July 14, 2014

Eugene W. Melnyk, P.E.
Project Manager
New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2915

BVNA Project No. 12014-000048.00
Transmitted via: e-mail

Subject: Vapor Intrusion Evaluation Report
201 Winchester Road, Village of Lakewood, Town of Busti
Chauataqua County, New York - NYSDEC Site Number: 0651503

Dear Mr. Melnyk:

On Behalf of Lexington Machining, LLC, Bureau Veritas North America, Inc. (BVNA) is pleased to present the attached Vapor Intrusion Evaluation Report for your review and approval. The evaluation was completed following the Vapor Intrusion Evaluation Work Plan (work plan) for the above referenced site dated April 2014 and approved by the Department on April 21, 2014.

Please contact me at (732) 225-6040 or john.stangline@us.bureauveritas.com with any questions.

Sincerely,

John A. Stangline, ARM, CPEA
Senior Consultant
Health Safety and Environmental Services
New York Regional Office

Reviewed by,

A. Lee Fankhauser, LSRP
Senior Consultant II

cc: Michael Lubin, Chairman, Lexington Machining LLC

Bureau Veritas North America, Inc.
Raritan Plaza I, 4th Floor, 110 Fieldcrest Avenue
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Vapor Intrusion Evaluation Report

Lexington Machining, LLC

NYSDEC Site Number: 0651503
Premier Lakewood, Inc. Site
201 Winchester Road
Village of Lakewood, Town of Busti
Chauataqua County, New York

Bureau Veritas Project No. 12014-000048.00
JULY 2014

Prepared by:

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1.0 BACKGROUND

Subsequent to active remediation, a Site Management Plan (SMP) was prepared for the Lexington Machining LLC (LMLLC) property located at 201 Winchester Road in Lakewood, New York, Site #0651530 (the Site). A Site location map is presented in Figure 1. The SMP was prepared to address low levels of volatile organic compounds (VOCs) remaining in soil and groundwater of the Site and was required by the New York State Department of Environmental Conservation (NYSDEC) draft Order on Consent and Administrative Settlement Index # B9-0792-08-10.

1.1 HISTORIC OPERATIONS

The site was undeveloped vacant land at least through the 1930s with initial construction of the existing manufacturing building beginning circa 1956. Die casting operations, including aluminum, magnesium, and zinc die castings manufactured for consumer and industrial products, have been located at the property since that time. The manufacturing plant was occupied through the 1980s by Falconer Metal Specialties, which was succeeded by Falconer Die Casting, Lexington Die Casting, and Premier Tool & Die, and Premier Lakewood, Inc. the current operator. Lexington Precision Corporation, the previous owner of the Property, was the owner of Lexington Die Casting before selling the manufacturing equipment and operation to Premier Tool & Die in 2006. The current site owner is LMLLC.

Operations at the site ceased circa April 2014 with ongoing removal of equipment and manufacturing materials anticipated through the end of August 2014.

1.2 SITE ENVIRONMENTAL SUMMARY

VOCs were identified in Site soil and groundwater during due diligence environmental site investigations and underground storage tank (UST) closure activities between July 2002 and November 2006. The primary soil and groundwater contaminant, 1,1,1-trichloroethane (1,1,1-TCA), had been previously used at the Site as a solvent and degreaser from approximately 1960 through 1991. Breakdown products of 1,1,1-TCA identified in groundwater include 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), chloroethane and vinyl chloride. Also identified in several groundwater samples were 1,1,2-trichloroethane (1,1,2-TCA) and its breakdown product 1,2-dichloroethane (1,2-DCA).

An enhanced in-situ bioremediation program was conducted to address VOCs in groundwater at the Site in August through November 2006. The program included injection of bio-amendments into groundwater to support and increase the rate of naturally occurring degradation of contaminants by reductive dechlorination.

Post-remediation groundwater sampling conducted in April 2007, indicated a reduction in 1,1,1-TCA concentrations and an increase in 1,1,1-TCA breakdown products such as 1,1-DCA, and chloroethane.

A groundwater sampling program was conducted in June 2010 to evaluate groundwater quality conditions at the Site. The concentrations of the primary contaminant, 1,1,1-TCA, had fallen below NYSDEC Groundwater Quality Standard (GWQS) in all but one monitoring well. The secondary contaminant, 1,1,2-TCA was detected in only one monitoring well at a concentration above the GWQS; the concentration was lower than the previously detected concentrations. Concentrations of contaminant breakdown products are generally increasing at the site. Concentrations of tertiary breakdown products chloroethane and chloroethane are increasing. Secondary breakdown product concentrations of 1,1-DCA, 1,2-DCA and 1,1-DCE, increased under the Site building but decreased in most other areas of the Site. These changes indicate that natural attenuation of the VOC contaminants at the Site is occurring.

Soil contaminants remaining at the site are located at depths of 4 to 11.5 feet beneath site structures and include chlorinated solvents and acetone at concentrations below criteria for protection of public health in residential, commercial or industrial settings, but above criteria for protection of groundwater.

Groundwater contaminants remaining at the Site, including chlorinated solvent VOCs, are present in overburden groundwater under approximately half of the 99,000 square foot manufacturing building and the northern portion of the LMLLC property. Groundwater elevations are generally encountered at depths of 10 to 16 feet below grade. One groundwater sample, collected from deep groundwater monitoring well (MW-11D) in June 2010, exhibited concentrations of four VOCs, three at concentrations below groundwater quality standards, and the fourth, acetone, detected slightly above standards. Monitoring well MW-11D is located outside the southwest corner of the manufacturing building and up-gradient of chemical use areas. No other VOCs have been detected above standards in the deep groundwater zone.

2.0 SCOPE OF INVESTIGATION

Bureau Veritas North America, Inc. (BVNA) prepared a Vapor Intrusion Evaluation Work Plan (Work Plan), dated April 2014, in accordance with the requirements of SMP Section 2.3.2, Soil Vapor Intrusion Evaluation. The Work Plan was submitted to the NYSDEC for review and approval on April 10, 2014. This evaluation was completed following the Work Plan as approved by the NYSDEC by correspondence dated April 21, 2014 (Appendix A).

In accordance with the SMP and approved Work Plan, the evaluation was performed over interior areas of the current site structure that contains residual volatile organic contamination and where potential SVI may occur. The sub-slab vapor sample locations were determined based on 1) site operations and general construction, 2) residual groundwater impacts, 3) residual soil impacts and 4) potential future site use. The conceptual approach and sampling locations were based upon manufacturing and light industrial operations within the site Main Building, building construction history, interior space divisions, and areas of residual impact.

The focus of this evaluation is on the compounds remaining in soil and groundwater of the Site. Those compounds include the following:

Acetone
1,1-dichloroethane
cis-1,2-dichloroethene
Benzene
1,2-dichloroethane
1,1,1-trichloroethane
Chloroethane
1,1-dichoroethene
1,1,2-trichloroethane

Figure 2 depicts site operating areas, general construction, residual soil and groundwater impacts, soil boring and groundwater monitoring well locations. Figure 2 also depicts sub-slab vapor, indoor air and ambient air sampling locations.

The investigation was guided by the methods in the Draft *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (Draft Guidance) dated October 2006, issued by the NYSDOH Center for Environmental Health, Bureau of Environmental Exposure Investigation.

3.0 SAMPLE COLLECTION

The applicable sections of the Draft Guidance, as specified herein, were followed for the collection of sub-slab vapor and air samples via temporary sample points. Vapor intrusion investigation samples were collected on March 19, 2014 within the recognized heating season.

3.1 SAMPLE NUMBER AND LOCATIONS

BVNA collected five sub-slab vapor samples, five indoor air samples and one ambient air sample at the site. Sample locations were selected in accordance with Draft Guidance Sections, 2.6.2 Sub-slab vapor, 2.6.3 Indoor air, and 2.6.4 Outdoor air with consideration of field conditions (buried piping, machinery, etc.).

Two sub-slab vapor and indoor air samples were collected within the approximate area of residual soil and/or groundwater impact. Three sub-slab vapor and indoor air samples were collected immediately outside of the approximate areas of residual impacts within the building. The ambient air sample was collected in a generally up-wind location of manufacturing operations on the site. Specific sampling locations were selected to avoid areas of the floor where cracks, floor penetrations or similar routes of vapor migration were apparent, areas of VOC use, and to accommodate operations and equipment.

Sample locations are depicted in Figure 2.

3.2 SAMPLING METHODOLOGY

Samples were collected following the methods outline in Draft Guidance Sections, 2.7.2 Sub-slab vapor, 2.7.3 Indoor air, and 2.7.4 Outdoor air.

Temporary sub-slab sampling points were installed in 1” boreholes to a depth of approximately 1.5 to 2” below the slab. Polyethylene tubing was inserted and the boreholes sealed with inert clay. Two to three volumes of air were evacuated from each borehole and the clay seal was re-packed. A 6-Liter evacuated (Summa®) canister and controller was used to collect sub-slab vapor samples from each borehole over a period of approximately 1 hour with a target ending pressure of -7” Hg. Five sub-slab vapor samples were collected.

Indoor air samples (five samples) were collected directly into 1.4-Liter Summa® canisters and one outdoor ambient air sample was collected into a 6-Liter Summa® canister. Each air sample was collected with an approximately 40 to 60 minute sampling time.

3.3 ANALYSIS AND QUALITY ASSURANCE / QUALITY CONTROL

Vapor and air samples were delivered under proper chain-of-custody procedures to EMSL located in Cinnaminson, New Jersey, a NYDOH, NY-ELAP approved laboratory (Number 10872). Samples were analyzed using USEPA Method TO-15 for samples collected in evacuated (Summa®) canisters per Draft Guidance, Section 2.9 Analytical Methods. EMSL conducted laboratory QA/QC as appropriate for analytical methods.

3.4 FIELD OBSERVATIONS

The facility is a metalworking and die-cast facility in active operation at the time of the evaluation and sampling (24 hour operations). Die cast machines and various metalworking stations are present throughout the facility, as well as warehouse and office space.

The facility is largely un-heated as the die-cast furnace machines present throughout the facility provide adequate radiant heat. The facility was noted to be between 65°F and 75°F under normal operation during the sampling. There is a radiant heater located in the shipping and secondary machining area.

Several significant potential sources of VOCs were observed during the sampling, including open containers with glycol oil, waste drums, and similar products. Lubricated machine parts are free-standing and present throughout the facility. The floor is predominantly coated with an oily residue in manufacturing areas.

There is a Hastings air re-circulation unit in the production area. A whole area fan is also present in the die-cast area. There are several ceiling fans which provide general exhaust ventilation.

Exterior ambient conditions were recorded with an average daytime temperature of 39°F with humidity and pressure recorded at 63% and 29.88 inches Hg respectively.

4.0 ANALYTICAL RESULTS

EMSL provided its Laboratory Report dated April 7, 2014 for the samples collected at the Lexington Machining site (Appendix B). EMSL reported five compounds detected in the ambient Outdoor Air sample, up to thirteen compounds detected in the sub-slab soil vapor samples and up to seventeen compounds detected in the indoor air samples. The Guidance includes “guideline values” derived by NYSDOH for several compounds; however; values are not provided for the compounds of concern at the Site.

Table 1 provides a summary of the sample analytical results for the vapor intrusion evaluation samples collected at the site. No chlorinated target compounds were reported above method detection limits by EMSL. Acetone was detected in each sample including sub-slab soil vapor samples, out-door ambient air and indoor air samples. Benzene was detected in sub-slab soil vapor sample Sub-Slab-3, while each of the five indoor air samples exhibited detectable concentrations of benzene. The outdoor ambient air sample did not exhibit detectable concentrations of benzene.

4.1 DISCUSSION

Acetone was detected in sub-slab samples in concentrations ranging from 100 to 290 parts per billion by volume (ppbv) with the highest concentration of 290 ppbv detected in sample Sub-Slab-3 in the Die-Cast area. Acetone was detected in the indoor air samples in concentrations ranging from 6.6 to 17 ppbv with the highest concentration reported in sample Indoor-1 located in the Secondary Machinery / Returnable Container Storage area. The mean acetone indoor air sample concentration is 9.42 ppbv.

There does not appear to be a correlation between the sub-slab vapor and indoor air concentrations of acetone. The sub-slab sample location exhibiting the highest acetone concentration was obtained in an area where the second lowest indoor air sample acetone concentration was obtained. There is no guideline value established for acetone within the Guidance.

Benzene was detected in only one sub-slab soil vapor sample, Sub-Slab-3, at a concentration of 7.1 ppbv. Each of the five indoor air samples exhibited detectable concentrations of benzene with the highest concentration 2.0 ppbv in sample Indoor-1. There does not appear to be a correlation between the sub-slab vapor and indoor air concentrations of benzene. The sub-slab sample location exhibiting the highest benzene concentration was obtained in an area where one of the two lowest indoor air sample benzene concentrations was obtained. There is no guideline value established for benzene within the Guidance.

No chlorinated compounds of concern or compounds for which the Guidance establishes air guideline values were detected in the sub-slab soil vapor, ambient or indoor air samples.

5.0 CONCLUSIONS

Based upon the implementation of the NYSDEC-approved Vapor Intrusion Evaluation Work Plan and associated field survey and sampling, there does not appear to be a significant risk of vapor intrusion associated with the residual contaminants of concern in soil and groundwater of the site.

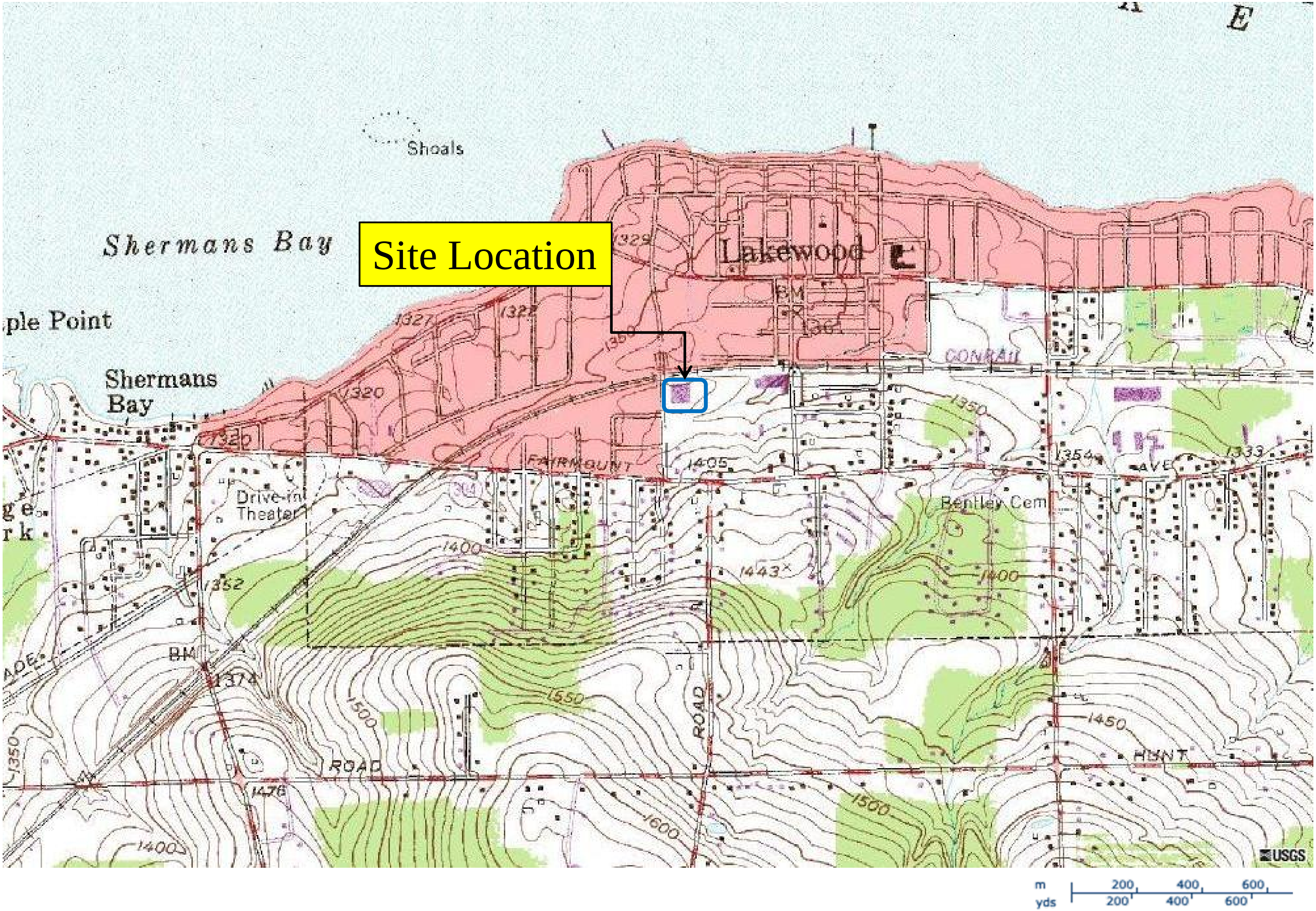
No additional action or investigation is recommended regarding vapor intrusion potential at the site.

6.0 SIGNATURES

Prepared by: ______________________________
John A. Stangline, ARM, CPEA
Senior Consultant

Reviewed by: ______________________________
A. Lee Fankhauser, LSRP
Senior Consultant II
New York Regional Office

Figures



Project Number: 12010-000147.00

Drawn By: JAS Date: 07-17-10

Reviewed By:WSM Date:07-29-10

Client:

Lexington Precision Corporation
800 third Avenue, 15th Floor
New York, New York 10022

Location:

Premier Lakewood, Inc.
201 Winchester Avenue
Lakewood, New York 14750

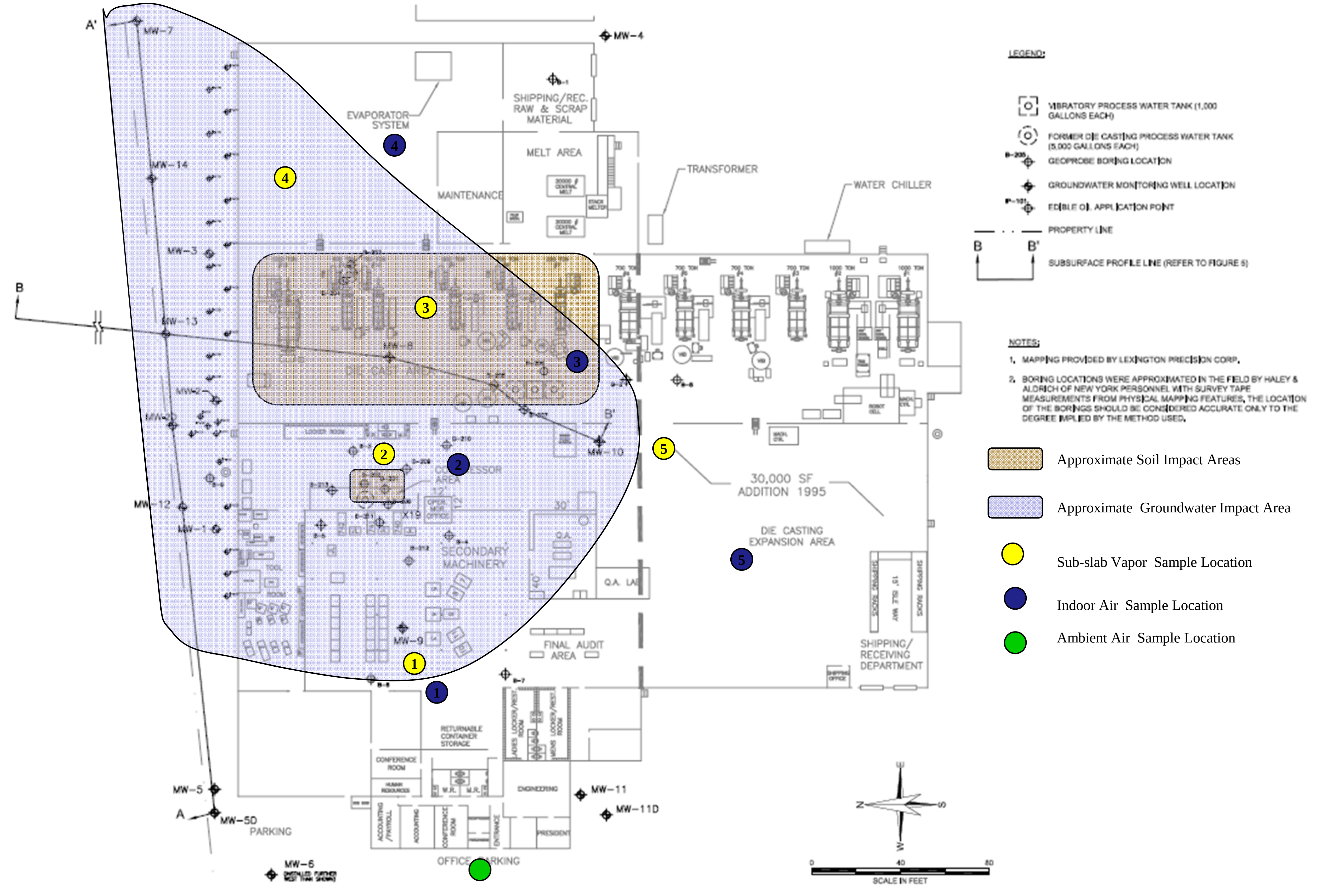
Title:

Site Location Map

Figure:

1

BUREAU VERITAS



NOTES:

1. MAPPING PROVIDED BY LEXINGTON PRECISION CORP.
2. BORING LOCATIONS WERE APPROXIMATED IN THE FIELD BY HALEY & ALDRICH OF NEW YORK PERSONNEL WITH SURVEY TAPE MEASUREMENTS FROM PHYSICAL MAPPING FEATURES. THE LOCATION OF THE BORINGS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

Survey Source: Summary of Environmental Investigations and Remedial Activities, Haley & Aldrich of New York, January 9, 2007

Project Number: 12014-000048.00 Drawn By: JAS Date: 06-12-14 Reviewed By: ALF Date:06-12-14	Client: **Lexington Precision Corporation** **800 third Avenue, 15th Floor** **New York, New York 10022**	Location: **Premier Lakewood, Inc.** **201 Winchester Avenue** **Lakewood, New York 14750**	Title: **Vapor Intrusion Evaluation** **Sample Locations**	Figure: 2

Tables

Lexington Precision Corporation
Premier Lakewood, Inc. Site
Table 1
Vapor Intrusion Evaluation Sampling Summary

Sample ID	Laboratory ID	Sample Type	Acetone		Benzene		Chloroethane	
Units			ppbv	ug/m3	ppbv	ug/m3	ppbv	ug/m3
Sub-Slab-1	491400228-0001	Sub-slab vapor	120	280	ND	ND	ND	ND
Sub-Slab-2	491400228-0002	Sub-slab vapor	100	240	ND	ND	ND	ND
Sub-Slab-3	491400228-0003	Sub-slab vapor	290	700	7.1	23	ND	ND
Sub-Slab-4	491400228-0004	Sub-slab vapor	200	470	ND	ND	ND	ND
Sub-Slab-5	491400228-0005	Sub-slab vapor	180	420	ND	ND	ND	ND
Ambient-Out	491400228-0006	Out-door air	3.3	7.7	ND	ND	ND	ND
Indoor-1	491400228-0007	Indoor air	17	41	2.0	6.3	ND	ND
Indoor-2	491400228-0008	Indoor air	6.6	16	1.1	3.6	ND	ND
Indoor-3	491400228-0009	Indoor air	6.7	16	1.2	3.8	ND	ND
Indoor-4	491400228-0010	Indoor air	9.3	22	1.3	4.0	ND	ND
Indoor-4	491400228-0011	Indoor air	7.5	18	1.1	3.4	ND	ND

All samples collected on March 19, 2014

ppbv - parts per billion by volume

ug/m3 - micro-grams per cubic meter

ND = Analyzed for but Not Detected at the MDL

Analytical results for compounds of concern at the Site (previously detected in soil or groundwater) are included in this table

Any other detected compounds are included in the full Laboratory Report.

Lexington Precision Corporation
Premier Lakewood, Inc. Site
Table 1
Vapor Intrusion Evaluation Sampling Summary

Sample ID	1,1-dichloroethane		1,2-dichloroethane		1,1-dichoroethene		cis-1,2-dichloroethene	
Units	ppbv	ug/m3	ppbv	ug/m3	ppbv	ug/m3	ppbv	ug/m3
Sub-Slab-1	ND	ND	ND	ND	ND	ND	ND	ND
Sub-Slab-2	ND	ND	ND	ND	ND	ND	ND	ND
Sub-Slab-3	ND	ND	ND	ND	ND	ND	ND	ND
Sub-Slab-4	ND	ND	ND	ND	ND	ND	ND	ND
Sub-Slab-5	ND	ND	ND	ND	ND	ND	ND	ND
Ambient-Out	ND	ND	ND	ND	ND	ND	ND	ND
Indoor-1	ND	ND	ND	ND	ND	ND	ND	ND
Indoor-2	ND	ND	ND	ND	ND	ND	ND	ND
Indoor-3	ND	ND	ND	ND	ND	ND	ND	ND
Indoor-4	ND	ND	ND	ND	ND	ND	ND	ND
Indoor-4	ND	ND	ND	ND	ND	ND	ND	ND

Lexington Precision Corporation
Premier Lakewood, Inc. Site
Table 1
Vapor Intrusion Evaluation Sampling Summary

Sample ID	1,1,1-trichloroethane		1,1,2-trichloroethane	
Units	ppbv	ug/m3	ppbv	ug/m3
Sub-Slab-1	ND	ND	ND	ND
Sub-Slab-2	ND	ND	ND	ND
Sub-Slab-3	ND	ND	ND	ND
Sub-Slab-4	ND	ND	ND	ND
Sub-Slab-5	ND	ND	ND	ND
Ambient-Out	ND	ND	ND	ND
Indoor-1	ND	ND	ND	ND
Indoor-2	ND	ND	ND	ND
Indoor-3	ND	ND	ND	ND
Indoor-4	ND	ND	ND	ND
Indoor-4	ND	ND	ND	ND

Appendix A

NYSDEC-APPROVED
VAPOR INTRUSION WORK PLAN

April 10, 2014

Eugene W. Melnyk, P.E.
Project Manager
New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2915

BVNA Project No. 12014-000048.00
Transmitted via: e-mail

Subject: **Vapor Intrusion Evaluation Work Plan**
201 201 Winchester Road, Village of Lakewood, Town of Busti
Chauataqua County, New York - NYSDEC Site Number: 0651503

Dear Mr. Melnyk:

On Behalf of Lexington Machining, LLC, Bureau Veritas North America, Inc. (BVNA) is pleased to present the attached Vapor Intrusion Evaluation Work Plan for your review and approval. In order to complete the sampling component of this work plan during the 2013/2014 heating season, sub-slab vapor, indoor air and ambient air samples were collected in accordance with this plan on March 19, 2014.

Please contact me at (732) 225-6040 or john.stangline@us.bureauveritas.com with any questions.

Sincerely,

John A. Stangline, ARM, CPEA
Senior Consultant
Health Safety and Environmental Services
New York Regional Office

Reviewed by,

A. Lee Fankhauser, LSRP
Senior Consultant II

cc: Michael Lubin, Chairman, Lexington Machining LLC

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Vapor Intrusion Evaluation Work Plan

Lexington Machining, LLC

NYSDEC Site Number: 0651503
Premier Lakewood, Inc. Site
201 Winchester Road
Village of Lakewood, Town of Busti
Chauataqua County, New York

Bureau Veritas Project No. 12014-000048.00
APRIL 2014

Prepared by:

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For the benefit of business and people

CONTENTS

FIGURES

APPENDICIES

1.0 BACKGROUND

Subsequent to active remediation, a Site Management Plan (SMP) was prepared for the Lexington Machining LLC (LMLLC) for the LMLLC property located at 201 Winchester Road in Lakewood, New York, Site #0651530 (the Site). A Site location map is presented in Figure 1. The SMP was prepared to address low levels of volatile organic compounds (VOCs) remaining in soil and groundwater of the Site and is required by the New York State Department of Environmental Conservation (NYSDEC) draft Order on Consent and Administrative Settlement Index # B9-0792-08-10.

VOCs were identified in Site soil and groundwater during due diligence environmental site investigations and underground storage tank (UST) closure activities between July 2002 and November 2006. The primary soil and groundwater contaminant, 1,1,1-trichloroethane (1,1,1-TCA), had been previously used at the Site as a solvent and degreaser from approximately 1960 through 1991. Breakdown products of 1,1,1-TCA identified in groundwater include 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), chloroethane and vinyl chloride. Also identified in several groundwater samples were 1,1,2-trichloroethane (1,1,2-TCA) and its breakdown product 1,2-dichloroethane (1,2-DCA).

An enhanced in-situ bioremediation program was conducted to address VOCs in groundwater at the Site in August through November 2006. The program included injection of bio-amendments into groundwater to support and increase the rate of naturally occurring degradation of contaminants by reductive dechlorination.

Post-remediation groundwater sampling conducted in April 2007, indicated a reduction in 1,1,1-TCA concentrations and an increase in 1,1,1-TCA breakdown products such as 1,1-DCA, and chloroethane

A groundwater sampling program was conducted in June 2010 to evaluate groundwater quality conditions at the Site. The concentrations of the primary contaminant, 1,1,1-TCA, had fallen below NYSDEC Groundwater Quality Standard (GWQS) in all but one monitoring well. The secondary contaminant, 1,1,2-TCA was detected in only one monitoring well at a concentration above the GWQS; the concentration was lower than the previously detected concentrations. Concentrations of contaminant breakdown products are generally increasing at the site. Concentrations of tertiary breakdown products chloroethane and chloroethane are increasing. Secondary breakdown product concentrations of 1,1-DCA, 1,2-DCA and 1,1-DCE, increased under the Site building but decreased in most other areas of the Site. These changes indicate that natural attenuation of the VOC contaminants at the Site is occurring.

Soil contaminants remaining at the site are located at depths of 4 to 11.5 feet beneath site structures and include chlorinated solvents and acetone at concentrations below criteria for protection of public health in residential, commercial or industrial settings, but above criteria for protection of groundwater.

Groundwater contaminants remaining at the Site, including chlorinated solvent VOCs, are present in overburden groundwater under approximately half of the 99,000 square foot manufacturing building and the northern portion of the LMLLC property. Groundwater elevations are generally encountered at depths of 10 to 16 feet below grade. One groundwater sample, collected from deep groundwater monitoring well (MW-11D) in June 2010, exhibited concentrations of four VOCs, three at concentrations below groundwater quality standards, and the fourth, acetone, detected slightly above standards. Monitoring well MW-11D is located outside the southwest corner of the manufacturing building and up-gradient of chemical use areas. No other VOCs have been detected above standards in the deep groundwater zone.

This Vapor Intrusion Evaluation Work Plan has been prepared in accordance with the requirements of SMP Section 2.3.2 Soil Vapor Intrusion Evaluation. This work plan will be implemented in accordance with the requirements of the SMP.

2.0 SCOPE OF INVESTIGATION

In accordance with the SMP, the evaluation will be performed over interior areas of the current site structure that contains residual volatile organic contamination and where potential SVI may occur. The proposed sub-slab vapor sample locations were determined based on 1) site operations and general construction, 2) residual groundwater impacts, 3) residual soil impacts and 4) potential future site use. The conceptual approach and proposed sampling locations are based upon manufacturing and light industrial operations within the site Main Building, building construction history, interior space divisions, and areas of residual impact.

