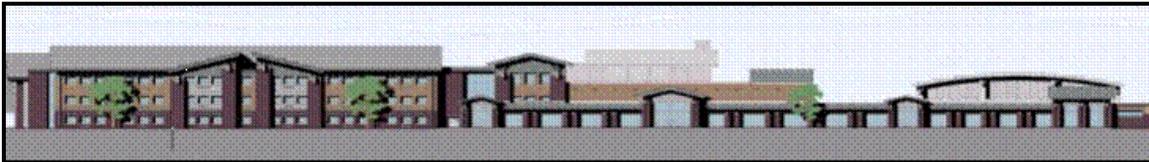


# **Sampling Results for the Keith Middle School Foundation Vent Stack and Indoor Air for Polychlorinated Biphenyls and Volatile Organic Compounds**

## **April 2012 Monitoring Round**

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TRC Project No. 115058

June 2012

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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 2012.

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-1 which vents building Section A west side (near the front of the school), VS-4 which vents building Section A east side (near the front of the school), VS-10 which vents Section B (near the auditorium), and VS-14 which vents Section C (the gymnasium). The passive sub-slab ventilation system was installed to allow any sub-slab soil gases to migrate from beneath the vapor barrier to the vent stacks, installed through the school building roof. Air samples were also collected immediately outside of the school during 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 2012 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 corresponding outdoor air background samples. However, PCBs were not detected in any of the vent stack air samples or in its corresponding outdoor air background sample. It should be noted that PCB vent stack air and its corresponding outdoor air detection limit 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 2012, it appears that there is variability in indoor air concentrations and the higher concentrations detected in April 2009, August 2010, April 2011 and April 2012

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;  $0.05 \text{ ug/m}^3$ ), 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;  $0.3 \text{ ug/m}^3$ ), 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;  $0.45 \text{ ug/m}^3$ ) 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), primarily developed between 1990 and 1995, consistent with the LTMMIP. MassDEP is in the process of updating the TELS/AALs, and published updated values for tetrachloroethene in January 2012. 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 (2012) 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 (MassDEP, 2008), and residential and commercial Indoor Air Threshold Values (IATVs; MassDEP 2011), 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, four VOCs (benzene, chloroform, ethylbenzene and methylene chloride) exceeded one or more comparison criteria. Three of these compounds (benzene, chloroform and ethylbenzene) were detected at concentrations below their corresponding MassDEP indoor air background value and residential IATV. Methylene chloride was detected at a concentration less than its MassDEP indoor air background value and commercial IATV, and only slightly greater than that detected in the background outdoor air sample. 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, six VOCs (2-butanone, benzene, chloroform, methyl tert butyl 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>
<b>EXECUTIVE SUMMARY .....</b>	<b>ES-1</b>
<b>1.0 INTRODUCTION.....</b>	<b>1-1</b>
1.1 Overview.....	1-1
1.2 Scope of Work .....	1-2
<b>2.0 SAMPLING LOCATIONS .....</b>	<b>2-1</b>
2.1 Indoor Air Quality Sample Locations.....	2-1
2.2 Foundation Vent Air Monitoring Sample Locations .....	2-1
<b>3.0 QUALITY ASSURANCE .....</b>	<b>3-1</b>
3.1 Data Validation Summary.....	3-1
3.2 TO-15 - Persistent Laboratory-Derived Contaminants.....	3-2
3.3 Collocated Sampler Precision .....	3-2
<b>4.0 SUMMARY OF RESULTS .....</b>	<b>4-1</b>
4.1 Indoor Air Quality Results.....	4-1
4.2 Vent Stack Air Results.....	4-2
<b>5.0 COMPARISON OF PCB RESULTS TO RISK-BASED AIR CONCENTRATIONS .....</b>	<b>5-1</b>
5.1 Indoor Air.....	5-1
5.2 Vent Stack Air.....	5-2
<b>6.0 COMPARISON OF VOC RESULTS TO COMPARISON CRITERIA.....</b>	<b>6-1</b>
6.1 Indoor Air.....	6-2
6.2 Vent Stack Air.....	6-3
6.3 Risk Characterization for Indoor Air .....	6-3
6.4 Trend Analysis for VOCs .....	6-4
6.5 Recommended Modifications to the LTMMIP.....	6-5
<b>7.0 CONCLUSIONS .....</b>	<b>7-1</b>
<b>8.0 REFERENCES.....</b>	<b>8-1</b>

## **TABLES**

Table 2-1.	April 2012 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 2012
Table 4-2.	Vent Stack Sample Results – April 2012
Table 5-1.	Comparison of PCB Indoor Air Quality Samples Results to Risk-Based Air Concentrations – April 2012
Table 5-2.	Comparison of PCB Vent Stack Air Sample Results to Risk-Based Air Concentrations – April 2012
Table 6-1.	Comparison of VOC Indoor Air Quality Sample Results to Comparison Criteria – April 2012
Table 6-2.	Comparison of VOC Vent Stack Air Sample Results to Comparison Criteria – April 2012

## **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 2012
Figure 5-2.	KMS Vent Stack PCB Trends – August 2006 through April 2012
Figure 6-1.	VOC Trends in KMS Building A (IAQ) – August 2006 through April 2012
Figure 6-2.	VOC Trends in KMS Building B (IAQ) – August 2006 through April 2012
Figure 6-3.	VOC Trends in KMS Building C (IAQ) – August 2006 through April 2012
Figure 6-4.	VOC Trends in KMS Vent Stack VS-1 – August 2006 through April 2012
Figure 6-5.	VOC Trends in KMS Vent Stack VS-4 – August 2006 through April 2012

## **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 2012.

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, 2011b, 2011c, 2011d and 2012).

This report presents monitoring data collected during April 2012. 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 2012 sampling event was the fourteenth 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 2012 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 2012 sampling event. Indoor air quality samples collected during the April 2012 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-29).

### **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 2012 sampling event. Vent stack samples collected during the April 2012 sampling event were designated with the vent stack number (e.g., VS-4) and a unique sample identification suffix indicating the sampling event number (e.g., VS-4-29).

### 3.0 QUALITY ASSURANCE

This section highlights the results of the QA/QC review for the April 2012 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 11 air samples and two trip blank samples collected at the Keith Middle School in New Bedford, Massachusetts. The samples were collected on April 18, 2012 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 number 11080581.

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.

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 18, 2012 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 sample C-29 were estimated (J/UJ) due to high pre and post flow controller calibration check relative percent difference. The nondetect results for trans-1,2-dichloroethene, trans-1,3-dichloropropene, and naphthalene in all samples should be qualified as estimated (UJ) due to calibration nonconformances. The direction of the bias cannot be determined from these nonconformances. The positive results for acetone in sample VS-14-29 and chloromethane in samples C-29, B-29, and A-29 should be qualified as estimated (J) due to possible co-elution with non-target compounds. These results may be biased high. Due to the interference of non-target compounds, the presence of chloromethane in samples VS-1-29, VS-4-29, VS-14-29, VS-10-29, and VS-10-29 DUP could not be confirmed and these affected nondetect results were qualified as estimated (UJ). These issues have a minor impact on the data usability; all results are still usable for project objectives.

### **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 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-15 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**

Samples BG-29 and BG-29 DUP were submitted as the field duplicate (collocated) pair with this sample set. Tables 3-1 and 3-2 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).

Samples VS-10-29 and VS-10-29 DUP were submitted as the field duplicate (collocated) pair with this sample set. Tables 3-1 and 3-2 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).

Samples VS-10-29/Vs-10-29 DUP and BG-29/BG-29 DUP were submitted as the field duplicate (collocated) pairs with this sample set. PCBs were not detected in samples VS-10-29 and VS-10-29 DUP. Tables 3-1 and 3-2 summarizes the RPDs of the detected analytes in sample pair BG-29/BG-29 DUP, which were within the acceptance criteria of 20%RPD or the difference of <2 times the reporting limit (RL).

## 4.0 SUMMARY OF RESULTS

The following section describes the findings from the sampling events conducted by TRC at the KMS during April 2012. The April 2012 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 two compounds reported throughout this report (acetone and methylene chloride) 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 18, 2012, 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 also in the background outdoor air samples. Total PCB detections ranged from 0.00499 ug/m<sup>3</sup> in the Building A sample to 0.0130 ug/m<sup>3</sup> in the Building B sample. The Building B total PCB detection is consistent with the higher concentrations reported in April 2009, August 2010 and April 2011. The total PCB detections in the background outdoor air samples were 0.000770 and 0.0000832 ug/m<sup>3</sup>.

A total of 12 VOCs were detected in the three indoor air quality samples and/or outdoor air background samples collected during April 2011. Four VOCs (2-butanone, acetone, chloromethane and difluorodichloromethane) 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, except for acetone which was detected in the indoor air samples at concentrations up to 3-fold those detected in the background

outdoor air samples. Methylene chloride was detected in the Building B sample at similar concentrations to that detected in the outdoor air background sample. Trichlorethene was only detected in the outdoor air background sample.

Benzene and toluene were detected in the three indoor air samples, but not in the background samples. The highest concentration of benzene and toluene were observed in the Building C sample. Chloroform, p/m-xylene, and o-xylene were detected in the Building B and Building C samples, with the highest concentrations observed in the Building C sample. Ethylbenzene was only detected in the Building B sample.

Acetone and methylene chloride are a 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 18, 2012, 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 2012, PCBs were not detected in the vent stack samples or in the outdoor air background sample.

A total of 11 VOCs were detected in the vent stack air samples and/or background sample, including the common laboratory contaminant acetone. Two of the detected VOCs (acetone and difluorodichloromethane) were detected in one or more of the vent stack air samples and at the outdoor air background sampling location. For difluorodichloromethane, lower concentrations were observed in the vent stack air samples than in the outdoor air sample. In contrast, acetone displayed concentrations up to 12-fold higher in the vent stack air samples than in the background sample. Chloromethane was detected in the background outdoor air sample, but was not detected in any of the vent stack air samples.

2-Butanone, benzene, chloroform, methyl tert butyl ether, tetrachloroethene, tetrahydrofuran, trichloroethene and trichlorofluoromethane 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 2012 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;  $0.05 \text{ ug/m}^3$ ) 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;  $0.3 \text{ ug/m}^3$ ), 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) and in the outdoor air background samples. The highest indoor air total PCB concentration (Building B sample) was approximately 4-fold lower than the PCB AL and roughly 20-fold lower than the ALTAEC; the Building A and Building C samples displayed concentrations of PCBs up to 10-fold lower than the AL and 60-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 30- and 90-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 2012. 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 2012, it appears that there is variability in indoor air concentrations and the higher concentrations detected in April 2009, August 2010, April 2011 and April 2012 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 0.0216 ug/m<sup>3</sup> to 0.0227 ug/m<sup>3</sup>, 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 2012. 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), primarily developed between 1990 and 1995, consistent with the LTMMIP. MassDEP is in the process of updating the TELs/AALs, and published updated values for tetrachloroethene in January 2012. 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 (except for tetrachloroethene) 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 2012; USEPA, 2012) 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, 2008) and residential and commercial Indoor Air Threshold Values (IATVs; December 2011) 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 four VOCs in the indoor air samples exceeded one or more comparison criteria. The compounds are benzene, chloroform, ethylbenzene and methylene chloride. Benzene, chloroform and ethylbenzene were detected at concentrations below Mass DEP indoor air background values and residential IATVs, indicating that the presence of these compounds in indoor air is not a site-related finding. Methylene chloride was detected at a concentration less than its MassDEP indoor air background value and commercial IATV, and only slightly greater than that detected in the background outdoor air sample.

Benzene, chloroform, ethylbenzene and methylene chloride 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, commercial EPA SL or the MassDEP commercial IATV which are more applicable to actual exposures occurring at the KMS than the AAL, residential EPA SL or MassDEP residential IATV, despite the “commercial” label. Therefore, the benzene, chloroform, ethylbenzene and methylene chloride

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.

## **6.2 Vent Stack Air**

As indicated on Table 6-2, concentrations of six VOCs in vent stack air samples exceeded one or more comparison criteria. The compounds include 2-butanone, benzene, chloroform, methyl tert butyl 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 tert butyl ether, tetrachloroethene 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 vent stack air concentrations do not exceed the TELs, applicable to short-term exposures, though the detected concentrations do exceed the AALs and/or residential/commercial EPA SLs. However, the detected concentrations only exceed the commercial EPA SL, most applicable to exposures occurring at the KMS, by approximately 4-fold on average. Therefore, these concentrations in the vent stack air samples are unlikely to be of concern.

Five of the 11 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, methyl tert butyl ether and tetrachloroethene. 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. Compounds detected in indoor air samples between March 2007 and April 2012 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 2012. 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 2012. 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 2012 data set for the following reasons:

- Risk calculations presented herein and in prior TRC reports (encompassing eighteen sampling events of monitoring data collected over 56 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 currently under regulatory review.

## 7.0 CONCLUSIONS

Indoor air quality and vent stack air sampling was conducted at the KMS during April 2012 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 2012. The following summarizes the conclusions of the air sampling data evaluation.

In general, all TO-10A and TO-15 data collected during April 2012 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 2012. The detected PCB concentrations for these samples were below risk-based action levels. Detected concentrations of benzene, chloroform, ethylbenzene and methylene chloride 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 2012 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 2012. 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 2012, it appears that there is variability in indoor air concentrations and the higher concentrations detected in April 2009, August 2010, April 2011 and April 2012 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 currently under regulatory review.

August 2012 is the date for the next sampling event.

## 8.0 REFERENCES

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# **TABLES**

**Table 2-1. April 2012 Sample Summary  
Keith Middle School  
New Bedford, Massachusetts**

<b>Sample ID</b>	<b>Sample Location</b>	<b>Sample Collected</b>	<b>Sample Type</b>
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		Vent Stack
VS-10	Building B, vent stack 10	XX	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	X	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-12		
		BG-29	BG-29 Dup	RPD (%)
VOCs ( $\mu\text{g}/\text{m}^3$ )	1,2,4-trichlorobenzene	< 1.48	< 1.48	NC
	1,2,4-trimethylbenzene	< 0.983	< 0.983	NC
	1,2-dichloroethane	< 0.809	< 0.809	NC
	1,3-dichlorobenzene	< 1.20	< 1.20	NC
	1,4-dioxane	< 0.721	< 0.721	NC
	2-butanone	<b>1.20</b>	< 0.590	Within 2xQL
	2-hexanone	< 0.820	< 0.820	NC
	acetone <sup>(1)</sup>	<b>5.94</b>	<b>5.51</b>	<b>7.51%</b>
	benzene	< 0.319	< 0.319	NC
	carbon disulfide	< 0.623	< 0.623	NC
	chloroform	< 0.098	< 0.098	NC
	chloromethane	<b>1.02</b>	<b>1.12</b>	<b>9.35%</b>
	cis-1,2-dichloroethene	< 0.793	< 0.793	NC
	difluorodichloromethane	<b>2.20</b>	<b>2.33</b>	<b>5.74%</b>
	ethylbenzene	< 0.869	< 0.869	NC
	methylene chloride <sup>(1)</sup>	< 4.86	<b>5.52</b>	Within 2xQL
	methyl isobutyl ketone (MIBK)	< 0.820	< 0.820	NC
	methyl tert butyl ether	< 0.721	< 0.721	NC
	p/m-xylene	< 1.74	< 1.74	NC
	o-xylene	< 8.69	< 8.69	NC
	styrene	< 0.852	< 0.852	NC
	tetrachloroethene	< 0.136	< 0.136	NC
	tetrahydrofuran	< 0.590	< 0.590	NC
	toluene	< 0.754	< 0.754	NC
trichloroethene	< 0.107	<b>0.124</b>	Within 2xQL	
trichlorofluoromethane	< 1.12	< 1.12	NC	
n-propylbenzene	< 0.983	< 0.983	NC	
1,3,5-trimethylbenzene	< 0.983	< 0.983	NC	
PCBs ( $\mu\text{g}/\text{m}^3$ )	Total PCBs	<b>0.000832</b>	<b>0.00077</b>	<b>7.74%</b>

Notes:

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

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

<sup>(1)</sup> 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-12		
		VS-10-29	VS-10-29 DUP	RPD (%)
VOCs ( $\mu\text{g}/\text{m}^3$ )	1,2,4-trichlorobenzene	< 14.80	< 14.80	NC
	1,2,4-trimethylbenzene	< 9.83	< 9.83	NC
	1,2-dichloroethane	< 8.09	< 8.09	NC
	1,3-dichlorobenzene	< 12.0	< 12.0	NC
	1,4-dioxane	< 7.21	< 7.21	NC
	2-butanone	<b>11.4</b>	<b>7.90</b>	<b>36.27%</b>
	2-hexanone	< 8.20	< 8.20	NC
	acetone <sup>(1)</sup>	<b>28.7</b>	< 23.80	Within 2xQL
	benzene	< 3.19	< 3.19	NC
	carbon disulfide	< 6.23	< 6.23	NC
	chloroform	< 0.977	< 0.977	NC
	chloromethane	< 4.13 UJ	< 4.13 UJ	NC
	cis-1,2-dichloroethene	< 7.93	< 7.93	NC
	difluorodichloromethane	< 9.89	< 9.89	NC
	ethylbenzene	< 8.69	< 8.69	NC
	methylene chloride <sup>(1)</sup>	< 48.6	< 48.6	NC
	methyl isobutyl ketone (MIBK)	< 8.20	< 8.20	NC
	methyl tert butyl ether	< 7.21	< 7.21	NC
	p/m-xylene	< 17.4	< 17.4	NC
	o-xylene	< 0.869	< 0.869	NC
	styrene	< 8.52	< 8.52	NC
	tetrachloroethene	< 1.36	< 1.36	NC
	tetrahydrofuran	< 5.90	< 5.90	NC
	toluene	< 7.54	< 7.54	NC
	trichloroethene	< 1.07	< 1.07	NC
	trichlorofluoromethane	< 11.2	< 11.2	NC
n-propylbenzene	< 9.83	< 9.83	NC	
1,3,5-trimethylbenzene	< 9.83	< 9.83	NC	
PCBs ( $\mu\text{g}/\text{m}^3$ )	Total PCBs	< 0.0221	< 0.0219	NC

Notes:

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

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

<sup>(1)</sup> Compound is a common laboratory contaminant as discussed in Section 3.

