Estimate (UJ) the nondetect results for sample TB-26 (PUF).

LCS Results

An LCS and LCSD was extracted and analyzed with each extraction batch. The following table summarizes the compounds recovered outside of the control limits and the resulting validation actions.

Compound	LCS ID: Associated Samples	Recovery (%)	Control Limits	
Tetrachlorobiphenyl	LCS-83: Filter samples A-26, B-26, C-26, BG-26, BG-26 DUP, TB-26	87.0	34.6-86.9	Validation action was not required as the results for the affected homolog groups were nondetect and therefore not affected by the potential high bias.
Pentachlorobiphenyl	LCS-82: PUF samples A-26, B-26, C-26, BG-26, BG-26 DUP, TB-26	1120	37.8-91.9	Validation action was not required as the results for the affected homolog groups were nondetect and therefore not affected by the potential high bias.

Internal Standard Performance

All internal standard criteria were met.

Field Duplicate Results

Samples VS-14-26/VS-14-26 DUP (PUF), BG-26/BG-26 DUP (PUF), and BG-26/BG-26 DUP (filter) were submitted as the field duplicate (collocated) pairs with this sample set. PCBs were not detected in samples VS-14-26/VS-14-26 DUP (PUF) and BG-26/BG-26 DUP (filter).

The following table summarizes the RPDs of the detected analytes in sample pair BG-26/BG-26 DUP (PUF), which were not within the acceptance criteria of 20%RPD or the difference of <2 times the reporting limit (RL). The positive and nondetect results for trichlorobiphenyl and total PCBs in samples BG-26 and BG-26 DUP (PUF) were estimated (J/UJ).

Parameter	BG-26 (PUF) (ug/m3)	BG-26 DUP (PUF) (ug/m3)	RPD (%)
Trichlorobiphenyl	0.000207	0.0000150 U	NC, Not within 2xRL
Total PCB	0.000207	0.0000150 U	NC, Not within 2xRL

Quantitation Limits and Sample Results

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

Two-fold dilutions were performed for PUF samples A-26, B-26, and C-26. Quantitation limits were elevated accordingly.



Memo

To: David Sullivan
From: Lorie MacKinnon
CC:
Date: 05/26/11
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDG L1105570

SUMMARY

Limited (Tier II) validation was performed on the data for 11 air samples and two trip blank samples collected at the Keith Middle School, Massachusetts. The samples were collected on April 21, 2011 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. The positive and nondetect results for C-26 were estimated (J/UJ) due to high pre and post flow controller calibration check relative percent difference. The results for 2-hexanone, 1,2,4-trimethylbenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, n-butylbenzene, 1,2,4-trichlorobenzene, 1,2,3-trichlorobenzene, and hexachlorobutadiene in all samples should be qualified as estimated (J/UJ) due to calibration nonconformances. The results for acetone, 2-butanone, tetrachloroethene, and trichloroethene in samples VS-14-26 and VS-14-26 DUP should be qualified as estimated (J) due to field duplicate precision results. The results for acetone in samples C-26, B-26, BG-26, BG-26-DUP, VS-4-26, and VS-14-26-DUP and chloromethane in samples C-26, B-26, A-26, and VS-BG-26 should be qualified as estimated (J) due to possible co-elution with non-target compounds. The direction of the bias cannot be determined from these nonconformances. Due to the interference of non-target compounds, the presence of chloromethane in samples VS-1-26, VS-4-26, VS-9-26, VS-14-26, and VS-14-26 DUP could not be confirmed. These affected nondetect results were qualified as estimated (UJ).

SAMPLES

Samples included in this review are listed below:

L1105570

C-26	B-26	A-26
BG-26	BG-26-DUP (1)	TB-26
VS-1-26	VS-4-26	VS-9-26
VS-14-26	VS-14-26-DUP (2)	VS-BG-26
VS-TB-26		

- 1) Field duplicate of BG-26
- 2) Field duplicate of VS-14-26

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
- Laboratory Duplicate results
- 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.

Holding Times and Sample Preservation

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

The pre and post flow controller calibration check relative percent difference (RPD) exceeded the acceptance limit of 20 in sample C-26, indicating that the flow was not consistent over the time of collection. The positive and nondetect results for sample C-26 were estimated (J/UJ).

GC/MS Tunes

The frequency and abundance of all bromofluorobenzene (BFB) tunes were within the acceptance criteria.

Initial and Continuing Calibrations

All initial calibration criteria were met.