Figure 2 depicts site operating areas, general construction, residual soil and groundwater impacts, soil boring and groundwater monitoring well locations. Figure 2 also depicts proposed sub-slab vapor, indoor air and ambient air sampling locations.

The Investigation is consistent with the Draft *Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (Draft Guidance) dated October 2006, issued by the NYSDOH Center for Environmental Health, Bureau of Environmental Exposure Investigation.

2.1 HISTORIC OPERATIONS

The site was undeveloped vacant land at least through the 1930s with initial construction of the existing manufacturing building beginning circa 1956. Die casting operations have been located at the property since that time. The manufacturing plant was occupied through the 1980s by Falconer Metal Specialties, which was succeeded by Falconer Die Casting, Lexington Die Casting, and Premier Tool & Die, and Premier Lakewood, Inc. the current operator. Lexington Precision Corporation, the previous owner of the Property, was the owner of Lexington Die Casting before selling the manufacturing equipment and operation to Premier Tool & Die in 2006. The current site owner is LMLLC.

Aluminum, magnesium, and zinc die castings are manufactured for consumer and industrial products. The castings are manufactured by melting metal ingots, forming the molten metal in molds, and removing the castings from the molds. The castings then undergo a rough finishing process where contact water is utilized to cool the castings, remove burrs and smooth rough edges. The castings are also finished by manual sanding, grinding, and smoothing.

Contact process and cooling water is handled and treated in a closed-loop system consisting of settling tanks and a filtration system. Until 2004, the process and cooling water system used five unregulated settling tanks that were located under the plant floor. In 2004, the below-grade tanks associated with the die-casting process were removed from service and replaced with aboveground tanks. Two of the 1,000-gallon below-grade tanks were cleaned and filled with concrete while the remaining three 1,000-gallon tanks were cleaned in-place and taken out of service.

Lubricants were used to release the castings from molds and in machinery. Non-hazardous cleaners and lubricants, including water-soluble products, were used at the manufacturing plant. Spent cleaning products and lubricants are accumulated in 55-gallon drums at the point of use and disposed as non-hazardous waste on an as needed basis by a licensed waste hauler.

Small-quantity hazardous wastes generated at the Site prior to 1991 reportedly included spent 1,1,1-trichloroethane (1,1,1-TCA), lubricating oils, and light-weight oils. 1,1,1-TCA, a chlorinated volatile organic compound (VOC), was used at the plant from approximately 1960 to 1991 as a solvent and degreaser and was stored in an above ground tank inside the plant. In 1991, the manufacturing plant reportedly began using only non-hazardous degreasers and cooling oils.

Available information indicates that underground fuel or solvent storage tanks are not currently and have not previously been present at the site. Available information indicates that petroleum and solvent are/were stored and handled in drums or in above ground tanks. The manufacturing plant generates solid waste in the form of paper, cardboard, wooden boxes, and spent filter media from the process and cooling water treatment system. Metal shavings and cuttings from the die casting manufacture and finishing processes are re-smelted. Dross (waste die-casting material that is not suitable for re-smelting) is sold back to suppliers.

2.2 GROUDWATER IMPACTS

Groundwater impacts were initially discovered at the site during an October 2002 Phase II site assessment. VOCs including 1,1,1-TCA, 1,1,2-TCA, 1,1-DCA, 1,1-DCE, and 1,2-, 1,3-, and 1,4-dichlorobenzene were detected at concentrations of 2.6 to 19.0 micrograms per liter (ug/L). Subsequent groundwater monitoring well installation and groundwater sampling at the site in 2005, 2006, 2007 and 2010 identified additional VOCs; primarily breakdown products of 1,1,1-TCA and 1,1,2-TCA. VOCs detected in groundwater at the site, with concentrations ranges as noted, include:

- acetone (3.79 to 200 ug/L),
- benzene (0.458 to 0.815ug/L (two detections)),
- chloroethane (1.08 to 1100 ug/L),
- 1,1-dichloroethane (0.502 to 400 ug/L),
- 1,2-dichloroethane (0.331 to 9.15 ug/L),
- 1,1-dichoroethene (0.572 to 500 ug/L),
- cis-1,2-dichloroethene (0.496 to 10.3 ug/L),
- 1,1,1-trichloroethane (1.6 to 174 ug/L), and
- 1,1,2-trichloroethane (2.02 to 3.4 ug/L).

The groundwater VOC impact at the site appears to be limited in vertical extent to the saturated overburden. Its lateral extent appears to cover an area approximately 1.5 acres in size that includes the northern two thirds of the manufacturing building and extends down-gradient to the north and northeast from the building to the northern property boundary. Concentrations of VOCs detected in samples from wells installed in October 2006 at the northern property boundary (MW-12, -13, and -14) were an order of magnitude lower (roughly ten times lower) than concentrations detected at the wells located up-gradient and closer to the building (MW-1, -2, and -3). In general, the VOCs that occur in groundwater are predominantly the bio-degradation products of 1,1,1-TCA and 1,1,2-TCA. Continued natural degradation of site contaminants is anticipated.

Acetone was identified in three samples during one groundwater sampling event in 2005 and in six samples in 2010. Acetone was detected in the field blank during the 2010 sampling event and may be a laboratory contaminant. Benzene was identified in one sample during one groundwater sampling event in 2005 and one sample in June 2010. The presence of acetone and benzene in groundwater sampling appear to be intermittent and may be the result of laboratory or field contaminants.

2.3 SOIL IMPACTS

Three phases of soil sampling performed at the site included the areas where chlorinated solvent had been stored, used or potentially used. The results of the sampling program indicate a minor VOC impact in soil at the site. 1,1,1-TCA was detected at a concentration of 6.3 mg/kg, above soil cleanup criteria for protection of groundwater quality in one location; however, 1,1,1-TCA was not detected at concentrations above any soil cleanup criteria for protection of public health.

1,2-DCA was detected at concentrations of 0.03 to 0.05 ppm at 6 locations at concentrations slightly above the groundwater protection criteria but well below public health and ecological resource protection criteria.

Acetone was detected in two soil samples at concentrations slightly above the groundwater protection criteria but well below public health and ecological resource protection criteria.

2.4 SOIL VAPOR EVALUATION

The building at the site has not been evaluated for soil vapor intrusion conditions prior to or after the remedy.

3.0 SAMPLE COLLECTION

The applicable sections of the Draft Guidance as specified herein will be used as guidance for the collection of sub-slab vapor and air samples via temporary sample points.

3.1 SAMPLE NUMBER AND LOCATIONS

BVNA will collect five sub-slab vapor, five indoor air and one ambient air samples at the site. Sample locations will be selected in accordance with Draft Guidance

Sections, 2.6.2 Sub-slab vapor, 2.6.3 Indoor air, and 2.6.4 Outdoor air. Proposed sample locations are depicted in Figure 2. Field conditions (buried piping, machinery, etc.) will be considered in selection of the final sampling locations.

3.2 SAMPLING METHODOLOGY

Samples will be collected following the methods outline in Draft Guidance Sections, 2.7.2 Sub-slab vapor, 2.7.3 Indoor air, and 2.7.4 Outdoor air.

3.3 ANALYSIS AND QUALITY ASSURANCE / QUALITY CONTROL

All samples will be analyzed using the methods allowed in Draft Guidance, Section 2.9 Analytical Methods (see Appendix A). Approved methods include USEPA Method TO-15 for samples collected in evacuated (Summa®) canisters.

BVNA will retain the services of EMSL located in Cinnaminson, New Jersey, NYDOH, NY-ELAP approved laboratory number 10872. EMSL will conduct laboratory QA/QC as appropriate for analytical methods.

4.0 SUMMARY REPORT

Preliminary (un-validated) SVI sampling data will be forwarded to the NYSDEC and NYSDOH for initial review and interpretation. Upon validation, the final data will be transmitted to the agencies, along with a recommendation for follow-up action, such as mitigation, if any are required. If any indoor air test results exceed NYSDOH guidelines, relevant NYSDOH fact sheets will be provided to all tenants and occupants of the property within 15 days of receipt of validated data.

SVI sampling results, evaluations, and any follow-up actions will also be summarized in the subsequent Periodic Review Report that will include:

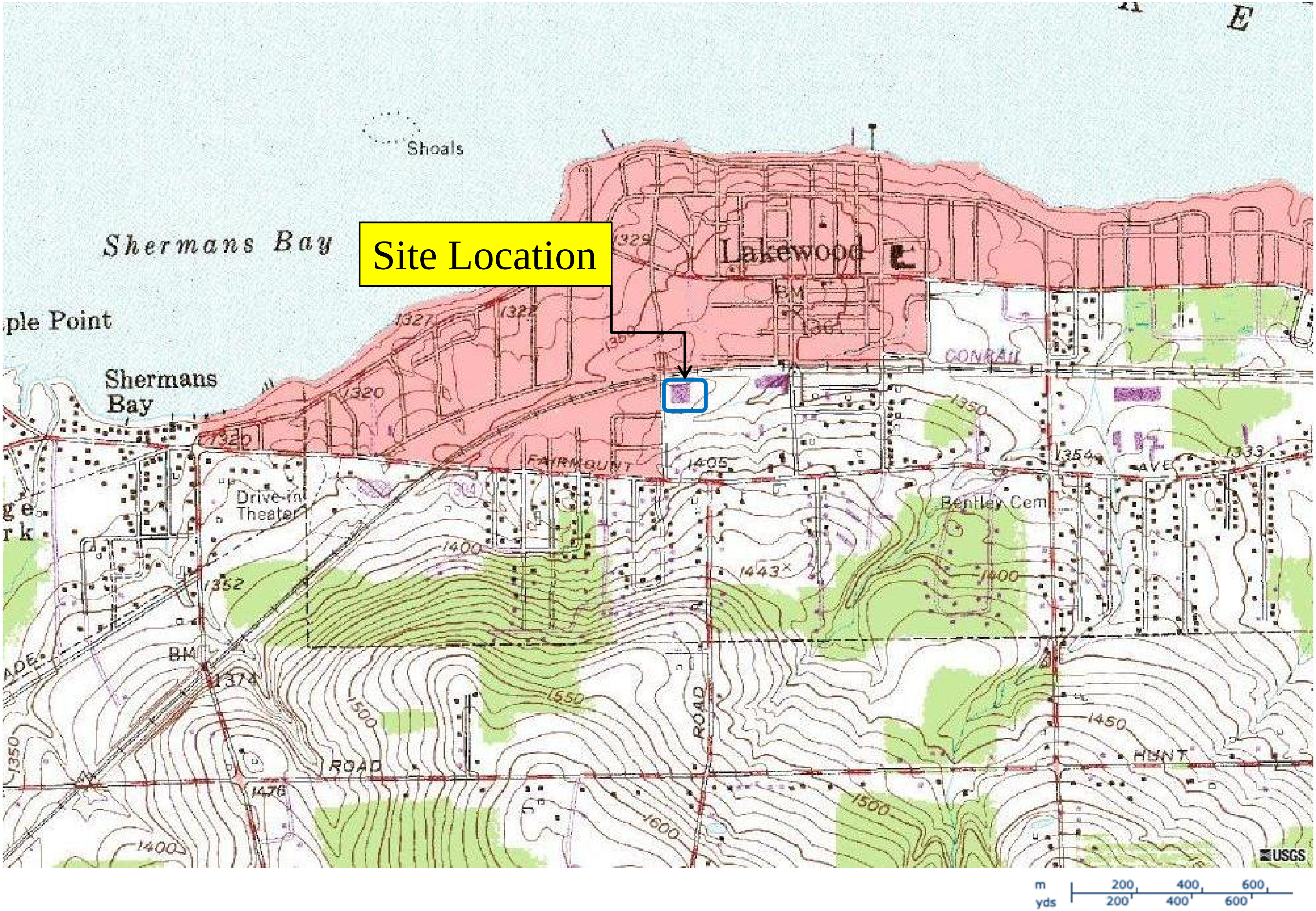
- A detailed description of the field activities
- A summary of analytical results for all samples (soil vapor, indoor air, and ambient air)

5.0 SIGNATURES

Prepared by: ______________________________
John A. Stangline, ARM, CPEA
Senior Consultant

Reviewed by:______________________________
A. Lee Fankhauser, LSRP
Senior Consultant II
New York Regional Office

Figures



Project Number: 12010-000147.00

Drawn By: JAS Date: 07-17-10

Reviewed By:WSM Date:07-29-10

Client:

Lexington Precision Corporation
800 third Avenue, 15th Floor
New York, New York 10022

Location:

Premier Lakewood, Inc.
201 Winchester Avenue
Lakewood, New York 14750

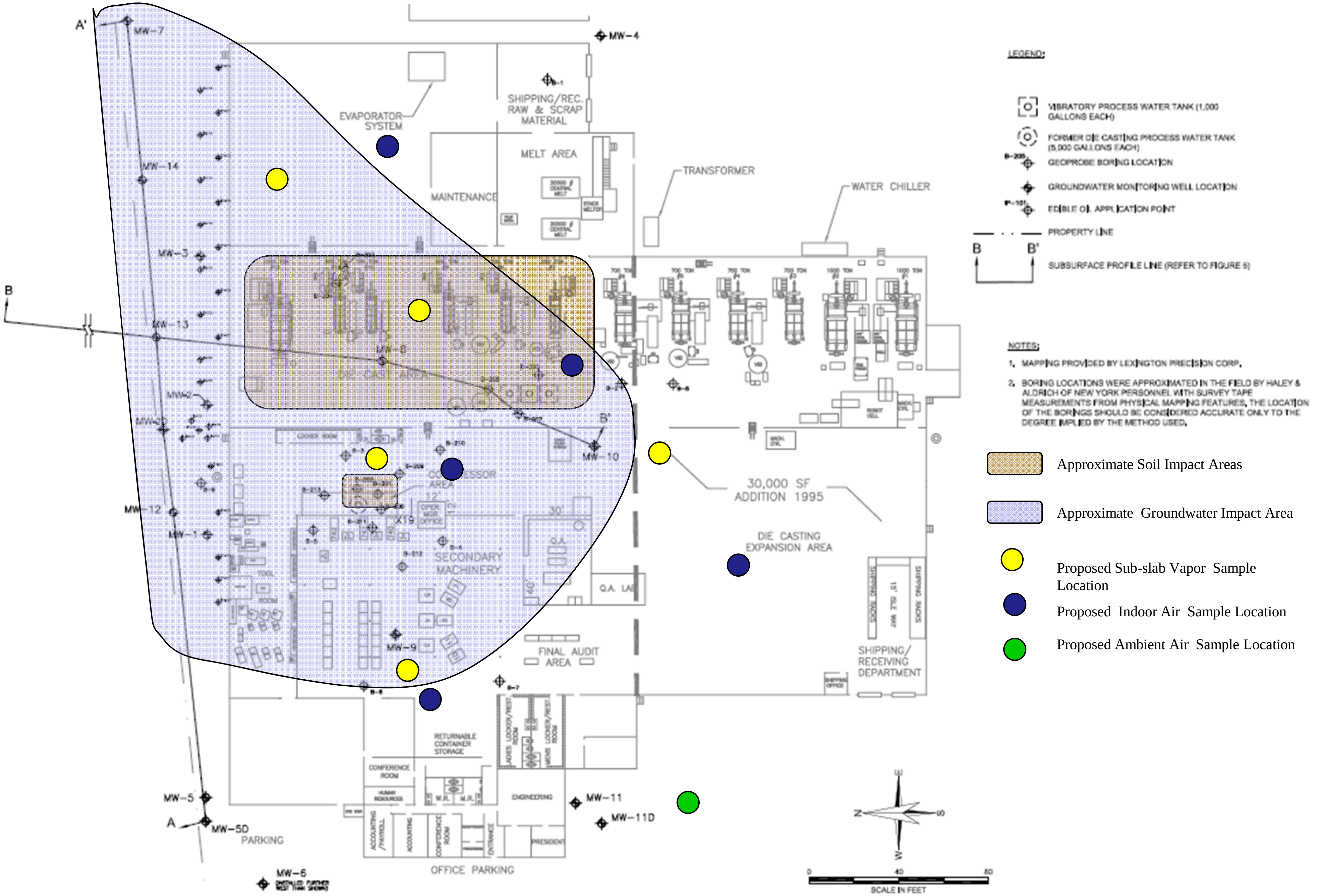
Title:

Site Location Map

Figure:

1

BUREAU VERITAS



Survey Source: Summary of Environmental Investigations and Remedial Activities, Haley & Aldrich of New York, January 9, 2007

Project Number: 12014-000048.00

Drawn By: JAS Date: 03-14-14

Reviewed By:WSM Date:03-17-14

Client:

Lexington Precision Corporation
800 third Avenue, 15th Floor
New York, New York 10022

Location:

Premier Lakewood, Inc.
201 Winchester Avenue
Lakewood, New York 14750

Title:

Proposed Vapor Intrusion Evaluation Sample Locations

Figure:

2

Appendix A

DRAFT GUIDANCE FOR EVALUATING SOIL VAPOR INTRUSION IN THE STATE OF NEW YORK, OCTOBER 2006

FINAL

Guidance for Evaluating Soil Vapor Intrusion in the State of New York

October 2006

Prepared by:

NEW YORK STATE DEPARTMENT OF HEALTH
Center for Environmental Health
Bureau of Environmental Exposure Investigation

Soil Vapor Intrusion Guidance Release History

October 2006 — Current version
February 2005 — Public comment draft

Contact Information

Comments and questions on the guidance may be sent to the following:

New York State Department of Health
Bureau of Environmental Exposure Investigation
Flanigan Square, Room 300
547 River Street
Troy, New York 12180-2216

Email: BEEI@health.state.ny.us
Telephone: 1-800-458-1158, extension 27850

New York State Departments of Health and Environmental Conservation — Web Sites on Soil Vapor Intrusion

This guidance, policy documents, training documents, fact sheets, etc. are available to the public on the following web sites:

New York State Department of Health
http://www.health.state.ny.us/environmental/indoors/vapor_intrusion

New York State Department of Environmental Conservation
http://www.dec.state.ny.us/website/der/guidance/vapor/index.html

As new information becomes available (e.g., revisions or amendments to the guidance, new fact sheets, etc.), these web sites will be updated accordingly.

Preface

This guidance has been prepared by the New York State Department of Health (NYSDOH) in consultation with the New York State Department of Environmental Conservation (NYSDEC) — collectively referred to as "the State" throughout this document. It is intended as general guidance for parties evaluating soil vapor intrusion in the State of New York. The guidance is not a regulation, rule or requirement.

The guidance describes the State's methodology for evaluating soil vapor intrusion at a site. It reflects our experience in conducting soil vapor intrusion investigations and presents a reasonable and practical approach to identifying and addressing current and potential human exposures to contaminated subsurface vapors associated with known or suspected volatile chemical contamination. The approach presented is analogous to the approach taken when investigating contamination in other environmental media (e.g., groundwater, soil, etc.) and addressing corresponding exposure concerns.

The guidance is organized into five sections:

> **Section 1** introduces the concept of soil vapor intrusion, associated human exposure issues, factors affecting soil vapor intrusion, factors affecting indoor air quality, and the general approach recommended to evaluating vapor intrusion;
>
> **Section 2** provides guidance on collecting appropriate and relevant data that can be used to identify current or potential human exposures;
>
> **Section 3** discusses how the investigation data are evaluated, recommends actions based on the evaluation, and presents tools that are used when determining appropriate actions to address exposures;
>
> **Section 4** provides an overview of soil vapor intrusion mitigation methods and basic recommendations pertaining to their selection for use, installation and design, post-mitigation testing, operation, maintenance and monitoring, termination of operation, and annual certification; and
>
> **Section 5** describes outreach techniques commonly used to inform the community about soil vapor intrusion issues.

The State recommends that the guidance be considered anywhere soil vapor intrusion is evaluated in the State of New York — whether the evaluation is undertaken voluntarily by a corporation, a municipality, or private citizen, or whether it is performed under one of the State's environmental remediation programs.

<u>PLEASE NOTE</u>:

- While soil vapor intrusion can also occur with "naturally-occurring" subsurface gases (e.g., radon, methane and hydrogen sulfide), the document discusses soil vapor intrusion in terms of environmental contamination only.
- The guidance document addresses soil vapor intrusion. However, vapor intrusion can also occur through direct volatilization of contaminants from groundwater into indoor air. This can occur when, for example, a basement slab is in contact with contaminated groundwater, contaminated groundwater enters (floods) a basement or crawl space, or contaminated groundwater enters a sump pit drainage system. In such cases, volatile

chemicals can be transferred directly from groundwater to indoor air without the intervening contamination of soil vapor. Although exposures of this nature are not discussed in this guidance, they should be addressed on a site-specific and building-specific basis.

- Throughout the guidance references are made to specific brands of field equipment. These references are for discussion purposes only and are intended to be illustrative. They should not be interpreted as endorsements by the State of any one company or their products.

ACRONYMNS and ABBREVIATIONS

ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substance and Disease Registry
BASE	Building Assessment and Survey Evaluation
BTSA	[NYSDOH] Bureau of Toxic Substance Assessment
CME	Continuing Medical Education
CSEMs	Case Studies in Environmental Medicine
DUSR	Data Usability Summary Report
ELAP	Environmental Laboratory Approval Program
EPA	United States Environmental Protection Agency
GC	Gas Chromatograph
HEI	Health Effects Institute
HVAC	Heating, Ventilating and Air-conditioning
mcg/m^3	micrograms per cubic meter
MeCl	Methylene Chloride
MEK	Methyl Ethyl Ketone; 2-Butanone
MTBE	Methyl-*tert*-Butyl Ether
NAPL	Non-Aqueous Phase Liquid
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OM&M	Operation, Maintenance and Monitoring
OSHA	Occupational Safety and Health Administration
OVM	Organic Vapor Monitor
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene or Perchloroethylene
PID	Photoionization Detector
QA/QC	Quality Assurance/Quality Control
RIOPA	Relationship of Indoor, Outdoor, and Personal Air
SF_6	Sulfur Hexafluoride
SSD	Sub-slab Depressurization System
SIM	Selective Ion Monitoring
SMD	Sub-Membrane Depressurization
SVE	Soil Vapor Extraction
SVOCs	Semi-volatile Organic Compounds
TAL	Target Analyte List
TCA	Trichloroethane
TCDD	Tetrachlorodibenzo-*p*-Dioxin Equivalents
TCE	Trichloroethene
TCL	Target Compound List
VOCs	Volatile Organic Compounds

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Section 1: Introduction

This section introduces the concept of soil vapor intrusion, associated human exposure issues, factors affecting soil vapor intrusion, factors affecting indoor air quality, and the general approach to evaluating vapor intrusion.

1.1 Soil vapor intrusion

The phrase "soil vapor intrusion" refers to the process by which volatile chemicals migrate from a subsurface source into the indoor air of buildings. Soil vapor, also referred to as soil gas, is the air found in the pore spaces between soil particles (Figure 1.1). Primarily because of a difference between interior and exterior pressures, soil vapor can enter a building through cracks or perforations in slabs or basement floors and walls, and through openings around sump pumps or where pipes and electrical wires go through the foundation. For example, heating, ventilation or air-conditioning (HVAC) systems and/or the operation of large mechanical appliances (e.g., exhaust fans, dryers, etc.) may create a negative pressure that can draw soil vapor into the building. This intrusion is similar to how radon gas enters buildings from the subsurface.

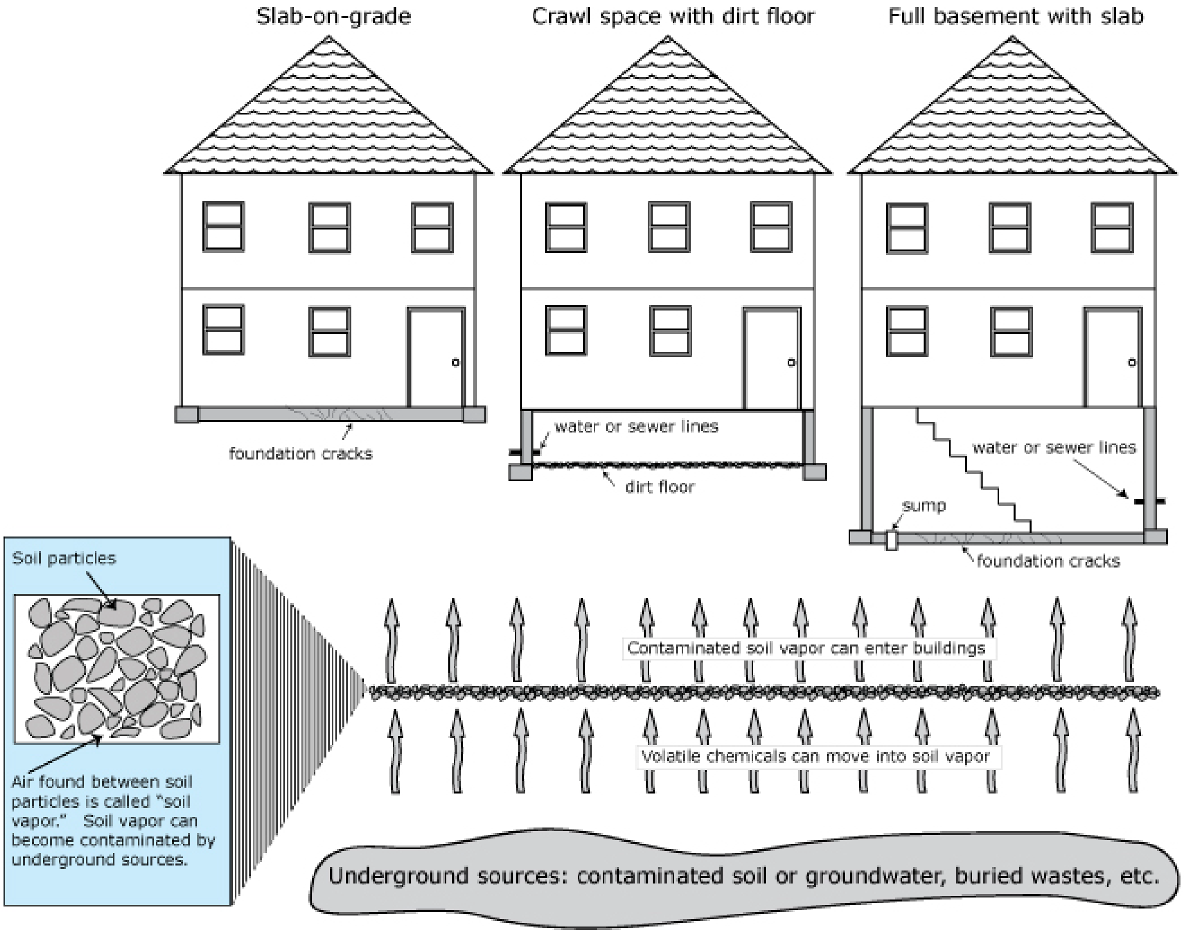


Figure 1.1
Generalized diagram of soil vapor intrusion

Soil vapor can become contaminated when chemicals evaporate from subsurface sources. Chemicals that can emit vapors are called "volatile chemicals." Volatile chemicals include volatile organic compounds (VOCs), some semi-volatile organic compounds (SVOCs), and some inorganic substances such as elemental mercury. Subsurface sources of volatile chemicals can include the following:

a. groundwater or soil that contains volatile chemicals;
b. non-aqueous phase liquid (NAPL);
c. buried wastes; and
d. underground storage tanks or drums.

If soil vapor is contaminated and enters a building, indoor air quality may be affected.

When contaminated vapors are present in the zone directly next to or under the foundation of a building, vapor intrusion is possible. Soil vapor can enter a building whether the building is old or new, or whether it is on a slab or has a crawl space or basement (Figure 1.1). However, the subsurface source of the contaminated vapor (e.g., contaminated soil or groundwater) does not need to be directly beneath a structure to contaminate the vapor immediately beneath the building's foundation (as suggested in Figure 1.1).

1.2 Soil vapor intrusion and human exposure

Humans can be exposed to contaminated soil vapor when the vapor is drawn into the building due to pressure differences [Section 1.1] and mixed with the indoor air. Inhalation is the primary route of exposure, or the manner in which the volatile chemicals, once in the indoor air, actually enter the body.

Both current and potential exposures are considered when evaluating soil vapor intrusion at sites (i.e., locations of suspected or known environmental contamination). *Current* exposures exist when vapor intrusion is documented in an occupied building. *Potential* exposures exist when volatile chemicals are present in the vapor phase beneath a building, but have not affected indoor air quality due to current site conditions. Potential exposures also exist when there is a chance that contaminated soil vapors may move beneath existing buildings not currently affected, when indoor air is affected but the building is currently unoccupied, or when there is a chance that new buildings can be built over existing subsurface vapor contamination.

Exposure to a volatile chemical due to vapor intrusion does not necessarily mean that health effects will occur. Whether or not a person experiences health effects depends on several factors, including the length of exposure (short-term or acute versus long-term or chronic), the amount of exposure (i.e., dose), the frequency of exposure, the toxicity of the volatile chemical and the individual's sensitivity to the chemical.

1.3 Factors affecting soil vapor migration and intrusion

Predicting the extent of soil vapor contamination from soil or groundwater contamination, as well as the potential for human exposure from soil vapor intrusion into buildings, is complicated by factors that can affect soil vapor migration and intrusion. For example, soil vapor contaminant plumes may not mimic groundwater contaminant plumes since different factors affect the migration pattern of each medium. In addition to the operation of HVAC systems, the operation of kitchen vents in restaurants or of elevators in office buildings may induce pressure gradients that result in the migration of vapor-phase contaminants away from a groundwater source of vapors and toward these buildings. This is similar to when the pumping of production wells or water supply wells draws contaminated groundwater away from its natural flow path.

Factors that can affect soil vapor migration and intrusion generally fall into two categories: environmental and building factors. Examples of environmental factors are provided in Table 1.1, and examples of building factors in Table 1.2. These factors are considered when conducting an investigation of the soil vapor intrusion pathway [Section 2] and when evaluating the results [Section 3].

Table 1.1 Environmental factors that may affect soil vapor intrusion

Environmental Factor	**Description**
Soil conditions	Generally, dry, coarse-grained soils facilitate the migration of subsurface vapors and wet, fine-grained or highly organic soils retard migration.
Volatile chemical concentrations	The potential for vapor intrusion generally increases with increasing concentrations of volatile chemicals in groundwater or subsurface soils, as well as with the presence of NAPL.
Source location	The potential for vapor intrusion generally decreases with increasing distance between the subsurface source of vapor contamination and overlying buildings. For example, the potential for vapor intrusion associated with contaminated groundwater decreases with increasing depth to groundwater.
Groundwater conditions	Volatile chemicals dissolved in groundwater may off-gas to the vadose zone from the surface of the water table. If contaminated groundwater is overlain by clean water (upper versus lower aquifer systems or significant downward groundwater gradients), then vapor phase migration or partitioning of the volatile chemicals is unlikely. Additionally, fluctuations in the groundwater table may results in contaminant smear zones. The "smear zone" is the area of subsurface soil contamination within the range of depths where the water table fluctuates. Chemicals floating on top of the water table, such as petroleum components, can sorb onto soils within this zone as the water table fluctuates. Sorption of chemicals can influence their gaseous and aqueous phase diffusion in the subsurface, and ultimately the rate at which they migrate.
Surface confining layer	A surface confining layer (e.g., frost layer, pavement or buildings) may temporarily or permanently retard the migration of subsurface vapors to outdoor air. Confining layers can also prevent rainfall from reaching subsurface soils, creating relatively dry soils that further increase the potential for soil vapor migration.
Fractures in bedrock and/or tight clay soils	Fractures in bedrock and desiccation fractures in clay can increase the potential for vapor intrusion beyond that expected for the bulk, unfractured bedrock or clay matrix by facilitating vapor migration (in horizontal and vertical directions) and movement of contaminated groundwater along spaces between fractures.
Underground conduits	Underground conduits (e.g., sewer and utility lines, drains or tree roots, septic systems) with highly permeable bedding materials relative to native materials can serve as preferential pathways for vapor migration due to relatively low resistance to flow.
Weather conditions	Wind and barometric pressure changes and thermal differences between air and surrounding soils may induce pressure gradients that affect soil vapor intrusion.
Biodegradation processes	Depending upon environmental conditions (e.g., soil moisture, oxygen levels, pH, mineral nutrients, organic compounds, and temperature), the presence of appropriate microbial populations, and the degradability of the volatile chemical of concern, biodegradation in the subsurface may reduce the potential for vapor intrusion. For example, readily biodegradable chemicals in soil vapor may not migrate a significant distance from a source area while less degradable chemicals may travel farther.