**Table 4-1. Indoor Air Quality Sample Results - April 2012**  
**Keith Middle School**  
**New Bedford, Massachusetts**

Analysis	Analyte	Sample Locations			Background		QA/QC Trip Blank
		A-29	B-29	C-29	BG-29	BG-29 Dup	
VOCs ( $\mu\text{g}/\text{m}^3$ )	1,2,4-trichlorobenzene	< 1.48	< 1.48	< 1.48 UJ	< 1.48	< 1.48	< 1.48
	1,2,4-trimethylbenzene	< 0.983	< 0.983	< 0.983 UJ	< 0.983	< 0.983	< 0.983
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809 UJ	< 0.809	< 0.809	< 0.809
	1,3-dichlorobenzene	< 1.20	< 1.20	< 1.20 UJ	< 1.20	< 1.20	< 1.20
	1,4-dioxane	< 0.721	< 0.721	< 0.721 UJ	< 0.721	< 0.721	< 0.721
	2-butanone	<b>1.95</b>	<b>2.60</b>	<b>2.93 J</b>	<b>1.20</b>	< 0.590	< 0.590
	2-hexanone	< 0.820	< 0.820	< 0.820 UJ	< 0.820	< 0.820	< 0.820
	acetone <sup>(1)</sup>	<b>14.8</b>	<b>17.0</b>	<b>17.3 J</b>	<b>5.94</b>	<b>5.51</b>	< 2.38
	benzene	<b>0.342</b>	<b>0.438</b>	<b>0.690 J</b>	< 0.319	< 0.319	< 0.319
	carbon disulfide	< 0.623	< 0.623	< 0.623 UJ	< 0.623	< 0.623	< 0.623
	chloroform	< 0.098	<b>0.112</b>	<b>0.127 J</b>	< 0.098	< 0.098	< 0.098
	chloromethane	<b>0.793 J</b>	<b>0.533 J</b>	<b>0.822 J</b>	<b>1.02</b>	<b>1.12</b>	< 0.413
	cis-1,2-dichloroethene	< 0.793	< 0.793	< 0.793 UJ	< 0.793	< 0.793	< 0.793
	difluorodichloromethane	<b>2.08</b>	<b>2.11</b>	<b>2.10 J</b>	<b>2.20</b>	<b>2.33</b>	< 0.989
	ethylbenzene	< 0.869	< 0.869	<b>1.13 J</b>	< 0.869	< 0.869	< 0.869
	methylene chloride <sup>(1)</sup>	< 4.86	<b>6.36</b>	< 4.86 UJ	< 4.86	<b>5.52</b>	< 4.86
	methyl isobutyl ketone (MIBK)	< 0.820	< 0.820	< 0.820 UJ	< 0.820	< 0.820	< 0.820
	methyl tert butyl ether	< 0.721	< 0.721	< 0.721 UJ	< 0.721	< 0.721	< 0.721
	p/m-xylene	< 1.74	<b>1.88</b>	<b>2.96 J</b>	< 1.74	< 1.74	< 1.74
	o-xylene	< 0.869	<b>0.934</b>	<b>0.995 J</b>	< 0.869	< 0.869	< 0.869
	styrene	< 0.852	< 0.852	< 0.852 UJ	< 0.852	< 0.852	< 0.852
	tetrachloroethene	< 0.136	< 0.136	< 0.136 UJ	< 0.136	< 0.136	< 0.136
	tetrahydrofuran	< 0.590	< 0.590	< 0.590 UJ	< 0.590	< 0.590	< 0.590
toluene	<b>1.11</b>	<b>2.06</b>	<b>4.41 J</b>	< 0.754	< 0.754	< 0.754	
trichloroethene	< 0.107	< 0.107	< 0.107 UJ	< 0.107	<b>0.124</b>	< 0.107	
trichlorofluoromethane	< 1.12	< 1.12	< 1.12 UJ	< 1.12	< 1.12	< 1.12	
n-propylbenzene	< 0.983	< 0.983	< 0.983 UJ	< 0.983	< 0.983	< 0.983	
1,3,5-trimethylbenzene	< 0.983	< 0.983	< 0.983 UJ	< 0.983	< 0.983	< 0.983	
PCBs ( $\mu\text{g}/\text{m}^3$ )	Total PCBs	<b>0.00499</b>	<b>0.0130</b>	<b>0.00578</b>	<b>0.000832</b>	<b>0.000770</b>	< 0.025 $\mu\text{g}$

**Notes:**

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

VOCs - volatile organic compounds

PCBs - polychlorinated biphenyls

$\mu\text{g}$  - micrograms; trip blank results are presented in micrograms ( $\mu\text{g}$ ) due to no air volume being collected during analysis.

<sup>(1)</sup> 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 2012**  
**Keith Middle School**  
**New Bedford, Massachusetts**

Analysis	Analyte	Sample Locations					Background	QA/QC
		VS-1-29	VS-4-29	VS-14-29	VS-10-29	VS-10-29-DUP	VS-BG-29	Trip Blank-VS
VOCs (µg/m <sup>3</sup> )	1,2,4-trichlorobenzene	< 1.48	< 1.48	< 1.48	< 14.80	< 14.80	< 1.48	< 1.48
	1,2,4-trimethylbenzene	< 0.983	< 0.983	< 0.983	< 9.83	< 9.83	< 0.983	< 0.983
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809	< 8.09	< 8.09	< 0.809	< 0.809
	1,3-dichlorobenzene	< 1.20	< 1.20	< 1.20	< 12.0	< 12.0	< 1.20	< 1.20
	1,4-dioxane	< 0.721	< 0.721	< 0.721	< 7.21	< 7.21	< 0.721	< 0.721
	2-butanone	<b>22.8</b>	<b>19.3</b>	<b>51.3</b>	<b>11.4</b>	<b>7.90</b>	< 0.590	< 0.590
	2-hexanone	< 0.820	< 0.820	< 0.820	< 8.20	< 8.20	< 0.820	< 0.820
	acetone <sup>(1)</sup>	<b>57.0</b>	<b>51.5</b>	<b>13.2</b> J	<b>28.7</b>	< 23.8	<b>4.77</b>	< 2.38
	benzene	<b>1.21</b>	<b>0.620</b>	< 0.319	< 3.19	< 3.19	< 0.319	< 0.319
	carbon disulfide	< 0.623	< 0.623	< 0.623	< 6.23	< 6.23	< 0.623	< 0.623
	chloroform	<b>2.31</b>	<b>1.37</b>	<b>4.27</b>	< 0.977	< 0.977	< 0.098	< 0.098
	chloromethane	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	< 4.13 UJ	< 4.13 UJ	<b>0.975</b>	< 0.413
	cis-1,2-dichloroethene	< 0.793	< 0.793	< 0.793	< 7.93	< 7.93	< 0.793	< 0.793
	difluorodichloromethane	<b>1.17</b>	<b>1.59</b>	< 0.989	< 9.89	< 9.89	<b>2.17</b>	< 0.989
	ethylbenzene	< 0.869	< 0.869	< 0.869	< 8.69	< 8.69	< 0.869	< 0.869
	methylene chloride <sup>(1)</sup>	< 4.86	< 4.86	< 4.86	< 48.6	< 48.6	< 4.86	< 4.86
	methyl isobutyl ketone (MIBK)	< 0.820	< 0.820	< 0.820	< 8.20	< 8.20	< 0.820	< 0.820
	methyl tert butyl ether	< 0.721	< 0.721	<b>20.8</b>	< 7.21	< 7.21	< 0.721	< 0.721
	p/m-xylene	< 1.74	< 1.74	< 1.74	< 17.4	< 17.4	< 1.74	< 1.74
	o-xylene	< 0.869	< 0.869	< 0.869	< 8.69	< 8.69	< 0.869	< 0.869
	styrene	< 0.852	< 0.852	< 0.852	< 8.52	< 8.52	< 0.852	< 0.852
tetrachloroethene	<b>2.79</b>	<b>6.31</b>	<b>8.68</b>	< 1.36	< 1.36	< 0.136	< 0.136	
tetrahydrofuran	<b>1.74</b>	<b>6.84</b>	<b>29.4</b>	< 5.90	< 5.90	< 0.590	< 0.590	
toluene	< 0.754	< 0.754	< 0.754	< 7.54	< 7.54	< 0.754	< 0.754	
trichloroethene	<b>0.290</b>	<b>0.242</b>	<b>0.591</b>	< 1.07	< 1.07	< 0.107	< 0.107	
trichlorofluoromethane	<b>1.30</b>	< 1.12	<b>1.93</b>	< 11.2	< 11.2	< 1.12	< 1.12	
n-propylbenzene	< 0.983	< 0.983	< 0.983	< 9.83	< 9.83	< 0.983	< 0.983	
1,3,5-trimethylbenzene	< 0.983	< 0.983	< 0.983	< 9.83	< 9.83	< 0.983	< 0.983	
PCBs (µg/m <sup>3</sup> )	Total PCBs	< 0.0221	< 0.0227	< 0.0217	< 0.0221	< 0.0219	< 0.0216	< 0.025 ug

Notes:

µg/m<sup>3</sup> - 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.

<sup>(1)</sup> 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 5-1. Comparison of PCB Indoor Air Quality Sample Results to Risk-Based Air Concentrations - April 2012**  
**Keith Middle School**  
**New Bedford, Massachusetts**

Analysis	Analyte	Sample Locations			Background Location		QA/QC Trip Blank	MassDEP Background	Comparison Values		
		A-29	B-29	C-29	BG-29	BG-29 Dup			AL*	ALTAEC*	PHL**
PCBs ( $\mu\text{g}/\text{m}^3$ )	Total PCBs	0.00499	0.0130	0.00578	0.000832	0.000770	< 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/pcbinscaulk/>)

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 2012  
Keith Middle School  
New Bedford, Massachusetts**

Analysis	Analyte	Sample Locations					Background	QA/QC	Comparison Values		
		VS-1-29	VS-4-29	VS-14-29	VS-10-29	VS-10-29-DUP	VS-BG-29	Trip Blank-VS			
PCBs ( $\mu\text{g}/\text{m}^3$ )	Total PCBs	< 0.0221	< 0.0227	< 0.0217	< 0.0221	< 0.0219	< 0.0216	< 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/pbcsincaulk/>)

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 2012**  
**Keith Middle School**  
**New Bedford, Massachusetts**

Analysis	Analyte	Sample Locations			Background Location		QA/QC	MassDEP	MassDEP	MassDEP	Comparison Values							
		A-29	B-29	C-29	BG-29	BG-29 Dup	Trip Blank	Background	IATV (residential)	IATV (commercial)	TEL*	AAL*	EPA SL (residential)	EPA SL (commercial)				
VOCs (µg/m <sup>3</sup> )	1,2,4-trichlorobenzene	< 1.48	< 1.48	< 1.48	UJ	< 1.48	< 1.48	< 0.983	< 0.983	< 0.983	0.59	3.4	170	--	--	0.42 (a)	1.76 (a)	
	1,2,4-trimethylbenzene	< 0.983	< 0.983	< 0.983	UJ	< 0.983	< 0.983	< 0.983	--	--	--	--	--	--	--	1.46 (a)	6.2 (a)	
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809	UJ	< 0.809	< 0.809	< 0.809	--	0.09	0.44	11.01	0.04	0.094 (a)	0.47 (a)			
	1,3-dichlorobenzene	< 1.20	< 1.20	< 1.20	UJ	< 1.20	< 1.20	< 1.20	--	0.6	170	--	--	0.22 (e)	1.1 (e)			
	1,4-dioxane	< 0.721	< 0.721	< 0.721	UJ	< 0.721	< 0.721	< 0.721	--	0.59	2.8	24.49	0.24	0.32 (a)	1.6 (a)			
	2-butanone	<b>1.95</b>	<b>2.60</b>	<b>2.93</b>	J	<b>1.20</b>	< 0.590	< 0.590	42.18	12	4400	200	10	1040 (a)	4400 (a)			
	2-hexanone	< 0.820	< 0.820	< 0.820	UJ	< 0.820	< 0.820	< 0.820	--	--	--	10.88	10.88	6.2 (a)	26 (a)			
	acetone <sup>(1)</sup>	<b>14.8</b>	<b>17.0</b>	<b>17.3</b>	J	<b>5.94</b>	<b>5.51</b>	< 2.38	27.04	91	700	160.54	160.54	6400 (a)	28000 (a)			
	benzene	<b>0.342</b>	<b>0.438</b>	<b>0.690</b>	J	< 0.319	< 0.319	< 0.319	21	2.3	11	1.74	<b>0.12</b>	<b>0.31 (a)</b>	1.6 (a)			
	carbon disulfide	< 0.623	< 0.623	< 0.623	UJ	< 0.623	< 0.623	< 0.623	--	--	--	0.1	0.1	146 (a)	620 (a)			
	chloroform	< 0.098	<b>0.112</b>	<b>0.127</b>	J	< 0.098	< 0.098	< 0.098	3.36	1.9	3	132.76	<b>0.04</b>	<b>0.11 (a)</b>	0.53 (a)			
	chloromethane	<b>0.793</b>	<b>J</b>	<b>0.533</b>	J	<b>1.02</b>	<b>1.12</b>	< 0.413	--	--	--	--	--	--	18.8 (a)	78 (a)		
	cis-1,2-dichloroethene	< 0.793	< 0.793	< 0.793	UJ	< 0.793	< 0.793	< 0.793	--	0.8	31	215.62	107.81	12.6 (f)	52 (f)			
	difluorodichloromethane	<b>2.08</b>	<b>2.11</b>	<b>2.10</b>	J	<b>2.20</b>	<b>2.33</b>	< 0.989	--	--	--	--	--	--	20 (a)	88 (a)		
	ethylbenzene	< 0.869	< 0.869	<b>1.13</b>	J	< 0.869	< 0.869	< 0.869	9.62	7.4	880	300	300	<b>0.97 (a)</b>	4.9 (a)			
	methylene chloride <sup>(1)</sup>	< 4.86	<b>6.36</b>	< 4.86	UJ	< 4.86	<b>5.52</b>	< 4.86	600	5	530	9.45	<b>0.24</b>	96 (a)	520 (a)			
	methyl isobutyl ketone (MIBK)	< 0.820	< 0.820	< 0.820	UJ	< 0.820	< 0.820	< 0.820	--	2.2	2600	55.7	55.7	620 (a)	2600 (a)			
	methyl tert butyl ether	< 0.721	< 0.721	< 0.721	UJ	< 0.721	< 0.721	< 0.721	--	39	2600	--	--	9.4 (a)	47 (a)			
	p/m-xylene	< 1.74	<b>1.88</b>	<b>2.96</b>	J	< 1.74	< 1.74	< 1.74	72.41**	20	88	11.8**	11.8**	20 (a)	88 (a)			
	o-xylene	< 0.869	<b>0.934</b>	<b>0.995</b>	J	< 0.869	< 0.869	< 0.869	72.41**	20	88	11.8**	11.8**	20 (a)	88 (a)			
	styrene	< 0.852	< 0.852	< 0.852	UJ	< 0.852	< 0.852	< 0.852	2.79	1.4	20	200	2	200 (a)	880 (a)			
	tetrachloroethene	< 0.136	< 0.136	< 0.136	UJ	< 0.136	< 0.136	< 0.136	11.01	1.4	4.1	50***	0.1***	8.4 (a)	36 (a)			
	tetrahydrofuran	< 0.590	< 0.590	< 0.590	UJ	< 0.590	< 0.590	< 0.590	--	--	--	160.35	80.18	420 (a)	1760 (a)			
	toluene	<b>1.11</b>	<b>2.06</b>	<b>4.41</b>	J	< 0.754	< 0.754	< 0.754	28.65	54	4400	80	20	1040 (a)	4400 (a)			
	trichloroethene	< 0.107	< 0.107	< 0.107	UJ	< 0.107	<b>0.124</b>	< 0.107	4.49	0.8	1.8	36.52	0.61	0.42 (a)	1.8 (a)			
	trichlorofluoromethane	< 1.12	< 1.12	< 1.12	UJ	< 1.12	< 1.12	< 1.12	--	--	--	--	--	146 (a)	620 (a)			
	n-propylbenzene	< 0.983	< 0.983	< 0.983	UJ	< 0.983	< 0.983	< 0.983	--	--	--	--	--	200 (a)	880 (a)			
	1,3,5-trimethylbenzene	< 0.983	< 0.983	< 0.983	UJ	< 0.983	< 0.983	< 0.983	--	--	--	--	--	1.46 (h)	6.2 (h)			

**Notes:**

µg/m<sup>3</sup> - micrograms per cubic meter

VOCs - volatile organic compounds

IATV - Indoor Air Threshold Value; Mass DEP interim final December 2011

EPA SL - EPA Screening Level; May 2012

- (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

<sup>(1)</sup> 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 (TELS) and Allowable Ambient Limits (AALs) for ambient air currently in effect (January, 2012)

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

\*\*\* - Values updated in January 2012; all other AAL/TELS are dated 1995.