The percent differences (%Ds) for 2-hexanone (26.8%), 1,2,4-trimethylbenzene (25.2%), 1,3-dichlorobenzene (27.9%), 1,4-dichlorobenzene (28.2%), 1,2-dichlorobenzene (26.5%), n-butylbenzene

(30.7%), 1,2,4-trichlorobenzene (41.7%), 1,2,3-trichlorobenzene (29.3%), and hexachlorobutadiene (45.8%) were outside of the acceptance criteria in the continuing calibration associated with all samples. The positive and nondetect results for 2-hexanone, 1,2,4-trimethylbenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, n-butylbenzene, 1,2,4-trichlorobenzene, 1,2,3-trichlorobenzene, and hexachlorobutadiene were estimated (J/UJ) in these samples due to continuing calibration nonconformances.

Blanks

Target compounds were not detected in the laboratory method blank and trip blank samples associated with the volatile organic compound analyses.

Target compounds were not detected in the canister certification samples Can 258 Shelf 3, Can 1680 Shelf 37, Can 725 Shelf 38, and Can 1695 Shelf 41, which were reported under Jobs L1104171, L1104609, L1104611, and L1104617.

Laboratory Duplicate Results

The laboratory performed a duplicate analysis on sample VS-4-26. All relative percent differences (RPDs) were within the laboratory control limit of 25.

LCS Results

The recovery for n-butylbenzene (131%) was above the control limits of 70-130 in the LCS associated with all samples. Validation actions were not required on this basis as n-butylbenzene was not detected in the associated samples and therefore not affected by the potential high bias.

Internal Standard Performance

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

Field Duplicate Results

Samples BG-26 and BG-26 DUP were submitted as the field duplicate (collocated) pair with this sample set. The following table summarizes the relative percent differences (RPDs) of the target VOCs detected in either sample, all of which were within the acceptance criteria of 20%RPD or the difference of <2 times the reporting limit (RL).

VOCs	BG-26 (µg/m ³)	BG-26 DUP (µg/m ³)	RPD (%)
Dichlorodifluoromethane	2.34	2.20	6.2
Chloromethane	0.898	0.891	0.8
Acetone	3.38	3.34	1.2
Trichlorofluoromethane	1.40	1.30	7.4
Methylene chloride	11.1	4.86 U	NC, Within 2xRL
Chloroform	0.132	0.098 U	NC, Within 2xRL
Trichloroethene	0.107 U	0.145	NC, Within 2xRL

Samples VS-14-26 and VS-14-26 DUP were submitted as the field duplicate (collocated) pair with this sample set. The following table summarizes the relative percent differences (RPDs) of the target VOCs detected in either sample, all of which were within the acceptance criteria of 20%RPD or the difference

of <2 times the reporting limit (RL), with the exception of acetone, 2-butanone, tetrachloroethene, and trichloroethene. The positive results for acetone, 2-butanone, tetrachloroethene, and trichloroethene in samples VS-14-26 and VS-14-26 DUP were estimated (J).

VOCs	VS-14-26 ($\mu\text{g}/\text{m}^3$)	VS-14-26 DUP ($\mu\text{g}/\text{m}^3$)	RPD (%)
Dichlorodifluoromethane	2.15	2.23	3.7
Acetone	74.9	42.2	55.8
Trichlorofluoromethane	3.57	3.63	1.7
Methyl tert-butyl ether	27.2	29.9	9.5
2-Butanone	35.5	11.8	100.2
Tetrahydrofuran	2.68	3.19	17.4
Toluene	1.02	1.05	2.9
Benzene	0.555	0.412	29.6, Within 2xRL
Chloroform	2.49	2.86	13.8
Tetrachloroethene	2.61	4.84	59.9
Trichloroethene	0.553	1.02	59.4

Quantitation Limits and Sample Results

The laboratory noted in the case narrative that the presence of select compounds could not be determined or select compounds should be considered estimates due to non-target compound interferences. The following table summarizes these compound identification issues.

Sample	Compound	Identification Issue	Validation Action
VS-1-26	Chloromethane	Non-target compounds interfered with possible identification of this compound.	Estimate (U) the nondetect results for chloromethane in samples VS-1-26, VS-4-26, VS-9-26, VS-14-26, and VS-14-26 DUP.
VS-4-26			
VS-9-26			
VS-14-26			
VS-14-26 DUP			
C-26	Acetone	Co-elution with non-target compound	Estimate (J) the positive results for acetone in samples C-26, B-26, BG-26, BG-26-DUP, VS-4-26, and VS-14-26-DUP.
B-26			
BG-26			
BG-26-DUP			
VS-4-26			
VS-14-26-DUP			
C-26	Chloromethane	Co-elution with non-target compound	Estimate (J) the positive results for chloromethane in samples C-26, B-26, A-26, and VS-BG-26.
B-26			
A-26			
VS-BG-26			

APPENDIX G

**DISCUSSION OF RISK-BASED COMPARISON
CRITERIA**

DISCUSSION OF RISK-BASED COMPARISON CRITERIA

PCBs

Two PCB risk-based air concentrations (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.