Table 1.2 Building factors that may affect vapor intrusion

Building Factor	**Description**
Operation of HVAC systems, fireplaces, and mechanical equipment (e.g., clothes dryers or exhaust fans/vents)	Operation may create a pressure differential between the building or indoor air and the surrounding soil that induces or retards the migration of vapor-phase contaminants toward and into the building. Vapor intrusion can be enhanced as the air vented outside is replaced.
Heated building	When buildings are closed up and heated, a difference in temperature between the inside and outdoor air induces a stack effect, venting warm air from higher floors to the outside. Vapor intrusion can be enhanced as the air is replaced in the lower parts of the building.
Air exchange rates	The rate at which outdoor air replenishes indoor air may affect vapor migration into a building as well the indoor air quality. For example, newer construction is typically designed to limit the exchange of air with the outside environment. This may result in the accumulation of vapors within a building.
Foundation type	Earthen floors and fieldstone walls may serve as preferential pathways for vapor intrusion.
Foundation integrity	Expansion joints or cold joints, wall cracks, or block wall cavities may serve as preferential pathways for vapor intrusion.
Subsurface features that penetrate the building's foundation	Foundation perforations for subsurface features (e.g., electrical, gas, sewer or water utility pipes, sumps, and drains) may serve as a preferential pathway for vapor intrusion.

1.4 Factors affecting indoor air quality

Chemicals are a part of our everyday life. They are found in the household products we use and in items we bring into our homes. As such, chemicals are found in indoor air of homes not affected by intrusion of contaminated soil vapor. Examples of alternate sources of volatile chemicals in indoor air are given in Table 1.3. Similarly, volatile chemicals can be in the outdoor air that enters a home or place of business. Certain commercial and industrial facilities, such as gasoline stations and dry cleaners, and vehicle exhaust are examples of possible sources of volatile chemicals in outdoor air.

Commonly found concentrations of these chemicals in indoor and outdoor air are referred to as "background levels." These levels are generally determined from the results of samples collected in homes, offices and outdoor areas not known to be affected by external sources of volatile chemicals (for example, a home not known to be near a chemical spill, a hazardous waste site, a dry-cleaner, or a factory). Background sources of volatile chemicals are considered when conducting an investigation of the soil vapor intrusion pathway [Section 2] and when evaluating the results [Section 3].

Table 1.3 Alternate sources of volatile chemicals in indoor air

Source	**Description**
Outdoor air	Outdoor sources of pollution can affect indoor air quality due to the exchange of outdoor and indoor air in buildings through natural ventilation, mechanical ventilation or infiltration. Outdoor sources of volatile compounds include automobiles, lawn mowers, oil storage tanks, dry cleaners, gasoline stations, industrial facilities, etc.
Attached or underground garages	Volatile chemicals from sources stored in the garage (e.g., automobiles, lawn mowers, oil storage tanks, gasoline containers, etc.) can affect indoor air quality due to the exchange of air between the garage and indoor space.
Off-gassing	Volatile chemicals may off-gas from building materials (e.g., adhesives or caulk), furnishings (e.g., new carpets or furniture), recently dry-cleaned clothing, or areas (such as floors or walls) contaminated by historical use of volatile chemicals in a building. Volatile chemicals may also off-gas from contaminated groundwater that infiltrates into the basement (e.g., at a sump) or during the use of contaminated domestic well water (e.g., at a tap or in a shower).
Household products	Household products include, but are not limited to, cleaners, mothballs, cigarette smoke, paints, paint strippers and thinners, air fresheners, lubricants, glues, solvents, pesticides, fuel oil storage, and gasoline storage.
Occupant activities	For example, in non-residential settings, the use of volatile chemicals in industrial or commercial processes or in products used for building maintenance. In residential settings, the use of products containing volatile chemicals for hobbies (e.g., glues, paints, etc.) or home businesses. People working at industrial or commercial facilities where volatile chemicals are used may bring the chemicals into their home on their clothing.
Indoor emissions	These include, but are not limited to, combustion products from gas, oil and wood heating systems that are vented outside improperly, as well as emissions from industrial process equipment and operations.

1.5 General approach to evaluating soil vapor intrusion

Since no two sites are exactly alike, the approach to evaluating soil vapor intrusion is dependent upon site-specific conditions. A thorough understanding of the site, including its history of use, characteristics (e.g., geology, geography, identified environmental contamination, etc.) and potentially exposed populations, is used to develop an investigation plan. Existing information is reviewed to determine what data are available and what additional data should be collected (i.e., to guide the investigation). In addition, factors affecting soil vapor migration and intrusion [Section 1.3] and indoor air quality [Section 1.4] are also considered when both conducting an investigation [Section 2] and evaluating the results [Section 3].

This data gathering and review process should be repeated until each of the following questions can be answered:

[1] Are subsurface vapors contaminated (i.e., soil vapor as defined in Section 1.1, including vapors located immediately beneath the foundation or slab of a building)? If so, what are the nature and extent of contamination? What is/are the source(s) of the contamination?

[2] What are the current and potential exposures to contaminated subsurface vapors via soil vapor intrusion?

[3] What actions, if any, should be taken to prevent or mitigate exposures related to soil vapor intrusion and to remediate subsurface vapor contamination?

When determining what actions, if any, are appropriate to mitigate current or prevent future human exposures, all information known about a site is considered (i.e., a "whole picture" approach is taken) because each site presents its own unique set of circumstances. This information includes, but is not limited to, the following: nature and extent of contamination in all environmental media, factors affecting vapor migration and intrusion, current and future site uses, off-site land uses, presence of alternate sources of volatile chemicals, and completed or proposed remedial actions.

Actions taken to minimize or prevent exposures typically do not preclude the site from being used for a desired purpose or from being developed. If appropriate, mitigation systems can be installed at existing buildings or installed during the construction of new buildings. In many cases, installation of mitigation systems on new buildings may be a prudent, proactive action. The costs associated with installing a system at the time of a building's construction are often considerably less than the costs associated with retrofitting a system to the building after construction is completed. Furthermore, in many parts of New York State, the mitigation system would also address concerns about human exposures to radon. To learn more about radon in New York State, please refer to the Radon: Frequently Asked Questions Fact Sheet in Appendix H or visit the NYSDOH's web site at http://www.health.state.ny.us/nysdoh/radon/radonhom.htm or contact the NYSDOH's Radon Program at 1-800-458-1158.

1.6 Conceptual site model

In accordance with the NYSDEC's *Draft DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC 2002), subsurface vapors and soil vapor intrusion should be included in an overall conceptual model for the site. As described in the NYSDEC's technical guidance, a conceptual site model should be used to develop a general understanding of the site to evaluate potential risks to public health and the environment and to assist in identifying and setting priorities for the activities to be conducted at the site. The conceptual site model also identifies potential sources of contamination, types of contaminants and affected media, release mechanisms and potential contaminant pathways, and actual/potential human and environmental receptors.

The components of a conceptual site model specific to soil vapor intrusion are provided throughout Section 1 of the guidance. The general approach for evaluating soil vapor intrusion described in Section 1.5 is analogous to the development of a conceptual site model specific to soil vapor intrusion. For additional information about the use of conceptual site models in the investigation and remediation of sites or a description of the conceptual site model process, the reader is referred to the NYSDEC's technical guidance.

1.7 Applicability of guidance

This guidance should be considered anywhere soil vapor intrusion is evaluated in the State of New York, whether the evaluation is being undertaken voluntarily by a corporation, a municipality, or private citizen, or under one of the state's environmental remediation programs.

1.7.1 Residential and non-residential settings

The guidance should be followed in residential and non-residential settings where people may be exposed involuntarily to chemicals from soil vapor intrusion.

1.7.2 Chlorinated and non-chlorinated volatile chemical sites

The guidance should be used when evaluating soil vapor intrusion at chlorinated and non-chlorinated volatile chemical sites, including petroleum hydrocarbon sites and manufactured gas plant sites. While the likelihood for exposures related to soil vapor intrusion may differ between sites due to site-specific conditions and chemical-specific properties, the extent of volatile chemical contamination and the nature of the contamination, these factors should be considered when developing the conceptual site model and implementing an investigation plan (as discussed in Sections 1.5 and 1.6). For example, if the conceptual site model suggests that soil vapor intrusion is not a concern at a petroleum hydrocarbon site due to biodegradation, the work plan might include the measurement of select bioparameters (e.g., oxygen, carbon dioxide, methane, etc.), along with the petroleum hydrocarbons, at varying depths to demonstrate bioattenuation in the vadose. The work plan might include sub-slab vapor sampling as well to demonstrate that conditions beneath nearby buildings are also resulting in bioattenuation of the petroleum hydrocarbons.

1.7.3 Current, new and past remedial sites

As discussed in the NYSDEC's Program Policy *DER-13: Strategy for Prioritizing Vapor Intrusion Evaluations at Remedial Sites in New York* (NYSDEC 2006), the soil vapor intrusion pathway will be evaluated at all completed, current and future remedial sites New York State. This soil vapor intrusion guidance document complements the NYSDEC's policy by providing recommendations on how to evaluate soil vapor intrusion. The combined goal of the policy and guidance documents is to conduct soil vapor intrusion evaluations as efficiently and effectively as possible at all remedial sites in New York.

1.8 Updates to the guidance

The investigation, evaluation, mitigation and remediation of soil vapor are evolving disciplines and this guidance document will be updated periodically, as appropriate. The history of the document's release is provided on the inside of the cover page. In addition, changes to the document are noted in Appendix A. The current version of the document supercedes previous versions. The current version of the guidance is available on the NYSDOH's web site (*http://www.health.state.ny.us/environmental/indoors/vapor_intrusion/*) or by contacting the NYSDOH's Bureau of Environmental Exposure Investigation [see Contact Information on the inside of the cover page]. Revisions or amendments to the guidance will be posted on the NYSDOH's web site.

Section 2: Investigation of the Soil Vapor Intrusion Pathway

Soil vapor is an environmental medium, like groundwater and soil, that should be characterized during the investigation of a site. This section provides guidance on collecting appropriate and relevant data that can be used to identify current or potential human exposures to contaminated subsurface vapors associated with a site. As discussed in Section 1.5, no two sites are exactly alike. Site-specific and/or building-specific conditions may warrant modifying the recommendations herein. Therefore, guidance provided in this section is presented in terms of general steps and strategies that should be applied when approaching an investigation of soil vapor intrusion.

2.1 Sites at which an investigation is appropriate

Data collected to date do not support the use of pre-determined concentrations of volatile chemicals (i.e., screening criteria) in either groundwater or soil to trigger a soil vapor intrusion investigation. Therefore, although the level of investigation may vary, the pathway should be investigated at any site with the following:

a. an existing subsurface source (e.g., on the basis of preliminary environmental sampling) or likely subsurface source (e.g., on the basis of known previous land uses) of volatile chemicals [Section 1.1]; and

b. existing buildings or the possibility that buildings may be constructed near a subsurface source of volatile chemicals.

2.2 Types of samples

The following are types of samples that are collected to investigate the soil vapor intrusion pathway:

a. subsurface vapor samples:

   1. *soil vapor* samples (i.e., soil vapor samples not beneath the foundation or slab of a building) and
   2. *sub-slab vapor* samples (i.e., soil vapor samples immediately beneath the foundation or slab of a building);

b. crawl space air samples;

c. indoor air samples; and

d. outdoor air samples.

The types of samples that should be collected depend upon the specific objective(s) of the sampling, as described below.

2.2.1 Soil vapor

Soil vapor samples are collected to determine whether this environmental medium is contaminated, characterize the nature and extent of contamination, and identify possible sources of the contamination. Our experience to date indicates soil vapor results alone typically cannot be relied upon to rule out sampling at nearby buildings. For example, concentrations of volatile chemicals in sub-slab vapor samples have been substantially higher (e.g., by a factor of 100 or more) than concentrations found in nearby soil vapor samples (e.g., collected at 8 feet below grade near the building). This may be due to differences in factors such as soil moisture content and pressure gradients. Therefore, exposures are evaluated primarily based on sub-slab vapor, indoor air and outdoor air sampling results and soil vapor results are primarily used as a tool to guide these investigations.

Soil vapor sampling results are also used when evaluating the effectiveness of direct or indirect measures to remediate contaminated subsurface vapors. (Soil vapor extraction is an example of a direct remedial measure, and groundwater pumping and treating an indirect measure.)

2.2.2 Sub-slab vapor

Sub-slab vapor samples are collected to characterize the nature and extent of soil vapor contamination immediately beneath a building with a basement foundation and/or a slab-on-grade. Sub-slab vapor sampling results are used in conjunction with indoor air and outdoor air sampling results when evaluating the following:

a. *current* human exposures;
b. the potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes); and
c. site-specific attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations).

Sub-slab vapor samples are often collected after soil vapor characterization and/or other environmental sampling (e.g., soil and groundwater characterization) indicate they are warranted. Sub-slab samples are typically collected concurrently with indoor and outdoor air samples. However, outside of the heating season, sub-slab vapor samples may be collected independently depending on the sampling objective (e.g., to characterize the extent of subsurface vapor contamination outside of the heating season to develop a more comprehensive, focused investigation plan for the heating season).

2.2.3 Crawl space air

Similar to sub-slab vapor samples, crawl space air samples are collected to characterize the nature and extent of contamination immediately beneath a building with a crawl space foundation. Crawl space air sampling results are used in conjunction with indoor air and outdoor air sampling results when evaluating the following:

a. *current* human exposures; and
b. the potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes).

2.2.4 Indoor air

Indoor air samples are collected to characterize exposures to air within a building, including those with earthen floors. Indoor air sampling results are used when evaluating the following:

a. *current* human exposures;
b. the potential for *future* exposures (e.g., if a currently vacant building should become occupied); and
c. site-specific attenuation factors (e.g., the ratio of indoor air to sub-slab vapor concentrations).

Indoor air samples are often collected after subsurface vapor characterization and other environmental sampling (e.g., soil and groundwater characterization) indicate they are warranted. When indoor air samples are collected, concurrent sub-slab vapor, crawl space air (if applicable) and outdoor air samples are collected to evaluate the indoor air results appropriately. However, indoor air and outdoor air samples, without sub-slab vapor samples, may be collected when confirming the effectiveness of a mitigation system [Section 4].

In addition, site-specific situations may warrant collecting indoor air samples prior to characterizing subsurface vapors and/or without concurrent sub-slab vapor sampling to examine immediate inhalation hazards. Examples of such situations may include, but are not limited to, the following:

a. in response to a spill event to qualitatively and/or quantitatively characterize the contamination;
b. if high readings are obtained in a building when screening with field equipment (e.g., a photoionization detector (PID), an organic vapor analyzer, or an explosimeter) and the source is unknown;
c. if significant odors are present and the source needs to be characterized; or
d. if groundwater beneath the building is contaminated, the building is prone to groundwater intrusion or flooding (e.g., sump pit overflows), and subsurface vapor sampling is not feasible. In these situations, the collection of water samples from the sump may also be appropriate.

2.2.5 Outdoor air

Outdoor air samples are collected to characterize site-specific background outdoor air conditions. Outdoor air samples should be collected simultaneously with indoor air samples to evaluate the potential influence, if any, of outdoor air on the indoor air sampled. Outdoor air samples may also be collected concurrently with soil vapor samples to identify potential outdoor air interferences associated with infiltration of outdoor air into the sampling apparatus while the soil vapor was collected.

2.3 Phase of a site investigation in which to sample

There is no single phase (e.g., preliminary site characterization or remedial investigation) of a site investigation during which sampling to evaluate the soil vapor intrusion pathway is appropriate. Initiation of investigation activities for this specific purpose should be determined on a site-by-site basis. However, if exposures due to soil vapor intrusion appear likely at any point during the investigation, evaluation of this exposure pathway should not be delayed.

If the locations of likely source areas are reasonably known, sampling earlier during the investigation of a site rather than later is recommended because of the iterative nature of the sampling process [Section 2.5]. However, if current site conditions are not well-defined, then sampling after contamination in other environmental media (e.g., groundwater and soil) has been characterized may be considered. In the latter scenario, groundwater, soil and other site information may be used to guide an investigation of the soil vapor intrusion pathway, such as selecting locations for subsurface vapor samples based on likely migration pathways and source areas [Sections 2.6.1 and 2.6.2]. At a minimum, depth to groundwater and soil stratigraphy should be identified prior to collecting soil vapor samples.

Sampling may be delayed at parcels that are undeveloped or contain unoccupied buildings provided

a. characterization of the parcel is not needed to
    1. address exposures in the surrounding area;
    2. design remedial measures for subsurface vapor contamination; or
    3. monitor or confirm the effectiveness of remedial measures; and

b. measures are in place that assure that the parcel will not be developed, or buildings occupied, without addressing exposure concerns [Section 3.6].

If exposures due to soil vapor intrusion appear likely, and a delay of sampling is contemplated, the State (i.e., the NYSDEC and NYSDOH) should be informed of the contemplated delay and the rationale for the delay. Furthermore, the party contemplating the delay should consider any comments the State may have on the information provided.

2.4 Time of year in which to sample

2.4.1 Soil vapor

Soil vapor samples are collected at any time during the year. Often, sampling is completed during the summer so the results can be used as a tool when selecting buildings to be sampled during the heating season.

2.4.2 Buildings

Sub-slab vapor samples and, unless immediate sampling is appropriate, indoor air samples are typically collected during the heating season because soil vapor intrusion is more likely to occur when a building's heating system is in operation and doors and windows are closed. In New York State, heating systems are generally expected to be operating routinely from November 15th to March 31st. However, these dates are not absolute; the timeframe for sampling may vary depending on factors such as the location of the site (e.g., upstate versus downstate) and the weather conditions for a particular year.

A soil vapor intrusion investigation at a building may be conducted outside of the heating season if the concern for vapor intrusion is greater during another time of year. This may occur at certain industrial buildings, for instance, where HVAC systems are actively managed to control the ratio of recirculated indoor air to make-up air from outside the building. Information about the site and potentially affected structures, including the factors discussed in Section 1.3, should be considered in determining the timing of an investigation.

Samples may be collected at any time of year if exposures due to soil vapor intrusion appear likely. However, samples collected at times when soil vapor intrusion is not expected to have its greatest effect on indoor air quality (typically, samples collected outside of the heating season) should not be used to rule out exposures. For example, results indicating "no further action" or "monitoring required" should be verified when soil vapor intrusion is believed to be most likely to ensure these actions are protective throughout the year.

2.5 Number of sampling rounds

Investigating the soil vapor intrusion pathway usually involves more than one round of subsurface vapor, indoor air and/or outdoor air sampling, for reasons such as the following:

a. to characterize the nature and extent of subsurface vapor contamination (similar to the delineation of groundwater contamination) and to address corresponding exposure concerns;

b. to evaluate fluctuations in concentrations due to

    1. different weather conditions (e.g., seasonal effects),
    2. changes in building conditions (e.g., various operating conditions of a building's HVAC system),
    3. changes in source strength, or
    4. vapor migration or contaminant biodegradation processes (particularly when degradation products may be more toxic than the parent compounds); or

c. to confirm sampling results or the effectiveness of mitigation or remedial systems.

Overall, as discussed in Section 1.5, successive rounds of sampling should be conducted until the following questions can be answered:

a. Are subsurface vapors contaminated? If so, what are the nature and extent of contamination? What is/are the source(s) of the contamination?

b. What are the current and potential exposures to contaminated subsurface vapors?

c. What actions, if any, are appropriate to prevent or mitigate exposures and to remediate subsurface vapor contamination?

Toward this end, multiple rounds of sampling may be appropriate to characterize the nature and extent of subsurface vapor contamination such that

a. both potential and current exposures are addressed [Section 2.6];

b. measures can be designed to remediate subsurface vapor contamination, either directly (e.g., SVE system) or indirectly (e.g., soil excavation or groundwater remediation), given that monitoring and mitigation are considered temporary measures implemented to address exposures related to vapor intrusion until contaminated environmental media are remediated [Section 3.4]; and

c. the effectiveness of remedial measures can be monitored and confirmed (e.g., endpoint sampling) [Section 4.5].

2.6 Sampling locations

The general approach for selecting sampling locations as part of a soil vapor intrusion investigation is similar to the approach for the investigation of other environmental media (e.g., soil and groundwater). Sampling locations should be selected with consideration of the conceptual site model [Section 1.6]. These locations should be selected to meet the stated objectives of the sampling program. Additionally, similar to the investigation of soil and groundwater, it is typical to start at a known or suspected source and work outward. The specific approach, however, will be dependent upon site-specific and building-specific conditions.

2.6.1 Soil vapor

If available, existing environmental data (e.g., groundwater and soil data) and site background information should be used to select locations for sampling soil vapor as part of a vapor intrusion investigation. Locations will vary depending upon surface features (e.g., presence or absence of buildings, areas of pavement, or vacant lot) and subsurface characteristics (e.g., soil stratigraphy, buried structures, utility corridors, or clay lenses), as well as the specific purpose of the sampling. Therefore, a figure illustrating proposed sampling locations (with respect to both areal position and depth), actual locations sampled in the field, and relevant on-site and off-site features should be included in all sampling work plans and reports.

Examples of how locations may vary given the specific purpose of the sampling follow. They include general guidelines that should be followed when selecting soil vapor sampling locations:

a. to evaluate the **potential for current on-site or off-site exposures**, samples should be collected
   1. in the vicinity of a building's foundation [see special sampling consideration at the end of Section 2.6.1 if sampling around a building with no surrounding surface confining layer], as well as between the building's foundation and the source (if known and not located beneath the building),
   2. along the site's perimeter, and
   3. at a depth comparable to the depth of foundation footings (determined on a building-specific or site-specific basis) or at least 1 foot above the water table in areas where the groundwater table is less than 6 feet below grade;

b. to evaluate the **potential for future exposures if development** on a known or suspected contaminated area on-site or off-site is possible, representative samples should be collected
   1. in areas with either known or suspected subsurface sources of volatile chemicals, in areas where elevated readings were obtained with field equipment during previous environmental investigations, and in areas of varying concentrations of contamination in the upper groundwater,
   2. in a grid pattern across the area (at an appropriate spacing interval for the size of the area) if information is limited for the area, and
   3. at multiple depths from the suspected subsurface source, or former source, to a depth comparable to the expected depth of foundation footings;

c. to evaluate the **potential for off-site soil vapor contamination**, samples should be collected
    1. along the site's perimeter,
    2. in areas of potential subsurface sources of vapor contamination (e.g., a groundwater plume that has migrated off-site), and
    3. at a depth comparable to the depth of foundation footings (determined on a site-specific basis) or at least 1 foot above the water table in areas where the groundwater table is less than 6 feet below grade;

d. to evaluate on-site and off-site **preferential migration pathways** in areas with low permeability soils, samples should be collected
    1. along preferential soil vapor flow paths, such as sewer lines, utility corridors, trenches, pipelines, and other subsurface structures that are likely to be bedded with higher permeability materials, and
    2. at depths corresponding to these subsurface features (will depend on site-specific conditions);

e. to characterize on-site or off-site **contamination in the vadose zone**, samples should be collected
    1. in areas with either known or suspected sources of volatile chemicals, in areas where elevated readings were obtained with field equipment (e.g., PID) during previous soil and groundwater investigations, and in areas of varying concentrations of contamination in the upper groundwater regime, and
    2. at appropriate depths associated with these areas (will depend on site-specific conditions); and

f. to investigate the **influence of contaminated groundwater or soil on soil vapor** and to characterize the **vertical profile** of contamination, samples should be collected from clusters of soil vapor probes at varying depths in the vadose zone [Figure 2.2, Section 2.7.1] and preferably in conjunction with the collection of groundwater or soil samples.

Soil vapor samples collected at depths shallower than 5 feet below grade may be prone to negative bias due to infiltration of outdoor air. Therefore, samples from these depths should be collected only if appropriate (based on site-specific conditions), and sampling procedures and results should be reviewed accordingly. The depth of sampling near buildings with slab-on-grade foundations is dependent upon site-specific conditions (e.g., building surrounded by grassy or surface confining layer).

When collecting soil vapor samples around a building with no surrounding surface confining layer (e.g., pavement or sidewalk), samples should be located in native or undisturbed soils away from fill material surrounding the building (approximately 10 feet away from the building) to avoid sampling in an area that may be influenced by the building's operations. For example, operation of HVAC systems, fireplaces, or mechanical equipment (e.g., clothes dryers or exhaust fans/vents) in a building may exacerbate the infiltration of outdoor air into the vadose zone adjacent to the building. As a result, soil vapor samples collected in uncovered areas adjacent to the building may not be representative.

Investigations of soil vapor contamination should proceed outward from known or suspected subsurface sources, as appropriate, on an areal basis until the nature and extent of subsurface vapor contamination has been characterized and human exposures have been addressed.

2.6.2 Sub-slab vapor

Existing environmental data (e.g., soil vapor, groundwater and soil data), site background information, and building construction details (e.g., basement, slab-on-grade, or multiple types of foundations, HVAC systems, etc.) should be considered when selecting buildings and locations within buildings for sub-slab vapor sampling.

At a minimum, these general guidelines should be followed when selecting buildings to sample for sub-slab vapors:

a. buildings, including residential dwellings, located above or directly adjacent to known or suspected areas of subsurface volatile chemical contamination should be sampled;

b. buildings in which screening with field equipment (e.g., PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) suggests a completed migration pathway, such as when readings are above background and from unidentified sources or when readings show increasing gradients, should be sampled; and

c. buildings within known or suspected areas of subsurface volatile chemical contamination that are used or occupied by sensitive population groups (e.g., daycare facilities, schools, nursing homes, etc.) should be given special consideration for sampling.

Investigations of sub-slab vapor and/or indoor air contamination should proceed outward from known or suspected sources, as appropriate, on an areal basis until the nature and extent of subsurface vapor contamination has been characterized and potential and current human exposures have been addressed. In cases of widespread vapor contamination and depending upon the basis for making decisions (e.g., a "blanket mitigation" approach within a specified area of documented vapor contamination [Section 3.3.1]), a representative number of buildings from an identified study area, rather than each building, may be sampled. Prior to implementation, this type of sampling approach should be approved by State agency personnel.

Within a building, sub-slab vapor samples should be collected

a. in at least one central location away from foundation footings, and

b. from the soil or aggregate immediately below the basement slab or slab-on-grade.

The number of sub-slab vapor samples that should be collected in a building depends upon the number of slabs (e.g., multiple slabs-on-grade in a large warehouse) and foundation types (e.g., combined basement and slab-on-grade in a residence). At least one sub-slab vapor sample should be collected from each representative area.

2.6.3 Indoor air

Existing environmental data (e.g., soil vapor, groundwater and soil data), site background information, and building construction details (e.g., basement, slab-on-grade, or multiple types of foundations; number and operation of HVAC systems; elevator shafts; tunnels or other confined-space entry points; etc.) should be considered when selecting buildings and locations within buildings for indoor air sampling. Indoor air samples are typically collected concurrently with sub-slab vapor and outdoor air samples [Section 2.2.4].

At a minimum, these general guidelines should be followed when selecting buildings to sample for indoor air:

a. where sub-slab vapor samples were collected without indoor air samples, buildings in which elevated concentrations of contaminants were measured in sub-slab vapor samples should be sampled;

b. buildings, including residential dwellings, located above or directly adjacent to known or suspected subsurface sources of volatile chemicals or known soil vapor contamination should be sampled;

c. buildings in which screening with field equipment (e.g., PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) suggests a completed migration pathway, such as when readings are above background and from unidentified sources or when readings show increasing gradients, should be sampled; and

d. buildings within known or suspected areas of subsurface volatile chemical contamination that are used or occupied by sensitive population groups (e.g., daycare facilities, schools, nursing homes, etc.) should be given special consideration for sampling.

To characterize contaminant concentration trends and potential exposures, indoor air samples should be collected

a. from the crawl space area,

b. from the basement (where vapor infiltration is suspected, such as near sump pumps or indoor wells, or in a central location) at a height approximately three feet above the floor to represent a height at which occupants normally are seated and/or sleep,

c. from the lowest level living space (in centrally-located, high activity use areas) at a height approximately three feet above the floor to represent a height at which occupants normally are seated and/or sleep, and

d. if in a commercial setting (e.g., a strip mall), from multiple tenant spaces at a height approximately three feet above the floor to represent a height at which occupants normally are seated.

These locations are illustrated in Figure 2.1.

Investigations of indoor air contamination should proceed outward from known or suspected subsurface sources, as appropriate, on an areal basis until potential and current human exposures associated with soil vapor intrusion have been addressed. In cases of widespread vapor contamination and depending upon the basis for making decisions (e.g., a "blanket mitigation" approach within a specified area of documented vapor contamination), a representative number of buildings from an identified study area, rather than each building, may be sampled. Prior to implementation, this type of sampling approach should be approved by State agency personnel.

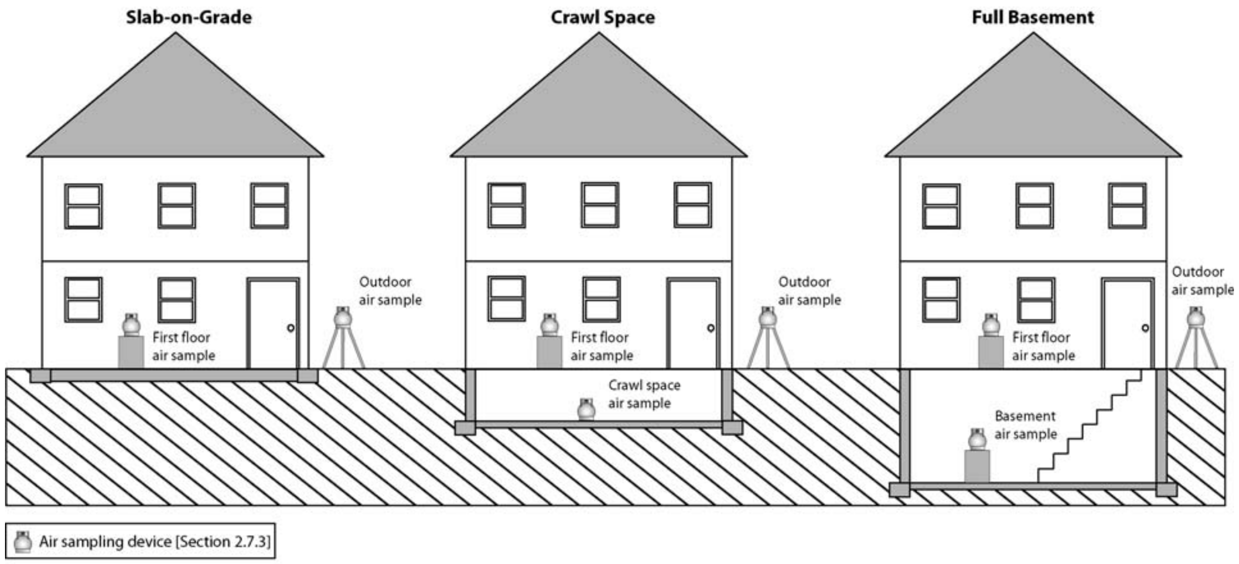


Figure 2.1
Schematic of indoor and outdoor air sampling locations

2.6.4 Outdoor air

Typically, an outdoor air sample is collected outside of each building where an indoor air sample is collected. However, if several buildings are being sampled within a localized area, representative outdoor air samples may be appropriate. For example, one outdoor air sample may be sufficient for three houses being sampled in a cul-de-sac. Outdoor air samples should be collected from a representative upwind location, away from wind obstructions (e.g., trees or bushes), and at a height above the ground to represent breathing zones (3 to 5 feet) [Figure 2.1]. A representative sample is one that is not biased toward obvious sources of volatile chemicals (e.g., automobiles, lawn mowers, oil storage tanks, gasoline stations, industrial facilities, etc.). For buildings with HVAC systems that draw outdoor air into the building, an outdoor air sample collected near the outdoor air intake may be appropriate.