-- - 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 2012**  
**Keith Middle School**  
**New Bedford, Massachusetts**

Analysis	Analyte	Sample Locations					Background VS-BG-29	QA/QC Trip Blank-VS	Comparison Values				
		VS-1-29	VS-4-29	VS-14-29	VS-10-29	VS-10-29-DUP			TEL*	AAL*	EPA SL (residential)	EPA SL (commercial)	
VOCs (µg/m <sup>3</sup> )	1,2,4-trichlorobenzene	< 1.48	< 1.48	< 1.48	< 14.80	< 14.80	< 1.48	< 1.48	--	--	0.42 (a)	1.76 (a)	
	1,2,4-trimethylbenzene	< 0.983	< 0.983	< 0.983	< 9.83	< 9.83	< 0.983	< 0.983	--	--	1.46 (a)	6.2 (a)	
	1,2-dichloroethane	< 0.809	< 0.809	< 0.809	< 8.09	< 8.09	< 0.809	< 0.809	11.01	0.04	0.094 (a)	0.47 (a)	
	1,3-dichlorobenzene	< 1.20	< 1.20	< 1.20	< 12.0	< 12.0	< 1.20	< 1.20	--	--	0.22 (e)	1.1 (e)	
	1,4-dioxane	< 0.721	< 0.721	< 0.721	< 7.21	< 7.21	< 0.721	< 0.721	24.49	0.24	0.32 (a)	1.6 (a)	
	2-butanone	<b>22.8</b>	<b>19.3</b>	<b>51.3</b>	<b>11.4</b>	<b>7.90</b>	< 0.590	< 0.590	200	<b>10</b>	1040 (a)	4400 (a)	
	2-hexanone	< 0.820	< 0.820	< 0.820	< 8.20	< 8.20	< 0.820	< 0.820	10.88	10.88	6.2 (a)	26 (a)	
	acetone <sup>(1)</sup>	<b>57.0</b>	<b>51.5</b>	<b>13.2</b>	<b>J</b>	<b>28.7</b>	< 23.8	<b>4.77</b>	< 2.38	160.54	160.54	6400 (a)	28000 (a)
	benzene	<b>1.21</b>	<b>0.620</b>	< 0.319	< 3.19	< 3.19	< 0.319	< 0.319	1.74	<b>0.12</b>	<b>0.31 (a)</b>	1.6 (a)	
	carbon disulfide	< 0.623	< 0.623	< 0.623	< 6.23	< 6.23	< 0.623	< 0.623	0.1	0.1	146 (a)	620 (a)	
	chloroform	<b>2.31</b>	<b>1.37</b>	<b>4.27</b>	< 0.977	< 0.977	< 0.098	< 0.098	132.76	<b>0.04</b>	<b>0.11 (a)</b>	<b>0.53 (a)</b>	
	chloromethane	< 0.413 UJ	< 0.413 UJ	< 0.413 UJ	< 4.13 UJ	< 4.13 UJ	<b>0.975</b>	< 0.413	--	--	18.8 (a)	78 (a)	
	cis-1,2-dichloroethene	< 0.793	< 0.793	< 0.793	< 7.93	< 7.93	< 0.793	< 0.793	215.62	107.81	12.6 (f)	52 (f)	
	difluorodichloromethane	<b>1.17</b>	<b>1.59</b>	< 0.989	< 9.89	< 9.89	<b>2.17</b>	< 0.989	--	--	20 (a)	88 (a)	
	ethylbenzene	< 0.869	< 0.869	< 0.869	< 8.69	< 8.69	< 0.869	< 0.869	300	300	0.97 (a)	4.9 (a)	
	methylene chloride <sup>(1)</sup>	< 4.86	< 4.86	< 4.86	< 48.6	< 48.6	< 4.86	< 4.86	9.45	0.24	96 (a)	520 (a)	
	methyl isobutyl ketone (MIBK)	< 0.820	< 0.820	< 0.820	< 8.20	< 8.20	< 0.820	< 0.820	55.7	55.7	620 (a)	2600 (a)	
	methyl tert butyl ether	< 0.721	< 0.721	<b>20.8</b>	< 7.21	< 7.21	< 0.721	< 0.721	--	--	<b>9.4 (a)</b>	47 (a)	
	p/m-xylene	< 1.74	< 1.74	< 1.74	< 17.4	< 17.4	< 1.74	< 1.74	11.8**	11.8**	20 (a)	88 (a)	
	o-xylene	< 0.869	< 0.869	< 0.869	< 8.69	< 8.69	< 0.869	< 0.869	11.8**	11.8**	20 (a)	88 (a)	
	styrene	< 0.852	< 0.852	< 0.852	< 8.52	< 8.52	< 0.852	< 0.852	200	2	200 (a)	880 (a)	
	tetrachloroethene	<b>2.79</b>	<b>6.31</b>	<b>8.68</b>	< 1.36	< 1.36	< 0.136	< 0.136	50***	<b>0.1***</b>	<b>8.4 (a)</b>	36 (a)	
	tetrahydrofuran	<b>1.74</b>	<b>6.84</b>	<b>29.4</b>	< 5.90	< 5.90	< 0.590	< 0.590	160.35	80.18	420 (a)	1760 (a)	
	toluene	< 0.754	< 0.754	< 0.754	< 7.54	< 7.54	< 0.754	< 0.754	80	20	1040 (a)	4400 (a)	
	trichloroethene	<b>0.290</b>	<b>0.242</b>	<b>0.591</b>	< 1.07	< 1.07	< 0.107	< 0.107	36.52	0.61	<b>0.42 (a)</b>	1.8 (a)	
	trichlorofluoromethane	<b>1.30</b>	< 1.12	<b>1.93</b>	< 11.2	< 11.2	< 1.12	< 1.12	--	--	146 (a)	620 (a)	
	n-propylbenzene	< 0.983	< 0.983	< 0.983	< 9.83	< 9.83	< 0.983	< 0.983	--	--	200 (a)	880 (a)	
	1,3,5-trimethylbenzene	< 0.983	< 0.983	< 0.983	< 9.83	< 9.83	< 0.983	< 0.983	--	--	1.46 (h)	6.2 (h)	

**Notes:**

µg/m<sup>3</sup> - micrograms per cubic meter

VOCs - volatile organic compounds

EPA SL - EPA Screening Level; May 2012

- (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

<sup>(1)</sup> 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 (January, 2012)

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

\*\*\* - Values updated in January 2012; all other AAL/TELS are dated 1995.

-- No corresponding comparison criterion.

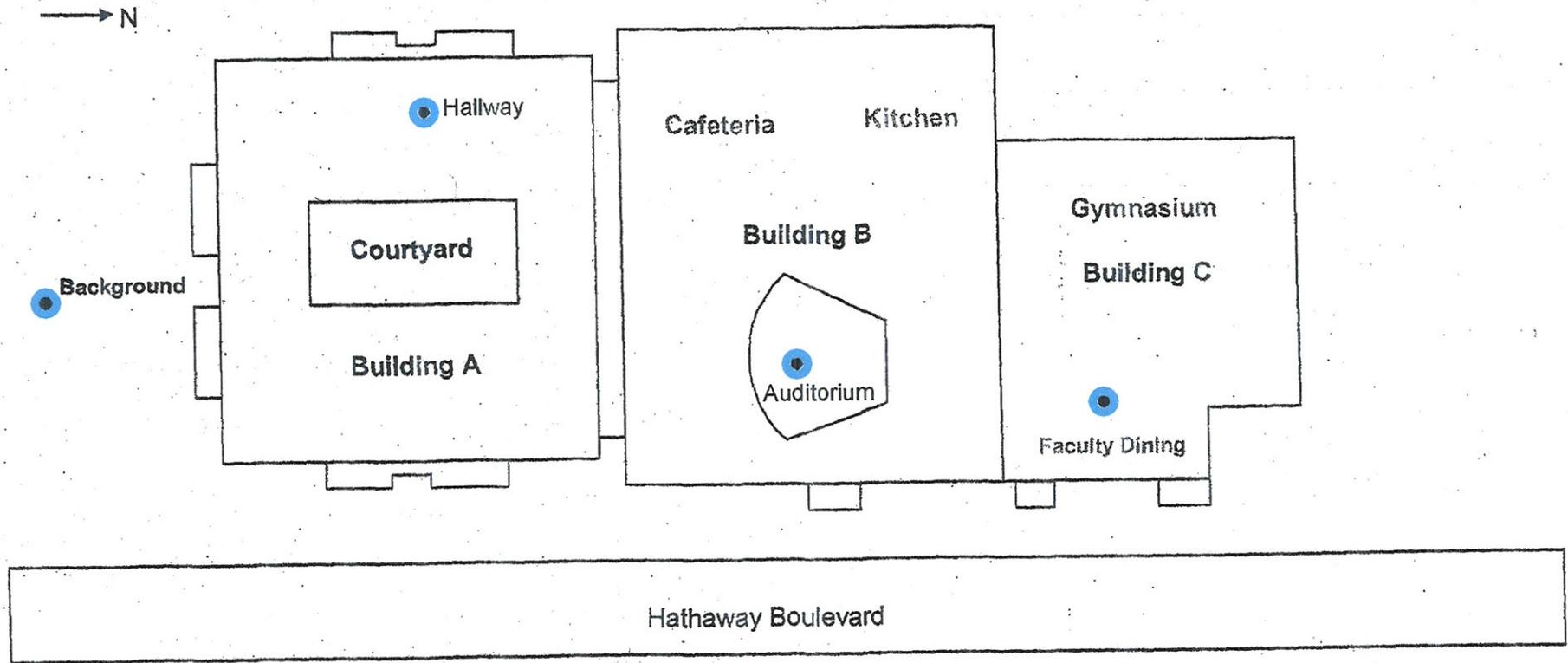
J - Concentration should be considered estimated.

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**



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

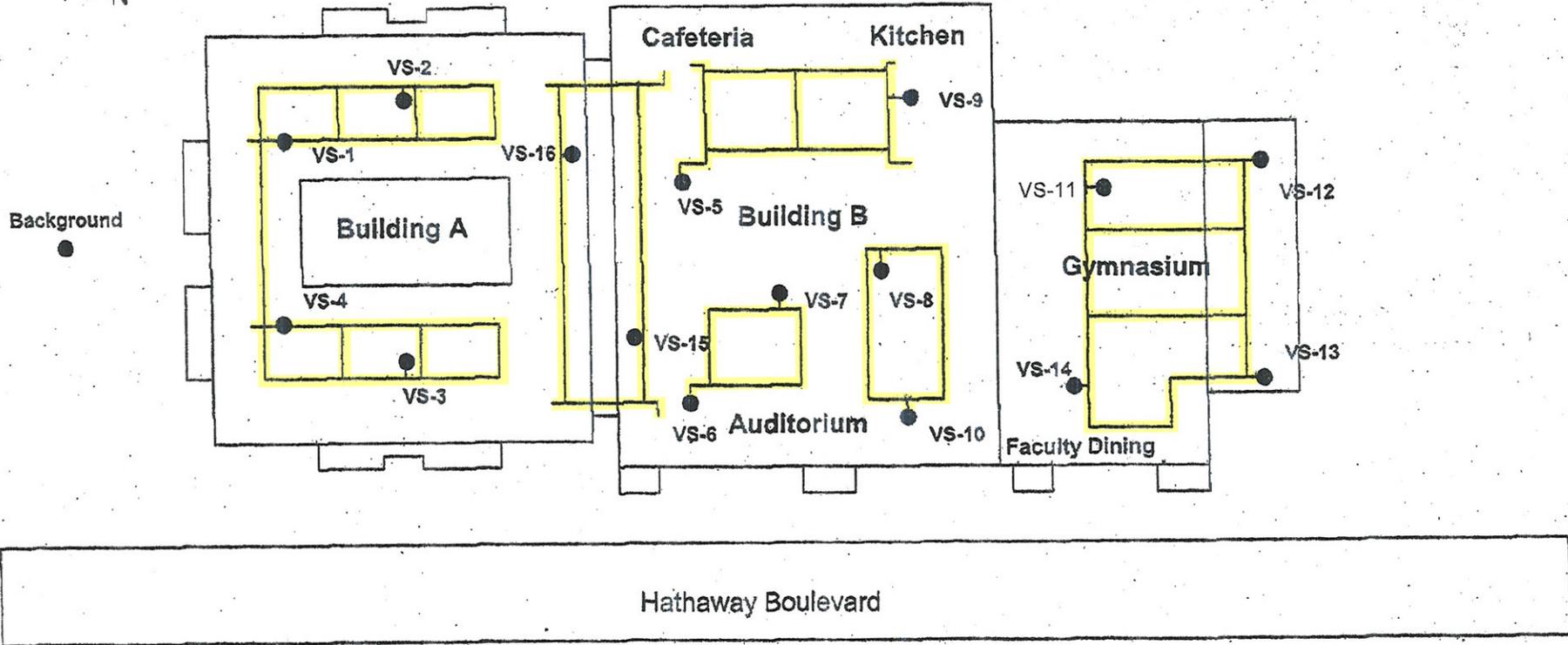
FIGURE

2-1

DRAWN BY: ---  
CHECKED BY: DMS

DATE:  
MAY 2008

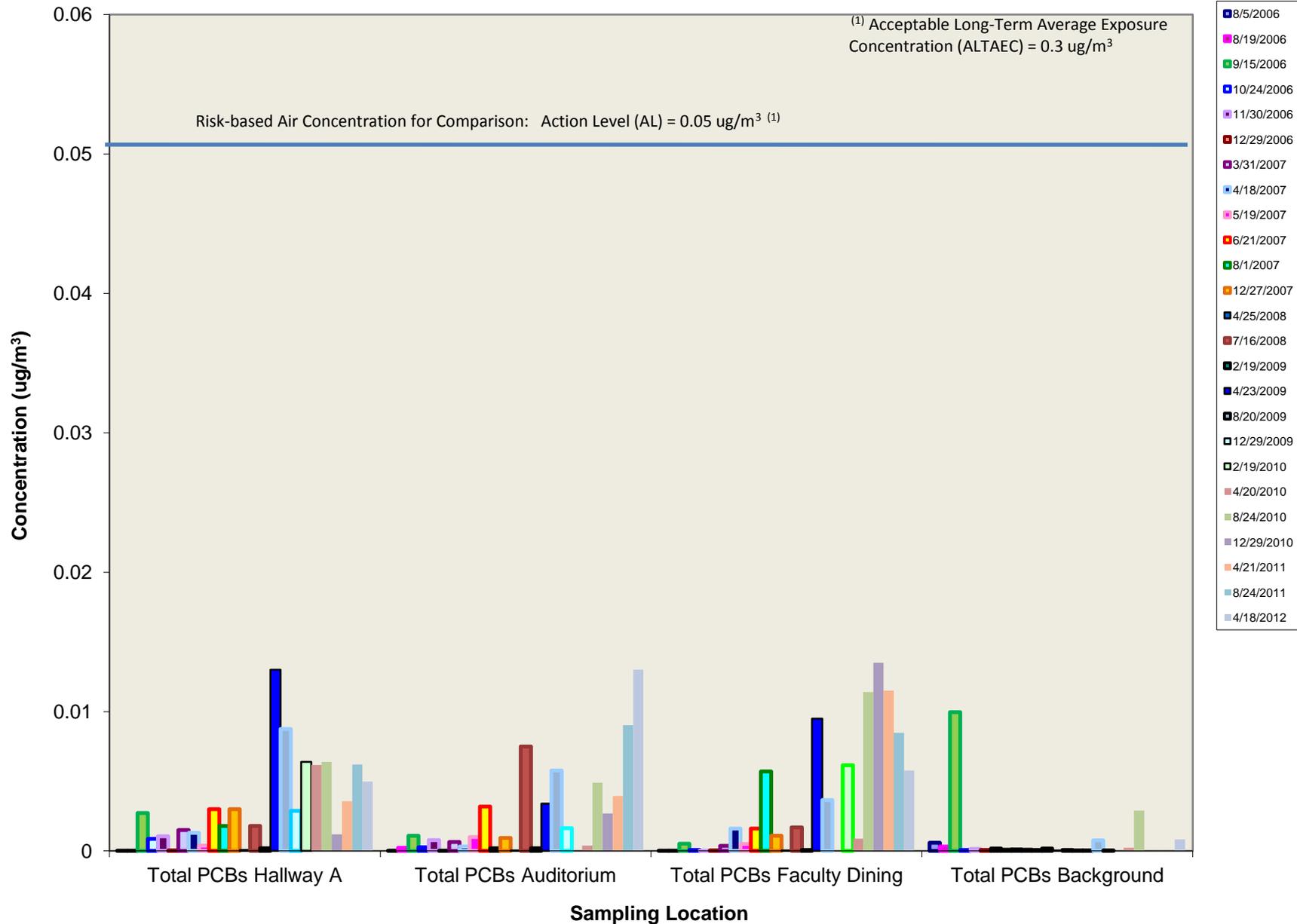
# Keith Middle School Foundation Venting System



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

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

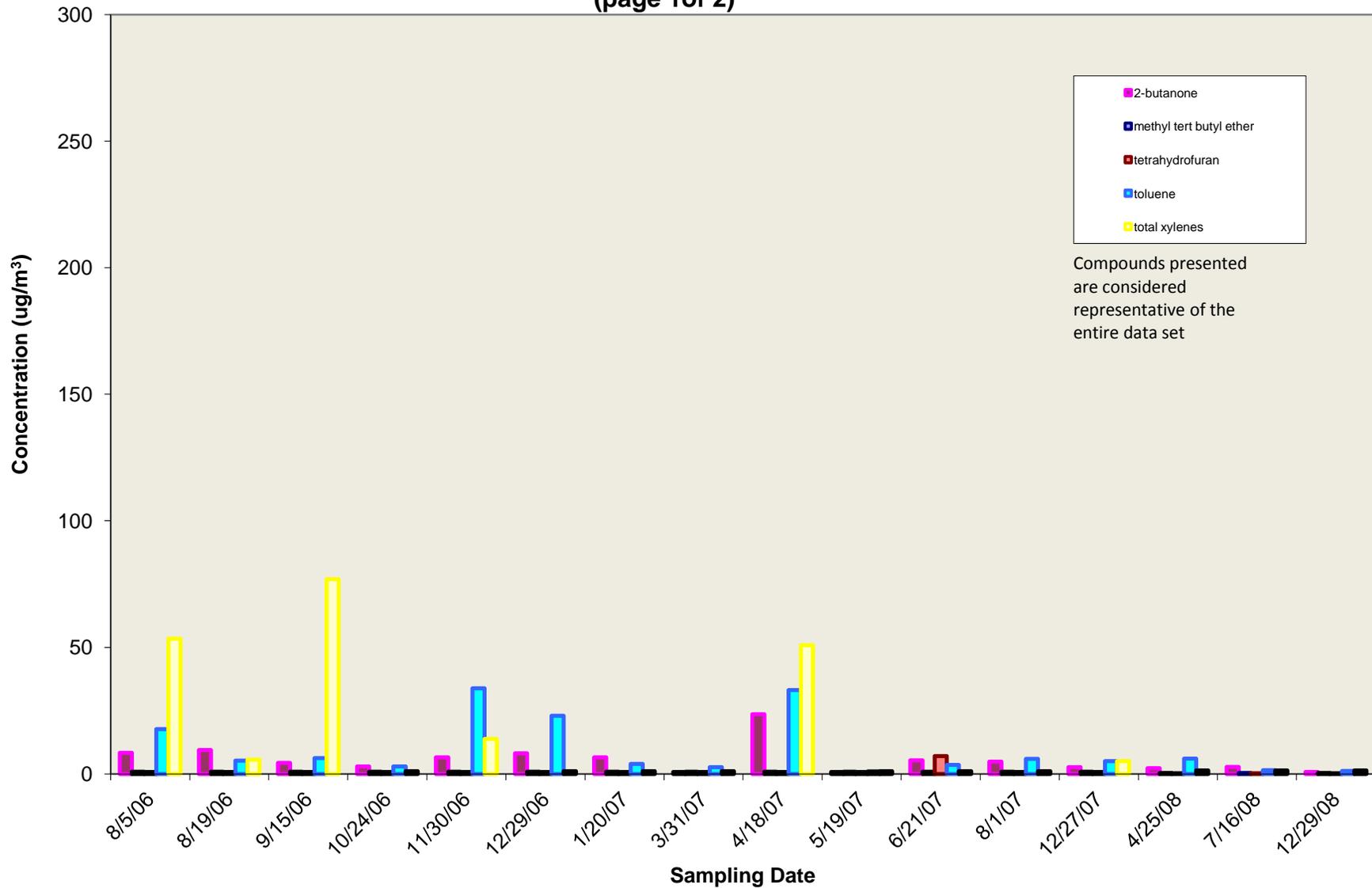
**Figure 5-1. Total PCB Trends in KMS Indoor Air Quality (IAQ) Samples - August 2006 through April 2012**



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.