In September 2009, EPA published Public Health Levels (PHLs) for PCBs which are calculated indoor air concentrations that maintain PCB exposures below a level that EPA = believes does not cause harm. PHLs were calculated for all ages of children from toddlers in day care to adolescents in high school as well as for adult school employees. In this report, indoor air PCB concentrations are compared to the PHL (0.45 ug/m^3) for adult school employees and children 12 to <15 years old, representative of the middle school age range. In calculating the PHL, EPA considered average PCB exposures from both school (e.g., school indoor and outdoor air, indoor dust and nearby outside soils) and non-school (e.g., diet, outside soils, indoor dust, and indoor and outdoor air) environments. EPA assumed that middle school children spend 6.5-hours per day at school (with 6 hours spent inside the school) for a 180-day school year.

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 from the subsurface beneath the KMS and convey the gases through PVC piping to outdoor air, limiting migration through the building slab and into indoor air. Little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is vented 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.

VOCs

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 (May 2011) 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 6-1 and 6-2 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.

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 consumer products that contain VOCs. 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 (MassDEP, 2008a) and residential and commercial Indoor Air Threshold Values (IATVs; December 2010) developed by MassDEP considering typical indoor air background concentrations and MassDEP risk management criteria. The residential IATVs assume continuous exposure (24 hours per day, 365 days per year for 30 years) while the commercial IATVs were developed to be applicable to exposures of lesser duration and intensity (8 hours per day, 250 days per year for 30 years). MassDEP considers investigation of the vapor intrusion pathway to be unnecessary when measured indoor air concentrations are at or below IATVs, assuming that the indoor air results are consistent with other site information and that adequate sampling has been performed. 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.

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.