2.7 Sampling protocols

The procedures recommended here may be modified depending on site-specific conditions, the sampling objectives, or emerging technologies and methodologies. Alternative sampling procedures should be described thoroughly and proposed in a work plan submitted for review by the State. The State will review and comment on the proposed procedure and consider the efficacy of the alternative sampling procedure based on the objectives of investigation. In all cases, work plans should thoroughly describe the proposed sampling procedure. Similarly, the procedures that were implemented in the field should be documented and included in the final report of the sampling results.

2.7.1 Soil vapor

Soil vapor probe installations [Figure 2.2] may be permanent, semi-permanent or temporary. In general, permanent or semi-permanent installations are preferred for data consistency reasons and to ensure outdoor air infiltration does not occur. Temporary probes should only be used if measures are taken to ensure that an adequate surface seal is created to prevent outdoor air infiltration and if tracer gas is used at every sampling location. [See Section 2.7.5 for additional information about the use of tracer gas when collecting soil vapor samples.] Soil vapor implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any permanent construction protocol:

a. implants should be installed using an appropriate method based on site conditions (e.g., direct push, manually driven, auger — if necessary to attain the desired depth or if sidewall smearing is a concern, etc.);

b. porous, inert backfill material (e.g., glass beads, washed #1 crushed stone, etc.) should be used to create a sampling zone 1 to 2 feet in length;

c. implants should be fitted with inert tubing (e.g., polyethylene, stainless steel, nylon, Teflon®, etc.) of the appropriate size (typically 1/8 inch to 1/4 inch diameter) and of laboratory or food grade quality to the surface;

d. soil vapor probes should be sealed above the sampling zone with a bentonite slurry for a minimum distance of 3 feet to prevent outdoor air infiltration and the remainder of the borehole backfilled with clean material;

e. for multiple probe depths, the borehole should be grouted with bentonite between probes to create discrete sampling zones or separate nested probes should be installed [Figure 2.2]; and

f. steps should be taken to minimize infiltration of water or outdoor air and to prevent accidental damage (e.g., setting a protective casing around the top of the probe tubing and grouting in place to the top of bentonite, sloping the ground surface to direct water away from the borehole like a groundwater monitoring well, etc.).

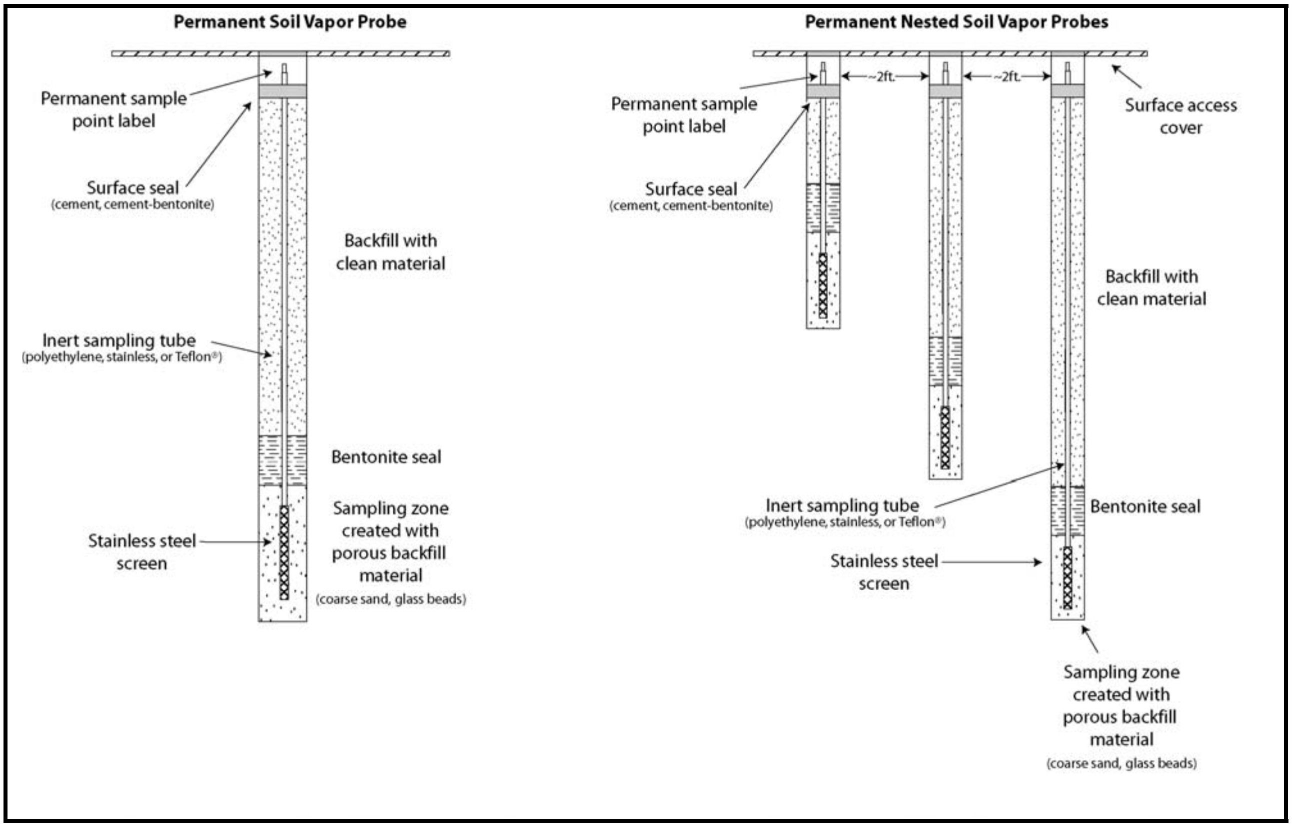


Figure 2.2

Schematics of a generic permanent soil vapor probe
and permanent nested soil vapor probes

[Note: Many variations exist and may be proposed in a work plan. Proposed installations should meet the sampling objectives and requirements of the analytical methods.]

To obtain representative samples and to minimize possible discrepancies, soil vapor samples should be collected in the following manner at all locations:

a. at least 24 hours after the installation of permanent probes and shortly after the installation of temporary probes, one to three implant volumes (i.e., the volume of the sample probe and tube) should be purged prior to collecting the samples;

b. flow rates for both purging and collecting should not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;

c. samples should be collected, using conventional sampling methods, in an appropriate container — one which

    i. meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation),

    ii. is consistent with the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and

    iii. is certified clean by the laboratory;

d. sample size depends upon the volume of that will achieve minimum reporting limits [Section 2.9]; and
e. a tracer gas (e.g., helium, butane, sulfur hexafluoride, etc.) should be used when collecting soil vapor samples to verify that adequate sampling techniques are being implemented (i.e., to verify infiltration of outdoor air is not occurring) [Section 2.7.5].

In some cases, weather conditions may present certain limitations on soil vapor sampling. For example, condensation in the sample tubing may be encountered during winter sampling due to low outdoor air temperatures. Devices, such as tube warmers, may be used to address these conditions. Anticipated limitations to the sampling should be discussed prior to the sampling event so appropriate measures can be taken to address these difficulties and produce representative and reliable data.

When soil vapor samples are collected, the following actions should be taken to document local conditions during sampling that may influence interpretation of the results:

a. if sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility should be identified;
b. outdoor plot sketches should be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor air sampling locations (if applicable), and compass orientation (north);
c. weather conditions (e.g., precipitation and outdoor temperature) should be noted for the past 24 to 48 hours; and
d. any pertinent observations should be recorded, such as odors and readings from field instrumentation.

Additional information that could be gathered to assist in the interpretation of the results includes barometric pressure, wind speed and wind direction.

The field sampling team should maintain a sample log sheet summarizing the following:

a. sample identification,
b. date and time of sample collection,
c. sampling depth,
d. identity of samplers,
e. sampling methods and devices,
f. purge volumes,
g. volume of soil vapor extracted,
h. if canisters used, the vacuum before and after samples were collected,
i. apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
j. chain of custody protocols and records used to track samples from sampling point to analysis.

2.7.2 Sub-slab vapor

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. Prior to installation of the sub-slab vapor probe, the building floor should be inspected and any penetrations (cracks, floor drains, utility perforations, sumps, etc.) should be noted and recorded. Probes should be installed at locations where the potential for ambient air infiltration via floor penetrations is minimal.

Sub-slab vapor probe installations [Figure 2.3] may be permanent, semi-permanent or temporary. A vacuum should not be used to remove drilling debris from the sampling port. Sub-slab implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

a. permanent recessed probes should be constructed with brass or stainless steel tubing and fittings;
b. temporary probes should be constructed with inert tubing (e.g., polyethylene, stainless steel, nylon, Teflon®, etc.) of the appropriate size (typically 1/8 inch to 1/4 inch diameter), and of laboratory or food grade quality;
c. tubing should not extend further than 2 inches into the sub-slab material;
d. porous, inert backfill material (e.g., glass beads, washed #1 crushed stone, etc.) should be added to cover about 1 inch of the probe tip for permanent installations; and
e. the implant should be sealed to the surface with non-VOC-containing and non-shrinking products for temporary installations (e.g., permagum grout, melted beeswax, putty, etc.) or cement for permanent installations.

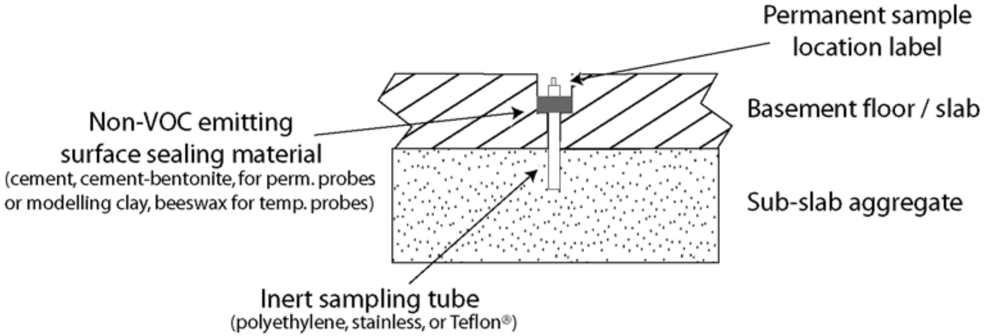


Figure 2.3

Schematic of a generic sub-slab vapor probe

[Note: Many variations exist and may be proposed in a work plan. Proposed installations should meet the sampling objectives and requirements of the analytical methods.]

To obtain representative samples that meet the data quality objectives, sub-slab vapor samples should be collected in the following manner:

a. after installation of the probes, one to three volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;

b. flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize ambient air infiltration during sampling; and

c. samples should be collected, using conventional sampling methods, in an appropriate container — one which

    i. meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation),

    ii. is consistent with the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and

    iii. is certified clean by the laboratory;

d. sample size depends upon the volume of that will achieve minimum reporting limits [Section 2.9], the flow rate, and the sampling duration; and

e. ideally, samples should be collected over the same period of time as concurrent indoor and outdoor air samples.

When sub-slab vapor samples are collected, the following actions should be taken to document conditions during sampling and ultimately to aid in the interpretation of the sampling results [Section 3]:

a. historic and current storage and uses of volatile chemicals should be identified, especially if sampling within a commercial or industrial building (e.g., use of volatile chemicals in commercial or industrial processes and/or during building maintenance);

b. the use of heating or air conditioning systems during sampling should be noted;

c. floor plan sketches should be drawn that include the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north), footings that create separate foundation sections, and any other pertinent information should be completed;

d. outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sampling locations (if applicable), compass orientation (north), and paved areas;

e. weather conditions (e.g., precipitation and indoor and outdoor temperature) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and

f. any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

Additional documentation that could be gathered to assist in the interpretation of the results includes information about air flow patterns and pressure relationships obtained by using smoke tubes or other devices (especially between floor levels and between suspected contaminant sources and other areas), the barometric pressure and photographs to accompany floor plan sketches.

The field sampling team should maintain a sample log sheet summarizing the following:

a. sample identification,
b. date and time of sample collection,
c. sampling depth,
d. identity of samplers,
e. sampling methods and devices,
f. soil vapor purge volumes,
g. volume of soil vapor extracted,
h. if canisters used, vacuum of canisters before and after samples collected,
i. apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
j. chain of custody protocols and records used to track samples from sampling point to analysis.

2.7.3 Indoor air

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. If possible, prior to collecting indoor samples, a pre-sampling inspection [Section 2.11.1] should be performed to evaluate the physical layout and conditions of the building being investigated, to identify conditions that may affect or interfere with the proposed sampling, and to prepare the building for sampling. This process is described in Section 2.11.1.

In general, indoor air samples should be collected in the following manner:

a. sampling duration should reflect the exposure scenario being evaluated without compromising the detection limit or sample collection flow rate (e.g., an 8 hour sample from a workplace with a single shift versus a 24 hour sample from a workplace with multiple shifts). To ensure that air is representative of the locations sampled and to avoid undue influence from sampling personnel, samples should be collected for at least 1 hour. If the goal of the sampling is to represent average concentrations over longer periods, then longer duration sampling periods may be appropriate. Typically, 24 hour samples are collected from residential settings;
b. personnel should avoid lingering in the immediate area of the sampling device while samples are being collected;
c. sample flow rates must conform to the specifications in the sample collection method and, if possible, should be consistent with the flow rates for concurrent outdoor air and sub-slab samples; and
d. samples must be collected, using conventional sampling methods, in an appropriate container — one which

i. meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation),

ii. is consistent with the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and

iii. is certified clean by the laboratory.

At sites with tetrachloroethene contamination, passive air monitors that are specifically analyzed for tetrachloroethene (i.e., "perc badges") are commonly used to collect indoor and outdoor air samples. If site characterization activities indicate that degradation products of tetrachloroethene also represent a vapor intrusion concern, perc badges may be used to indicate the likelihood of vapor intrusion (i.e., by using tetrachloroethene as a surrogate) followed, as appropriate, by more comprehensive sampling and laboratory analyses to quantify both tetrachloroethene and its degradation products. Perc badge samples ideally should be collected over a twenty-four hour period, but for no less than eight hours.

The following actions should be taken to document conditions during indoor air sampling and ultimately to aid in the interpretation of the sampling results [Section 3]:

a. historic and current uses and storage of volatile chemicals should be identified, especially if sampling within a commercial or industrial building (e.g., use of volatile chemicals in commercial or industrial processes and/or during building maintenance);

b. a product inventory survey documenting sources of volatile chemicals present in the building during the indoor air sampling that could potentially influence the sample results should be completed [Section 2.11.2];

c. the use of heating or air conditioning systems during sampling should be noted;

d. floor plan sketches should be drawn that include the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system supply and return registers, compass orientation (north), footings that create separate foundation sections, and any other pertinent information should be completed;

e. outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sampling locations (if applicable), compass orientation (north), and paved areas;

f. weather conditions (e.g., precipitation and indoor and outdoor temperature) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and

g. any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppbRAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

Additional documentation that could be gathered to assist in the interpretation of the results includes information about air flow patterns and pressure relationships obtained by using smoke tubes or other devices (especially between floor levels and between suspected contaminant sources and other areas), the barometric pressure and photographs to accompany floor plan sketches.

The field sampling team should maintain a sample log sheet summarizing the following:

a. sample identification,
b. date and time of sample collection,
c. sampling height,
d. identity of samplers,
e. sampling methods and devices,
f. depending upon the method, volume of air sampled,
g. if canisters are used, vacuum of canisters before and after samples collected, and
h. chain of custody protocols and records used to track samples from sampling point to analysis.

2.7.4 Outdoor air

Outdoor air samples should be collected simultaneously with indoor air samples to evaluate the potential influence, if any, of outdoor air on indoor air quality. They may also be collected simultaneously with soil vapor samples to identify potential outdoor air interferences associated with infiltration of outdoor air into the sampling apparatus while the soil vapor was collected. To obtain representative samples that meet the data quality objectives, outdoor air samples should be collected in a manner consistent with that for indoor air samples (described in Section 2.7.3).

The following actions should be taken to document conditions during outdoor air sampling and ultimately to aid in the interpretation of the sampling results [Section 3]:

a. outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sampling locations, the location of potential interferences (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), and paved areas;
b. weather conditions (e.g., precipitation and outdoor temperature) should be reported; and
c. any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

2.7.5 Tracer gas

When collecting soil vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control measure to verify the integrity of the soil vapor probe seal. Without the use of a tracer, there is no way to verify that a soil vapor sample has not been diluted by outdoor air.

Depending on the nature of the contaminants of concern, a number of different compounds can be used as a tracer. Typically, sulfur hexafluoride (SF_6) or helium are used as tracers because they are readily available, have low toxicity, and can be monitored with portable measurement devices. Butane and propane (or other gases) could also be used as a tracer in some situations. Compounds other than those mentioned here may be appropriate, provided they meet project-specific data quality objectives. Where applicable, steps should be taken to ensure that the gas used by the laboratory to clean the air sampling container is different from the gas used as a tracer during sampling (e.g., helium).

The protocol for using a tracer gas is straightforward: simply enrich the atmosphere in the immediate vicinity of the area where the probe intersects the ground surface with the tracer gas, and measure a vapor sample from the probe for the presence of high concentrations (> 10%) of the tracer. A cardboard box, a plastic pail, or even a garbage bag can serve to keep the tracer gas in contact with the probe during the testing. If there are concerns about infiltration of ambient air through other parts of the sampling train (such as around the fittings, not just at the probe/ground interface), then consideration should be given to ensuring that the tracer gas is in contact with the entire sampling apparatus. In these cases, field personnel may prefer to use a liquid tracer — soaking paper towels with a liquid tracer and placing the towels around the probe/ground interface, around fittings, and/or in the corner of a shroud.

There are two basic approaches to testing for the tracer gas:

1. include the tracer gas in the list of target analytes reported by the laboratory; or
2. use a portable monitoring device to analyze a sample of soil vapor for the tracer prior to and after sampling for the compounds of concern. (Note that the tracer gas samples can be collected via syringe, Tedlar® bag etc. They need not be collected in Summa® canisters or minicans.)

The advantage of the second approach is that the real time tracer sampling results can be used to confirm the integrity of the probe seals prior to formal sample collection.

Figure 2.4 depicts common methods for using tracer gas. In examples a, b and c, the tracer gas is released in the enclosure prior to initially purging the sample point. Care should be taken to avoid excessive purging prior to sample collection. Care should also be taken to prevent pressure build-up in the enclosure during introduction of the tracer gas. Inspection of the installed sample probe, specifically noting the integrity of the surface seal and the porosity of the soil in which the probe is installed, will help to determine the tracer gas setup. Figure 2.4a may be most effective at preventing tracer gas infiltration, however, it may not be appropriate in some situations depending on site-specific conditions. Figures 2.4b and 2.4c may be sufficient for probes installed in tight soils with well-constructed surface seals. Figure 2d provides an example of using a liquid tracer. In all cases, the same tracer gas application should be used for all probes at any given site.

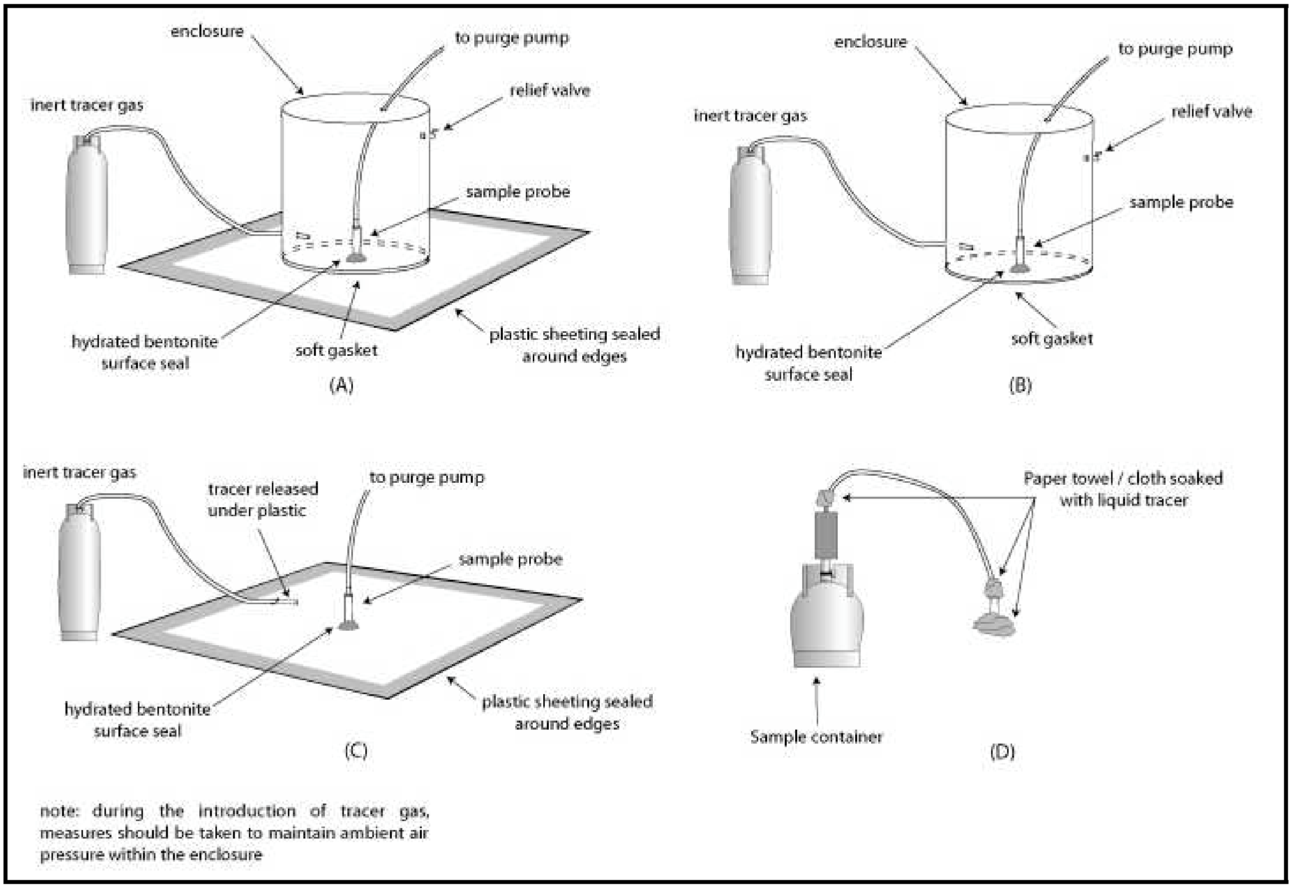


Figure 2.4
Schematics of generic tracer gas applications when collecting soil vapor samples

Because minor leakage around the probe seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (> 10%) of tracer gas are observed in a sample, the probe seal should be enhanced to reduce the infiltration of outdoor air.

Where permanent or semi-permanent sampling probes are used, tracer gas samples should be collected at each of the sampling probes during the initial stages of a soil vapor sampling program. If the results of the initial samples indicate that the probe seals are adequate, reducing the number of locations at which tracer gas samples are employed may be considered. At a minimum, tracer gas samples should be collected with at least 10% of the soil vapor samples collected in subsequent sampling rounds. When using permanent soil vapor probes as part of a long-term monitoring program, annual testing of the probe integrity is recommended. Where temporary probes are used, tracer gas should be used at every sampling location, every time.

2.8 Quality assurance / quality control (QA / QC)

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

In general, appropriate QA/QC procedures should be followed during all aspects of sample collection and analysis to ensure that sampling error is minimized and high quality data are obtained. Sampling team members should avoid actions (e.g., fueling vehicles, using permanent marking pens, wearing freshly dry-cleaned clothing or personal fragrances, etc.) which can cause sample interference in the field. Portable air monitoring equipment or field instrumentation should be properly maintained, calibrated and tested to ensure validity of measurements. Air sampling equipment should be stored, transported and between samples decontaminated in a manner consistent with the best environmental consulting practices to minimize problems such as field contamination and cross-contamination. Samples should be collected using certified clean sample devices. Where applicable, steps should be taken to ensure that the gas used by the laboratory to clean the sample device is different from the gas used as a tracer during sampling (e.g., helium). Samples should meet sample holding times and temperatures, and should be delivered to the analytical laboratory as soon as possible after collection. In addition, laboratory accession procedures should be followed, including field documentation (sample collection information and locations), chain of custody, field blanks, field sample duplicates and laboratory duplicates, as appropriate.

Some methods call for collecting samples in duplicate (e.g., indoor air sampling using passive sampling devices for tetrachloroethene) to assess errors. Duplicate and/or split samples should be collected in accordance with the sampling and analytical methods being implemented.

For certain regulatory programs, a Data Usability Summary Report (DUSR) or equivalent report may be required to determine whether or not the data, as presented, meets the site or project specific criteria for data quality and data use. This requirement may dictate the level of QC and the category of data deliverable to request from the laboratory. Guidance on preparing these reports is available by contacting the NYSDEC's Division of Environmental Remediation.

New York State Public Health Law requires laboratories analyzing environmental samples collected from within New York State to have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. If ELAP certification is not currently required for an analyte (e.g., trichloroethene), the analysis should be performed by a laboratory that has ELAP certification for similar compounds in air and uses analytical methods with minimum reporting limits similar to background (e.g., tetrachloroethene via EPA Method TO-15). Questions about a laboratory's current certification status should be directed to an ELAP representative at 518-485-5570 or by email at elap@health.state.ny.us.

The work plan should state that all samples that will be used to make decisions on appropriate actions to address exposures and environmental contamination will be analyzed by an ELAP-certified laboratory. The name of the laboratory should also be provided. Similarly, the name of the laboratory that was used should be included in the report of the sampling results. For samples collected and tested in the field for screening purposes by using field testing technology, the qualifications of the field technician should be documented in the work plan.

2.9 Analytical methods

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

Proposed analytical procedures should be identified in work plans. Similarly, the analytical procedures that were used and corresponding reporting limits should be identified when reporting the sampling results. When selecting an appropriate analytical method, the data quality objectives should be considered. As described in Section 3, comparing sampling results for volatile chemicals with background concentrations and with indoor air/sub-slab vapor matrices are critical components of the data evaluation process. Therefore, samples should be analyzed by methods that can achieve minimum reporting limits to allow for comparison of the results with background levels and with the levels presented in the matrices [Section 3.4.2]. If there are additional data quality objectives, they should be considered also. Typically, a minimum reporting limit of 1 microgram per cubic meter (1 mcg/m^3) or less is sufficient for most analytes. Examples of commonly used analytical methods include the following:

a. EPA Method TO-15 for a wide range of VOCs (e.g., samples from evacuated canisters),

b. NYSDOH Method 311-9 for tetrachloroethene (i.e., samples from perc badges),

c. EPA Method TO-17 for VOCs (e.g., samples collected with sorbent tubes), and

d. EPA Method TO-15 for VOCs with selective ion monitoring (SIM) (e.g., to achieve minimum reporting limits lower than those achieved with Method TO-15 alone).

The laboratory should verify that they are capable of detecting the appropriate analytes and can report them at the appropriate reporting limit.

2.9.1 Subsurface vapor

Soil vapor and sub-slab vapor samples should be analyzed for a wide range of volatile chemicals during the first round of sampling (at a minimum) — unless it can be demonstrated that an abbreviated or site-specific analyte list is appropriate. This is analogous to analyzing groundwater samples for a suite of compounds (e.g., EPA's target analyte list/target compound list (TAL/TCL) chemicals) during the initial rounds of site characterization. Based on the initial sampling results, development and application of a site-specific analyte list may be considered for analysis of subsequent soil vapor and sub-slab vapor samples.

If a site-specific analyte list is developed, it should include the following:

a. volatile chemicals which have been previously detected in environmental media (e.g., soil, groundwater and air) at the site;

b. volatile chemicals which are known or demonstrated constituents of the contamination in question (e.g., petroleum products or tars from former manufactured gas plants); and

c. expected degradation products of the chemicals mentioned in a or b.

A site-specific analyte list might also include indicator compounds to assist in identifying and differentiating subsurface sources of volatile chemical contamination. The following are examples of indicator compounds that have been included in site-specific analyte lists given the nature of the contamination or type of site:

a. gasoline: benzene, toluene, ethylbenzene, xylenes, trimethylbenzene isomers, individual C-4 to C-8 aliphatics (e.g., hexane, cyclohexane, dimethylpentane, 2,2,4-trimethylpentane, etc.), and appropriate oxygenate additives (e.g., methyl-*tert*-butyl ether, ethanol, etc.);

b. middle distillate fuels (#2 fuel oil, diesel and kerosene): n-nonane, n-decane, n-undecane, n-dodecane, ethylbenzene, xylenes, trimethylbenzene isomers, tetramethylbenzene isomers, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene;

c. manufactured gas plant sites: trimethylbenzene isomers, tetramethylbenzene isomers, thiopenes, indene, indane, and naphthalene;

d. natural gas: propane, propene, butane, iso-butane, methylbutane, and n-pentane with lower levels of higher molecular weight aliphatic, olefinic, and some aromatic compounds; and

e. solvent-using industries: the solvent and its expected degradation products (e.g., tetrachloroethene, trichloroethene, dichloroethene(s), and vinyl chloride).

2.9.2 Indoor air

Indoor and outdoor air samples should be analyzed for a wide range of volatile chemicals if there are no existing data for subsurface vapors — unless it can be demonstrated that an abbreviated or site-specific analyte list is appropriate. If indoor air sampling is appropriate based on the levels of volatile chemicals in subsurface vapors, analysis of indoor air samples specifically for those volatile chemicals may be considered.

2.9.3 Outdoor air

Outdoor air samples should be analyzed in a manner consistent with corresponding indoor air samples.

2.10 Field laboratories and mobile gas chromatographs (GCs)

Use of field laboratories and mobile GCs as screening tools when collecting soil vapor samples may be considered on a site-specific basis. However, without ELAP certification, screening tools such as these are not acceptable when collecting sub-slab vapor, indoor air and outdoor air samples for the purpose of evaluating exposures related to soil vapor intrusion. ELAP certification for a particular laboratory does not indicate mobile laboratory or GC certification. Mobile laboratories and GCs have specific certification requirements through ELAP. Questions regarding a mobile laboratory's certification should be directed to the laboratory itself.