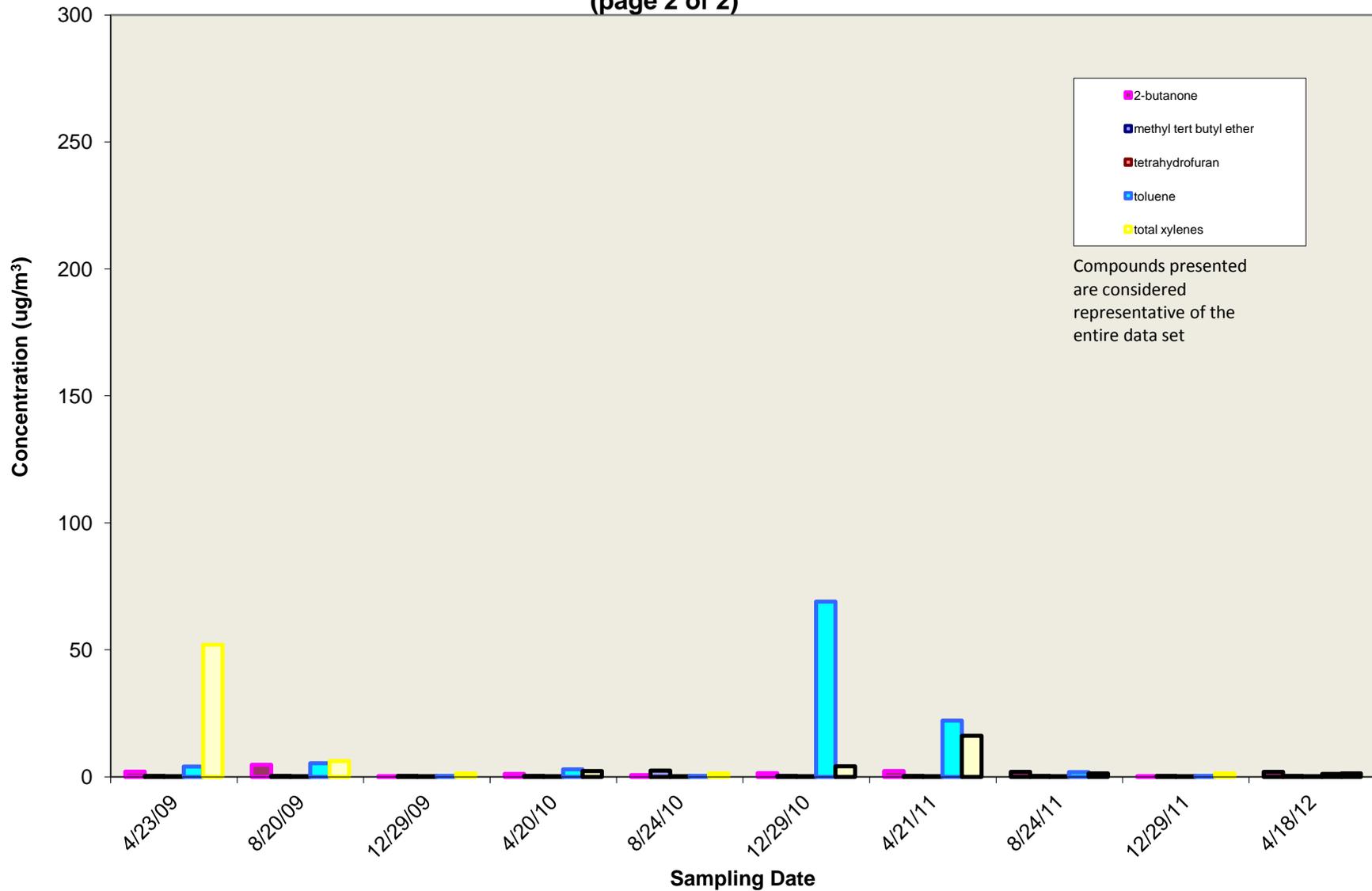


**Figure 6-1. VOC Trends in KMS Building A (IAQ) - August 2006 through April 2012**  
 (page 1 of 2)



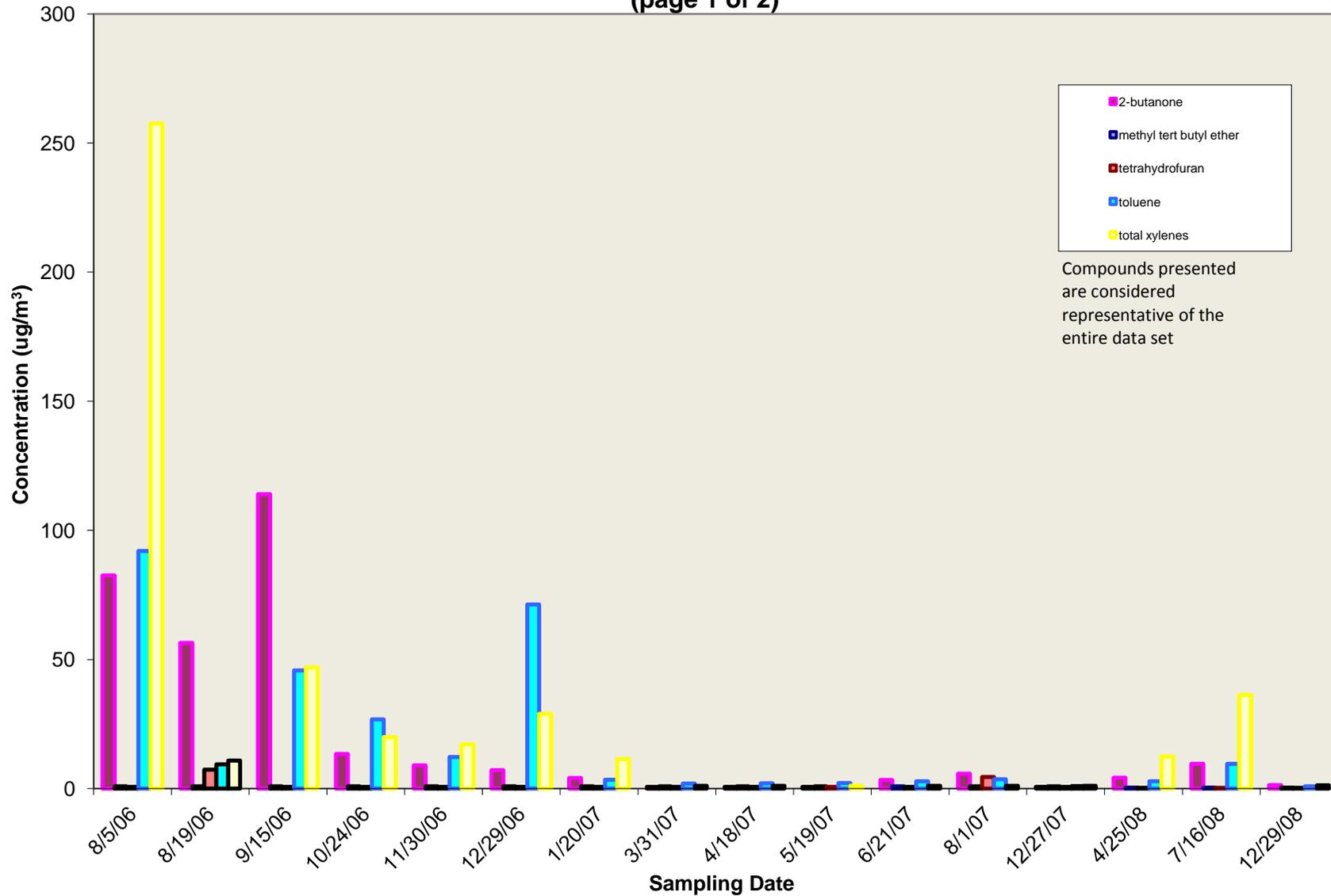
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-1. VOC Trends in KMS Building A (IAQ) - August 2006 through April 2012**  
 (page 2 of 2)



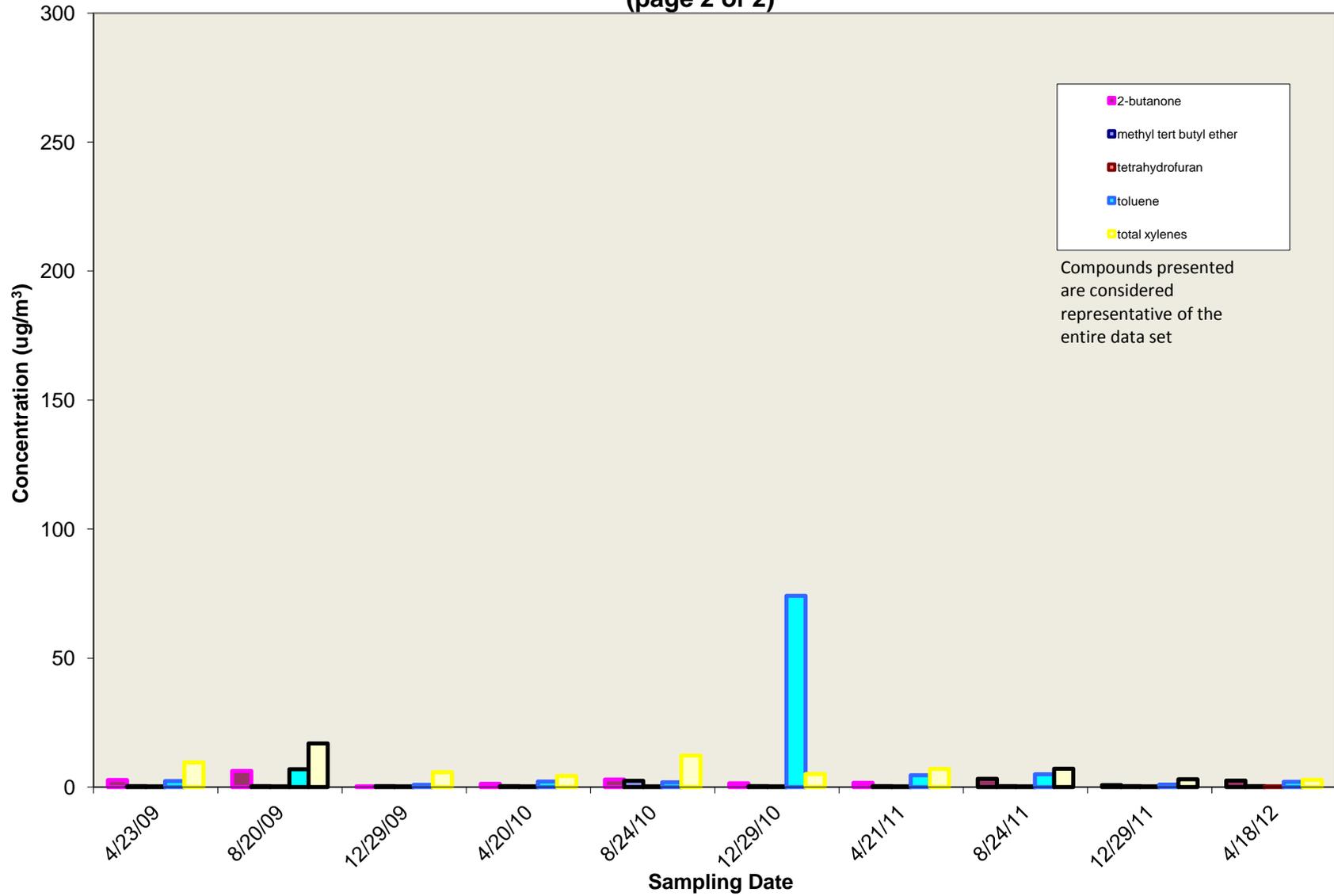
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-2. VOC Trends in KMS Building B (IAQ) - August 2006 through April 2012**  
 (page 1 of 2)



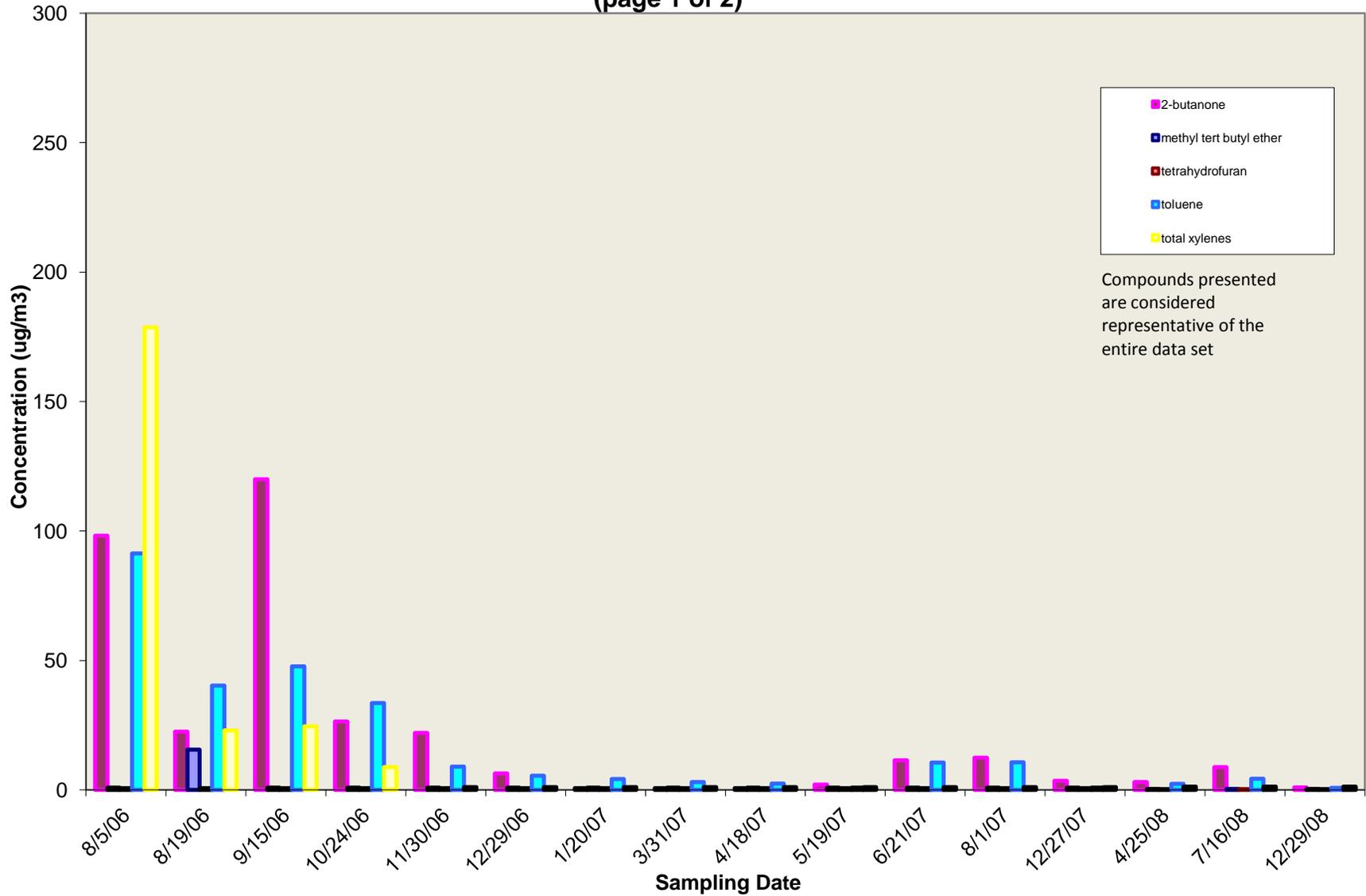
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-2. VOC Trends in KMS Building B (IAQ) - August 2006 through April 2012**  
 (page 2 of 2)



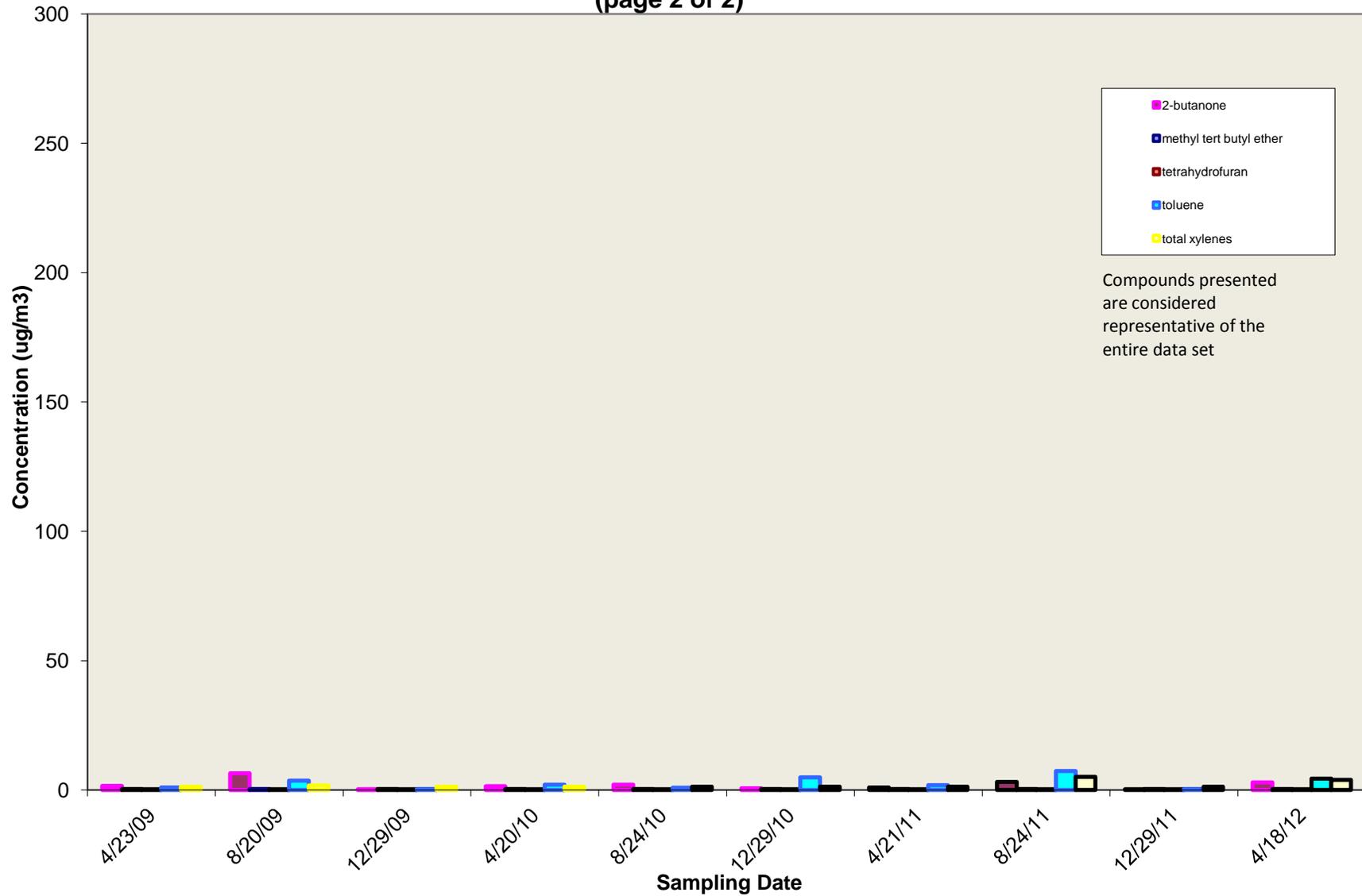
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-3. VOC Trends in KMS Building C (IAQ) - August 2006 through April 2012**  
 (page 1 of 2)