APPENDIX H

INDOOR AIR RISK CALCULATIONS – COMMERCIAL WORKER

Table 1 Statistics of Detected Analytical Results for Indoor Air Samples - 2007 through 2011
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	# of Samples	# of Detects	Freq. of Detects	Min. of Detects (ug/m3)	Max. of Detects (ug/m3)	Location of Max. Detected	Min. of Non-Detects (ug/m3)	Max. of Non-Detects (ug/m3)	Mean Concentration (ug/m3)	EPC (ug/m3)	EPC Basis
VOCs (ug/m3)	1,2,4-trichlorobenzene	48	2	4.2%	11.7	12.2	A-11	1.48	3.71	1.6E+00	12.2	Max. of Detects
	1,2,4-trimethylbenzene	48	10	20.8%	1	4.97	A-26	0.982	2.46	1.1E+00	1.647	95% Chebyshev (Mean, Sd) UCL
	2,2,4-Trimethylpentane	45	4	8.9%	1.11	1.64	A-25	0.934	2.33	8.2E-01	0.914	95% Student's-t UCL
	2-butanone	48	37	77.1%	0.669	23.6	A-11	0.589	1.47	3.3E+00	4.23	95% Approximate Gamma UCL
	acetone ⁽¹⁾	48	44	91.7%	2.56	134	A-13	2.37	13.3	2.3E+01	28.93	95% Approximate Gamma UCL
	Benzene	48	25	52.1%	0.338	1.56	A-26	0.319	1.6	7.2E-01	0.78	95% Student's-t UCL
	Carbon Disulfide	48	4	8.3%	0.666	1.66	A-20	0.622	1.56	5.4E-01	0.608	95% Student's-t UCL
	Chloroform	48	19	39.6%	0.098	0.245	C-17	0.098	2.44	5.3E-01	0.245	Max. of Detects
	chloromethane	48	14	29.2%	0.433	15	C-13	0.413	1.03	9.1E-01	2.302	95% Chebyshev (Mean, Sd) UCL
	cyclohexane	45	7	15.6%	0.713	7.36	C-13	0.688	1.72	8.6E-01	1.612	95% Chebyshev (Mean, Sd) UCL
	Dichlorodifluoromethane	30	30	100.0%	1.99	3.1	C-24	--	--	2.4E+00	2.52	95% Student's-t UCL
	ethanol ⁽¹⁾	45	44	97.8%	4.16	191	C-17	4.71	4.71	2.9E+01	36.75	95% H-UCL
	ethylbenzene	48	15	31.3%	0.868	10.1	A-19	0.868	2.17	1.5E+00	2.814	95% Chebyshev (Mean, Sd) UCL
	Ethyl Acetate	27	1	3.7%	1.94	1.94	C-17	1.8	1.8	9.4E-01	1.94	Max. of Detects
	Freon-113	27	1	3.7%	2.02	2.02	C-17	1.53	1.53	8.1E-01	2.02	Max. of Detects
	isopropanol ⁽¹⁾	45	31	68.9%	1.25	42.6	C-19	1.23	1.23	4.2E+00	8.608	95% Chebyshev (Mean, Sd) UCL
	methylene chloride ⁽¹⁾	48	7	14.6%	3.48	318	C-14	0.694	4.86	9.1E+00	37.87	95% Chebyshev (Mean, Sd) UCL
	Methyl Isobutyl Ketone	30	5	16.7%	1.33	18.8	B-17	0.819	0.819	1.5E+00	4.627	95% Chebyshev (Mean, Sd) UCL
	p/m-xylene	48	18	37.5%	1.74	39	A-19	1.74	4.34	4.7E+00	9.75	95% Chebyshev (Mean, Sd) UCL
	o-xylene	48	14	29.2%	1.01	14	B-17	0.868	2.17	2.0E+00	4.032	95% Chebyshev (Mean, Sd) UCL
	n-heptane	45	7	15.6%	0.63075	16.5	A-11	0.819	2.05	1.1E+00	2.611	95% Chebyshev (Mean, Sd) UCL
	n-hexane	45	16	35.6%	0.715	145	C-14	0.704	3.52	4.5E+00	18.42	95% Chebyshev (Mean, Sd) UCL
	Propylene	45	5	11.1%	0.392	0.506	B-23	0.344	1.72	4.8E-01	0.506	Max. of Detects
	styrene	48	19	39.6%	0.868	7.26	A-14	0.851	2.13	1.5E+00	2.559	95% Chebyshev (Mean, Sd) UCL
	Tetrachloroethylene	48	13	27.1%	0.136	0.393	A-20	0.136	3.39	7.2E-01	0.393	Max. of Detects
	tetrahydrofuran	48	2	4.2%	4.52	7.05	A-13	0.589	1.47	6.7E-01	7.05	Max. of Detects
toluene	48	41	85.4%	0.777	74.1	B-25	0.753	1.88	7.0E+00	16.25	95% Chebyshev (Mean, Sd) UCL	
Trichloroethylene	48	7	14.6%	0.107	0.215	A-19	0.107	2.68	5.5E-01	0.215	Max. of Detects	
trichlorofluoromethane	48	25	52.1%	0.85	3.08	C-14	1.12	2.81	1.4E+00	1.452	95% Student's-t UCL	
n-Propylbenzene	3	1	33.3%	1.06	1.06	A-26	0.982	0.982	6.8E-01	1.06	Max. of Detects	
1,3,5-Trimethylbenzene	27	1	3.7%	1.96	1.96	A-26	0.982	0.982	5.5E-01	1.96	Max. of Detects	
PCBs (ug/m3)	Total PCBs	45	38	84.4%	0.00031	0.013	A-19	0.000071	0.00038	3.1E-03	0.00429	95% Approximate Gamma UCL

Notes:

ug/m3 - micrograms per cubic meter.

Values in **Bold** indicate the compound was detected.

VOCs - Volatile Organic Compounds.

PCBs - polychlorinated biphenyls.

(1) Compound is a common laboratory contaminant and detects may be associated with laboratory contamination for 2007 samples.

EPC - Exposure point concentration.

UCL - Upper concentration limit.