2.11 Surveys and pre-sampling building preparation

[Reference: NYSDOH's *Indoor Air Sampling & Analysis Guidance (February 1, 2005)*]

2.11.1 Pre-sampling building inspection and preparation

A pre-sampling inspection should be performed prior to each sampling event to identify and minimize conditions that may interfere with the proposed testing. The inspection should evaluate the type of structure, floor layout, air flows and physical conditions of the building(s) being studied. This information, along with information on sources of potential indoor air contamination [Section 2.11.2], should be identified on a building inventory form. An example of a building inventory form is given in Appendix B. Items to be included in the building inventory include the following:

a. construction characteristics, including foundation cracks and utility penetrations or other openings that may serve as preferential pathways for vapor intrusion;
b. presence of an attached garage;
c. recent renovations or maintenance to the building (e.g., fresh paint, new carpet or furniture);
d. mechanical equipment that can affect pressure gradients (e.g., heating systems, clothes dryers or exhaust fans);
e. use or storage of petroleum products (e.g., fuel containers, gasoline operated equipment and unvented kerosene heaters); and
f. recent use of petroleum-based finishes or products containing volatile chemicals.

Each room on the floor of the building being tested and on lower floors, if possible, should be inspected. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building. Where applicable, readings should be provided in units that denote the calibration gas (e.g., isobutylene-equivalent ppm, benzene-equivalent ppm, etc.).

Potential interference from products or activities releasing volatile chemicals should be controlled to the extent practicable. Removing the source from the indoor environment prior to testing is the most effective means of reducing interference. Ensuring that containers are tightly sealed may be sufficient. When testing for volatile organic compounds, containers should be tested with portable vapor monitoring equipment to determine whether compounds are leaking. The inability to eliminate potential interference may be justification for not testing, especially when testing for similar compounds at low levels. The investigator should consider the possibility that chemicals may adsorb onto porous materials and may take time to dissipate.

In some cases, the goal of the testing is to evaluate the impact from products used or stored in the building (e.g., pesticide misapplications, school renovation projects). If the goal of the testing is to determine whether products are an indoor volatile chemical contaminant source, the removing these sources does not apply.

Once interfering conditions are corrected (if applicable), ventilation may be appropriate prior to sampling to minimize residual contamination in the indoor air. If ventilation is appropriate, it should be completed 24 hours or more prior to the scheduled sampling time. Where applicable, ventilation can be accomplished by operating the building's HVAC system to maximize outside air intake. Opening windows and doors, and operating exhaust fans may also help or may be appropriate if the building has no HVAC system.

Air samples are sometimes designed to represent typical exposure in a mechanically ventilated building and the operation of HVAC systems during sampling should be noted on the building inventory form [Appendix B]. When samples are collected, the building's HVAC system should be operating in a manner consistent with normal operating conditions when the building is occupied (e.g., schools, businesses, etc.). Unnecessary building ventilation should be avoided within 24 hours prior to and during sampling. During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time.

Depending upon the goal of the indoor air sampling, some situations may warrant deviation from the above protocol regarding building ventilation. In such cases, building conditions and sampling efforts should be understood and noted within the framework and scope of the investigation.

To avoid potential interferences and dilution effects, occupants should make a reasonable effort to avoid the following for 24 hours prior to sampling:

a. opening any windows, fireplace dampers, openings or vents;
b. operating ventilation fans unless special arrangements are made;
c. smoking in the building;
d. painting;
e. using a wood stove, fireplace or other auxiliary heating equipment (e.g., kerosene heater);
f. operating or storing automobile in an attached garage;
g. allowing containers of gasoline or oil to remain within the house or garage area, except for fuel oil tanks;
h. cleaning, waxing or polishing furniture, floors or other woodwork with petroleum- or oil-based products;
i. using air fresheners, scented candles or odor eliminators;
j. engaging in any hobbies that use materials containing volatile chemicals;
k. using cosmetics including hairspray, nail polish, nail polish removers, perfume/cologne, etc.;
l. lawn mowing, paving with asphalt, or snow blowing;
m. applying pesticides;
n. using building repair or maintenance products, such as caulk or roofing tar; and
o. bringing freshly dry-cleaned clothing or furnishings into the building.

2.11.2 Product inventory

The primary objective of the product inventory is to identify potential air sampling interference by characterizing the occurrence and use of chemicals and products throughout the building, keeping in mind the goal of the investigation and site-specific contaminants of concern. For example, it is not appropriate to provide detailed information for each individual container of like items. However, it is appropriate to indicate that "20 bottles of perfume" or "12 cans of latex paint" were present with containers in good condition. This information is used to help formulate an indoor environment profile.

An inventory should be provided for each room on the floor of the building being tested and on lower floors, if possible. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppbRAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building. Where applicable, readings should be provided in units that denote the calibration gas (e.g., isobutylene-equivalent ppm, benzene-equivalent ppm, etc.).

Products in buildings should be inventoried every time air is tested to provide an accurate assessment of the potential contribution of volatile chemicals. If available, chemical ingredients of interest (e.g., analyte list) should be recorded for each product. If the ingredients are not listed on the label, record the product's exact and full name, and the manufacturer's name, address and telephone number, if available. In some cases, material Safety Data Sheets may be useful for identifying confounding sources of volatile chemicals in air. Adequately documented photographs of the products and their labeled ingredients can supplement the inventory and facilitate recording the information.

2.12 Role of modeling

At sites where there is a potential for human exposures to subsurface contamination due to soil vapor intrusion (as described in Section 2.1), use of modeling as the sole means of evaluating potential exposures should be avoided. The limitations of modeling (e.g., exclusion of preferential migration pathways) introduce uncertainty as to whether human exposure is occurring, in absence of actual field data. Conclusions drawn from modeling should be verified with actual field data. For example, if modeling results indicate indoor air concentrations are predicted to be below applicable guidelines or levels of concern, indoor air and/or sub-slab vapor sampling would be appropriate to verify a conclusion that mitigation or other actions are not needed.

Modeling may, however, be used as a tool in the evaluation process. Examples of situations in which modeling may be used as a tool include, but are not limited to, the following:

a. to help identify potential migration pathways on the basis of site-specific conditions;

b. to estimate potential exposures when field samples cannot be collected (e.g., access to collect the samples is denied or buildings have not yet been constructed over the subsurface contamination); and

c. to identify a preferred order for sampling buildings by predicting expected indoor air concentrations within each of the buildings if there are numerous buildings overlying the subsurface contamination.

Use of any model at a site should be discussed with the agencies prior to the model's development and application. If a model is used, it should incorporate site-specific parameters (e.g., attenuation factors, soil conditions, concentrations of volatile chemicals, depth to subsurface source, characteristics of subsurface source, and foundation slab thickness) as much as possible. Furthermore, both the limitations of the model (e.g., exclusion of preferential migration pathways) and the sensitivity of the variables in the model should be understood and identified with the modeling results.

Section 3: Data Evaluation and Recommendations for Action

Section 3 describes the process by which data obtained during the investigation are evaluated. The goals of the evaluation are as follows:

a. to determine what volatile chemicals, if any, are present in the investigated media;

b. to identify the likely cause(s) of their presence; and

c. to identify completed and potential human exposures whether actions to address exposures should be taken.

Also discussed are actions typically recommended based on the evaluation. Actions to remediate the source(s) of soil vapor contamination, such as soil excavation or air-sparge/soil vapor extraction systems, are beyond the scope of this guidance and are not included.

3.1 Data quality

Before the data are evaluated, their representativeness and reliability should be verified. To assess analytical errors and the usability of the data, a qualified person should review the analytical data package and all associated QA/QC information to make sure that

a. the data package is complete;

b. holding times have been met;

c. the QC data fall within the protocol limits and specifications;

d. the data have been generated using established and agreed upon analytical protocols;

e. the raw data confirm the results provided in the data summary sheets and QC verification forms; and

f. correct data qualifiers have been used.

As discussed in Section 2.8, for sites in an environmental remediation program (e.g., State Superfund), a DUSR or equivalent report should be generated in accordance with NYSDEC guidance and should be submitted for regulatory review and approval.

If the investigation was not completed in accordance with the guidelines set forth in Section 2, additional investigation may be appropriate to either replace or complement the existing data. For example, product inventories [Section 2.11.2] filled out incompletely or incorrectly may need to be redone (and in some cases with additional air sampling) so that likely sources of volatile chemicals in the indoor air can be identified and appropriate actions to mitigate exposures can be recommended.

3.2 Overview

The results of individual soil vapor, sub-slab vapor, indoor air and outdoor air samples are not reviewed in isolation. Rather, they are evaluated with the consideration of several additional factors, which include the following:

a. the nature and extent of contamination in *all* environmental media;

b. factors that affect vapor migration and intrusion;

c. completed or proposed remedial actions;
d. sources of volatile chemicals;
e. background levels of volatile chemicals in air;
f. relevant standards, criteria and guidance values; and
g. past, current and future land uses.

These factors are described in detail in this subsection.

3.2.1 Nature and extent of contamination in all environmental media

The type of volatile chemicals present and the extent of contamination in all environmental media — including soil, groundwater, subsurface vapors, indoor air and outdoor air — is considered when evaluating the data. Trends in environmental data (e.g., groundwater monitoring results show concentrations of volatile chemicals are decreasing) are also considered. This information is used to identify possible sources of contamination and migration pathways, as well as to recommend appropriate actions to address exposures.

3.2.2 Factors that affect vapor migration and intrusion

As discussed in Section 1.3, there are numerous site-specific environmental factors [Table 1.1] and building factors [Table 1.2] that can affect soil vapor migration and intrusion. This information is used to identify possible sources of contamination and migration pathways, as well as to recommend appropriate actions to address exposures.

3.2.3 Sources of volatile chemicals

An understanding of the likely sources of the chemicals is crucial for determining appropriate actions to address exposure, as well as identifying the parties responsible for implementing the actions. Volatile chemicals that are not site-related may be present in the investigated media for reasons such as the following:

a. *subsurface vapors* — misuse, misapplication, or improper disposal of the chemicals to the subsurface, unidentified subsurface sources of vapor contamination, presence of septic systems (where products, such as cleaning agents or degreasers, may be disposed), biodegradation of natural organic matter in soil, infiltration into the subsurface from a building under positive pressure in which the chemicals are heavily used (i.e., reverse process from soil vapor intrusion), etc.;

b. *indoor air* — use and storage (current or historic) of volatile chemical-containing products, off-gassing from building materials or new furnishings, use of contaminated groundwater during private well usage, infiltration of outdoor air containing volatile chemicals, etc. [Table 1.3]; and

c. *outdoor air* — emissions from automobiles, lawn mowers, oil storage tanks, gasoline stations, dry cleaners or other commercial/industrial facilities, etc. [Table 1.3].

Site-related chemicals may also be present for these same reasons. Information about household products and their ingredients are available on web sites, such as the National Institute of Health's site at http://householdproducts.nlm.nih.gov.

3.2.4 Background levels of volatile chemicals in air

Chemicals are part of our everyday life [Section 1.4]. As such, they are found in the indoor air of buildings not affected by intrusion of contaminated soil vapor. They are also found in the outdoor air that enters a home or place of business. Commonly found concentrations of these chemicals in indoor and outdoor air are referred to as "background levels." Background levels of volatile chemicals are one of the factors considered when evaluating sampling results at a site [Section 3.3.2 – 3.3.4]. Estimates of background levels come from studies where air samples were collected in homes, offices and outdoor areas.

Several studies have been conducted, both nationally and in the State of New York, to provide information on indoor and outdoor air background levels in a variety of settings (e.g., residential or commercial buildings). Each of these studies offers useful information and has its own limitations. Each database provides statistical measures of background levels and the criteria used to select sampling locations. The criteria in some of the studies required that sampling locations not be located near known sources of volatile chemicals (for example, not near a chemical spill, hazardous waste site, dry-cleaner, or factory). The criteria may also have included checking containers of volatile chemicals in or near the building to make sure they are tightly closed or removing those products before samples are taken. Depending on the criteria for site selection and sampling conditions, statistical measures of background levels in a given study may differ from what would be expected if indoor air were sampled in randomly selected homes.

The background databases that are used for evaluating indoor and outdoor air data are introduced below. A more detailed description of each database along with statistical measures of background levels are provided in Appendix C.

a. *NYSDOH 2003: Study of Volatile Organic Chemicals in Air of Fuel Oil Heated Homes*

   Results of indoor and outdoor air samples collected from 104 single-family fuel oil heated homes throughout New York State. Samples collected in evacuated canisters and analyzed for 69 aromatic, aliphatic, and halogenated hydrocarbons, and ketones by modified EPA Method TO-15. Limitations: only fuel oil heated homes were included, homes were not randomly selected, and five boroughs of New York City were excluded.

b. *EPA 2001: Building Assessment and Survey Evaluation (BASE) Database*

   Study of measured concentrations of volatile organic compounds from 100 randomly selected public and commercial office buildings. Samples collected by evacuated canisters and/or tube methodologies. Limitations: only represents office settings, two methodologies used for sampling and analysis that are not completely overlapping and do not show agreement in results in some cases.

c. *NYSDOH 1997: Control Home Database*

   Indoor and outdoor air samples compiled from 53 residences in New York State that were considered "control Homes" with neighborhood, construction, and occupancy similar to potentially impacted homes that were being investigated at the time. Limitations: multiple methodologies for sampling and analysis, small sample size, and varying detection limits often higher than current background levels.

d. *EPA 1988: National Ambient Volatile Organic Compounds (VOCs) Data Base Update*

   Published and unpublished air data compiled by the EPA in 1988. The document includes data from studies between 1970 to 1987. The database covers more than

300 chemicals in indoor and outdoor settings. Limitations: data are compiled from numerous studies with limitations on selection or screening criteria, data are 20-35 years old, indoor air data include both residential and office spaces, sample size for some analytes is very small (less than 10). Outdoor air data include rural, suburban, urban, source dominated and remote locations.

e. *Health Effects Institute (HEI) 2005: Relationship of Indoor, Outdoor, and Personal Air (RIOPA)*

Indoor, outdoor and personal air concentrations of 18 VOCs, 10 carbonyl compounds and particulate matter (PM2.5) were measured in 100 homes in each of 3 cities between the summer of 1999 and the spring of 2001. Limitations: limited numbers of VOCs, passive organic vapor badge method is subject to sampling bias in stationary versus mobile locations, the passive organic vapor badge method is only approved for tetrachloroethene in New York State.

Among the databases, the Upper Fence (see *NOTE below) values from the NYSDOH Fuel Oil Study data may be used as initial benchmarks when evaluating residential indoor air (see Appendix C.1) and the 90th percentile values from the EPA BASE data for indoor air in office and commercial buildings (see Appendix C.2). These initial benchmark values should be considered along with the overall distribution of results in the background database to characterize sampling results from a single building or from multiple buildings in a community. The Health Effects Institute 2005 database and the older NYSDOH and EPA databases can also provide useful information on the range of concentrations found in air. The database or combination of databases that best represents site-specific conditions should be used as the basis for comparison. State agency personnel should review and have the opportunity to comment on the proposed use of other databases or subsets of data within a database for evaluating test results.

*NOTE: The Upper Fence is calculated as 1.5 times the interquartile range (difference between the 25th and 75th percentile values) above the 75th percentile value. It is a boundary estimate used to account for outliers in the data.

3.2.5 Relevant standards, criteria and guidance values

a. *Subsurface vapors*

The State of New York does not have any standards, criteria or guidance values for concentrations of volatile chemicals in subsurface vapors (either soil vapor or sub-slab vapor).

b. *Indoor and outdoor air*

The NYSDOH has developed several guidelines for chemicals in air. The development process is initiated for specific situations. For example, in New York State, particularly in New York City, dry cleaners are often located in apartment buildings. Because air in buildings mixes to some extent and the dry cleaning chemical tetrachloroethene (PCE) is volatile, it may migrate to residential apartments. When the NYSDOH became aware of this problem and how widespread it is, the NYSDOH developed an air guideline for PCE of 100 micrograms per cubic meter (mcg/m^3). In addition to PCE, the NYSDOH has developed guidelines for methylene chloride (also referred to as dichloromethane) and trichloroethene (TCE) in air, as well as dioxin and polychlorinated biphenyls (PCBs) in indoor air. Each guideline went through a peer review process, in which expert scientists outside of the NYSDOH reviewed the technical documentation that describes the scientific basis for the guidance value. The peer reviewers provided technical comments on the data and methods used to derive the guidelines, each of which were addressed by the NYSDOH. Upon completion of the reviews and responses to comments, the guidelines were finalized.

Air guideline values derived by the NYSDOH are summarized in Table 3.1. Additional information about these guidelines is provided in the following:

- Appendix D — overview of how the NYSDOH develops air guidelines; and
- Appendix H — copies of fact sheets that discuss the air guidelines for PCE and TCE.

The purpose of a guideline is to help guide decisions about the nature of efforts to reduce exposure to the chemical. Reasonable and practical actions should be taken to reduce exposures when indoor air levels are above background, even when they are below the guideline. The urgency to complete these actions increases with indoor air levels, particularly when air levels are above the guideline, and additional actions taken if the initial actions do not sufficiently reduce levels. In all cases, the specific corrective actions to be taken depend on a case-by-case evaluation of the situation. The goal of the recommended actions is to reduce chemical levels in indoor air to as close to background as practical.

Table 3.1 Air guideline values derived by the NYSDOH

Chemical		**Air Guideline Value (mcg/m^3)**	**Reference**
methylene chloride (also referred to as dichloromethane)	MeCl	60	1
polychlorinated biphenyls	PCBs	1*	2,3
tetrachlorodibenzo-*p*-dioxin equivalents	TCDD	0.00001*	3,4
tetrachloroethene	PCE	100	5
trichloroethene	TCE	5	6,7

*The guideline is specific to indoor air.

References:

[1] NYSDOH. 1988. Letter from N. Kim to T. Allen, Division of Air, New York State Department of Environmental Conservation. November 28, 1988.

[2] NYSDOH. 1985. Binghamton State Office Building (BSOB) Re-Entry Guidelines: PCBs. Document 1330P. Albany, NY: Bureau of Toxic Substance Assessment.

[3] NYSDOH. 1988. Letter from D. Axelrod to J. Egan, New York State Office of General Services. March 8, 1988.

[4] NYSDOH. 1984. Re-Entry Guidelines. Binghamton State Office Building. Document 0549P. Albany, NY: Bureau of Toxic Substance Assessment.

[5] NYSDOH. 1997. Tetrachloroethene Ambient Air Criteria Document. Albany, NY: Bureau of Toxic Substance Assessment.

[6] NYSDOH. 2003. Letter from N. Kim to D. Desnoyers, Division of Environmental Remediation, New York State Department of Environmental Conservation. October 31, 2003. [Provided in Appendix D.]

[7] NYSDOH. 2006. Final Report: Trichloroethene (TCE) Air Criteria Document. Center for Environmental Health, Bureau of Toxic Substance Assessment. Troy, NY.

3.2.6 Completed or proposed remedial actions

The status and effectiveness of actions taken to remediate environmental contamination (e.g., soil removal, groundwater treatment, soil vapor extraction, etc.) are considered when making decisions pertaining to additional sampling and the selection of mitigation actions. For example,

a. if a comparison of pre-remediation and post-remediation subsurface vapor sampling results indicates negligible improvement in the quality of subsurface vapors,

    1. additional sampling may be appropriate to document a decreasing trend in subsurface vapor concentrations;
    2. termination of mitigation system operations may not be appropriate without additional sampling; or
    3. additional remedial actions may be appropriate to address contaminated subsurface vapors;

b. when monitoring a building is appropriate, it may be more cost-effective to install a mitigation system if subsurface contamination is wide-spread and is expected to take many years to remediate; and

c. if exposures in an on-site building will be addressed concurrently by a method selected to remediate subsurface contamination (e.g., a soil vapor extraction system), installation of a mitigation system may be redundant. However, if the remedial system is not expected to be operational in the immediate future, or if it is not expected to mitigate indoor air levels in a reasonable time frame, a mitigation system may still be appropriate. [Refer to Section 4.1 for a description of the appropriate use of concurrent techniques.]

3.2.7 Past, current and future land uses

Past, current and future land uses are considered when evaluating the investigation data and determining appropriate actions for further investigation or measures to address exposures. For example,

a. if the parcel or buildings were historically used for commercial or industrial purposes (e.g., gasoline station, automotive repair facility, electroplating facility, etc.), but are currently used for residential purposes or commercial or industrial purposes where volatile chemicals are not used in current operations, off-gassing of volatile chemicals from building materials [Table 1.3] or additional subsurface sources should be considered;

b. subsurface vapor sampling of a parcel that is undeveloped or contains unoccupied buildings may be appropriate based on the data evaluation. However, sampling may be delayed as discussed in Section 2.3;

c. air sampling of a building may be appropriate based on the data evaluation. However, provisions may be put in place to defer sampling until occupancy of the building is expected; or

d. if actions should be taken to mitigate exposures related to soil vapor intrusion should the site be developed, the appropriate mitigation method will depend upon the proposed land use — a parking lot, recreational field, single-family home, commercial building, high-rise building with underground parking, occupied or unoccupied building, etc. — since each presents a different exposure scenario.

3.3 Sampling results and recommended actions

This subsection describes the process for evaluating sampling results. It also describes actions that may be recommended based on the evaluation. The evaluation procedures and actions described may not be directly applicable to samples collected as part of an emergency response. For guidance on how to proceed in such situations, refer to Section 3.5.

3.3.1 Soil vapor

If soil vapor samples are collected from locations where there are no known sources of volatile chemicals, we do not expect the chemicals to reach detectable levels in the samples. However, concentrations of volatile chemicals in soil vapor are commonly detected. This is likely due to several factors, including infiltration of outdoor air into the subsurface (to a limited extent) and background interferences (similar to indoor and outdoor air [Section 3.2.4]).

New York State currently does not have any standards, criteria or guidance values for concentrations of compounds in soil vapor. Additionally, there are currently no databases available of background levels of volatile chemicals in soil vapor. In the absence of this information, soil vapor sampling results are reviewed "as a whole," in conjunction with the results of other environmental sampling and the site conceptual model, to identify trends and spatial variations in the data [Section 3.2.1]. To put some perspective on the data, soil vapor results might be compared to background outdoor air levels [Section 3.2.4], site-related outdoor air sampling results, or the NYSDOH's guidelines for volatile chemicals in air [Table 3.1].

These comparisons are used to

a. identify areas of relatively elevated concentrations of volatile chemicals in soil vapor;

b. select buildings for sub-slab vapor, indoor air and outdoor air sampling;

c. identify possible sources of subsurface vapor contamination;

d. monitor the progress, or verify the completion, of efforts to remediate subsurface vapor contamination (either directly or indirectly); and

e. characterize the nature and extent of subsurface vapor contamination.

When determining appropriate actions, the following should also be considered:

a. Soil vapor results may not indicate a traditional plume-like pattern of contamination (as is often described for groundwater). Rather, the nature and extent of contamination may follow a "hit and miss" pattern.

b. Our experience to date indicates soil vapor results alone typically cannot be relied upon to rule out sampling at nearby buildings. For example, concentrations of volatile chemicals in sub-slab vapor samples have been substantially higher (e.g., by a factor of 100 or more) than concentrations found in nearby soil vapor samples (e.g., collected at 8 feet below grade near the building). This may be due to differences in factors such as soil moisture content and pressure gradients. Therefore, exposures are evaluated primarily based on sub-slab vapor, indoor air and outdoor air sampling results and soil vapor results are primarily used as a tool to guide these investigations.

There are no concentrations of volatile chemicals in soil vapor that automatically trigger action or no further action. Based on the comparisons and considerations described, the following actions may be recommended:

a. *No further soil vapor sampling*

The nature and extent of subsurface vapor contamination has been adequately characterized with respect to addressing exposures and designing measures to remediate subsurface vapor contamination (either directly or indirectly).

Sub-slab vapor samples, rather than soil vapor samples, will be used to identify potential exposures and to characterize the nature and extent of subsurface vapor contamination since soil vapor results are not following a consistent pattern (i.e., hit and miss).

b. *Additional soil vapor sampling*

To characterize the nature and extent of subsurface vapor contamination if soil vapor results are following a consistent pattern (e.g., traditional plume-like pattern).

To identify possible sources of subsurface vapor contamination.

To verify sampling results that appear inconsistent with previous sampling and/or the current understanding of the site [Sections 3.2.1 and 3.2.2].

To resample locations where results may have been invalidated by short-circuiting (outdoor air infiltration), cross contamination, or other problems.

To monitor the progress, or verify the completion, of efforts to remediate subsurface vapor contamination (either directly or indirectly).

c. *Sub-slab vapor, indoor air and outdoor air sampling*

Generally, if soil vapor results are fairly consistent throughout the study area, buildings closest to the site are sampled first. The investigation then proceeds outward, as appropriate, on an areal basis until potential and current human exposures have been adequately addressed. If there is an area of relatively elevated concentrations of volatile chemicals in soil vapor (when looking at the soil vapor results as a whole), then the buildings in this area are also sampled.

d. *Address exposures related to soil vapor intrusion*

Provisions on parcels may be appropriate so that the parcel will not be developed or buildings occupied without addressing exposure concerns [Sections 2.3 and 3.6].

As discussed previously, soil vapor sampling results alone typically do not drive actions to mitigate exposures in existing buildings. Rather, they guide sampling efforts in buildings. However, a "blanket mitigation" approach may be taken provided the nature and extent of soil vapor contamination has been sufficiently characterized. A "blanket mitigation" approach is where an area is defined within which each building may be offered a mitigation system. The offer is made regardless of what actions may be appropriate based on an evaluation of air results (e.g., no further action or monitoring).

Notes:

a. The recommended actions may be modified or supported upon consideration of the factors given in Section 3.2.

b. Additional sampling may become appropriate based on the migration of subsurface contamination (e.g., contaminated groundwater or vapors) or if environmental monitoring indicates a change in chemical constituents (e.g., the production of degradation products that may be more toxic than the parent compounds).

3.3.2 Sub-slab vapor

The goals of collecting sub-slab vapor samples are to identify potential and current (when collected concurrently with indoor and outdoor air samples) exposures associated with soil vapor intrusion and to characterize the nature and extent of subsurface vapor contamination. As discussed in Sections 3.2.5 and 3.3.1, New York State currently does not have any standards, criteria or guidance values for concentrations of compounds in sub-slab vapor. Additionally, there are no databases available of background levels of volatile chemicals in subsurface vapors.

The detection of volatile chemicals in sub-slab vapor samples does not necessarily indicate soil vapor intrusion is occurring or actions should be taken to address exposures. When making these decisions, the State considers the following:

a. the sampling results — sub-slab vapor, indoor air, outdoor air, soil vapor;
b. background concentrations of volatile chemicals in indoor air;
c. the NYSDOH's guidelines for volatile chemicals in air [Table 3.1];
d. human health risks (i.e., cancer and non-cancer health effects) associated with exposure to the volatile chemical in air;
e. attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations),
f. the NYSDOH's decision matrices [described in Section 3.4], and
g. the factors described in Section 3.2.

Based on this evaluation, the following actions may be recommended:

a. *No further action*

   When the volatile chemical is not detected in the indoor air and sub-slab sample results are not expected to substantially affect indoor air quality.

b. *Take reasonable and practical actions to identify source(s) and reduce exposures*

   The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile organic compound-containing products in places where people do not spend much time, such as a garage or outdoor shed). Resampling may be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

c. *Resampling*

Resampling may also be recommended when the results are not consistent with the conceptual site model. For example, when the sub-slab vapor results of a building do not indicate a need to take action, but the sub-slab vapor results of adjacent buildings indicate a need to take actions to address exposures related to soil vapor intrusion.

Resampling may be appropriate if samples were collected outside of the heating season. As discussed in Section 2.4.2, results obtained outside of the heating season should not be used to rule out exposures related to soil vapor intrusion.

d. *Monitoring*

Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, may be recommended to determine whether concentrations in indoor air or sub-slab vapor have changed. It is also recommended to determine what affect, if any, active soil and groundwater remediation techniques (e.g., chemical oxidation, air sparging, etc.) may be having on subsurface vapor and indoor air quality. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions.

e. *Mitigate*

Mitigation may be appropriate to minimize current or potential exposures associated with soil vapor intrusion. Mitigation methods are described in Section 4.

Notes:

a. The recommended actions may be modified or supported upon consideration of the factors given in Section 3.2.

b. Additional sampling may be appropriate based on the migration of subsurface contamination (e.g., contaminated groundwater or vapors) or if environmental monitoring indicates a change in chemical constituents (e.g., the production of degradation products that may be more toxic than the parent compounds).

c. Monitoring and mitigation measures to address exposures related to soil vapor intrusion are considered interim measures implemented until contaminated environmental media (e.g., soil, groundwater and/or soil vapor) are remediated.

d. Actions more protective of human health may be proposed. For example, such a decision may be based on a comparison of the costs associated with resampling or monitoring to the costs associated with installation and monitoring of a mitigation system.

e. Additional sampling associated with post-mitigation testing, operation, maintenance and monitoring activities, and termination of mitigation system operations is described in Section 4.

3.3.3 Indoor air

Indoor air samples are used to assess current exposures to volatile chemicals in air. The detection of volatile chemicals in indoor air samples does not necessarily indicate soil vapor intrusion is occurring or actions should be taken to address exposures. When making these decisions, the State considers the following:

a. the sampling results — sub-slab vapor, indoor air, outdoor air, soil vapor;

b. background concentrations of volatile chemicals in indoor air;

c. the NYSDOH's guidelines for volatile chemicals in air [Table 3.1];

d. human health risks (i.e., cancer and non-cancer health effects) associated with exposure to the volatile chemical in air;

e. attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations), and

f. the NYSDOH's decision matrices [described in Section 3.4], and

g. the factors described in Section 3.2.

When evaluating indoor air data, the results are compared to background levels of volatile chemicals in indoor air [Section 3.2.4], the NYSDOH's guidelines for volatile chemicals in air [Table 3.1], the NYSDOH's decision matrices [Section 3.4], and human health risks (i.e., cancer and non-cancer health effects) associated with exposure to the volatile chemical in air. This helps to put the results into perspective and to determine the need for action and the urgency with which actions should be taken. As discussed in Section 3.2.5, the urgency to complete reasonable and practical actions to reduce exposures increases with indoor air levels, particularly when air levels are above a guideline.

Generally, if the results are comparable to background levels, then no further action is needed to address *current* human exposures. However, additional sampling may be appropriate if

a. samples were collected at times when vapor intrusion is not expected to have its greatest effect on indoor air quality (typically, samples collected outside of the heating season). As discussed in Section 2.4, these results may not be used to rule out exposures related to soil vapor intrusion;

b. the potential for exposures related to soil vapor intrusion should be monitored based on the sub-slab vapor results [Section 3.3.2]; and/or

c. subsurface conditions change over time (e.g., due to the migration of contaminated groundwater or vapors).

If the concentrations of volatile chemicals are not consistent with background levels, then the likely cause of the exposure should be determined. Understanding the source is crucial for selecting the best method to address exposures. For example, although a volatile chemical may be detected in the sub-slab vapor sample, the results may indicate that indoor air effects are more likely to be coming from products stored in the building or from outdoor air rather than from contaminated soil vapors. Therefore, a sub-slab depressurization system to minimize exposures associated with soil vapor intrusion may not be appropriate.