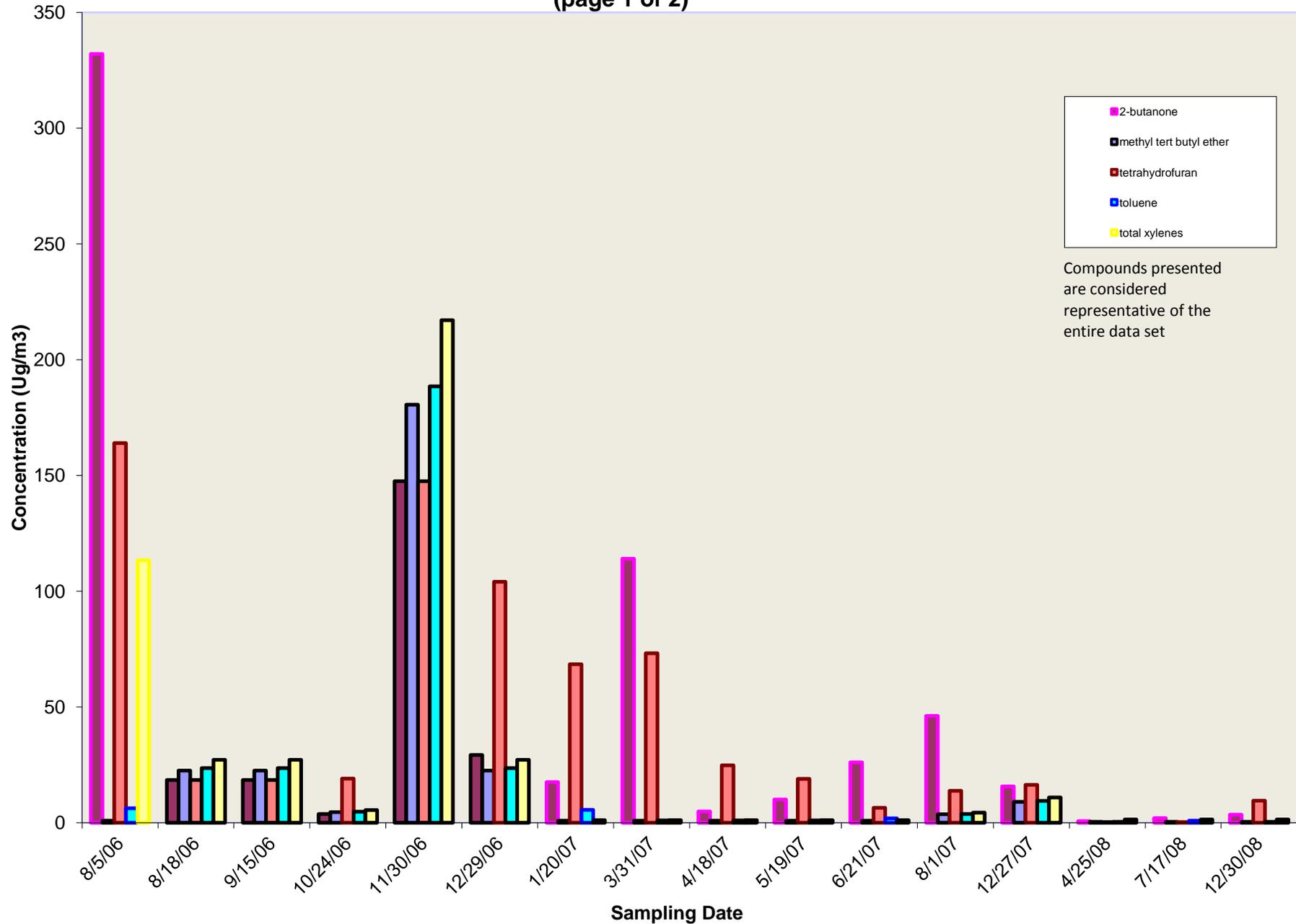
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-3. VOC Trends in KMS Building C (IAQ) - August 2006 through April 2012**  
(page 2 of 2)



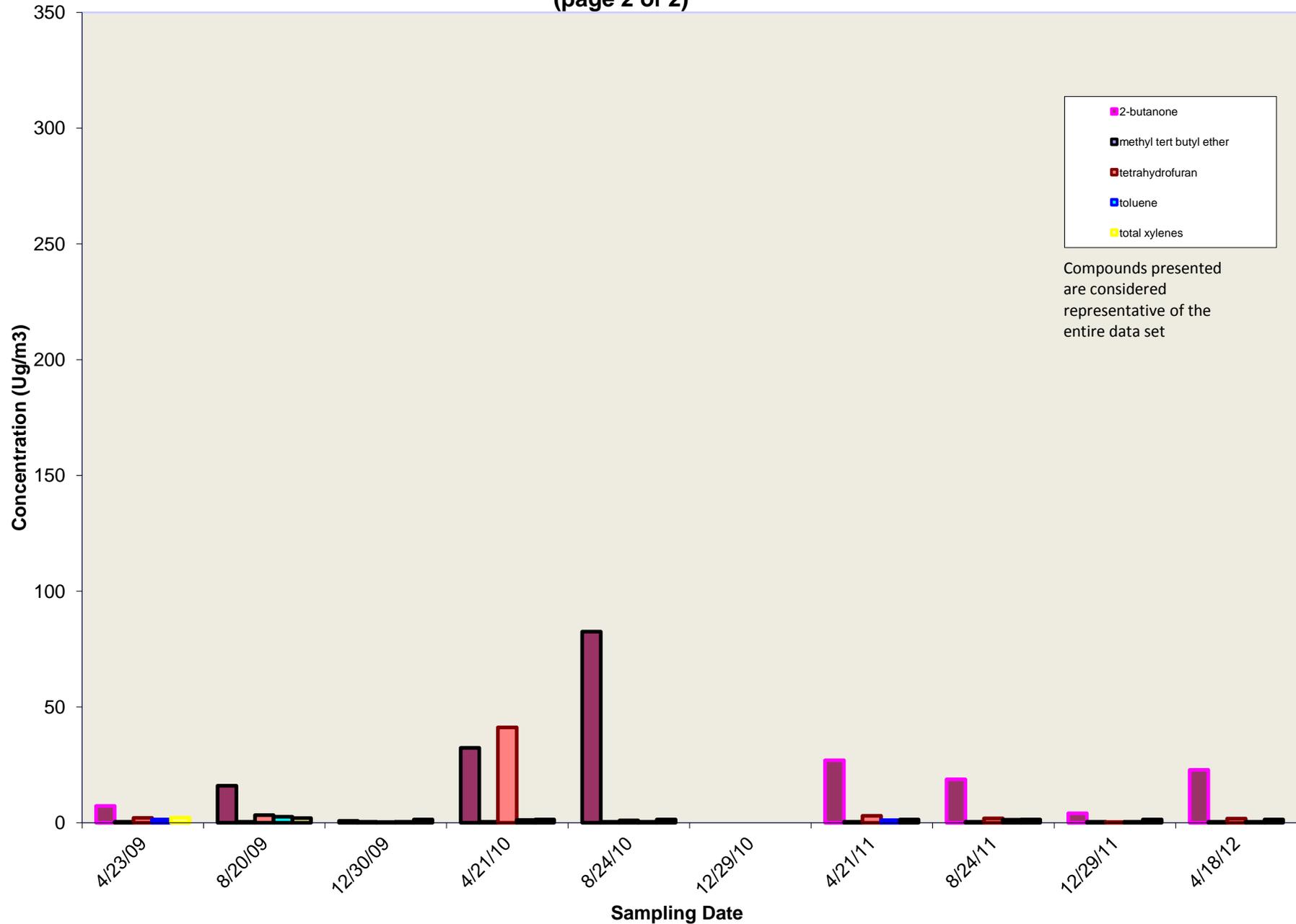
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-4. VOC Trends in KMS Vent Stack VS-1 - August 2006 through April 2012**  
(page 1 of 2)



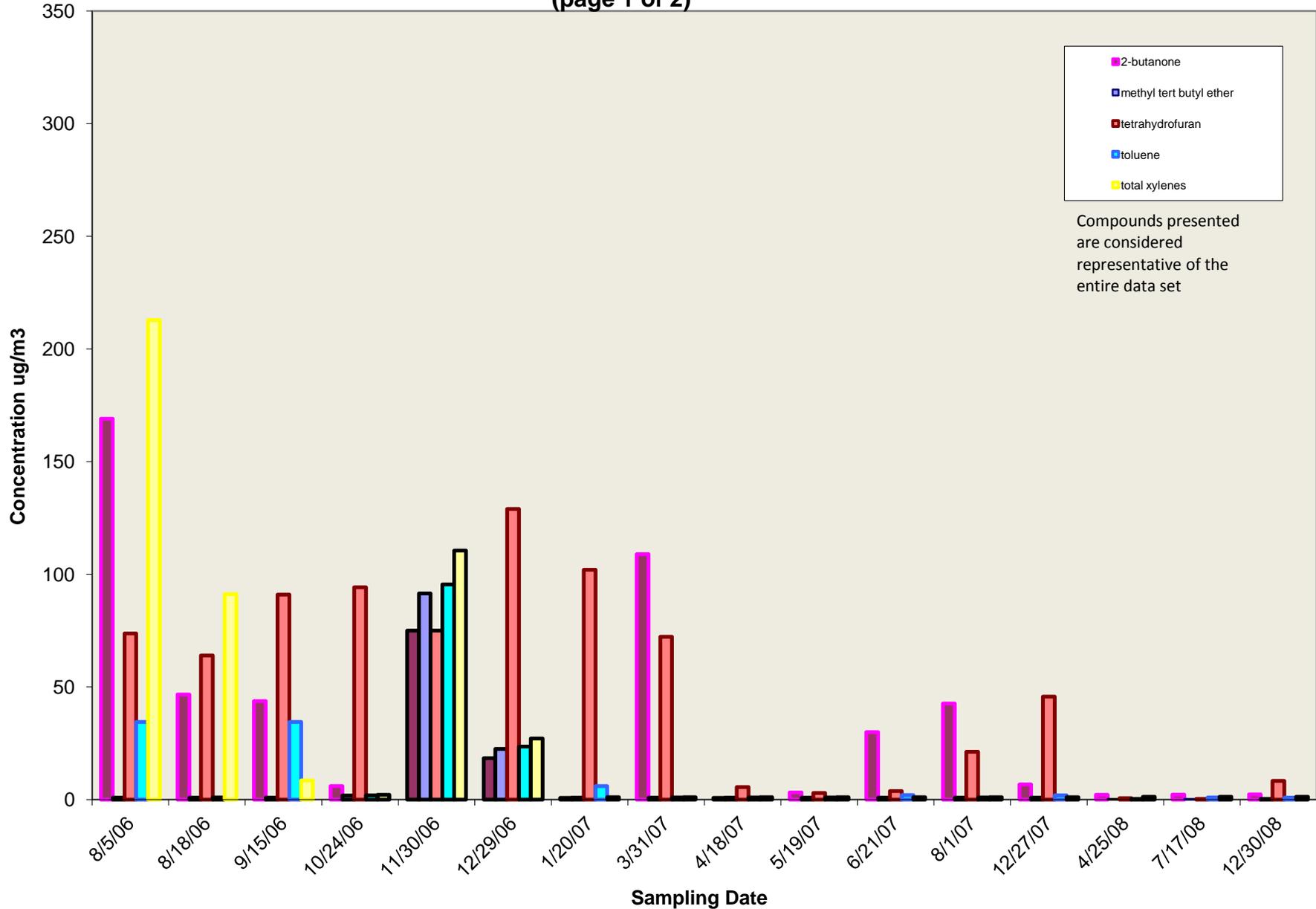
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-4. VOC Trends in KMS Vent Stack VS-1 - August 2006 through April 2012**  
 (page 2 of 2)



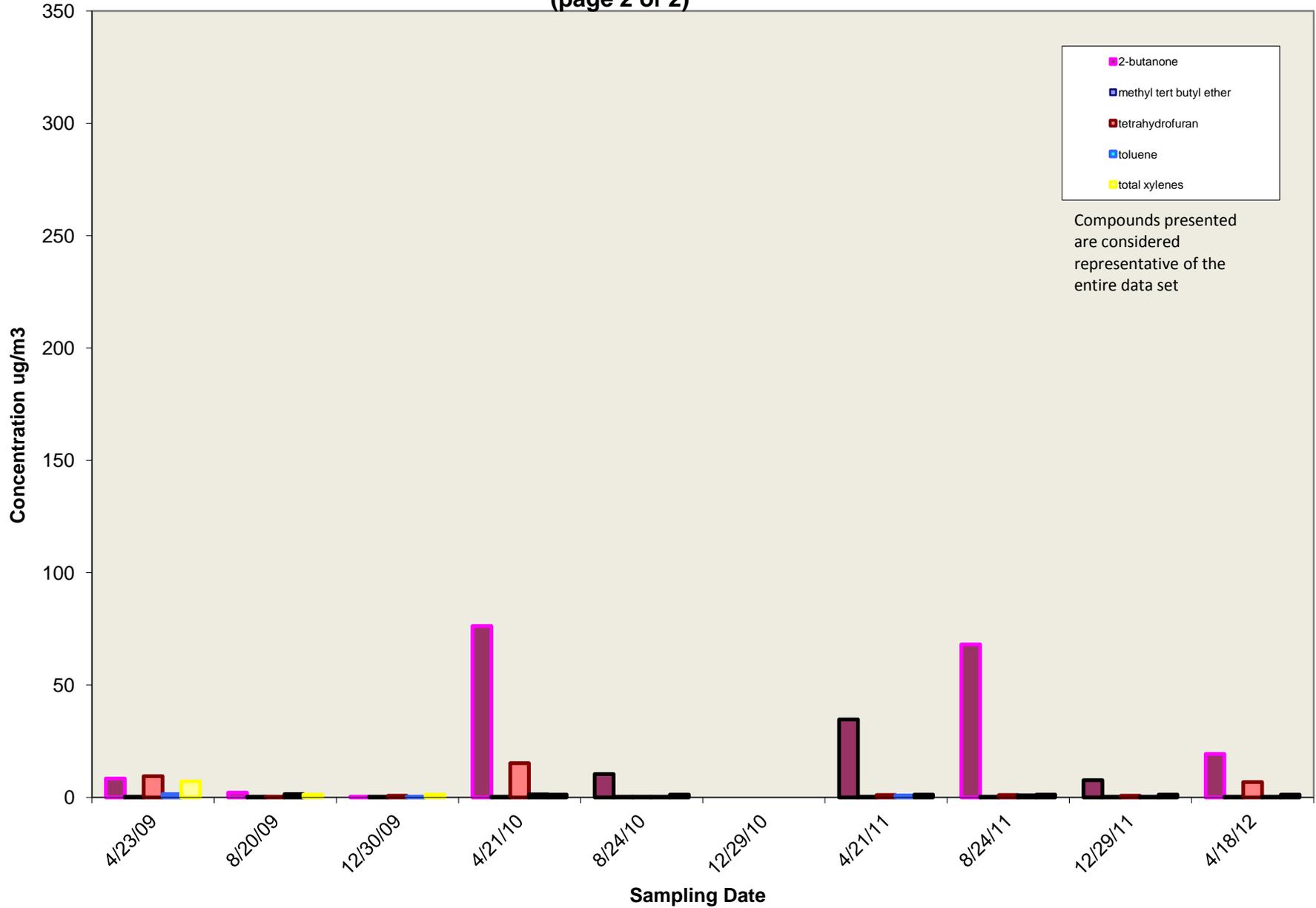
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

**Figure 6-5. VOC Trends in KMS Vent Stack VS-4 - August 2006 through April 2012**  
 (page 1 of 2)



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 2012**  
 (page 2 of 2)



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% C<sub>14</sub>, 30% C<sub>16</sub>, 5% C<sub>12</sub>, 5% C<sub>18</sub>)dimethylbenzyl ammonium chlorides
    - n-alkyl(68% C<sub>12</sub>, 32% C<sub>14</sub>)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(C<sub>14</sub> 50%, C<sub>12</sub> 40%, C<sub>16</sub> 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

Round 29

Setup Date: 4/17/12  
Recovery Date: 4/18/12

Sampler(s): D. GILL  
Sampler(s): J. MULLALL

TO-15A							
Location	Time		Vacuum (in Hg)		SUMMA Serial No.:	Flow Controller Serial No.:	Starting Flow Rate
	Start	Stop	Start	Finish			
C	1426	1440	30.2	12.65	1787	203	3.0
B	1431	1445	29.77	8.16	1796	481	3.0
A	1435	1450	30.14	5.85	1791	288	3.3
BG	1442	1454	30.27	5.42	1782	237	3.3
BG DUP	1442	1454	29.96	9.13	655	346	3.0
BLANK	—	—	—	—	1781	248	3.0

TO-4A								
Location	Time		PUF Number	Serial Number	Sampler		Flow Rate (Mag Reading)	
					Counter (Hrs)			
	Start	Stop			Start	Finish	Initial	Final
C	1426	1440	—	5	5823.8	5865.9	55	54
B	1431	1445	—	3	5821.1	5863.6	55	50
A	1435	1450	—	2	1710.7	1952.9	55	50
BG	1442	1454	—	4	5841.4	6083.3	54	54
BG DUP	1442	1454	—	1	5332.8	5574.7	54	54