Table 2
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 µg/m ³	ADEcancer (Cancer) µg/m ³	ADEnon-cancer (Non-cancer) µg/m ³	Unit Risk (µg/m ³) ⁻¹	Chronic Noncancer Reference Concentration µg/m ³	Cancer Risk (--)	Hazard Quotient (--)	
1,2,4-Trichlorobenzene	12.2	9.9E-01	2.8E+00	NA	(1) 2.0E+02	(1) NA	1.E-02	
2-Butanone	4.432	3.6E-01	1.0E+00	NA	(1) 5.0E+03	(1) NA	2.E-04	
Acetone	30.36	2.5E+00	6.9E+00	NA	(1) 8.0E+02	(1) NA	9.E-03	
Carbon disulfide	0.532	4.3E-02	1.2E-01	NA	7.0E+02	(2) NA	2.E-04	
Ethyl acetate	1.94	1.6E-01	4.4E-01	NA	3.0E+03	(8) NA	1.E-04	
Benzene	0.738	6.0E-02	1.7E-01	7.8E-06	(1) 3.0E+01	(1) 5.E-07	6.E-03	
Chloroform	0.165	1.3E-02	3.8E-02	2.3E-05	(1) 6.6E+02	(1) 3.E-07	6.E-05	
Chloromethane	2.707	2.2E-01	6.2E-01	NA	(2) 9.0E+01	(2) NA	7.E-03	
Difluorodichloromethane	2.507	2.0E-01	5.7E-01	NA	2.0E+02	(3) NA	3.E-03	
Ethylbenzene	2.83	2.3E-01	6.5E-01	NA	(1) 1.0E+03	(1) NA	6.E-04	
Freon 113	2.02	1.6E-01	4.6E-01	NA	3.0E+04	(3) NA	2.E-05	
Methylene chloride	46.29	3.8E+00	1.1E+01	4.7E-07	(1) 3.0E+03	(1) 2.E-06	4.E-03	
Methyl isobutyl ketone	5.085	4.1E-01	1.2E+00	NA	(1) 3.0E+03	(1) NA	4.E-04	
Styrene	2.685	2.2E-01	6.1E-01	5.7E-07	(1) 1.0E+03	(1) 1.E-07	6.E-04	
Tetrachloroethene	0.209	1.7E-02	4.8E-02	5.5E-05	(1) 4.6E+03	(1) 9.E-07	1.E-05	
Tetrahydrofuran	7.05	5.7E-01	1.6E+00	1.9E-06	(7) 3.0E+02	(7) 1.E-06	5.E-03	
Toluene	16.58	1.4E+00	3.8E+00	NA	(1) 5.0E+03	(1) NA	8.E-04	
Trichlorofluoromethane	1.447	1.2E-01	3.3E-01	NA	7.0E+02	(3) NA	5.E-04	
Trichloroethene	0.126	1.0E-02	2.9E-02	1.7E-06	(1) 1.8E+02	(1) 2.E-08	2.E-04	
Xylenes	14.358	1.2E+00	3.3E+00	NA	(1) 1.0E+02	(1) NA	3.E-02	
n-Hexane	18.42	1.5E+00	4.2E+00	NA	(4) 2.0E+02	(4) NA	2.E-02	
n-Heptane	2.611	2.1E-01	6.0E-01	NA	(4) 2.0E+02	(4) NA	3.E-03	
Cyclohexane	1.612	1.3E-01	3.7E-01	NA	(4) 2.0E+02	(4) NA	2.E-03	
1,2,4-Trimethylbenzene	1.484	1.2E-01	3.4E-01	NA	(5) 5.0E+01	(5) NA	7.E-03	
2,2,4-Trimethylpentane	0.914	7.5E-02	2.1E-01	NA	(4) 2.0E+02	(4) NA	1.E-03	
Ethanol	36.75	3.0E+00	8.4E+00	NA	4.0E+03	(6) NA	2.E-03	
Isopropanol	8.608	7.0E-01	2.0E+00	NA	4.0E+03	(6) NA	5.E-04	
Propylene	0.691	5.6E-02	1.6E-01	NA	(5) 5.0E+01	(5) NA	3.E-03	
PCBs	0.00404	3.3E-04	9.2E-04	1.0E-04	(1) 2.0E-02	(1) 3.E-08	5.E-02	

Where:

LADEcancer = IAC x EFx 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
 µg/m³ = micrograms per cubic meter

And where:
 Exposure Frequency (EF) = 250 days/year
 Exposure Duration (ED) = 8 hrs/event [1]
 Exposure Period (EP) = 25 yr [1]
 Unit Conversion (UC) = 0.04 days/hr
 Averaging Period (APcancer) = 25550 days [1]
 Averaging Period (APnon-cancer) = 9125 days [1]

[1] MADEP, 2008

Sources of Toxicity Values:
 (1) MassDEP 2008; MCP standards derivation
 (2) IRIS, 2008
 (3) HEAST, 1997
 (4) Used C5-C8 aliphatic value from MassDEP 2008
 (5) Used C9-C10 aromatic value from MassDEP 2008
 (6) California EPA Reference Exposure Level for methanol
 (7) EPA provisional value from the Superfund Technical Support Center
 (8) Converted from IRIS RfD (0.9 mg/kg-day x 70 kg x 1/20 m³/day x 1000)

	Cancer Risk	Hazard Index
TOTAL:	5E-06	2.E-01

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