As discussed in Sections 1.4 and 3.2.3, volatile chemicals may be present in the indoor air due to any one, or a combination, of the following:

a. the indoor environment itself and/or building characteristics;

b. off-gassing of volatile chemicals from contaminated water that may enter the building at the tap or shower head, or during flooding events, or contaminated water that rests in a sump or a subsurface drain;

c. outdoor sources; and/or

d. migration from the subsurface (i.e., soil vapor intrusion).

To determine the likely cause, the following assessment is completed:

a. qualitative and quantitative comparisons are made between the types and concentrations of the contaminants found in the indoor air sample(s) and those found in the outdoor air and sub-slab vapor sample;

b. qualitative and quantitative comparisons are made between indoor air results obtained in different locations of the building (e.g., different floors or rooms);

c. indoor air results are compared to the product inventory to evaluate the extent to which indoor sources are affecting indoor air quality; and

d. the indoor air quality questionnaire and building inventory form is reviewed to identify potential preferential pathways for soil vapor intrusion into the building, potential outdoor sources of volatile chemicals to the outdoor air (e.g., gasoline station or dry cleaner), and routes of air distribution within the building (e.g., HVAC system operations, airflow observations, etc.).

If a likely source or multiple sources can be identified from the available information, one or more of the following actions may be recommended given the source:

a. *Indoor source or building characteristics*

Products containing volatile chemicals should be tightly capped. Alternatively, the products can be stored in places where people do not spend much time, such as a garage or outdoor shed. If the products are no longer needed, consideration should be given to disposing of them properly (e.g., hazardous waste cleanup days). The list of products and corresponding readings from field instrumentation provided in the product inventory [Appendix B] can help identify products that may be contributing to the levels that were detected in the indoor air.

If exposures are assumed to be associated with off-gassing of new building materials, paint, etc., resampling may be appropriate to confirm this assumption or to confirm that actions taken to address these exposures have been effective.

b. *Off-gassing from contaminated groundwater within the building*

Measures should be taken to prevent contaminated groundwater from entering the house (e.g., filter on private well supply, sealed sump, etc.).

c. *Outdoor source*

No further action to address exposures related to soil vapor intrusion, unless the evaluation for soil vapor intrusion cannot be completed until outdoor interferences are addressed.

d. *Soil vapor intrusion*

Depending upon the relationship between indoor air concentrations and sub-slab vapor concentrations and the results of environmental sampling in the area, resampling, monitoring or mitigation may be recommended by the State.

1. Resampling, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, may be recommended when the results are not consistent with the conceptual site model. For example, when indoor air results are comparable or higher than the corresponding sub-slab vapor results and the results do not appear to be due to building characteristics or alternate sources (either indoor or outdoor).

2. Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, may be recommended to determine whether concentrations in indoor air or sub-slab vapor have changed. It is also recommended to determine what affect, if any, active soil and groundwater remediation techniques (e.g., chemical oxidation, air sparging, etc.) may be having on subsurface vapor and indoor air quality. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions.

3. Methods to mitigate exposures related to soil vapor intrusion are described in Section 4.

The party responsible for implementing the recommended actions will differ depending upon several factors, including the identified source of the volatile chemicals, the environmental remediation program, and site-specific and building-specific conditions. For example, to the extent that all site data and site conditions demonstrate that soil vapor intrusion is not occurring and that the potential for soil vapor intrusion to occur is not likely, the vapor intrusion investigation would be considered complete. In general, if indoor exposures represent a concern due to indoor sources, then the State will provide guidance to the property owner and/or tenant on ways to reduce their exposure. If indoor exposures represent a concern due to outdoor sources, then the NYSDEC will decide who is responsible for further investigation and any necessary remediation. Depending upon the outdoor source, this responsibility may or may not fall upon the party conducting the soil vapor intrusion investigation.

Likely sources may not be evident given the information available. Therefore, the above recommendations cannot be made. This situation most often arises for the following reasons:

a. Interfering indoor sources are identified. However, the possibility of vapor intrusion cannot be ruled out due to the concentrations of the same volatile chemicals detected in the sub-slab vapor sample. Differentiating the contribution of each source is not possible.

b. Indoor air samples were collected without concurrent outdoor air and sub-slab vapor samples. Depending upon other information that may be available (e.g., building inventory and well-characterized subsurface vapor contamination), identifying likely sources and recommending appropriate actions may not be possible.

c. All appropriate air samples are collected. However, the indoor air quality questionnaire and building inventory forms are filled out incompletely or incorrectly. The contribution of indoor sources cannot be evaluated.

When the source(s) of volatile chemicals to indoor air cannot be identified with confidence, resampling is typically recommended with corrections made as appropriate. For example, using the three scenarios presented above:

a. resampling occurs after interferences are removed;

b. concurrent indoor air, outdoor air and sub-slab vapor samples are collected; and

c. an indoor air quality questionnaire and building inventory form is filled out completely and correctly when samples are collected.

Notes: See notes presented in Section 3.3.2.

3.3.4 Outdoor air

Outdoor air sampling results are primarily used to evaluate the extent to which outdoor air may be contributing to the levels of volatile chemicals detected in indoor air. However, people are also exposed to the outdoor air and the outdoor air results are indicative of outdoor air conditions. As such, outdoor air results are also reviewed to determine whether outdoor air conditions present a potential concern that requires further investigation.

As discussed in Sections 1.4 and 3.2.3, volatile chemicals may be present in outdoor air due to emissions from automobiles, lawn mowers, oil storage tanks, gasoline stations, and dry cleaners or other commercial and industrial facilities. To determine what extent, if any, outdoor air is affecting indoor air quality, indoor air results are compared to outdoor air results. To determine whether outdoor air conditions present a potential concern that requires further investigation, the State looks at the data set as a whole and considers the following:

a. background concentrations of volatile chemicals in outdoor air;

b. the NYSDOH's guidelines for volatile chemicals in air [Table 3.1];

c. human health risks (i.e., cancer and non-cancer health effects) associated with exposure to the volatile chemical in air; and

d. the factors described in Section 3.2.

3.4 Decision matrices

3.4.1 Overview

Decision matrices are risk management tools, developed by the NYSDOH in conjunction with other agencies, to provide guidance on a case-by-case basis about actions that should be taken to address current and potential exposures related to soil vapor intrusion. The matrices are intended to be used when evaluating the results from buildings with full slab foundations. The matrices encapsulate the data evaluation processes and actions recommended to address exposures discussed in Sections 3.3.2 and 3.3.3. The general format of a decision matrix is shown in Table 3.2.

Table 3.2 General format of a decision matrix

	Indoor Air Concentration of Volatile Chemical (mcg/m^3)		
Sub-slab Vapor Concentration of Volatile Chemical (mcg/m^3)	Concentration Range 1	Concentration Range 2	Concentration Range 3
Concentration Range 1	ACTION	ACTION	ACTION
Concentration Range 2	ACTION	ACTION	ACTION
Concentration Range 3	ACTION	ACTION	ACTION

Indoor air and sub-slab vapor concentration ranges in a matrix are selected based on a number of considerations in addition to health risks. For example, factors that are considered when selecting the ranges include, but are not limited to, the following:

a. human health risks (i.e., cancer and non-cancer health effects) associated with exposure to the volatile chemical in air;

b. the NYSDOH's guidelines for volatile chemicals in air [Table 3.1];

c. background concentrations of volatile chemicals in air [Section 3.2.4];

d. analytical capabilities currently available; and

e. attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations).

3.4.2 Matrices

The NYSDOH has developed two matrices, which are included at the end of Section 3.4, to use as tools in making decisions when soil vapor may be entering buildings. The first decision matrix was originally developed for TCE and the second for PCE. As summarized in Table 3.3, four chemicals have been assigned to the two matrices to date.

Table 3.3 Volatile chemicals and their decision matrices

Chemical	**Soil Vapor/Indoor Air Matrix***
Carbon tetrachloride	Matrix 1
Tetrachloroethene (PCE)	Matrix 2
1,1,1-Trichloroethane (1,1,1-TCA)	Matrix 2
Trichloroethene (TCE)	Matrix 1

*The decision matrices are available at the end of Section 3.4.

Because the matrices are risk management tools and consider a number of factors, the NYSDOH intends to assign chemicals to one of these two matrices, if possible. For example, if a chemical other than those already assigned to a matrix is identified as a chemical of concern during a soil vapor intrusion investigation, assignment of that chemical into one of the existing decision matrices will be considered by the NYSDOH. Factors that will be considered in assigning a chemical to a matrix include, but are not limited to, the following:

a. human health risks, including such factors as a chemical's ability to cause cancer, reproductive, developmental, liver, kidney, nervous system, immune system or other effects, in animals and humans and the doses that may cause those effects;

b. the data gaps in its toxicologic database;

c. background concentrations of volatile chemicals in indoor air [Section 3.2.4]; and

d. analytical capabilities currently available.

If the NYSDOH determines that the assignment of the chemical into an existing matrix is inappropriate, then the NYSDOH will either modify an existing matrix or develop a new matrix.

To use the matrices appropriately as a tool in the decision-making process, the following should be considered:

a. The matrices are generic. As such, it may be appropriate to modify a recommended action to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, resampling may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Additionally, actions more protective of public health than those specified within the matrix may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action is usually undertaken for reasons other than public health (e.g., seeking community acceptance, reducing excessive costs, etc.).

b. Indoor air concentrations detected in samples collected from the building's basement or, if the building has a slab-on-grade foundation, from the building's lowest occupied living space should be used.

c. Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of vapor contamination, nor does it preclude remediating contaminated soil vapors or the source of soil vapor contamination.

d. When current exposures are attributed to sources other than vapor intrusion, the agencies should be provided documentation(e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix and to support assessment and follow-up by the agencies.

3.4.3 Description of recommended actions

Actions recommended in the matrix are based on the relationship between sub-slab vapor concentrations and corresponding indoor air concentrations. They are intended to address both potential and current human exposures and include the following:

a. *No further action*

When the volatile chemical is not detected in the indoor air sample and the concentration detected in the corresponding sub-slab vapor sample is not expected to substantially affect indoor air quality.

b. *Take reasonable and practical actions to identify source(s) and reduce exposures*

The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile chemical-containing products in places where people do not spend much time, such as a garage or shed). Resampling may also be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

d. *Monitor*

Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is appropriate to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be appropriate to determine whether existing building conditions (e.g., positive pressure HVAC systems) are maintaining the desired mitigation endpoint and to determine whether changes are appropriate.

The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions.

e. *Mitigate*

Mitigation is appropriate to minimize current or potential exposures associated with soil vapor intrusion. Methods to mitigate exposures related to soil vapor intrusion are described in Section 4.

f. *Monitor / Mitigate*

Monitoring or mitigation may be recommended after considering the magnitude of sub-slab vapor and indoor air concentrations along with building- and site-specific conditions.

Soil Vapor / Indoor Air Matrix 1

October 2006

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m^3)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m^3)			
	< 0.25	0.25 to < 1	1 to < 5.0	5.0 and above
< 5	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
5 to < 50	5. No further action	6. MONITOR	7. MONITOR	8. MITIGATE
50 to < 250	9. MONITOR	10. MONITOR / MITIGATE	11. MITIGATE	12. MITIGATE
250 and above	13. MITIGATE	14. MITIGATE	15. MITIGATE	16. MITIGATE

No further action:
Given that the compound was not detected in the indoor air sample and that the concentration detected in the sub-slab vapor sample is not expected to significantly affect indoor air quality, no additional actions are needed to address human exposures.

Take reasonable and practical actions to identify source(s) and reduce exposures:
The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile organic compound-containing products in places where people do not spend much time, such as a garage or outdoor shed). Resampling may be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

MONITOR:
Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MITIGATE:
Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system, and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MONITOR / MITIGATE:
Monitoring or mitigation may be recommended after considering the magnitude of sub-slab vapor and indoor air concentrations along with building- and site-specific conditions.

See additional notes on page 2.

ADDITIONAL NOTES FOR MATRIX 1

This matrix summarizes the minimum actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

[1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, resampling may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Additionally, actions more protective of public health than those specified within the matrix may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action is usually undertaken for reasons other than public health (e.g., seeking community acceptance, reducing excessive costs, etc.).

[2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of vapor contamination, nor does it preclude remediating contaminated soil vapors or the source of soil vapor contamination.

[3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.25 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples, a minimum reporting limit of 5 micrograms per cubic meter is recommended for buildings with full slab foundations, and 1 microgram per cubic meter for buildings with less than a full slab foundation.

[4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions may be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.

[5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.

[6] The party responsible for implementing the recommended actions will differ depending upon several factors, including the identified source of the volatile chemicals, the environmental remediation program, and site-specific and building-specific conditions. For example, to the extent that all site data and site conditions demonstrate that soil vapor intrusion is not occurring and that the potential for soil vapor intrusion to occur is not likely, the soil vapor intrusion investigation would be considered complete. In general, if indoor exposures represent a concern due to indoor sources, then the State will provide guidance to the property owner and/or tenant on ways to reduce their exposure. If indoor exposures represent a concern due to outdoor sources, then the NYSDEC will decide who is responsible for further investigation and any necessary remediation. Depending upon the outdoor source, this responsibility may or may not fall upon the party conducting the soil vapor intrusion investigation.

Soil Vapor / Indoor Air Matrix 2

October 2006

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg / m³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg / m³)			
	< 3	3 to < 30	30 to < 100	100 and above
< 100	1. No further action	2. Take reasonable and practical actions to identify source(s) and reduce exposures	3. Take reasonable and practical actions to identify source(s) and reduce exposures	4. Take reasonable and practical actions to identify source(s) and reduce exposures
100 to < 1,000	5. MONITOR	6. MONITOR / MITIGATE	7. MITIGATE	8. MITIGATE
1,000 and above	9. MITIGATE	10. MITIGATE	11. MITIGATE	12. MITIGATE

No further action:
Given that the compound was not detected in the indoor air sample and that the concentration detected in the sub-slab vapor sample is not expected to significantly affect indoor air quality, no additional actions are needed to address human exposures.

Take reasonable and practical actions to identify source(s) and reduce exposures:
The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Therefore, steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile organic compound-containing products in places where people do not spend much time, such as a garage or outdoor shed). Resampling may be recommended to demonstrate the effectiveness of actions taken to reduce exposures.

MONITOR:
Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building-specific basis, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MITIGATE:
Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system, and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

MONITOR / MITIGATE:
Monitoring or mitigation may be recommended after considering the magnitude of sub-slab vapor and indoor air concentrations along with building- and site-specific conditions.

See additional notes on page 2.

ADDITIONAL NOTES FOR MATRIX 2

This matrix summarizes the minimum actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

[1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, resampling may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Additionally, actions more protective of public health than those specified within the matrix may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action is usually undertaken for reasons other than public health (e.g., seeking community acceptance, reducing excessive costs, etc.).

[2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of vapor contamination, nor does it preclude remediating contaminated soil vapors or the source of soil vapor contamination.

[3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 3 micrograms per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples, a minimum reporting limit of 5 micrograms per cubic meter is recommended.

[4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions may be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.

[5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.

[6] The party responsible for implementing the recommended actions will differ depending upon several factors, including the identified source of the volatile chemicals, the environmental remediation program, and site-specific and building-specific conditions. For example, to the extent that all site data and site conditions demonstrate that soil vapor intrusion is not occurring and that the potential for soil vapor intrusion to occur is not likely, the soil vapor intrusion investigation would be considered complete. In general, if indoor exposures represent a concern due to indoor sources, then the State will provide guidance to the property owner and/or tenant on ways to reduce their exposure. If indoor exposures represent a concern due to outdoor sources, then the NYSDEC will decide who is responsible for further investigation and any necessary remediation. Depending upon the outdoor source, this responsibility may or may not fall upon the party conducting the soil vapor intrusion investigation.

3.5 Emergency response

The NYSDOH's staff are responsible for recommending that residents relocate in cases where there may be health risks resulting from exposure to petroleum spills. These roles and responsibilities are outlined in Environmental Health Manual Technical Reference and Procedural Items BTSA-01. Air sampling is appropriate in some cases for demonstrating that spill cleanup and engineering controls have been effective in reducing indoor air impacts and associated health risks to residents. At a minimum, air samples are collected from the basement, first floor and from outdoors. Whether sub-slab or soil gas samples will be taken is evaluated on a case-by-case basis. Air testing data are sometimes used as the basis for ending emergency relocation financial support. For additional information, please contact the NYSDOH's Bureau of Toxic Substance Assessment by calling 1-800-458-1158.

Emergency actions not related to petroleum spills are handled on a case-by-case basis.

3.6 Parcels that are undeveloped or contain unoccupied buildings

If investigation of a parcel that is undeveloped or contains unoccupied buildings is being delayed until the site is being developed or occupied, measures should be in place that assure the State that no development or occupation will occur without addressing the exposures. Institutional controls may be used for this purpose. An institutional control is any non-physical means of enforcing a restriction on the use of real property that

a. limits human or environmental exposure,
b. provides notice to potential owners, operators or members of the public, or
c. prevents actions that would interfere with the effectiveness of remedial actions or with the effectiveness and/or integrity of operation, maintenance or monitoring activities at a site.

An institutional control that is often used is an environmental easement. An environmental easement is an enforced mechanism used for property where the remedial actions leave residual contamination that makes the property suitable for some, but not all uses, or includes engineering controls that must be maintained for the easement to be effective. The purpose of the easement is to ensure that such use restrictions or engineering controls remain in place. An environmental easement

a. can only be created by the property owner (the *grantor*) through a written instrument recorded in the appropriate county recording office. It can only be granted to the State (the *grantee*) and can only be extinguished or amended by a written instrument executed by the Commissioner of the Department of Environmental Conservation and duly recorded;
b. is binding upon all subsequent owners and occupants of the property. The deed or deeds for the property (as well as any other written instruments conveying any interest in the property) must contain a prominent notice that it is subject to an environmental easement; and
c. may be enforced in perpetuity against the *grantor*, subsequent owners of the property, lessees, and any person using the property by its grantor, by the State, or by the municipality in which the property is located.

If these actions cannot be implemented, alternative measures should be in place that assure the State that the parcel will not be developed or buildings occupied without addressing the exposure concerns. For example, arrangements should be made for the town, village or city to notify the appropriate party when new construction or tenants are proposed for the parcel (e.g., permit applications and grants) or ownership of the parcel changes.

Section 4: Soil Vapor Intrusion Mitigation

As discussed in Section 1.1, soil vapor can enter a building through cracks or perforations in slabs or basement floors and walls, and through openings around sump pumps or where pipes and electrical wires go through the foundation primarily because of a difference between interior and exterior pressures. This intrusion is similar to how radon gas enters buildings from the subsurface. Fortunately, given this similarity, well-established techniques for mitigating exposures to radon may also be used to mitigate exposures related to soil vapor intrusion.

Once it is determined that steps should to be taken to address exposures associated with soil vapor intrusion, they should be implemented with all due expediency. This section provides an overview of:

a. methods of mitigation,
b. installation and design of mitigation systems,
c. post-mitigation testing,
d. operation, maintenance and monitoring of mitigation systems,
e. termination of mitigation system operations, and
f. annual certification.

Mitigation is considered to be an interim measure to address exposures until contaminated environmental media are remediated, or until mitigation is no longer needed to address exposures related to soil vapor intrusion.

4.1 Methods of mitigation

The most effective mitigation methods involve sealing infiltration points and actively manipulating the pressure differential between the building's interior and exterior (on a continuous basis). As discussed in the following subsections, the appropriate method to use will largely depend upon the building's foundation design. Furthermore, buildings having more than one foundation design feature (e.g., a basement under one portion of the house and a crawl space beneath the remainder) may require a combination of mitigation methods. This section describes methods of mitigation that are expected to be the most reliable options under a wide range of circumstances. Occasionally, there are site-specific or building-specific conditions under which alternative methods (such as HVAC modification, sealing, room pressurization, passive ventilation systems, or vapor barriers) may be more appropriate. Such mitigation proposals may be considered on a case-by-case basis.

4.1.1 Buildings with a basement slab or slab-on-grade foundation

In conjunction with *sealing* potential subsurface vapor entry points, an active *sub-slab depressurization system* (SSD system) is the preferred mitigation method for buildings with a basement slab or slab-on-grade foundation. A SSD system uses a fan-powered vent and piping to draw vapors from the soil beneath the building's slab (i.e., essentially creating a vacuum beneath the slab) and discharge them to the atmosphere. This results in lower sub-slab air pressure relative to indoor air pressure, which prevents the infiltration of sub-slab vapors into the building.

The most common approach to achieving depressurization beneath the slab is to insert the piping through the floor slab into the crushed rock or soil underneath. However, the EPA, in their "Consumer's Guide to Radon Reduction" (EPA 402-K-03-002; revised February 2003), lists the following approaches as ways to reduce radon levels in a building, either in place of the more common sub-slab suction point method or in conjunction with that method:

a. *Drain tile suction* — Some houses have drain tiles or perforated pipe to direct water away from the foundation of the house. Suction on these tiles or pipes is often effective;

b. *Sump hole suction* — If the building has a sump pump to remove unwanted water, the sump can be capped so that it can continue to drain water and serve as the location for piping. If the sump is not used as the suction or extraction point, the associated wiring and piping should be sealed and an air-tight cover should be installed to enhance the performance of the SSD system; and

c. *Block wall suction* — If the building has hollow block foundation walls, the void network within the wall may be depressurized by drawing air from inside the wall and venting it to the outside. This method is often used in combination with sub-slab depressurization.

The depressurization approach, or combination of approaches, selected for a building should be determined on a building-specific basis due to building-specific features that may be conducive to a specific depressurization approach. For example, if the contaminants are entering the building through a block wall, block wall suction in conjunction with traditional sub-slab depressurization may be more effective at minimizing exposures related to soil vapor intrusion rather than sub-slab depressurization alone.

Although sealing is not a reliable mitigation technique on its own, it can significantly improve the effectiveness of a SSD system since it limits the flow of subsurface vapors into the building. All joints, cracks and other penetrations of slabs, floor assemblies and foundation walls below or in contact with the ground surface should be sealed with materials that prevent air leakage.

If the State concurs that a SSD system is not a practicable alternative or that exposures will be mitigated concurrently by a method selected to remediate subsurface contamination, alternative mitigation methods may be considered, such as the following:

a. *HVAC modification* — a technique where the building's HVAC system is modified to avoid depressurization of the building relative to underlying and surrounding soil (i.e., to maintain a positive pressure within the building); and

b. *Soil vapor extraction (SVE) system* — a technique used to remediate contaminated subsurface soil vapor. SVE systems use high flow rates, induced vacuum or both to collect and remove contamination, while SSD systems use a minimal flow rate to effect the minimum pressure gradient (see the EPA's technical guidance documents for recommended gradients; Section 4.2.3) needed to reverse air flow across a building's foundation. Depending upon the SVE system's design, the system may also serve to mitigate exposures. For example, the SVE system's radius of influence includes the subsurface beneath affected buildings or horizontal legs of the system will be installed beneath affected buildings. However, complications can arise if the SVE system is no longer effective at remediating contaminated vapors, exposures should still be mitigated due to residual vapor contamination.

4.1.2 Buildings with a crawl space foundation

A *soil vapor retarder* with *sub-membrane depressurization (SMD) system* is the preferred mitigation method for buildings with a crawl space foundation. A soil vapor retarder is a synthetic membrane or other comparable material that is placed on the ground in the crawl space to retard the flow of soil vapors into the building. A SMD system is similar to a SSD system. It uses a fan-powered vent and piping to draw vapors from beneath the soil vapor retarder and discharge them to the atmosphere. This results in lower air pressure beneath the membrane relative to air pressure in the crawl space, which prevents the infiltration of subsurface vapors into the building.

If the State concurs that a soil vapor retarder with a SMD system is not a practicable alternative or that exposures will be mitigated concurrently by a method selected to remediate subsurface contamination, alternative mitigation methods may be considered, such as the following:

a. *HVAC modification* — a technique where the building's HVAC system is modified to avoid depressurization of the building relative to the crawl space;

b. C*rawl space ventilation with sealing* — a technique that uses a fan to draw air out of the crawl space; and

c. *SVE system* [Section 4.1.1].

4.1.3 Buildings with dirt floor basements

Either a SSD system with a newly poured slab or a SMD system with a soil vapor retarder may be used. However, the former method is preferred.

4.1.4 Buildings with multiple foundation types

Mitigation in a building with a combination of foundations should be achieved by applying the specific methods described previously [Sections 4.1.1 through 4.1.3] to the corresponding foundation segments of the building. Special consideration should be given to the points at which different foundation types join, since additional soil vapor entry routes exist in such locations. Often, the various systems can be installed and connected to a common depressurization system and fan.

4.1.5 Undeveloped parcels

If sampling results indicate a mitigation system is recommended to address exposures in buildings that may be constructed, then a SSD system with sealing, or a SMD system with a soil vapor retarder, or a combination of these methods is recommended, as appropriate to the design of the proposed buildings.

4.1.6 Additional references

The following documents provide additional information on selecting an appropriate mitigation method:

a. *A Consumer's Guide to Radon Reduction*
EPA [EPA 402-K-03-002, revised February 2003]

This document provides assistance in selecting a qualified radon mitigation contractor to reduce the radon levels in a home, determining an appropriate radon reduction method, and maintaining a radon reduction system. It is available at the EPA's web site: http://www.epa.gov/iaq/radon/pubs/index.html; and

b. *Reducing Radon in Schools: A Team Approach*
EPA [EPA 402-R-94-008, April 1994]

This document will provide assistance in determining the best way to reduce elevated radon levels found in a school. It provides guidance on the process of confirming a radon problem, selecting the best mitigation strategy, and directing the efforts of a multidisciplinary team assembled to address elevated radon levels in a way that will contribute to the improvement of the overall indoor air quality of the school. Copies can be ordered from the EPA's Indoor Air Quality Information Clearinghouse at 1-800-438-4318.

4.2 Design and installation of mitigation systems

Once a mitigation method is selected, it should be designed and installed. The components of the design and installation of mitigation systems, the procedures for specific mitigation techniques, and references for technical guidance are provided in the following subsections.

4.2.1 General recommendations

Systems should be designed and installed by a professional engineer or environmental professional. In most areas of the state, there are contractors who have met certain requirements and are trained to identify and fix radon problems in buildings. To obtain the names of local contractors, contact the NYSDOH's Radon Program at 1-800-458-1158, extension 27556, or visit the National Radon Safety Board's web site (www.nrsb.org) or National Environmental Health Association's web site (www.neha.org).

Typically, the party responsible for remediating the site is responsible for arranging design and installation activities. If no responsible party is available, the State will arrange for the design and installation of the system. All design and installation activities should be documented and reported to the agencies. Furthermore, once a mitigation system is installed, an information package should be given to the building's owner and tenants, if applicable, to facilitate their understanding of the system's operation, maintenance and monitoring [Section 5.6].

With the exception of SVE systems, the mitigation methods introduced in Section 4.1 are not intended to remediate the source of subsurface vapors (e.g., contaminated groundwater, soil, etc.). Rather, they are designed to minimize the infiltration of subsurface vapors into a building. For consistency in implementing the techniques in residential buildings, mitigation systems should be designed and installed in accordance with the following:

a. *Standard Practice for Installing Radon Mitigation Systems in Existing Low-rise Residential Buildings* (ASTM E-2121)

American Society for Testing and Materials (ASTM) International [ASTM E-2121-03, February 10, 2003]

This document applies to existing buildings. The purpose of this document is to provide radon mitigation contractors with uniform standards that will ensure quality and effectiveness in the design, installation, and evaluation of radon mitigation systems in detached and attached residential buildings three stories or less in height. Information on how to obtain a copy of this standard is available in Appendix E; and

b. *Model Standards and Techniques for Control of Radon in New Residential Buildings* EPA [EPA 402-R-94-009, March 1994]

This document applies to new construction and contains information on how to incorporate radon reduction techniques and materials in residential construction. A copy of this document is provided in Appendix F.

4.2.2 System-specific recommendations

Basic design and installation recommendations for mitigation systems follow. These are based upon recommendations and requirements given by the EPA for mitigating exposures related to radon intrusion (for additional information see EPA's web site on radon at http://www.epa.gov/iaq/radon/pubs/index.html).

a. *Sealing* — To improve the effectiveness of depressurization and ventilation systems and to limit the flow of subsurface vapors into the building, materials that prevent air leakage should be used, such as elastomeric joint sealant (as defined in ASTM C920-87), compatible caulks, non-shrink mortar, grouts, expanding foam, "Dranjer" drain seals, or airtight gaskets. Some effective sealants may contain volatile organic compounds; in some situations, this may be a consideration in choosing an appropriate sealing material.

b. *Soil vapor retarder (membrane)* —

1. To retard the infiltration of subsurface vapors into the building and enhance the performance of a SMD system, a minimum 6 mil (or 3 mil cross-laminated) polyethylene or equivalent flexible sheeting material should be used.

2. The sheet should cover the entire floor area and be sealed at seams (with at least a 12 inch overlap) and penetrations, around the perimeter of interior piers and to the foundation walls.

3. Enough of the sheeting should be used so it will not be pulled away from the walls when the depressurization system is turned on and the sheet is drawn down.

4. If a membrane is installed in areas that may have future foot traffic (e.g., a dirt floor in a basement), consideration should be given to also installing a wearing surface such as sand or stone to protect the integrity of the membrane. Additionally, a layer of fine sand may be prudent beneath the membrane to protect it from penetrations by sharp objects in the dirt floor.

c. *Depressurization systems —*

1. The systems should be designed to avoid the creation of other health, safety, or environmental hazards to building occupants (e.g., backdrafting of natural draft combustion appliances).

2. The systems should be designed to minimize soil vapor intrusion effectively while minimizing excess energy usage, to avoid compromising moisture and temperature controls and other comfort features, and to minimize noise.

3. To evaluate the potential effectiveness of a SSD before it is installed, a diagnostic test (commonly referred to as a "communication" test) should be performed to measure the ability of a suction field and air flow to extend through the material beneath the slab. This test is commonly conducted by applying suction on a centrally located hole drilled through the concrete slab and simultaneously observing the movement of smoke downward into small holes drilled in the slab at locations separated from the central suction hole. A similar quantitative evaluation may also be performed by using a digital micromanometer or comparable instrument. Depending on test results, multiple suction points may be needed to achieve the desired effectiveness of the system.

4. Passive systems (i.e., a SSD system without a vent fan) are not as effective as active systems and their performance varies depending upon ambient temperatures and wind conditions. Therefore, active systems should be used to ensure exposures are being addressed.

5. The vent fan and discharge piping should not be located in or below a livable or occupied area of the building to avoid entry of extracted subsurface vapors into the building in the event of a fan or pipe leak.

6. To avoid entry of extracted subsurface vapors into the building, the vent pipe's exhaust should be
    - i. above the eave of the roof (preferably, above the highest eave of the building at least 12 inches above the surface of the roof),
    - ii. at least 10 feet above ground level,
    - iii. at least 10 feet away from any opening that is less than 2 feet below the exhaust point, and
    - iv. 10 feet from any adjoining or adjacent buildings, or HVAC intakes or supply registers.

7. Rain caps, if used, should be installed so as not to increase the potential for extracted subsurface vapors to enter the building.

8. To avoid accidental changes to the system that could disrupt its function, the depressurization system should be labeled clearly. An example of such labeling is shown in Figure 5.1.