# Keith Middle School Sampling Data Sheet

## Vent Air Sampling

Round 29

Setup Date: 4/13/12  
 Recovery Date: 4/18/12

Sampler(s): D. GILL, J. MULHALL  
 Sampler(s): \_\_\_\_\_

TO-15A							
Location	Time		Vacuum (in Hg)		SUMMA Serial No.:	Flow Controller Serial No.:	Starting Flow Rate
	Start	Stop	Start	Finish			
BG	0954	1345	29.8	6.23	525	74	9.0
VS-1	1004	1355	30.09	6.42	516	76	9.0
VS-4	1011	1358	29.92	8.10	1729	9	8.9
VS-10	1020	1410	26.57	4.32	124	334	9.0
VS-10 DUP	1020	1410	30.29	7.46	192	488	8.9
VS-14	1023	1414	30.08	7.09	541	175	8.9
BLANK	—	—	—	—	376	404	9.0

TO-10A				
Location	Time		Flow Rate (LPM)	
	Start	Stop	Start	Finish
BG	0954	1345	5.04	5.04
VS-1	1004	1355	5.11	4.64
VS-4	1011	1358	5.03	4.63
VS-10	1020	1410	5.01	4.80
VS-10 DUP	1020	1410	5.02	4.85
VS-14	1023	1414	5.02	4.90



**APPENDIX C**

**FIELD REDUCED DATA**

OUTDOOR SAMPLING LOCATIONS

Average Temp (oF/ K): 64.6      291.1

Average Baro. Press ("Hg / mmHg): 30.11      784.8

Wednesday, April 18, 2012

Location	Serial #	m <sub>s</sub>	b <sub>s</sub>	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 <sup>3</sup> )
BG-29	TO-4A 825	0.032 ✓	-0.705 ✓	54 -		54 -		54	0.00	248	8:44.14	8:08.33	1451	359.4
BG-29-Dup	TO-4A 822	0.033 ✓	-0.683 ✓	54 -		54 -		54	0.00	239	5:33.28	5:57.47	1451	346.8
VS-1-29	TO-10A				5.11		4.64		9.84	4.88	10:04	13:55	231	1.13
VS-4-29	TO-10A				5.03		4.63		8.28	4.83	10:11	13:58	227	1.10
VS-14-29	TO-10A				5.02		4.90		2.42	4.96	10:23	14:14	231	1.15
VS-10-29	TO-10A				5.01		4.80		4.28	4.91	10:20	14:10	230	1.13
VS-10-29-DUP	TO-10A				5.02		4.85		3.44	4.94	10:20	14:10	230	1.14
VS-BG-29	TO-10A				5.04		5.04		0.00	5.04	9:54	13:45	231	1.16

Sample tubes were full of ice. No Flow VS-12 & 8

DATA Entered  
4/18/12  
DSY

VERM  
4-26-12

INDOOR SAMPLING LOCATIONS

Average Temp (oF/ K): 67.0      292.4

Average Baro. Press ("Hg / mmHg): 30.11      764.8

Wednesday, April 18, 2012

Location	Serial #	m <sub>s</sub>	b <sub>s</sub>	Start Reading ("H2O)	Start Reading (ppm)	Stop Reading ("H2O)	Stop Reading (ppm)	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 <sup>3</sup> )
A-Hallway	TO-4A 820	0.034	-0.871	55		50		52.5	9.52	235	171.07	195.29	1453	342.1
B- (Auditorium)	TO-4A 823	0.035	-1.036	55		50		52.5	9.52	233	562.11	586.39	1457	339.9
C-Lounge	TO-4A 821	0.032	-0.457	55		54		54.5	1.83	242	562.38	586.59	1453	351.2

Note:

DATA Entered  
DSG  
4/18/12

✓ EMM  
4-26-12

**APPENDIX D**

**EQUIPMENT CALIBRATION SHEETS**

Network: New Bedford Site: Keith Middle Serial #: 2-820 Station #: A  
 Technician: JM/DG Date: 4/17/2012 OrificeS/N: 1125 Orif. Cal. Date: 12-Jan-12

Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 23.6 Bar. Press., Pa (in Hg) 29.99  
 Amb. Temp, Ta (K) 296.6 Bar. Press., Pa (mmHg) 761.7

Orifice Data

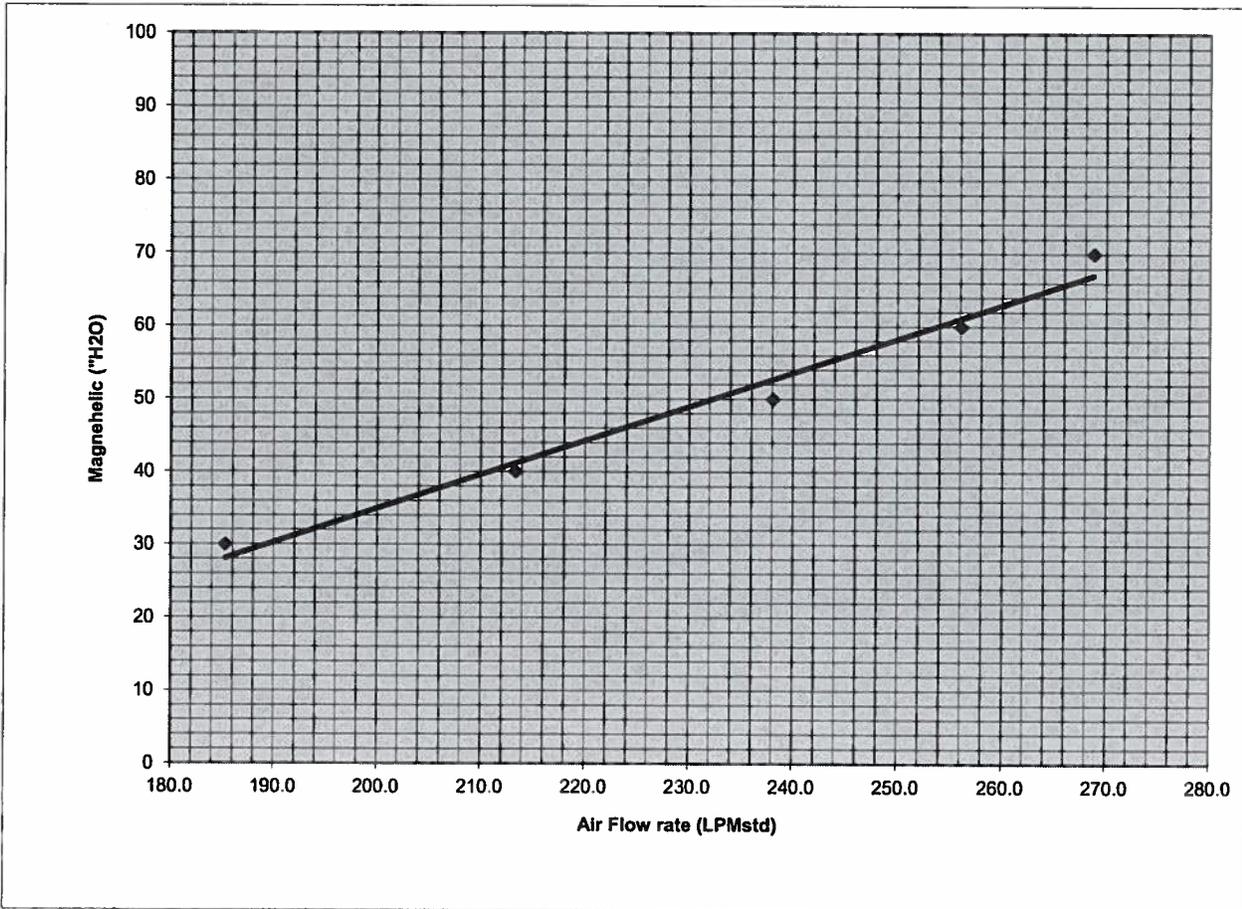
Qstd (m<sub>o</sub>) = 9.58371 Qstd (b<sub>o</sub>) = -0.03738 Qstd (r<sub>o</sub>) = 0.99998

ΔH	Q <sub>std</sub>	l	l <sub>c</sub>
6.40	268.797	70	8.39
5.80	256.075	60	7.77
5.00	238.039	50	7.09
4.00	213.320	40	6.35
3.00	185.263	30	5.50

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

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

m<sub>s</sub> = 0.034 b<sub>s</sub> = -0.87132 r<sub>s</sub> = 0.99599



Desired Flow Rate (lpm): 250

Sampler Setting: 58.2

m<sub>mag</sub> = 0.466

b<sub>mag</sub> = -58.24390

r<sub>mag</sub> = 0.98879

DATA ENTERED  
Checked  
DSG 4/18/12  
ETM 4-26-12

Network: New Bedford Site: Keith Middle Serial #: 3-823 Station #: B  
 Technician: JM/DG Date: 4/17/2012 OrificeS/N: 1125 Orif. Cal. Date: 12-Jan-12

Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 23.6 Bar. Press., Pa (in Hg) 29.99  
 Amb. Temp, Ta (K) 296.6 Bar. Press., Pa (mmHg) 761.7

Orifice Data

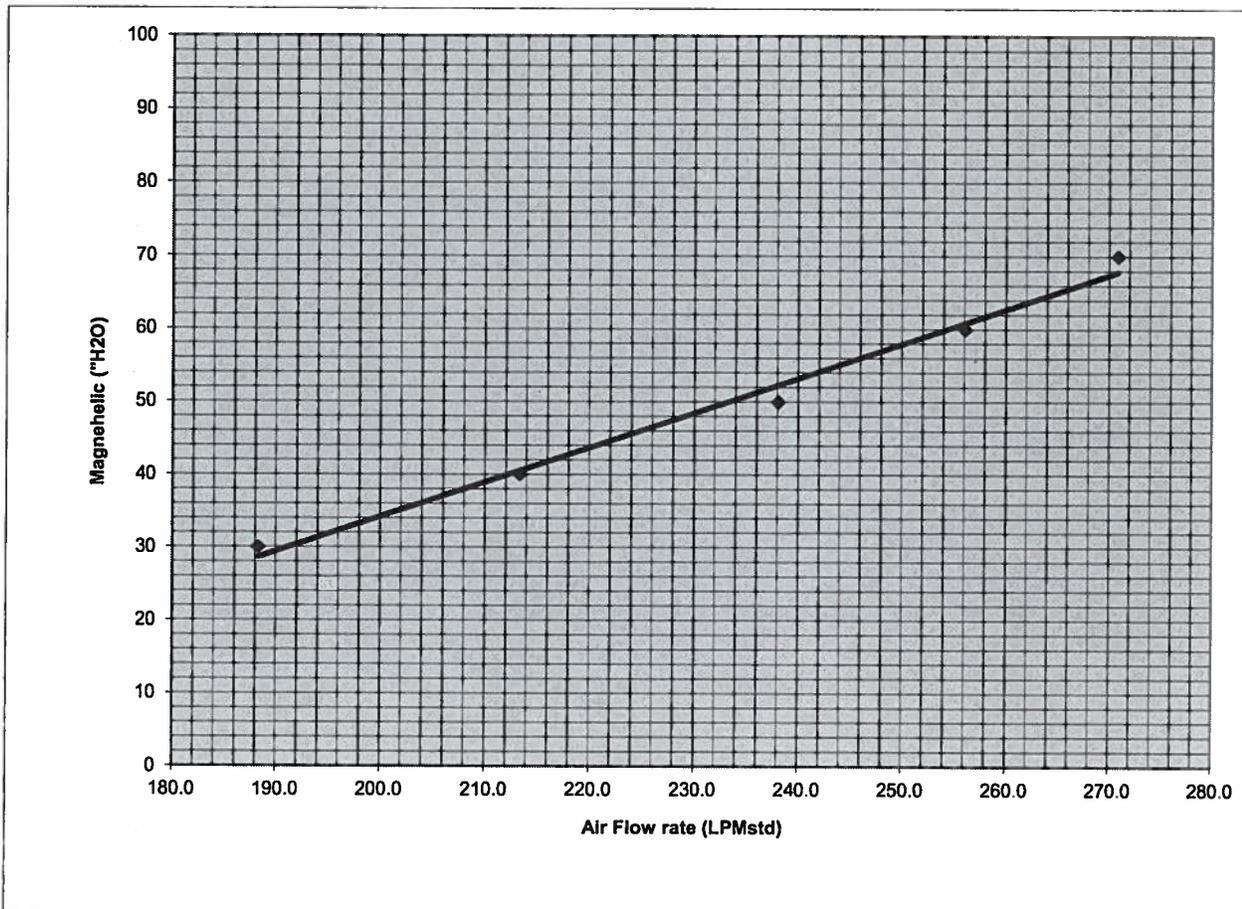
Qstd (m<sub>o</sub>) = 9.58371 Qstd (b<sub>o</sub>) = -0.03738 Qstd (r<sub>o</sub>) = 0.99998

ΔH	Q <sub>std</sub>	I	I <sub>c</sub>
6.50	270.859	70	8.39
5.80	256.075	60	7.77
5.00	238.039	50	7.09
4.00	213.320	40	6.35
3.10	188.261	30	5.50

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

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

m<sub>s</sub> = 0.035 b<sub>s</sub> = -1.03643 r<sub>s</sub> = 0.99844



Desired Flow Rate (lpm): 250

Sampler Setting: 57.9

m<sub>mag</sub> = 0.475

b<sub>mag</sub> = -60.78135

r<sub>mag</sub> = 0.99368

DATA Entered  
Checked

DSG 4/18/12  
EDM 4-26-12

Network: New Bedford      Site: Keith Middle      Serial #: 5-821      Station #: C  
 Technician: JM/DG      Date: 4/17/2012      OrificeS/N: 1125      Orif. Cal. Date: 12-Jan-12  
 Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C)      23.6      Bar. Press., Pa (in Hg)      29.99  
 Amb. Temp, Ta (K)      296.6      Bar. Press., Pa (mmHg)      761.7

Orifice Data

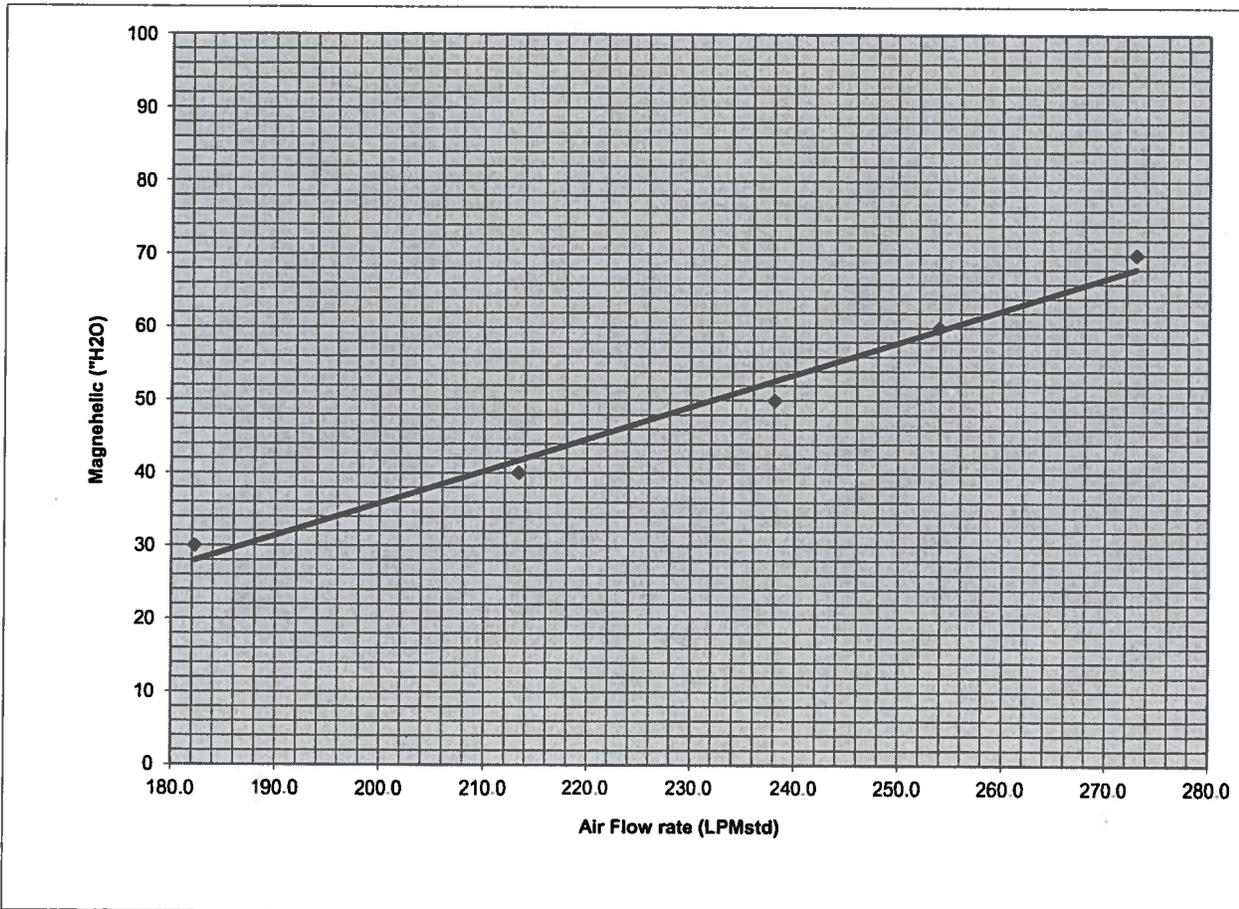
Qstd (m<sub>o</sub>) = 9.58371      Qstd (b<sub>o</sub>) = -0.03738      Qstd (r<sub>o</sub>) = 0.99998

ΔH	Q <sub>std</sub>	I	I <sub>c</sub>
6.60	272.905	70	8.39
5.70	253.892	60	7.77
5.00	238.039	50	7.09
4.00	213.320	40	6.35
2.90	182.215	30	5.50

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

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

m<sub>s</sub> = 0.032      b<sub>s</sub> = -0.45698      r<sub>s</sub> = 0.99701



Desired Flow Rate (lpm): 250

Sampler Setting: 57.9

m<sub>mag</sub> = 0.442

b<sub>mag</sub> = -52.68173

r<sub>mag</sub> = 0.99097

Data Entered  
Checked

4/18/12 DJG  
SMW 4-26-12

Network: New Bedford Site: Keith Middle Serial #: 1-825 Station #: BG  
 Technician: JM/DG Date: 4/17/2012 OrificeS/N: 1125 Orif. Cal. Date: 12-Jan-12

Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 23.6 Bar. Press., Pa (in Hg) 29.99  
 Amb. Temp, Ta (K) 296.6 Bar. Press., Pa (mmHg) 761.7

Orifice Data

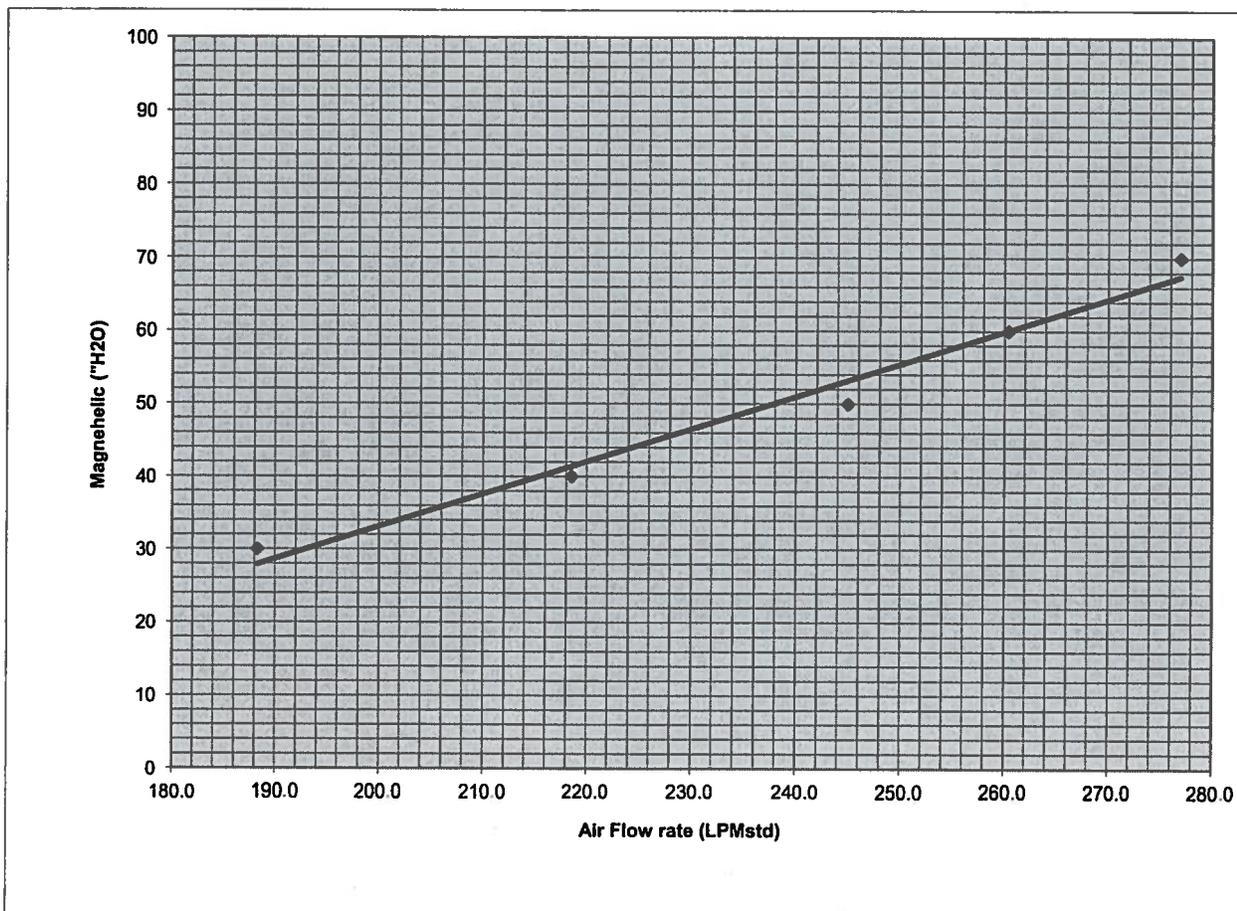
Qstd (m<sub>o</sub>) = 9.58371 Qstd (b<sub>o</sub>) = -0.03738 Qstd (r<sub>o</sub>) = 0.99998

ΔH	Q <sub>std</sub>	l	l <sub>c</sub>
6.80	276.950	70	8.39
6.00	260.386	60	7.77
5.30	244.960	50	7.09
4.20	218.492	40	6.35
3.10	188.261	30	5.50

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

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

m<sub>s</sub> = 0.032 b<sub>s</sub> = -0.70531 r<sub>s</sub> = 0.99567



Desired Flow Rate (lpm): 250

Sampler Setting: 55.4

m<sub>mag</sub> = 0.446

b<sub>mag</sub> = -55.96340

r<sub>mag</sub> = 0.98845

DATA Entered  
Checked

DJA 4/18/12  
JM 4-26-12

Network: New Bedford Site: Keith Middle Serial #: 4-822 Station #: BG-DUP  
 Technician: JM/DG Date: 4/17/2012 Orifice S/N: 1125 Orif. Cal. Date: 12-Jan-12  
 Reason for Puff Sampler Calibration: Monthly Recal

Amb. Temp, Ta (°C) 23.6 Bar. Press., Pa (in Hg) 29.99  
 Amb. Temp, Ta (K) 296.6 Bar. Press., Pa (mmHg) 761.7

Orifice Data

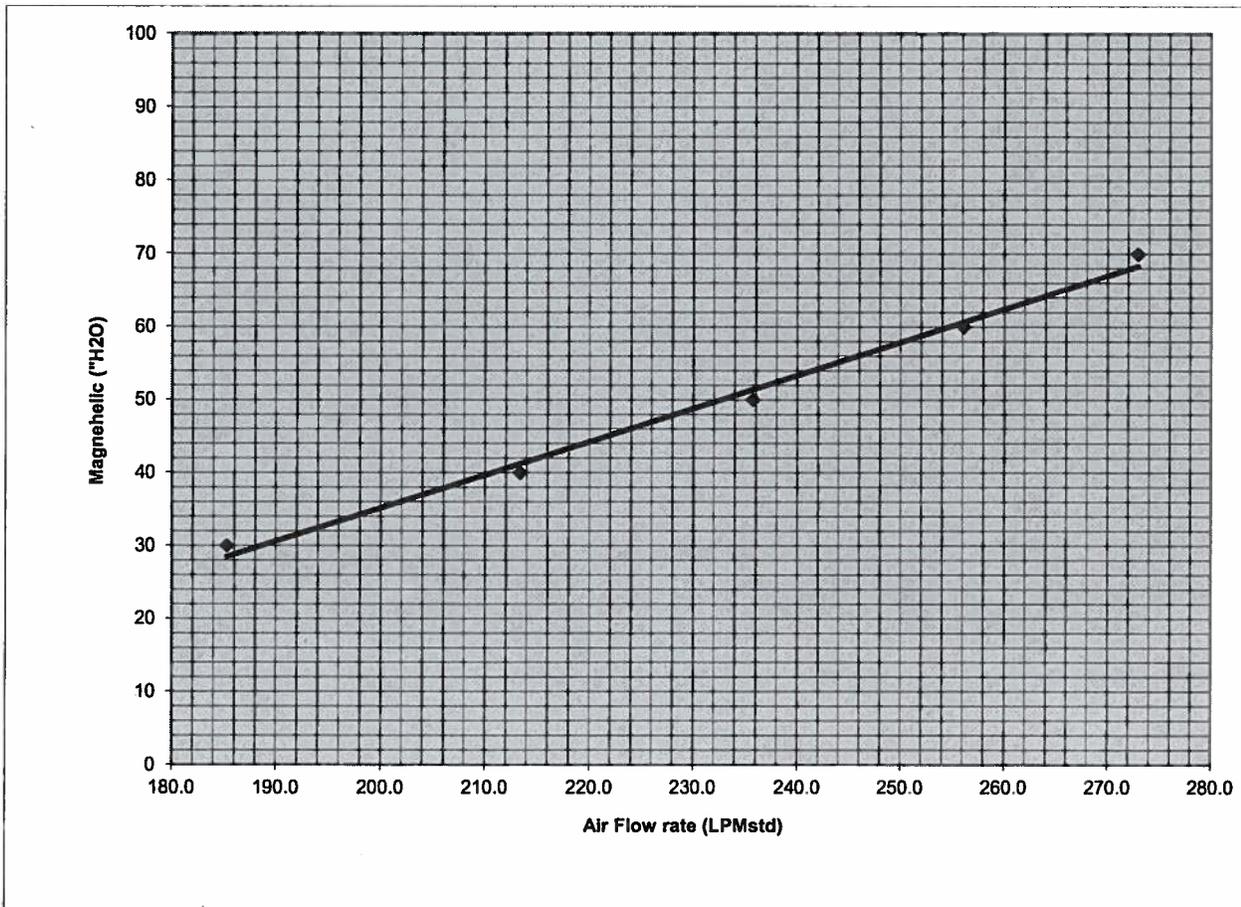
Qstd (m<sub>o</sub>) = 9.58371 Qstd (b<sub>o</sub>) = -0.03738 Qstd (r<sub>o</sub>) = 0.99998

ΔH	Q <sub>std</sub>	I	I <sub>c</sub>
6.60	272.905	70	8.39
5.80	256.075	60	7.77
4.90	235.685	50	7.09
4.00	213.320	40	6.35
3.00	185.263	30	5.50

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

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

m<sub>s</sub> = 0.033 b<sub>s</sub> = -0.66312 r<sub>s</sub> = 0.99942



Desired Flow Rate (lpm): 250 Sampler Setting: 57.9

m<sub>mag</sub> = 0.454 b<sub>mag</sub> = -55.73409 r<sub>mag</sub> = 0.99546

DATA Entered  
Checked

DJG 4/20/12  
JM 4-26-12

Keith Middle School PS1 Calibration Data Sheet

Round 29

Sampler ID: 5  
 Sampler Location: C HALLWAY

Initial Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
70	3.4	3.2	6.6
60	2.9	2.8	5.7
50	2.6	2.4	5.0
40	2.1	1.9	4.0
30	1.5	1.4	2.9

Post Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
50	2.5	2.4	4.9

Sampler ID: 3  
 Sampler Location: B AUDITORIUM

Initial Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
70	3.4	3.1	6.5
60	3.0	2.8	5.8
50	2.6	2.4	5.0
40	2.1	1.9	4.0
30	1.7	1.4	3.1

Post Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
50	2.6	2.4	5.0

Sampler ID: 2  
 Sampler Location: A HALLWAY RM 169

Initial Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
70	3.3	3.1	6.4
60	3.0	2.8	5.8
50	2.6	2.4	5.0
40	2.1	1.9	4.0
30	1.6	1.4	3.0

Post Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
50	2.6	2.5	5.1

Sampler ID: 1  
 Sampler Location: BG

Initial Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
70	3.5	3.3	6.8
60	3.1	2.9	6.0
50	2.7	2.6	5.3
40	2.2	2.0	4.2
30	1.6	1.5	3.1

Post Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
50	2.7	2.6	5.3

Sampler ID: BG 4  
 Sampler Location: BG DUP

Initial Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
70	3.4	3.2	6.6
60	2.9	2.9	5.8
50	2.5	2.4	4.9
40	2.1	1.9	4.0
30	1.6	1.4	3.0

Post Calibration			
Magnehelic Reading	Manometer		total
	Left	Right	
50	2.5	2.4	4.9

4/17 → 4/8/12

Orifice ID: 1125 Cal. Date: 1/12/12  
 Initial Cal Temp: 23.6 F (C)  
 Initial Cal Press: 29.99 inHg / mmHg  
 Post Cal Temp: 23.6 F (C)  
 Post Cal Press: 30.15 inHg / mmHg



OK  
4-26-12

### PS-1 Post-Sampling Flow Audit

$$\text{Qstd Orifice (m}^3/\text{min)} = (1/m_o) * (\text{SQRT}(H_o * (T\text{std}/P\text{std})) - b_o)$$

$$\text{Qstd Sampler (m}^3/\text{min)} = (1/m_s) * (\text{SQRT}(H_s * (T\text{std}/P\text{std})) - b_s) / 1000$$

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

4/18/2012		Press ("Hg): 30.15 - Press - P <sub>s</sub> (mmHg): 765.8											
Temp (°C):	Temp - T <sub>s</sub> (K):	Sampler Serial #	Sampler Reading - H <sub>s</sub> ("h20)	Orifice Reading - H <sub>o</sub> ("h20)	Orifice #	Orifice Slope - m <sub>o</sub>	Orifice Intercept - b <sub>o</sub>	Qstd Orifice	Sampler #	Sampler Slope - m <sub>s</sub>	Sampler Intercept - b <sub>s</sub>	Qstd Sampler	% Difference
A-29	23.6	296.6	820	50	1125	9.58371	-0.03738	0.241	820	0.034	-0.87132	0.235	2.54
B-29	23.6	296.6	823	50	1125	9.58371	-0.03738	0.239	823	0.035	-1.03643	0.233	2.42
C-29	23.8	296.6	821	50	1125	9.58371	-0.03738	0.236	821	0.032	-0.45698	0.237	-0.13
BG-29	23.6	296.6	825	50	1125	9.58371	-0.03738	0.246	825	0.032	-0.70531	0.244	0.50
BG-DUP-29	23.6	296.6	822	50	1125	9.58371	-0.03738	0.236	822	0.033	-0.66312	0.236	0.26

Acceptance Limit <= 10% Difference

Data Entered  
4/18/12 DSH

✓  
4/18/12

DATE	Time (est)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (°F)				Relative Humidity	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour			altimeter (in.)	sea level (mb)	1 hr	3 hr	6 hr
19	9:53	S 5	10	Overcast	OVC048	53	44			72%	30.12	1019.7			
19	8:53	SW 3	10	Overcast	OVC048	50	43			77%	30.11	1019.6			
19	7:53	Calm	10	Overcast	OVC055	49	42	49	46	77%	30.11	1019.6			
19	6:53	Calm	10	Light Rain	OVC060	48	42			80%	30.11	1019.6			
19	5:53	Calm	10	Overcast	BKN070	47	41			80%	30.1	1019.3			
					OVC090										
19	4:53	Calm	10	Fair	CLR	47	41			80%	30.1	1019.3			
19	3:53	Calm	10	Mostly Cloudy	BKN110	48	41			77%	30.1	1019.4			
19	2:53	SW 5	10	Overcast	OVC100	48	40			74%	30.11	1019.6			
19	1:53	S 5	10	Overcast	OVC100	48	40	50	47	74%	30.12	1019.9			
19	0:53	SW 3	10	Overcast	OVC110	47	41			80%	30.14	1020.5			
18	23:53	S 3	10	Mostly Cloudy	BKN110	48	41			77%	30.15	1020.8			
18	22:53	S 5	10	Overcast	OVC110	48	41			77%	30.16	1021.2			
18	21:53	S 5	10	Mostly Cloudy	BKN110	48	40			74%	30.17	1021.6			
18	20:53	SW 5	10	Mostly Cloudy	BKN110	49	40			71%	30.17	1021.6			
18	19:53	S 7	10	Mostly Cloudy	BKN120	50	41	61	50	71%	30.16	1021.4			
18	18:53	SE 7	10	Mostly Cloudy	BKN110	51	42			71%	30.15	1021			
18	17:53	S 8	10	Mostly Cloudy	BKN110	52	40			64%	30.15	1021			
18	16:53	SE 10	10	A Few Clouds	FEW120	54	38			55%	30.14	1020.5			
18	15:53	S 9	10	Fair	CLR	57	35			44%	30.14	1020.4			
18	14:53	SE 10	10	Fair	CLR	60	36			41%	30.15	1021			
18	13:53	SE 15	10	Fair	CLR	60	37	64	55	42%	30.16	1021.1			
18	12:53	Calm	10	Fair	CLR	62	34			35%	30.16	1021.1			
18	11:53	NE 8	10	Fair	CLR	60	35			39%	30.18	1022			
18	10:53	E 13	10	Fair	CLR	59	35			41%	30.2	1022.6			
18	9:53	N 8	10	Fair	CLR	59	33			38%	30.2	1022.8			
18	8:53	N 10	10	Fair	CLR	56	32			40%	30.21	1022.8			
18	7:53	N 14 G 20	10	Fair	CLR	55	32	59	53	42%	30.2	1022.8			
18	6:53	N 3	10	Fair	CLR	54	30			40%	30.19	1022.3			
18	5:53	N 3	10	Fair	CLR	54	27			35%	30.18	1021.8			
18	4:53	N 5	10	Fair	CLR	56	26			32%	30.15	1020.9			
18	3:53	N 5	10	Fair	CLR	56	28			34%	30.13	1020.1			
18	2:53	Vrbl 6	10	Fair	CLR	58	27			31%	30.11	1019.7			
18	1:53	NW 5	10	Fair	CLR	59	27	74	59	29%	30.1	1019.2			
18	0:53	Vrbl 5	10	Fair	CLR	62	28			28%	30.1	1019.2			
17	23:53	NW 10 G 21	10	Fair	CLR	64	26			24%	30.08	1018.6			
17	22:53	NW 9 G 20	10	Fair	CLR	66	24			20%	30.08	1018.5			
17	21:53	NW 12 G 23	10	Fair	CLR	68	24			19%	30.06	1018			
17	20:53	NW 9 G 16	10	Fair	CLR	71	22			16%	30.04	1017.2			
17	19:53	NW 5	10	Fair	CLR	74	21	85	74	14%	30.01	1016.1			
17	18:53	NW 9	10	Fair	CLR	77	23			13%	29.98	1015.2			
17	17:53	Vrbl 5	10	Fair	CLR	82	29			14%	29.98	1015.1			
17	16:53	W 13 G 20	10	Fair	CLR	83	24			11%	29.98	1015.1			
17	15:53	W 8 G 17	10	Fair	CLR	84	28			13%	29.98	1015			
17	14:53	Vrbl 6 G 22	10	Fair	CLR	84	33			16%	29.98	1015.3			
17	13:53	SE 7	10	Fair	CLR	80	48	84	58	33%	29.99	1015.5			
17	12:53	SE 9	10	Fair	CLR	83	51			33%	29.99	1015.6			
17	11:53	Calm	10	NA	NA	81	39			22%	30	1015.9			
17	10:53	Calm	10	A Few Clouds	FEW095	79	43			28%	30.01	1016.1			
17	9:53	Vrbl 3	0	Partly Cloudy	SCT065	76	48			37%	30	1015.8			
17	8:53	Calm	0	Fair	CLR	67	55			66%	29.99	1015.6			
17	7:53	Calm	5	Fog/Mist	CLR	58	53	58	50	84%	29.99	1015.4			
17	6:53	Calm	2.5	Fog/Mist	CLR	52	51			97%	29.97	1014.8			
17	5:53	Calm	3	Fog/Mist	CLR	51	49			92%	29.95	1014.1			
17	4:53	Calm	4	Fog/Mist	CLR	51	49			92%	29.92	1013.1			
17	3:53	S 6	4	Fog/Mist	CLR	52	50			93%	29.92	1013			
17	2:53	S 3	5	Fog/Mist	CLR	52	50			93%	29.92	1013.2			
17	1:53	S 5	4	Fog/Mist	OVC004	51	50	57	51	96%	29.93	1013.6			
17	0:53	S 5	4	Fog/Mist	OVC004	53	51			93%	29.94	1013.9			
16	23:53	S 7	4	Fog/Mist	OVC004	53	51			93%	29.96	1014.4			
16	22:53	S 9	4	Fog/Mist	OVC004	53	51			93%	29.96	1014.4			
16	21:53	S 7	5	Fog/Mist	SCT004	53	51			93%	29.98	1015.1			
16	20:53	S 6	6	Fog/Mist	CLR	55	51			87%	29.98	1015.2			
16	19:53	S 7	7	Fair	CLR	57	52	75	57	83%	29.97	1014.8			
16	18:53	S 8	8	Fair	CLR	62	53			73%	29.97	1014.7			
16	17:53	S 9	10	Fair	CLR	69	55			61%	29.96	1014.5			
16	16:53	S 12	10	Fair	CLR	71	56			59%	29.96	1014.6			
16	15:53	S 10	10	Fair	CLR	73	55			53%	29.98	1015.1			
16	14:53	S 10	10	Fair	CLR	75	55			50%	29.98	1015.3			
16	13:53	SE 12	10	Fair	CLR	75	55	78	59	50%	29.99	1015.5			
16	12:53	S 10	10	Fair	CLR	78	56			47%	30.01	1016.1			
16	11:53	S 9	10	Fair	CLR	77	56			48%	30.02	1016.5			
16	10:53	SE 8	9	Fair	CLR	70	54			57%	30.02	1016.7			

Post Cal Pressure

Average Temp 64.6 Average Press 30.11

Pre Cal Pressure

**APPENDIX E**

**LABORATORY DATA REPORTS (ON CD)**

**APPENDIX F**

**LABORATORY DATA VALIDATION  
MEMORANDA**



# Memo

To: David Sullivan  
From: Lorie MacKinnon  
CC:  
Date: 05/23/12  
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDG 12040230

## SUMMARY

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Limited (Tier II) validation was performed on the data for 13 air samples and two trip blank samples collected at the Keith Middle School in New Bedford, Massachusetts. The samples were collected on April 18, 2012 and submitted to Pace Analytical Services, Inc. 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 number 12040230.