9. A warning device or indicator should be installed to alert building occupants if the active system stops working properly. Examples of system failure warning devices and indicators include the following: a liquid gauge (e.g., a

manometer), a sound alarm, a light indicator, and a dial (needle display) gauge. The warning device or indicator should be placed where it can be easily heard or seen. The party installing the system should verify the warning device or indicator is working properly. Building occupants should be made aware of the warning device or indicator (what it is, where it is located, how it works, how to read/understand it, and what to do if it indicates the system is not working properly).

d. *HVAC systems* — HVAC systems should be carefully designed, installed and operated to avoid depressurization of basements and other areas in contact with the soil.

e. *Crawl space ventilation* —

1. Ventilation systems should be designed to avoid the creation of other health, safety, or environmental hazards to building occupants (e.g., backdrafting of natural draft combustion appliances).

2. Openings and cracks in floors above the crawl space that would permit conditioned air to pass into or out of the occupied spaces of the building, should be identified, closed and sealed.

f. *SVE systems designed to also mitigate exposures* —

1. The systems should be designed to avoid the creation of other health, safety, or environmental hazards to building occupants (e.g., backdrafting of natural draft combustion appliances).

2. To avoid reentry of soil vapor into the building(s), the exhaust point should be located away from the openings of buildings and HVAC air intakes. Depending upon the concentrations of volatile chemicals in subsurface vapors and the expected mass removal rate, treatment (e.g., via carbon filters) of the SVE system effluent may be appropriate to minimize outdoor air effects.

3. The SVE system's radius of influence should adequately address buildings requiring mitigation, as well as subsurface sources requiring remediation. If it does not, additional actions may be appropriate. For example, if the radius of influence does not completely extend beneath a building, a complementary air monitoring program may be appropriate to confirm that exposures are being addressed adequately while the SVE system is operating.

4.2.3 Technical guidance

To address exposures effectively in larger buildings, some of the same techniques used in residential buildings can be scaled up in size, number, or performance (e.g., adjustments in the size and air movement capacity of the vent pipe fan, or installation of multiple suction points through the slab instead of a single point). The design of the techniques may also be modified (e.g., installation of horizontal pipes beneath the building instead of a single suction point).

Detailed technical guidance on designing and installing mitigation systems in residential and non-residential buildings is provided in various documents, such as the following, released by the EPA and others:

a. References provided in ASTM's E-2121 (see Appendix E for information on how to obtain a copy) and the EPA's *Model Standards and Techniques for Control of Radon in New Residential Buildings* (Appendix F);

b. *Radon Reduction Techniques for Existing Detached Houses: Technical Guidance (Third Edition) for Active Soil Depressurization Systems*
EPA [EPA 625/R-93-011, October 1993]

   This technical guidance document has been prepared to serve as a comprehensive aid in the detailed selection, design, installation, and operation of indoor radon reduction measures for existing houses based on active soil depressurization techniques. It is intended for use by radon mitigation contractors, building contractors, concerned homeowners, state and local officials and other interested persons. Copies can be ordered from the EPA's Indoor Air Quality Information Clearinghouse at 1-800-438-4318;

c. *Protecting Your Home From Radon: A Step-by-Step Manual for Radon Reduction*
Kladder *et al.*, 1993

   This manual is designed to provide sufficient information to a homeowner to make many of the basic repairs that can significantly reduce radon levels in the home;

d. *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes*
EPA [EPA 402-K-01-002, April 2001]

   This fully illustrated guide contains all the information needed in one place to educate home builders about radon-resistant new construction (RRNC), including the following: basic questions and detailed answers about radon and RRNC, specific planning steps before installing a system, detailed installation instructions with helpful illustrations, tips and tricks when installing a system, marketing know-how when dealing with homebuyers, and architectural drawings. This document is available at the EPA's web site: http://www.epa.gov/iaq/radon/pubs/index.html; and

e. *Radon Prevention in the Design and Construction of Schools and Other Large Buildings*
EPA [EPA 625-R-92-016, June 1994]

   It is typically easier and much less expensive to design and construct a new building with radon-resistant and/or easy-to-mitigate features, than to add these features after the building is completed and occupied. Specific guidelines on how to incorporate radon prevention features in the design and construction of schools and other large buildings are detailed in this manual. Copies can be ordered from the EPA's Indoor Air Quality Information Clearinghouse at 1-800-438-4318. This document is also available on the EPA Office of Research and Development's web site: http://www.epa.gov/ORD/NRMRL/pubs/625r92016/625r92016.htm.

4.3 Post-mitigation or confirmation testing

Once a mitigation system is installed, its effectiveness and proper installation should be confirmed. The party that installed the system should conduct post-mitigation testing and for developing a post-mitigation testing plan. Minimum objectives for post-mitigation testing associated with specific mitigation methods are provided in the following subsections. All post-mitigation testing activities should be documented and reported to the agencies.

4.3.1 SSD systems with sealing

a. Reasonable and practical actions should be taken to identify and fix leaks. With the depressurization system operating, smoke tubes are used to check for leaks through concrete cracks, floor joints, and at the suction point. Any leaks identified should be resealed until smoke is no longer observed flowing through the opening.

b. Once a depressurization system is installed, its operation may compete with the proper venting of fireplaces, wood stoves and other combustion or vented appliances (e.g., furnaces, clothes dryers, and water heaters), resulting in the accumulation of exhaust gases in the building and the potential for carbon monoxide poisoning. Therefore, in buildings with natural draft combustion appliances, the building should be tested for backdrafting of the appliances. Backdrafting conditions should be corrected before the depressurization system is placed in operation.

c. The distance that a pressure change is induced in the sub-slab area (i.e., a pressure field extension test) should be conducted. Analogous to a communication test, this test is commonly conducted by operating the depressurization system and simultaneously observing the movement of smoke downward into small holes (e.g., 3/8 inch) drilled through the slab at sufficient locations to demonstrate that a vacuum is being created beneath the entire slab. A similar quantitative evaluation may also be performed by using a digital micromanometer or comparable instrument. If adequate depressurization is not occurring, the reason (e.g., improper fan operation) should be identified and corrected.

d. Adequate operation of the warning device or indicator should be confirmed.

e. Except as indicated below, post-mitigation indoor and outdoor air sampling should be conducted in all buildings where pre-mitigation samples were collected and in all buildings where physical data suggest possible impediments to comprehensive sub-slab communication of the depressurization system (i.e., locations with wet or dense sub-slab soils, multiple foundations and footings, minimal pressure differentials between the interior and sub-slab). Generally, indoor and outdoor air sampling locations, protocols and analytical methods should be consistent between pre-mitigation and post-mitigation sampling, where applicable. In buildings with basements, post-mitigation indoor air sampling from the basement alone (i.e., without a concurrent indoor air sample from the first floor) is recommended in most circumstances.

   Typically, post-mitigation sampling should be conducted no sooner than 30 days after installing a depressurization system. If the system is installed outside of the heating season or at the end of a season, post-mitigation air sampling may be postponed until the heating season.

   In cases of widespread mitigation due to vapor contamination and depending upon the basis of making decisions (e.g., a "blanket mitigation" approach within a specified area of documented vapor contamination [Section 3.3.1]), a representative number of buildings from an identified study area, rather than each building, may be sampled. Prior to implementation, this type of post-mitigation sampling approach should be approved by State agency personnel.

In newly constructed buildings, a site-specific and building-specific indoor air sampling plan is recommended due to potential interferences caused by the off-gassing of volatile chemicals in new building materials (e.g., paints, carpets, furniture, etc. [Section 1.4]). In these situations, if indoor air sampling is appropriate samples should be

i. collected while the system is operational but before potentially interfering factors are brought into the building,

ii. analyzed for a targeted list of volatile chemicals based on previous environmental sampling (e.g., groundwater, soil, soil vapor, etc.), and/or

iii. collected while the system is operational but after potentially interfering factors have had an opportunity to off-gas.

If post-mitigation sampling results do not indicate a significant decrease in the concentrations of volatile chemicals previously believed to be present in the indoor air due to soil vapor intrusion, the reason (e.g., indoor or outdoor sources, improper operation of the mitigation system, etc.) should be identified and corrected as appropriate.

4.3.2 SMD systems with soil vapor retarder

a. Reasonable and practical actions should be taken to identify and fix leaks. With the depressurization system operating, smoke tubes are used to check for leaks in the membrane at seams, edge seals and at locations where the sheet was sealed around obstructions. Any leaks identified should be resealed until smoke is no longer observed flowing through the opening.

b. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].

c. Adequate operation of the warning device or indicator should be confirmed.

d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [as discussed in Section 4.3.1].

4.3.3 HVAC modifications

a. Check the building for positive pressure conditions (e.g., verify a pressure controller is maintaining the desired pressure differential and/or measure the pressure differential between the sub-slab and indoor air by using field instruments).

b. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].

c. Adequate operation of the warning device or indicator, if applicable, should be confirmed.

d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [Section 4.3.1].

4.3.4 Crawl space ventilation and sealing

a. Reasonable and practical actions should be taken to identify and fix leaks. With the ventilation system operating, smoke tubes are used to check for leaks in openings and cracks in floors above the crawl space that were sealed during installation of the system. Any leaks identified should be resealed until smoke is no longer observed flowing through the opening.

b. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].

c. Adequate operation of the warning device or indicator, if applicable, should be confirmed.

d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [as discussed in Section 4.3.1].

4.3.5 SVE systems designed to also mitigate exposures

a. Backdrafting conditions should be evaluated and corrected [Section 4.3.1].

b. The distance that a pressure change is induced in the sub-slab area should be conducted. This may be done by operating the SVE system and simultaneously observing the movement of smoke downward into small holes (e.g., 3/8 inch) drilled through the building's slab at sufficient locations to demonstrate that a vacuum is being created beneath the entire slab.

c. Adequate operation of the warning device or indicator, if applicable, should be confirmed.

d. Post-mitigation indoor and outdoor air testing should be conducted in buildings where pre-mitigation samples were collected [Section 4.3.1].

4.4 Operation, maintenance and monitoring of mitigation systems

When mitigation systems are implemented at a site, the operation, maintenance and monitoring (OM&M) protocols for the systems should be included in a site-specific site management plan (formerly referred to as operation, maintenance and monitoring plan). The party that installed the system should conduct OM&M activities and should develop the site management plan. Recommendations for minimum OM&M activities associated with specific mitigation methods are provided in the following subsections. Also included is a discussion of non-routine maintenance. All routine and non-routine OM&M activities should be documented and reported to the agencies.

4.4.1 SSD and SMD systems

Routine maintenance should commence within 18 months after the system becomes operational, and should occur every 12 to 18 months thereafter. Based upon a demonstration of the system's reliability, the State recommends that, if a different frequency is desired, a petition describing the alternative frequency and the reasons that frequency is preferred be submitted to the State. Any comments the State may have on the petition should be considered before the frequency is altered.

During routine maintenance, the following activities (at a minimum) should be conducted:

a. a visual inspection of the complete system (e.g., vent fan, piping, warning device or indicator, labeling on systems, soil vapor retarder integrity, etc.),
b. identification and repair of leaks [Sections 4.3.1 and 4.3.2], and
c. inspection of the exhaust or discharge point to verify no air intakes have been located nearby.

As appropriate preventative maintenance (e.g., replacing vent fans), repairs and/or adjustments should be made to the system to ensure its continued effectiveness at mitigating exposures related to soil vapor intrusion. The need for preventative maintenance will depend upon the life expectancy and warranty for the specific part, as well as visual observations over time. The need for repairs and/or adjustments will depend upon the results of a specific activity compared to that obtained when system operations were initiated.

If significant changes are made to the system or when the system's performance is unacceptable, the system may need to be redesigned and restarted. Many, if not all, of the post-mitigation testing activities, as described in Sections 4.3.1 and/or 4.3, may be appropriate. The extent of such activities will primarily depend upon the reason for the changes and the documentation of sub-slab depressurization.

Generally, air monitoring is not recommended if the system has been installed properly and is maintaining a vacuum beneath the entire slab.

In addition to the routine OM&M activities described here, the building's owner and tenants are given information packages that explains the system's operation, maintenance and monitoring [Section 5.6]. Therefore, at any time during the system's operation, the building's owner or tenants may check that the system is operating properly.

4.4.2 Other mitigation systems

For other mitigation systems (e.g., HVAC modifications, crawl space ventilation, etc.), routine maintenance activities are generally comparable to post-mitigation testing activities [Section 4.3]. Activities typically include a visual inspection of the complete system, and identification and repair of leaks. System performance checks, such as air stream velocity measurements of ventilation systems, also should be performed.

As appropriate, preventative maintenance (e.g., replacing filters, cleaning lines, etc.), repairs and/or adjustments should be made to the system to ensure its continued effectiveness at mitigating exposures related to soil vapor intrusion. If significant changes are made to the system or when the system's performance is unacceptable, redesigning and restarting the system may be appropriate[Section 4.4.1].

Air monitoring, such as periodic sub-slab vapor, indoor air and outdoor air sampling, may be appropriate to determine whether existing building conditions are maintaining the desired mitigation endpoint and to determine whether changes are appropriate. The type and frequency of monitoring is determined based upon site-specific and building-specific conditions, taking into account applicable environmental data, building operating conditions, and the mitigation method employed.

4.4.3 Non-routine maintenance

Non-routine maintenance may also be appropriate during the operation of a mitigation system. Examples of such situations include the following:

a. the building's owners or occupants report that the warning device or indicator indicates the mitigation system is not operating properly;

b. the mitigation system becomes damaged; or

c. the building has undergone renovations that may reduce the effectiveness of the mitigation system.

Activities conducted during non-routine maintenance visits will vary depending upon the reason for the visit. In general, building-related activities may include examining the building for structural or HVAC system changes, or other changes that may affect the performance of the depressurization system (e.g., new combustion appliances, deterioration of the concrete slab, or significant changes to any of the building factors listed in Table 1.2). Depressurization system-related activities may include examining the operation of the warning device or indicator and the vent fan, or the extent of sub-slab depressurization. Repairs or adjustments should be made to the system as appropriate. If appropriate, the system should be redesigned and restarted [Section 4.4.1].

4.5 Termination of mitigation system operations

Mitigation systems should not be turned off, until the State receives, and has had the opportunity to comment on, a proposal to turn off mitigation systems. The party seeking to turn off the mitigation systems should consider any comments the State may have on the proposal, except in emergency situations. Systems should remain in place and operational until they are no longer needed to address current or potential exposures related to soil vapor intrusion. This determination should be based upon several factors, including the following:

a. subsurface sources (e.g., groundwater, soil, etc.) of volatile chemical contamination in subsurface vapors have been remediated based upon an evaluation of appropriate post-remedial sampling results;

b. residual contamination, if any, in subsurface vapors is not expected to affect indoor air quality significantly based upon soil vapor and/or sub-slab vapor sampling results;

c. residual contamination, if any, in subsurface vapors is not affecting indoor air quality when active mitigation systems are turned off based upon indoor air, outdoor air and sub-slab vapor sampling results at a representative number of buildings; and

d. there is no "rebound" effect for which additional mitigation efforts would be appropriate observed when the mitigation system is turned off for prolonged periods of time. This determination should be based upon indoor air, outdoor air and/or sub-slab vapor sampling from the building over a time period, determined by site-specific conditions.

Given the prevalence of radon throughout the State of New York, consideration should be given to leaving the system in place and operating to address exposures related to radon intrusion after concurrence is reached that the system is no longer needed to mitigate exposures related to soil vapor intrusion. This action should be done only with permission of the property owner and after the property owner is aware of their responsibilities in operating, monitoring and maintaining the system for this specific purpose. If the property owner declines the offer, the system should be shut down and, if requested, removed in a timely manner.

4.6 Annual certification and notification recommendations

Mitigation systems are considered engineering controls, defined as any physical barrier or method employed to

1. actively or passively contain, stabilize, or monitor hazardous waste or petroleum,
2. restrict the movement of hazardous waste or petroleum to ensure the long-term effectiveness of remedial actions, or
3. eliminate potential exposure pathways to hazardous waste or petroleum.

Therefore, depending upon the remedial program, submission of an annual certification to the State may be required. This certification must be prepared and submitted by a professional engineer or environmental professional and affirm that the engineering controls are in place, are performing properly and remain effective. This requirement of certification remains in effect until the State provides notification, in writing, that this certification is no longer needed.

If a property owner declines a mitigation system, the party responsible for arranging the design and installation of the system should renew the offer on an annual basis, unless they demonstrate environmental conditions have changed such that a system is no longer needed.

Section 5: Community Outreach

While community outreach is an essential component of the investigation and remediation of any site, it is particularly critical when evaluating soil vapor intrusion at a site due to the following:

a. a heightened awareness by environmental professionals and the general public (both nationally and state-wide) for the importance of soil vapor intrusion;

b. the relatively complicated nature of the exposure pathway (e.g., chemicals in groundwater or soil ending up in the indoor air of buildings versus contaminated groundwater entering the house through the use of a private well);

c. the unknowns associated with the evolving science of investigating, evaluating, and mitigating exposures related to soil vapor intrusion; and

d. the relatively complicated nature of mitigating the exposure pathway (e.g., the design, installation and operation of a sub-slab depressurization system in a home versus an immediate switch from using private well water to using bottled water).

When people have been or may be exposed to contamination, providing them with accurate and timely information about those exposures is extremely important. This information should include details about the types of chemicals, the levels of exposure, and possible health effects from those exposures. In addition, information should include details about the planning and progress of the investigation and remediation efforts. Techniques commonly used to inform the community about soil vapor intrusion issues are described in this section. The type, or types, of techniques selected for a site will vary depending upon the community's needs, site-specific conditions and remedial program-specific requirements.

5.1 Site contact list

A contact list contains names, addresses and telephone numbers of individuals and organizations with interest or involvement in a site. They may be affected by or interested in the site, or have information that staff needs to make effective remedial decisions. Contact lists typically include residents near the site, elected officials, appropriate federal, state, and local government contacts, local media, organized environmental groups and the responsible party, as well as local businesses, civic and recreational groups, religious facilities, school district officials, and all staff (NYSDEC, NYSDOH, county health department, EPA, etc.) involved in the site. The checklist provided in Appendix G.1 will help to identify who should be included in a particular site's contact list.

With respect to soil vapor intrusion, the site contact list is often used to

a. send a fact sheet announcing a proposed investigation in the area, a major project decision or proposal, the project's status or progress, a public meeting or availability session, or the availability of documents in the repositories;

b. contact building owners and tenants to arrange sampling dates and times and to transmit sampling results (in written form and/or verbally); and

c. provide community members with verbal updates on the project's status or progress.

The member of the project team (defined as the NYSDEC, NYSDOH, responsible party, etc.) that develops and maintains the site contact list is determined on a site-specific and/or program-specific basis. Development and revision of the contact list are ongoing activities throughout the site's investigation and remediation. Guidance on how to create a site contact list is provided in Appendix G.1.

5.2 Project staff contact sheet

As implied by the name, this is a summary of the contact information for staff working on the site that can be handed out to the community. Often included on the sheet are the name, title, affiliation, role or area of expertise, address, telephone number, email address, facsimile number for each staff member. The contact sheet provides the community with a quick reference on whom to call with questions, comments or concerns about the site. Project staff may also use the site contact sheet to direct inquiries to the most appropriate person. This is particularly useful when there are many agencies working on the site and many issues, such as site investigation, health studies, medical outreach, etc., being addressed.

The site contact sheet should be handed out at public meetings or availability sessions, when door-to-door visits and sampling are conducted, and in conjunction with other appropriate outreach activities. The sheet should be developed early on in the process and kept up-to-date. The member of the project team that develops and maintains the staff contact sheet is determined on a site-specific and/or program-specific basis.

5.3 Fact sheets

A fact sheet is a written summary of important information about a site. It presents information in clear and concise terms for the community. Fact sheets aid consistent distribution of information and citizens' understanding of significant issues associated with site-related activities. With respect to soil vapor intrusion, fact sheets are often used to

a. announce a proposed soil vapor intrusion investigation in the area, either as a stand-alone activity or in conjunction with the site's overall investigation;
b. summarize the results of an investigation and the anticipated next steps in the process;
c. invite the public to a meeting or availability session to discuss the proposed investigation, the results of a recently completed investigation, the anticipated next steps, etc.; and
d. provide additional information on topics associated with soil vapor intrusion, such as specific air guidelines for volatile chemicals.

The member of the project team that plans, develops and distributes the fact sheet is determined on a site-specific and/or program-specific basis. Factors to consider when designating the lead include the site's remedial program, the expected content of the fact sheet, and the relationship of various team members with the community. For example, if the community strongly distrusts the responsible party and wants to know how the state is determining that their actions are appropriate, the state should be the lead. A combination of team members may also be suitable.

All team members should be included in reviewing and finalizing the fact sheet. Once the state approves the fact sheet, it may be released to the public. Timely distribution of the fact sheet is important. Sufficient time should be allowed in the development and review schedule to ensure that the fact sheet is distributed — *and that it is received* — before the critical activity takes place. Specific timeframes for release include the following:

a. 2 weeks prior to a public meeting or availability session, or commencement of field activities;
b. within 24 hours of receiving a specific request for an available fact sheet from the community (e.g., members of the community that did not receive a copy of the fact sheet in the mail);
c. if applicable, before a comment period begins (otherwise a 30-day comment period becomes, in reality, a 25-day comment period); and
d. if appropriate, concurrently with letters to the community explaining sampling results.

Copies of fact sheets commonly used to supplement discussions related to soil vapor intrusion are provided in Appendix H. They are also available from the NYSDOH's soil vapor intrusion web page: http://www.health.state.ny.us/environmental/indoors/vapor_intrusion/. Additional guidance on how to plan, develop and distribute fact sheets is provided in Appendix G.2.

5.4 Public gatherings

The following are several types of public gatherings where project staff can meet with the community:

a. Traditional Public Meetings: Project staff generally present information and answer questions. Citizens are encouraged to ask questions and provide comments;
b. Public Availability Sessions: The session is held in a casual setting, without a formal agenda and presentation. Staff generally conduct an availability session about a specific aspect of a site, which it publicizes ahead of time. The format promotes detailed individual or small group discussion between staff and the public. An availability session may be targeted to a specific subgroup of the overall community. For example, a session may be held where project staff meet with building owners and tenants to discuss their individual sampling results;
c. Public Forum: The forum is held in a casual setting, without a formal presentation. Typically, the format is one of "question and answer" — a panel of project staff (or, if applicable, outside experts) answer questions asked by community members in an open discussion; and
d. Other: Project staff may be invited to give presentations or to make themselves available for questions at community group meetings, such as community or neighborhood board meetings, school board meetings, etc.

If appropriate, a combination of the above may be used. The type, or combination of types, of gathering (if any) selected should be decided based on site-specific, program requirements and community-specific conditions, such as the following:

a. Is the investigation limited to on-site buildings, to a localized area of off-site buildings, or to the off-site neighborhood surrounding the site?;
b. Is the soil vapor investigation being performed as part of ongoing site investigation activities (and consequently ongoing outreach activities), or is this issue being revisited at a site where remediation was considered "complete?";

c. What type of outreach has the community favored in the past?;
d. What are the objectives of the meeting? Can one meeting type accomplish each of the objectives or are different meeting types needed on successive days (e.g., public meeting followed by an availability session)?; and
e. Who is the desired audience? Should the meeting be held in the afternoon to accommodate an elderly population and repeated in the evening for people who work during normal business hours?

The member of the project team that coordinates and implements the gathering is determined on a site-specific and/or program-specific basis. Factors to consider when designating the lead include the site's remedial program, the expected subject of the meeting, and the relationship of various team members with the community. A combination of team members may also be appropriate.

Additional guidance on how to plan and conduct a public meeting and an availability session is provided in Appendices G.3 and G.4.

5.5 Letters transmitting results

When indoor air and/or sub-slab vapor samples are collected from within or beneath a building, a letter providing the sampling results and the conclusions drawn from the data evaluation should be transmitted to the building's owner. If the building is a rental property, the transmittal letter should be sent to the tenants residing in the areas where the samples were collected and a copy to the property owner/landlord. In some cases where responsible parties are carrying out indoor air sampling, access agreements are commonly executed between such a party and the property owner. Consequently, the transmittal letter may be sent to the property owner, and where feasible by prior arrangement with the property owner and/or tenant, with a copy to the tenant.

A transmittal letter should include the following (as applicable):

a. the address of the building sampled;
b. the date samples were collected;
c. the type of samples collected (e.g., sub-slab vapor, indoor air and outdoor air);
d. indoor air sampling locations (e.g., basement, crawl space, first floor living room, etc.)
e. who collected the samples (e.g., the state, or [Consultant Name] on behalf of [Responsible Party name], etc.);
f. why samples were collected (e.g., to evaluate the potential for exposures associated with soil vapor intrusion);
g. the site name and number (usually included in the subject line);
h. the compound(s) or group of compounds of concern (e.g., trichloroethene or volatile organic compounds);
i. an overview of the sampling results (e.g., a table summarizing compounds detected in each sample and/or a figure illustrating sampling locations and corresponding results);

j. copies of the laboratory sheets for each sample collected and the completed building questionnaire/inventory;

k. a statement of the conclusions drawn and the next steps (e.g., soil vapor intrusion appears to be the likely source of volatile chemicals in your indoor air and we would like to install a sub-slab depressurization system to minimize exposures);

l. if applicable, what information should be shared with employees and/or patrons of the facility (e.g., the transmittal letter and enclosed fact sheets, a situation-specific fact sheet and cover memorandum, etc.);

m. contact information for project staff; and

n. fact sheets that supplement information provided in the letter.

The member of the project team that transmits the letter is typically the member that conducted the investigation. A representative of each member should be copied on each transmittal. For example, for investigations conducted by the state, letters are transmitted by the NYSDOH; state and local agencies, as well as a representative for the responsible party (or other non-agency project staff), should be copied. For investigations conducted by the responsible party, the responsible party should transmit letters that have been reviewed and approved by the state, and copy state and local agency representatives.

The level of detail provided in the letter will depend upon who transmits the letter. For example, letters written by the NYSDOH may recommend actions to reduce exposures to indoor sources (i.e., not site-related sources) of volatile chemicals, or address expected risks associated with an identified exposure. Letters transmitted by a responsible party generally focus on site-related contamination and their identified next steps. These letters generally refer the recipients to the state for questions regarding non-site-related compounds and health concerns. For additional guidance on the content of the transmittal letters, contact the NYSDOH's Bureau of Environmental Exposure Investigation at 1-800-458-1158, extension 27850.

Timely distribution of the transmittal letter is important. Generally, final (i.e., verified) sampling results from the laboratory are available 6 to 8 weeks after the samples are submitted. As soon as they are available, final results should be forwarded to the team member that is transmitting them. Sufficient time should be allowed in the development and review schedule to ensure that the letter is transmitted within 2 weeks after final results are available.

If there is significant community interest in the sampling results, reasonable attempts should be made to inform the building owners and tenants of their results verbally in addition to sending a transmittal letter. Other interested community members, such as residents, press and elected officials, may be given an overview of the investigation results and the conclusions drawn *after* each building owner and tenant has been notified.

5.6 Soil vapor intrusion mitigation information

Once a mitigation system (e.g., sub-slab depressurization system) is installed in a building, an information package should be given to the building's owner and tenants, if applicable, to facilitate their understanding of the system's operation, maintenance and monitoring. This package should include the following:

a. a description of the mitigation system installed and its basic operating principles;

b. how the owner or tenant can check that the system is operating properly;

c. how the system will be maintained and monitored and by whom;

d. a list of appropriate actions for the owner or tenant to take if the system's warning device or indicator (e.g., pressure gauge, alarm, etc.) indicates system degradation or failure; and

e. contact information (e.g., names, telephone numbers, etc.) if the owner or tenant has questions, comments or concerns.

The building's owner should also receive the following information:

a. any building permits required by local codes;

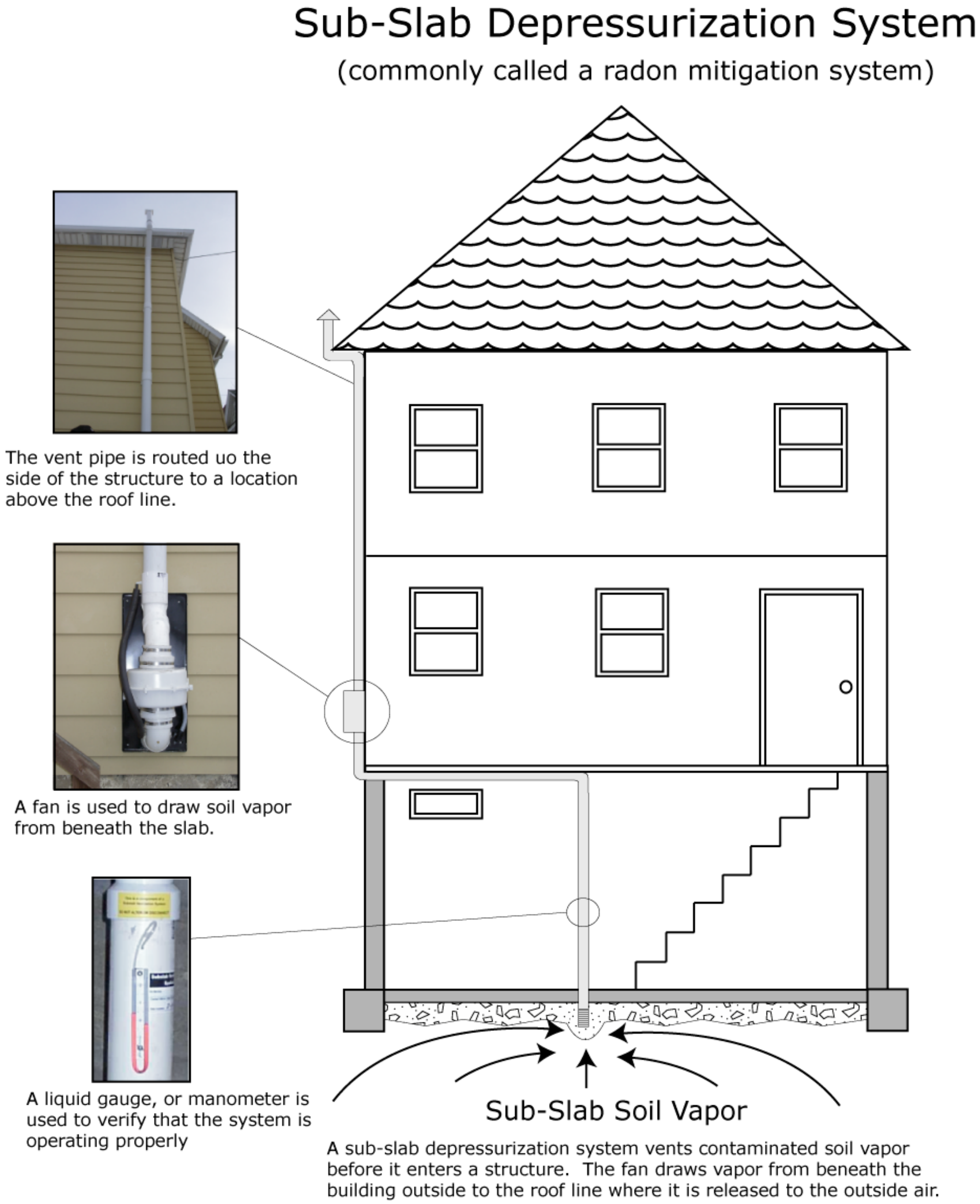
b. copies of contracts and warranties; and

c. a description of the proper operating procedures of any mechanical or electrical system installed, including manufacturer's operation and maintenance instructions and warranties.

Wherever possible, illustrations should be provided. For example, pictures of a manometer under normal operating conditions [Figure 5.1], as well as drawings or schematics showing the system at work [Figure 5.2].