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. All results are usable for project objectives.

## SAMPLES

Samples included in this review are listed below:

VS-1-29	VS-4-29	VS-14-29
VS-10-29	VS-10-29 DUP (1)	VS-BG-29
VS-TB-29	A-29	B-29
C-29	BG-29	BG-29 DUP (2)
TB-29	HS-A-203-2	HS-A-203-DUP (3)

- (1) Field duplicate of VS-10-29
- (2) Field duplicate of BG-29

(3) Field duplicate of HS-A-203-2

## **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 VER PUF samples (Lot#: 041612-1, 041612-2, 041612-3, 28730-1, 28744-1, and 032912-1) and VER Filter sample (Lot #032912-4) which were analyzed and reported under job numbers 12040173, 12030223, and 12040101.

### **Surrogate Spike Recoveries**

All recovery criteria were met.

## LCS Results

An LCS and LCSD was extracted and analyzed with each extraction batch. All recovery and precision criteria were met.

## Internal Standard Performance

All criteria were met.

## Field Duplicate Results

Samples VS-10-29/VS-10-29 DUP, BG-29/BG-29 DUP, and HS-A-203-2/HS-A-203 DUP were submitted as the field duplicate (collocated) pairs with this sample set. PCBs were not detected in samples VS-10-29 and VS-10-29 DUP.

The following table summarizes the RPDs of the detected analytes in sample pair BG-29/BG-29 DUP, which were within the acceptance criteria of 20%RPD or the difference of <2 times the reporting limit (RL).

Parameter	RL (ug/m3)	BG-29 (ug/m3)	BG-29 DUP (ug/m3)	RPD (%)
Trichlorobiphenyl	0.0000140	0.000802	0.000699	13.7
Tetrachlorobiphenyl	0.0000280	0.0000297	0.0000713	82.3, Within 2xRL
Total PCB	-	0.000832	0.00077	7.7

The following table summarizes the RPDs of the detected analytes in sample pair HS-A-203-2/HS-A-203 DUP, which were within the acceptance criteria of 20%RPD or the difference of <2 times the reporting limit (RL).

Parameter	RL (ug/m3)	HS-A-203-2 (ug/m3)	HS-A-203 DUP (ug/m3)	RPD (%)
Dichlorobiphenyl	0.000662	0.0346	0.0387	11.2
Trichlorobiphenyl	0.000662	0.167	0.188	11.8
Tetrachlorobiphenyl	0.00133	0.138	0.153	10.3
Pentachlorobiphenyl	0.00133	0.00266	0.00301	12.3
Total PCB	-	0.343	0.383	11.0

## Quantitation Limits and Sample Results

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

Dilutions were not required.



# Memo

To: David Sullivan  
From: Lorie MacKinnon  
CC:  
Date: 05/23/12  
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDGs L1206836 and L1206918

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## 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 18, 2012 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. Alpha reported the results under job numbers L1206836 and L1206918.

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 sample C-29 were estimated (J/UJ) due to high pre and post flow controller calibration check relative percent difference. The nondetect results for trans-1,2-dichloroethene, trans-1,3-dichloropropene, and naphthalene in all samples should be qualified as estimated (UJ) due to calibration nonconformances. The direction of the bias cannot be determined from these nonconformances. The positive results for acetone in sample VS-14-29 and chloromethane in samples C-29, B-29, and A-29 should be qualified as estimated (J) due to possible co-elution with non-target compounds. These results may be biased high. Due to the interference of non-target compounds, the presence of chloromethane in samples VS-1-29, VS-4-29, VS-14-29, VS-10-29, and VS-10-29 DUP could not be confirmed and these affected nondetect results were qualified as estimated (UJ). These issues have a minor impact on the data usability; all results are still usable for project objectives.

## **SAMPLES**

Samples included in this review are listed below:

### **L1206836**

C-29	B-29	A-29
BG-29	BG-29 DUP (1)	TB-29

### **L1206918**

VS-1-29	VS-4-29	VS-14-29
VS-10-29	VS-10-29 DUP (2)	VS-BG-29
VS-TB-29		

- 1) Field duplicate of BG-29
- 2) Field duplicate of VS-10-29

## **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-29 (22%), indicating that the flow was not consistent over the time of collection. The positive and nondetect results for sample C-29 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 trans-1,2-dichloroethene (29.4), trans-1,3-dichloropropene (25.6), and naphthalene (25.7) were outside of the acceptance criteria in the continuing calibration associated with all samples. The nondetect results for trans-1,2-dichloroethene, trans-1,3-dichloropropene, and naphthalene were estimated (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 655 Shelf 42 (L1205315), Can 1795 Shelf 52 (L1205791), and Can 110 Shelf 2, which were associated with all samples in these sample sets.

## Laboratory Duplicate Results

The laboratory performed a duplicate analysis on sample VS-1-29. All relative percent differences (RPDs) were within the laboratory control limit of 25.

## LCS Results

LCS samples were analyzed along with the field samples. All recovery criteria were met.

## Internal Standard Performance

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

## Field Duplicate Results

Samples VS-10-29 and VS-10-29 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	RL ( $\mu\text{g}/\text{m}^3$ )	VS-10-29 ( $\mu\text{g}/\text{m}^3$ )	VS-10-29 DUP ( $\mu\text{g}/\text{m}^3$ )	RPD (%)
Acetone	23.8	28.7	23.8 U	Not calculable; Within 2xRL
2-Butanone	5.90	11.4	7.90	36.3, Within 2xRL

Samples BG-29 and BG-29 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	RL ( $\mu\text{g}/\text{m}^3$ )	BG-29 ( $\mu\text{g}/\text{m}^3$ )	BG-29 DUP ( $\mu\text{g}/\text{m}^3$ )	RPD (%)
Dichlorodifluoromethane	0.989	2.20	2.33	5.7
Chloromethane	0.413	1.02	1.12	9.3
Acetone	2.38	5.94	5.51	7.5
2-Butanone	0.59	1.20	0.590 U	Not calculable, Within 2xQL
Methylene chloride	4.86	4.86 U	5.52	Not calculable, Within 2xQL
Trichloroethene	0.107	0.107 U	0.124	Not calculable, Within 2xQL

### Quantitation Limits and Sample Results

Ten fold dilutions were performed for samples VS-10-29 and VS-10-29 DUP due to high concentrations of non-target compounds in these samples. Quantitation limits were elevated accordingly.

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
C-29	Chloromethane	Co-elution with non-target compound	Estimate (J) the positive results for chloromethane in samples C-29, B-29, and A-29.
B-29			
A-29			
VS-14-29	Acetone	Co-elution with non-target compound	Estimate (J) the positive result for acetone in sample VS-14-29.
VS-1-29	Chloromethane	Non-target compounds interfered with possible identification of this compound	Estimate (UJ) the nondetect results for chloromethane in these samples.
VS-4-29			
VS-14-29			
VS-10-29			
VS-10-29 DUP			

**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;  $0.05 \text{ ug/m}^3$ ) 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;  $0.3 \text{ ug/m}^3$ ), 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 ( $0.45 \text{ ug/m}^3$ ) 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), primarily developed between 1990 and 1995, consistent with the LTMMIP. MassDEP is in the process of updating the TELs/AALs, and published updated values for tetrachloroethene in January 2012. 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 ( $1 \times 10^{-6}$ ) 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, except for tetrachloroethene, 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 2012) 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  $1 \times 10^{-6}$ ) 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 ( $1 \times 10^{-5}$ ), 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, 2008) and residential and commercial Indoor Air Threshold Values (IATVs; December 2011) 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  $1 \times 10^{-6}$  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  $1 \times 10^{-5}$  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
<b>VOCs</b> (ug/m3)	1,2,4-trichlorobenzene	57	2	3.5%	11.7	12.2	A-11	1.48	3.71	1.5E+00	2.704	95% Chebyshev (Mean, Sd) UCL
	1,2,4-trimethylbenzene	57	12	21.1%	1	4.97	A-26	0.982	2.46	1.0E+00	1.512	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	57	44	77.2%	0.669	23.6	A-11	0.589	1.47	3.1E+00	3.845	95% Approximate Gamma UCL
	acetone <sup>(1)</sup>	57	53	93.0%	2.56	134	A-13	2.37	13.3	2.1E+01	26.07	95% Approximate Gamma UCL
	Benzene	57	34	59.6%	0.338	1.56	A-26	0.319	1.6	6.9E-01	0.749	95% Student's-t UCL
	Carbon Disulfide	57	4	7.0%	0.666	1.66	A-20	0.622	1.56	5.0E-01	0.546	95% Student's-t UCL
	Chloroform	57	24	42.1%	0.098	0.245	C-17	0.098	2.44	4.6E-01	0.245	Max. of Detects
	chloromethane	57	22	38.6%	0.433	15	C-13	0.413	1.03	8.6E-01	2.036	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	39	39	100.0%	1.99	3.1	C-24	--	--	2.4E+00	2.46	95% Student's-t UCL
	ethanol <sup>(1)</sup>	45	44	97.8%	4.16	191	C-17	4.71	4.71	2.9E+01	36.75	95% H-UCL
	ethylbenzene	57	18	31.6%	0.868	10.1	A-19	0.868	2.17	1.4E+00	2.505	95% Chebyshev (Mean, Sd) UCL
	Ethyl Acetate	27	1	3.7%	1.94	1.94	C-17	1.8	1.8	9.4E-01	1.004	95% Student's-t UCL
	Freon-113	27	1	3.7%	2.02	2.02	C-17	1.53	1.53	8.1E-01	0.891	95% Student's-t UCL
	isopropanol <sup>(1)</sup>	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 <sup>(1)</sup>	57	9	15.8%	3.48	318	C-14	0.694	4.86	8.1E+00	32.31	95% Chebyshev (Mean, Sd) UCL
	Methyl Isobutyl Ketone	39	5	12.8%	1.33	18.8	B-17	0.819	0.82	1.3E+00	3.669	95% Chebyshev (Mean, Sd) UCL
	p/m-xylene	57	23	40.4%	1.74	39	A-19	1.74	4.34	4.3E+00	8.587	95% Chebyshev (Mean, Sd) UCL
	o-xylene	57	19	33.3%	0.882	14	B-17	0.868	2.17	1.8E+00	3.555	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	57	21	36.8%	0.868	7.26	A-14	0.851	2.13	1.4E+00	2.27	95% Chebyshev (Mean, Sd) UCL
	Tetrachloroethylene	57	13	22.8%	0.136	0.393	A-20	0.136	3.39	6.1E-01	0.393	Max. of Detects
	tetrahydrofuran	57	2	3.5%	4.52	7.05	A-13	0.589	1.47	6.1E-01	1.213	95% Chebyshev (Mean, Sd) UCL
toluene	57	48	84.2%	0.777	74.1	B-25	0.753	1.88	6.3E+00	7.89	95% H-UCL	
Trichloroethylene	57	8	14.0%	0.107	0.215	A-19	0.107	2.68	4.8E-01	0.215	Max. of Detects	
trichlorofluoromethane	57	32	56.1%	0.85	3.08	C-14	1.12	2.81	1.3E+00	1.409	95% Student's-t UCL	
n-Propylbenzene	12	2	16.7%	0.983	1.06	A-26	0.982	0.983	5.8E-01	0.687	95% Student's-t UCL	
1,3,5-Trimethylbenzene	36	1	2.8%	1.96	1.96	A-26	0.982	0.983	5.3E-01	0.601	95% Student's-t UCL	
<b>PCBs</b> (ug/m3)	Total PCBs	54	47	87.0%	0.00031	0.013	A-19	0.000071	0.00038	3.7E-03	0.00494	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 <sup>3</sup>	ADEcancer (Cancer) µg/m <sup>3</sup>	ADEnon-cancer (Non-cancer) µg/m <sup>3</sup>	Unit Risk (µg/m <sup>3</sup> ) <sup>-1</sup>	Chronic Noncancer Reference Concentration µg/m <sup>3</sup>	Cancer Risk (--)	Hazard Quotient (--)	
1,2,4-Trichlorobenzene	2.704	2.2E-01	6.2E-01	NA	(1) 2.0E+00 (7)	NA	3.E-01	
2-Butanone	3.845	3.1E-01	8.8E-01	NA	(1) 5.0E+03 (1)	NA	2.E-04	
Acetone	26.07	2.1E+00	6.0E+00	NA	(1) 8.0E+02 (1)	NA	7.E-04	
Carbon disulfide	0.546	4.5E-02	1.2E-01	NA	(2) 7.0E+02 (2)	NA	2.E-04	
Ethyl acetate	1.004	8.2E-02	2.3E-01	NA	3.0E+03 (8)	NA	8.E-05	
Benzene	0.749	6.1E-02	1.7E-01	7.8E-06	(1) 3.0E+01 (1)	5.E-07	6.E-03	
Chloroform	0.245	2.0E-02	5.6E-02	2.3E-05	(1) 6.6E+02 (1)	5.E-07	8.E-05	
Chloromethane	2.036	1.7E-01	4.6E-01	NA	(2) 9.0E+01 (2)	NA	5.E-03	
Difluorodichloromethane	2.46	2.0E-01	5.6E-01	NA	2.0E+02 (3)	NA	3.E-03	
Ethylbenzene	2.505	2.0E-01	5.7E-01	NA	(1) 1.0E+03 (1)	NA	6.E-04	
Freon 113	0.891	7.3E-02	2.0E-01	NA	3.0E+04 (3)	NA	7.E-06	
Methylene chloride	32.31	2.6E+00	7.4E+00	1.0E-08	(2) 6.0E+02 (2)	3.E-08	1.E-02	
Methyl isobutyl ketone	3.669	3.0E-01	8.4E-01	NA	(1) 3.0E+03 (1)	NA	3.E-04	
Styrene	2.27	1.9E-01	5.2E-01	5.7E-07	(1) 1.0E+03 (1)	1.E-07	5.E-04	
Tetrachloroethene	0.393	3.2E-02	9.0E-02	5.5E-05	(1) 3.0E+02 (10)	1.8E-06	3.E-04	
Tetrahydrofuran	1.213	9.9E-02	2.8E-01	3.0E-06	(9) 2.0E+03 (2)	3.E-07	1.E-04	
Toluene	7.89	6.4E-01	1.8E+00	NA	(1) 5.0E+03 (1)	NA	4.E-04	
Trichlorofluoromethane	1.409	1.1E-01	3.2E-01	NA	7.0E+02 (3)	NA	5.E-04	
Trichloroethene	0.215	1.8E-02	4.9E-02	4.0E-06	(2) 2.0E+00 (2)	7.E-08	2.E-02	
Xylenes	12.142	9.9E-01	2.8E+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	2.80	2.3E-01	6.4E-01	NA	(5) 5.0E+01 (5)	NA	1.E-02	
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	0.506	4.1E-02	1.2E-01	NA	(5) 5.0E+01 (5)	NA	2.E-03	
PCBs	0.00494	4.0E-04	1.1E-03	1.0E-04	(1) 2.0E-02 (1)	4.E-08	6.E-02	

Where:

LADecancer = IAC x EF x ED x EP/APcancer

ADEnon-cancer = IAC x EF x ED x EP / APnon-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/m<sup>3</sup> = micrograms per cubic meter

Sources of Toxicity Values:

- (1) MassDEP 2008; MCP standards derivation
- (2) IRIS, 2012
- (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 m<sup>3</sup>/day x 1000)
- (9) Presented in Appendix B of the IRIS Toxicity Review for Tetrahydrofuran (February 2012)
- (10) AAL-based value (MassDEP, 2012)

And where:

Exposure Frequency (EF) =	250	days/year (5 days a week for 50 weeks of exposure)
Exposure Duration (ED) =	8	hrs/event [1]
Exposure Period (EP) =	25	yr [1]
Unit Conversion (UC) =	0.04	days/hr
Averaging Period (APcancer) =	25550	days [1]
Averaging Period (APnon-cancer) =	9125	days [1]

[1] MADEP, 2008

	Cancer Risk	Hazard Index
<b>TOTAL:</b>	3E-06	5.E-01

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