The member of the project team who provides this information is the member who installed the mitigation system.

Figure 5.1
Manometer indicating the SSD system is operating properly.



Sub-Slab Depressurization System

(commonly called a radon mitigation system)

The vent pipe is routed uo the side of the structure to a location above the roof line.

A fan is used to draw soil vapor from beneath the slab.

A liquid gauge, or manometer is used to verify that the system is operating properly

A sub-slab depressurization system vents contaminated soil vapor before it enters a structure. The fan draws vapor from beneath the building outside to the roof line where it is released to the outside air.

Figure 5.2
Example of an illustration showing how a SSD system works.

5.7 Toll-free "800" numbers

Toll-free information numbers provide quick, easy access for people who have questions, comments or concerns about a site. At a minimum, the NYSDOH site project manager's name and the following "800" number should be shared with the community in fact sheets and transmittal letters, at public gatherings, when samples are collected, and with other outreach techniques for their use if they have health-related questions, concerns or comments related to soil vapor intrusion at the site.

NYSDOH
Center for Environmental Health
Bureau of Environmental Exposure Investigation
Toll-free Information Line

1-800-458-1158, ext. 27850

Note: The "800" number is an *information* line — not a "*hotline*" — because callers may not receive immediate response, such as on nights or weekends.

Similarly, applicable toll-free numbers setup and maintained by other project team members should also be shared with the community whenever appropriate. Additional information on the use of toll-free "800" numbers as an outreach tool is provided in Appendix G.5.

5.8 Door-to-door visits

Door-to-door visits involve gathering or distributing site information by meeting individuals at their residences or businesses. Typically, this outreach technique is used to supplement other communication, such as telephone calls and letters. With respect to soil vapor intrusion, project staff may visit residents near a site to provide information, answer questions, or obtain permission for activities on private properties. All team members should be aware of the specifics of the door-to-door visits (e.g., who will be conducting the visits, the reason, the dates, etc.).

Additional information on conducting door-to-door visits is provided in Appendix G.6.

5.9 Document repositories

A document repository is a collection of documents and other information developed during the investigation and remediation of a site. It is located in a convenient, public facility, such as a library, so that affected and interested members of the public can easily access and review important information about the site. A repository is maintained through the site's operation and maintenance phase, or until its release from the applicable remedial program.

A site document repository helps the public review

a. documents about which the state is seeking public comment;
b. studies, reports and other information; and
c. complete versions of documents summarized in fact sheets, meeting presentations or media releases (summaries should note the locations of local repositories where the complete documents are available).

The member of the project team that establishes and maintains the document repository is determined on a site-specific and/or program-specific basis. Additional guidance on how to establish and maintain a document repository is provided in Appendix G.7.

5.10 Medical community outreach

Outreach to the medical community is an activity or combination of activities undertaken to assist local health care providers in caring for people who have concerns about site-specific environmental exposures. The goal of this type of outreach is to assist the individual provider by giving him/her much of the site-specific information related to the contaminants and to provide information about the site itself. This type of outreach is undertaken whenever the NYSDOH and/or other health agencies determine that the site-specific contaminants may be unfamiliar to the local medical community. Conversely, this outreach can be undertaken when community members express the concern that their health care providers may be unfamiliar with potential adverse health effects related to contaminants at the site.

The targeted audience for this type of outreach consists of specific groups of health care providers most likely to treat people with concerns about potential environmental exposures. Some examples of targeted groups of specialists could include any combination of the following: Family Practice, Internal Medicine, Preventive Medicine, Oncology, Neurology, Allergy, Pediatrics, Obstetrics, Dermatology and Emergency Medicine. Likewise, materials can be sent to medical and nursing schools, residency programs, and medical libraries if they are located nearby. Developing the targeted list of health-care providers is a cooperative effort between local and state departments of health, with input from the community as well.

The NYSDOH, in partnership with the Agency for Toxic Substance and Disease Registry (ATSDR) and the local health department, can conduct these activities, which could include any one or a combination of the following:

a. announcements made at public meetings that the NYSDOH Center for Environmental Health will mail out information packets to individual physicians at the request of any concerned citizen;

b. an article placed in a local newspaper, or, if applicable, in a newsletter periodically sent to residents, stating that the NYSDOH Center for Environmental Health will mail out packets to individual physicians at the request of any concerned citizen. The NYSDOH "800" number and two NYSDOH contact names would be given;

c. an article submitted to the newsletter of the local county medical society, stating that the NYSDOH and the ATSDR have information to help providers with questions about site-related contamination in the area of the site. The NYSDOH "800" number and two NYSDOH contact names would be given; and

d. materials sent to medical and nursing schools, residency programs, and medical libraries if they are located nearby.

Local and state departments of health, and ATSDR, have developed appropriate outreach materials. The information packets should contain a letter to the physician, site-specific fact sheets, brochures, and booklets about potential exposures and about the contaminants in the area of the site. As an example, here is a list of fact sheets and pamphlets that an information packet for a site with PCE and TCE as contaminants of concern might contain:

a. a letter of explanation to the provider, including the NYSDOH "800" number to call for access to more information, as well as two NYSDOH contacts with whom to speak initially;

b. a site-specific fact sheet written for the community, explaining various site-related issues;

c. a compact disc of ATSDR case studies in environmental medicine (CSEMs), with opportunities for earning many free continuing medical education (CME) credits through the Centers for Disease Control and Prevention;

d. a hard copy of both the "Trichloroethylene (TCE) Toxicity" and "Taking an Environmental Exposure History" case studies;

e. two small "quick reference guides" produced by ATSDR about evaluating environmental exposures and doing an exposure history;

f. a NYSDOH fact sheet on Trichloroethene (TCE) in indoor and outdoor air;

g. an ATSDR fact sheet on Trichloroethylene (TCE);

h. a NYSDOH fact sheet on Tetrachloroethene (PERC) in indoor and outdoor air; and

i. an ATSDR fact sheet on Tetrachloroethylene (PERC).

For additional information on this outreach tool, please contact the NYSDOH Center for Environmental Health's Outreach and Education Unit at 1-800-458-1158, extension 27530.

References

American Society for Testing and Materials (ASTM) International. 2003. "Standard Practice for Installing Radon Mitigation Systems in Existing Low-rise Residential Buildings" (ASTM E-2121-03, February 10, 2003).

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New York State Department of Environmental Conservation. "Draft DER-10 Technical Guidance for Site Investigation and Remediation." Division of Environmental Remediation. December 2002.

New York State Department of Environmental Conservation. 2006. "Program Policy DER-13: Strategy for Prioritizing Vapor Intrusion Evaluations at Remedial Sites in New York." Division of Environmental Remediation. October 2006.

New York State Department of Health. 2005. "Indoor Air Sampling and Analysis Guidance." February 1, 2005. Available on the NYSDOH's web site at http://www.health.state.ny.us/nysdoh/indoor/guidance.htm.

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United State Environmental Protection Agency. 1994c. "Reducing Radon in Schools: A Team Approach" (EPA 402-R-94-008, April 1994).

United State Environmental Protection Agency. 2001. "Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes" (EPA 402-K-01-002, April 2001).

United State Environmental Protection Agency. 2003. "Consumer's Guide to Radon Reduction" (EPA 402-K-03-002; revised February 2003).

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2915
Phone: (716) 851-7220 **Fax:** (716) 851-7226
Website: www.dec.ny.gov

Joe Martens
Commissioner

April 21, 2014

Mr. John Stangline
Bureau Veritas North America, Inc.
Raritan Plaza
110 Fieldcrest Avenue
Edison, New Jersey 08837

Dear Mr. Stangline:

Lexington Machining Site
NYSDEC Site No. 907044; Spill No. 0651503
Order No. B9-0792-08-10
Vapor Intrusion Evaluation Work Plan Approval

The New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH) have reviewed the Vapor Intrusion Work Plan (work plan) for the above referenced site dated April 2014 as prepared by Bureau Veritas North America, Inc. and submitted April 10, 2014. The work plan is herby approved.

The work plan submittal letter indicated that the work plan was previously implemented on March 19, 2014. Please provide a summary report of the results of this evaluation. For the future, please provide the NYSDEC advance notice of any site activities specified in the Site Management Plan.

For future correspondence, the NYSDEC Site Number for the site is 907044. The number currently referenced, 0651503, refers to the spill number previously opened for site.

If you have any questions regarding the above, please feel free to contact me at 716-851-7220 or by email at ewmelnyk@gw.dec.state.ny.us.

Sincerely,

Eugene Melnyk

Eugene W. Melnyk, P.E.
Project Manager

ec: Deanna Ripstein - NYSDOH
Martin Doster – NYSDEC
Patrick Foster – NYSDEC
Michael Lubin, Lexington Machining LLC
Jesse Hiney – Nixon Peabody

Appendix B

EMSL LABORATORY REPORT

EMSL Analytical, Inc.
200 Route 130 North, Cinnaminson, NJ 08077
Phone/Fax:(856)858-4800/ (856)858-4571
http://www.EMSL.com TO-15_Lab@emsl.com

EMSL Order: **491400228**
CustomerID: **CLAY50B**
Customer PO:
ProjectID:

Attn: **Spencer Pizzani**
Bureau Veritas North America, Inc.
110 Fieldcrest Avenue; 4th Floor
Edison, NJ 08837
Project: **12014.000048.00**

Phone: 732-225-6040
Fax: 732-225-4577
Received: 3/21/2014
Report Date: 4/7/2014

Laboratory Report

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Lab Sample Number	Client Sample Identification	Start Collection Date	Start Collection Time
491400228-0001	**SUBSLAB-1**	**3/19/2014**	**14:12**
491400228-0002	**SUBSLAB-2**	**3/19/2014**	**14:15**
491400228-0003	**SUBSLAB-3**	**3/19/2014**	**14:21**
491400228-0004	**SUBSLAB-4**	**3/19/2014**	**14:41**
491400228-0005	**SUBSLAB-5**	**3/19/2014**	**14:49**
491400228-0006	**AMBIENT-OUT**	**3/19/2014**	**13:40**
491400228-0007	**INDOOR-1**	**3/19/2014**	**13:44**
491400228-0008	**INDOOR-2**	**3/19/2014**	**13:51**
491400228-0009	**INDOOR-3**	**3/19/2014**	**13:55**
491400228-0010	**INDOOR-4**	**3/19/2014**	**13:58**
491400228-0011	**INDOOR-5**	**3/19/2014**	**14:04**

I certify that this data package is in compliance with the terms and conditions of this contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and electronic data has been authorized by the laboratory manager or his/her designee, as verified by the following signature.

Marjorie Howley

Initial Report Date: **4/7/2014**
Amended Report Date:

Approved EMSL Signatory
Marjorie Howley, TO-15 Laboratory Manager

Please visit our website at http://www.EMSL.com

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200 Route 130 North, Cinnaminson, NJ 08077
Phone/Fax:(856)858-4800/ (856)858-4571
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EMSL Order: 491400228
EMSL Sample ID: 491400228-0001
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-1

Lab File ID: K9375.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E15518

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	10		ND	24
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	5.0		ND	25
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	5.0		ND	35
Chloromethane	74-87-3	50.49	ND	5.0		ND	10
n-Butane	106-97-8	58.12	**15**	5.0		**35**	12
Vinyl chloride	75-01-4	62.50	ND	5.0		ND	13
1,3-Butadiene	106-99-0	54.09	ND	5.0		ND	11
Bromomethane	74-83-9	94.94	ND	5.0		ND	19
Chloroethane	75-00-3	64.52	ND	5.0		ND	13
Ethanol	64-17-5	46.07	**200**	5.0		**380**	9.4
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	5.0		ND	22
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	5.0		ND	28
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**9.6**	5.0		**24**	12
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	5.0		ND	38
Acetone	67-64-1	58.08	**120**	5.0		**280**	12
1,1-Dichloroethene	75-35-4	96.94	ND	5.0		ND	20
Acetonitrile	75-05-8	41.00	ND	5.0		ND	8.4
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	5.0		ND	15
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	5.0		ND	22
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	5.0		ND	16
Carbon disulfide	75-15-0	76.14	**12**	5.0		**37**	16
Methylene chloride	75-09-2	84.94	ND	5.0		ND	17
Acrylonitrile	107-13-1	53.00	ND	5.0		ND	11
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	5.0		ND	18
trans-1,2-Dichloroethene	156-60-5	96.94	ND	5.0		ND	20
n-Hexane	110-54-3	86.17	ND	5.0		ND	18
1,1-Dichloroethane	75-34-3	98.96	ND	5.0		ND	20
Vinyl acetate	108-05-4	86.00	ND	5.0		ND	18
2-Butanone(MEK)	78-93-3	72.10	**12**	5.0		**37**	15
cis-1,2-Dichloroethene	156-59-2	96.94	ND	5.0		ND	20
Ethyl acetate	141-78-6	88.10	ND	5.0		ND	18

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Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	5.0		ND	24
Tetrahydrofuran	109-99-9	72.11	ND	5.0		ND	15
1,1,1-Trichloroethane	71-55-6	133.4	ND	5.0		ND	27
Cyclohexane	110-82-7	84.16	ND	5.0		ND	17
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	5.0		ND	23
Carbon tetrachloride	56-23-5	153.8	ND	5.0		ND	31
n-Heptane	142-82-5	100.2	ND	5.0		ND	20
1,2-Dichloroethane	107-06-2	98.96	ND	5.0		ND	20
Benzene	71-43-2	78.11	ND	5.0		ND	16
Trichloroethene	79-01-6	131.4	ND	5.0		ND	27
1,2-Dichloropropane	78-87-5	113.0	ND	5.0		ND	23
Methyl Methacrylate	80-62-6	100.12	ND	5.0		ND	20
Bromodichloromethane	75-27-4	163.8	ND	5.0		ND	33
1,4-Dioxane	123-91-1	88.12	ND	5.0		ND	18
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	5.0		ND	20
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	5.0		ND	23
Toluene	108-88-3	92.14	ND	5.0		ND	19
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	5.0		ND	23
1,1,2-Trichloroethane	79-00-5	133.4	ND	5.0		ND	27
2-Hexanone(MBK)	591-78-6	100.1	ND	5.0		ND	20
Tetrachloroethene	127-18-4	165.8	ND	5.0		ND	34
Dibromochloromethane	124-48-1	208.3	ND	5.0		ND	43
1,2-Dibromoethane	106-93-4	187.8	ND	5.0		ND	38
Chlorobenzene	108-90-7	112.6	ND	5.0		ND	23
Ethylbenzene	100-41-4	106.2	ND	5.0		ND	22
Xylene (p,m)	1330-20-7	106.2	ND	10		ND	43
Xylene (Ortho)	95-47-6	106.2	ND	5.0		ND	22
Styrene	100-42-5	104.1	ND	5.0		ND	21
Isopropylbenzene (cumene)	98-82-8	120.19	ND	5.0		ND	25
Bromoform	75-25-2	252.8	ND	5.0		ND	52
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	5.0		ND	34

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Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	**7.0**	5.0		**34**	25
1,3,5-Trimethylbenzene	108-67-8	120.2	**6.0**	5.0		**30**	25
2-Chlorotoluene	95-49-8	126.6	ND	5.0		ND	26
1,2,4-Trimethylbenzene	95-63-6	120.2	**17**	5.0		**86**	25
1,3-Dichlorobenzene	541-73-1	147.0	ND	5.0		ND	30
1,4-Dichlorobenzene	106-46-7	147.0	ND	5.0		ND	30
Benzyl chloride	100-44-7	126.0	ND	5.0		ND	26
1,2-Dichlorobenzene	95-50-1	147.0	ND	5.0		ND	30
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	5.0		ND	37
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	5.0		ND	53
Naphthalene	91-20-3	128.17	ND	5.0		ND	26

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	11.2	10	112%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
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Received Date: 03/21/2014
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Project: 12014.000048.00
Client Sample ID: SUBSLAB-1

Lab File ID: K9375.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E15518

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	130	JN	240	4.73
Pentanal	000110-62-3	86	23	JN	82	19.41
1-Pentanol	000071-41-0	88	40	JN	140	21.37
Hexanal	000066-25-1	100	81	JN	330	22.63
Nonane	000111-84-2	128	33	JN	170	24.01
Unknown		92	48	J	180	25.47
Decane	000124-18-5	142	73	JN	420	26.31
Unknown hydrocarbon		92	20	J	77	26.74
Undecane	001120-21-4	156	130	JN	840	28.36
Unknown Substituted Benzene		92	32	J	120	28.64
Unknown Substituted Benzene		92	21	J	80	28.77
Unknown Substituted Benzene		92	18	J	68	29.35
Unknown Substituted Benzene		92	19	J	70	29.47
Unknown hydrocarbon		92	18	J	67	29.70
Dodecane	000112-40-3	170	73	JN	510	30.22
Unknown hydrocarbon		92	18	J	67	30.38
Substituted Cyclohexane		92	17	J	63	30.56
Unknown Substituted Benzene		92	18	J	69	30.94
Tridecane	000629-50-5	184	41	JN	310	32.05

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.
B = Compound also found in method blank.
J= Estimated value based on a 1:1 response to internal standard.
N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0002
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-2

Sampling Date: 03/19/2014
Canister ID: E0419

Lab File ID: K9376.D
Sample Vol(ml): 25
Dilution Factor: 10

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	10		ND	24
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	5.0		ND	25
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	5.0		ND	35
Chloromethane	74-87-3	50.49	ND	5.0		ND	10
n-Butane	106-97-8	58.12	ND	5.0		ND	12
Vinyl chloride	75-01-4	62.50	ND	5.0		ND	13
1,3-Butadiene	106-99-0	54.09	ND	5.0		ND	11
Bromomethane	74-83-9	94.94	ND	5.0		ND	19
Chloroethane	75-00-3	64.52	ND	5.0		ND	13
Ethanol	64-17-5	46.07	**10**	5.0		**19**	9.4
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	5.0		ND	22
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	5.0		ND	28
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	ND	5.0		ND	12
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	5.0		ND	38
Acetone	67-64-1	58.08	**100**	5.0		**240**	12
1,1-Dichloroethene	75-35-4	96.94	ND	5.0		ND	20
Acetonitrile	75-05-8	41.00	ND	5.0		ND	8.4
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	5.0		ND	15
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	5.0		ND	22
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	5.0		ND	16
Carbon disulfide	75-15-0	76.14	ND	5.0		ND	16
Methylene chloride	75-09-2	84.94	ND	5.0		ND	17
Acrylonitrile	107-13-1	53.00	ND	5.0		ND	11
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	5.0		ND	18
trans-1,2-Dichloroethene	156-60-5	96.94	ND	5.0		ND	20
n-Hexane	110-54-3	86.17	ND	5.0		ND	18
1,1-Dichloroethane	75-34-3	98.96	ND	5.0		ND	20
Vinyl acetate	108-05-4	86.00	ND	5.0		ND	18
2-Butanone(MEK)	78-93-3	72.10	**5.4**	5.0		**16**	15
cis-1,2-Dichloroethene	156-59-2	96.94	ND	5.0		ND	20
Ethyl acetate	141-78-6	88.10	ND	5.0		ND	18

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Project: 12014.000048.00
Client Sample ID: SUBSLAB-2

Lab File ID: K9376.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0419

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	5.0		ND	24
Tetrahydrofuran	109-99-9	72.11	ND	5.0		ND	15
1,1,1-Trichloroethane	71-55-6	133.4	ND	5.0		ND	27
Cyclohexane	110-82-7	84.16	ND	5.0		ND	17
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	5.0		ND	23
Carbon tetrachloride	56-23-5	153.8	ND	5.0		ND	31
n-Heptane	142-82-5	100.2	ND	5.0		ND	20
1,2-Dichloroethane	107-06-2	98.96	ND	5.0		ND	20
Benzene	71-43-2	78.11	ND	5.0		ND	16
Trichloroethene	79-01-6	131.4	ND	5.0		ND	27
1,2-Dichloropropane	78-87-5	113.0	ND	5.0		ND	23
Methyl Methacrylate	80-62-6	100.12	ND	5.0		ND	20
Bromodichloromethane	75-27-4	163.8	ND	5.0		ND	33
1,4-Dioxane	123-91-1	88.12	ND	5.0		ND	18
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	5.0		ND	20
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	5.0		ND	23
Toluene	108-88-3	92.14	ND	5.0		ND	19
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	5.0		ND	23
1,1,2-Trichloroethane	79-00-5	133.4	ND	5.0		ND	27
2-Hexanone(MBK)	591-78-6	100.1	ND	5.0		ND	20
Tetrachloroethene	127-18-4	165.8	ND	5.0		ND	34
Dibromochloromethane	124-48-1	208.3	ND	5.0		ND	43
1,2-Dibromoethane	106-93-4	187.8	ND	5.0		ND	38
Chlorobenzene	108-90-7	112.6	ND	5.0		ND	23
Ethylbenzene	100-41-4	106.2	ND	5.0		ND	22
Xylene (p,m)	1330-20-7	106.2	ND	10		ND	43
Xylene (Ortho)	95-47-6	106.2	ND	5.0		ND	22
Styrene	100-42-5	104.1	ND	5.0		ND	21
Isopropylbenzene (cumene)	98-82-8	120.19	ND	5.0		ND	25
Bromoform	75-25-2	252.8	ND	5.0		ND	52
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	5.0		ND	34

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0002
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-2

Lab File ID: K9376.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0419

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	5.0		ND	25
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	5.0		ND	25
2-Chlorotoluene	95-49-8	126.6	ND	5.0		ND	26
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	5.0		ND	25
1,3-Dichlorobenzene	541-73-1	147.0	ND	5.0		ND	30
1,4-Dichlorobenzene	106-46-7	147.0	ND	5.0		ND	30
Benzyl chloride	100-44-7	126.0	ND	5.0		ND	26
1,2-Dichlorobenzene	95-50-1	147.0	ND	5.0		ND	30
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	5.0		ND	37
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	5.0		ND	53
Naphthalene	91-20-3	128.17	ND	5.0		ND	26

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	10.7	10	107%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0002
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-2

Lab File ID: K9376.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0419

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Silanol, trimethyl-	001066-40-6	90	**110**	JN	**400**	12.05
Substituted Cyclohexane		92	**17**	J	**62**	25.47
Decane	000124-18-5	142	**12**	JN	**67**	26.32
Undecane	001120-21-4	156	**14**	JN	**91**	28.36
Substituted Cyclohexane		92	**12**	J	**44**	28.64
Dodecane	000112-40-3	170	**15**	JN	**110**	30.22
Unknown Substituted Naphthalene		92	**10**	J	**39**	30.33

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.
B = Compound also found in method blank.
J= Estimated value based on a 1:1 response to internal standard.
N= Presumptive evidence of compound based on library match.

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0003
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-3

Lab File ID: K9377.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0385

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	10		ND	24
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	5.0		ND	25
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	5.0		ND	35
Chloromethane	74-87-3	50.49	ND	5.0		ND	10
n-Butane	106-97-8	58.12	**83**	5.0		**200**	12
Vinyl chloride	75-01-4	62.50	ND	5.0		ND	13
1,3-Butadiene	106-99-0	54.09	ND	5.0		ND	11
Bromomethane	74-83-9	94.94	ND	5.0		ND	19
Chloroethane	75-00-3	64.52	ND	5.0		ND	13
Ethanol	64-17-5	46.07	**360**	5.0		**680**	9.4
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	5.0		ND	22
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	5.0		ND	28
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**16**	5.0		**38**	12
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	5.0		ND	38
Acetone	67-64-1	58.08	**290**	5.0		**700**	12
1,1-Dichloroethene	75-35-4	96.94	ND	5.0		ND	20
Acetonitrile	75-05-8	41.00	ND	5.0		ND	8.4
Tertiary butyl alcohol(TBA)	75-65-0	74.12	**16**	5.0		**48**	15
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	5.0		ND	22
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	5.0		ND	16
Carbon disulfide	75-15-0	76.14	ND	5.0		ND	16
Methylene chloride	75-09-2	84.94	ND	5.0		ND	17
Acrylonitrile	107-13-1	53.00	ND	5.0		ND	11
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	5.0		ND	18
trans-1,2-Dichloroethene	156-60-5	96.94	ND	5.0		ND	20
n-Hexane	110-54-3	86.17	**15**	5.0		**51**	18
1,1-Dichloroethane	75-34-3	98.96	ND	5.0		ND	20
Vinyl acetate	108-05-4	86.00	ND	5.0		ND	18
2-Butanone(MEK)	78-93-3	72.10	**40**	5.0		**120**	15
cis-1,2-Dichloroethene	156-59-2	96.94	ND	5.0		ND	20
Ethyl acetate	141-78-6	88.10	ND	5.0		ND	18

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0003
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-3

Lab File ID: K9377.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0385

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	5.0		ND	24
Tetrahydrofuran	109-99-9	72.11	ND	5.0		ND	15
1,1,1-Trichloroethane	71-55-6	133.4	ND	5.0		ND	27
Cyclohexane	110-82-7	84.16	**6.6**	5.0		**23**	17
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	5.0		ND	23
Carbon tetrachloride	56-23-5	153.8	ND	5.0		ND	31
n-Heptane	142-82-5	100.2	ND	5.0		ND	20
1,2-Dichloroethane	107-06-2	98.96	ND	5.0		ND	20
Benzene	71-43-2	78.11	**7.1**	5.0		**23**	16
Trichloroethene	79-01-6	131.4	ND	5.0		ND	27
1,2-Dichloropropane	78-87-5	113.0	ND	5.0		ND	23
Methyl Methacrylate	80-62-6	100.12	ND	5.0		ND	20
Bromodichloromethane	75-27-4	163.8	ND	5.0		ND	33
1,4-Dioxane	123-91-1	88.12	ND	5.0		ND	18
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	**7.7**	5.0		**32**	20
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	5.0		ND	23
Toluene	108-88-3	92.14	**14**	5.0		**52**	19
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	5.0		ND	23
1,1,2-Trichloroethane	79-00-5	133.4	ND	5.0		ND	27
2-Hexanone(MBK)	591-78-6	100.1	**21**	5.0		**86**	20
Tetrachloroethene	127-18-4	165.8	ND	5.0		ND	34
Dibromochloromethane	124-48-1	208.3	ND	5.0		ND	43
1,2-Dibromoethane	106-93-4	187.8	ND	5.0		ND	38
Chlorobenzene	108-90-7	112.6	ND	5.0		ND	23
Ethylbenzene	100-41-4	106.2	ND	5.0		ND	22
Xylene (p,m)	1330-20-7	106.2	ND	10		ND	43
Xylene (Ortho)	95-47-6	106.2	ND	5.0		ND	22
Styrene	100-42-5	104.1	ND	5.0		ND	21
Isopropylbenzene (cumene)	98-82-8	120.19	**18**	5.0		**89**	25
Bromoform	75-25-2	252.8	ND	5.0		ND	52
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	5.0		ND	34

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0003
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-3

Lab File ID: K9377.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0385

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	5.0		ND	25
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	5.0		ND	25
2-Chlorotoluene	95-49-8	126.6	ND	5.0		ND	26
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	5.0		ND	25
1,3-Dichlorobenzene	541-73-1	147.0	ND	5.0		ND	30
1,4-Dichlorobenzene	106-46-7	147.0	ND	5.0		ND	30
Benzyl chloride	100-44-7	126.0	ND	5.0		ND	26
1,2-Dichlorobenzene	95-50-1	147.0	ND	5.0		ND	30
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	5.0		ND	37
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	5.0		ND	53
Naphthalene	91-20-3	128.17	ND	5.0		ND	26

ND = Non Detect

Surrogate	**Result**	**Spike**	**Recovery**
4-Bromofluorobenzene	11.1	10	111%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0003
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-3

Lab File ID: K9377.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0385

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	**1000**	JN	**1800**	4.74
Isobutane	000075-28-5	58	**72**	JN	**170**	5.14
Acetaldehyde	000075-07-0	44	**49**	JN	**89**	5.93
Butane, 2-methyl-	000078-78-4	72	**28**	JN	**81**	6.89
Pentane	000109-66-0	72	**32**	JN	**93**	7.67
Pentane, 2-methyl-	000107-83-5	86	**26**	JN	**91**	10.83
Silanol, trimethyl-	001066-40-6	90	**580**	JN	**2100**	12.05
Disiloxane, hexamethyl-	000107-46-0	162	**220**	JN	**1500**	16.19
1-Butanol	000071-36-3	74	**49**	JN	**150**	17.73
2-Pentanone	000107-87-9	86	**22**	JN	**78**	19.03
Pentanal	000110-62-3	86	**62**	JN	**220**	19.41
Octane	000111-65-9	114	**29**	JN	**140**	21.26
1-Pentanol	000071-41-0	88	**31**	JN	**110**	21.37
Hexanal	000066-25-1	100	**86**	JN	**350**	22.64
3-Heptanone	000106-35-4	114	**39**	JN	**180**	24.79
2-Heptanone	000110-43-0	114	**22**	JN	**100**	24.94
Decane	000124-18-5	142	**30**	JN	**170**	26.32
.alpha.-Methylstyrene	000098-83-9	118	**60**	JN	**290**	27.44
Undecane	001120-21-4	156	**18**	JN	**110**	28.36

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.
B = Compound also found in method blank.
J= Estimated value based on a 1:1 response to internal standard.
N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0004RE
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-4

Lab File ID: K9406.D
Sample Vol(ml): 32
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0369

Analysis Date: 04/05/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	10		ND	24
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	5.0		ND	25
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	5.0		ND	35
Chloromethane	74-87-3	50.49	ND	5.0		ND	10
n-Butane	106-97-8	58.12	**8.3**	5.0		**20**	12
Vinyl chloride	75-01-4	62.50	ND	5.0		ND	13
1,3-Butadiene	106-99-0	54.09	ND	5.0		ND	11
Bromomethane	74-83-9	94.94	ND	5.0		ND	19
Chloroethane	75-00-3	64.52	ND	5.0		ND	13
Ethanol	64-17-5	46.07	**41**	5.0		**77**	9.4
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	5.0		ND	22
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	5.0		ND	28
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**6.7**	5.0		**16**	12
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	5.0		ND	38
Acetone	67-64-1	58.08	**200**	5.0		**470**	12
1,1-Dichloroethene	75-35-4	96.94	ND	5.0		ND	20
Acetonitrile	75-05-8	41.00	ND	5.0		ND	8.4
Tertiary butyl alcohol(TBA)	75-65-0	74.12	**14**	5.0		**42**	15
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	5.0		ND	22
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	5.0		ND	16
Carbon disulfide	75-15-0	76.14	**7.1**	5.0		**22**	16
Methylene chloride	75-09-2	84.94	ND	5.0		ND	17
Acrylonitrile	107-13-1	53.00	ND	5.0		ND	11
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	5.0		ND	18
trans-1,2-Dichloroethene	156-60-5	96.94	ND	5.0		ND	20
n-Hexane	110-54-3	86.17	ND	5.0		ND	18
1,1-Dichloroethane	75-34-3	98.96	ND	5.0		ND	20
Vinyl acetate	108-05-4	86.00	ND	5.0		ND	18
2-Butanone(MEK)	78-93-3	72.10	**12**	5.0		**34**	15
cis-1,2-Dichloroethene	156-59-2	96.94	ND	5.0		ND	20
Ethyl acetate	141-78-6	88.10	ND	5.0		ND	18

EMSL Order: 491400228
EMSL Sample ID: 491400228-0004RE
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-4

Lab File ID: K9406.D
Sample Vol(ml): 32
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0369

Analysis Date: 04/05/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	5.0		ND	24
Tetrahydrofuran	109-99-9	72.11	ND	5.0		ND	15
1,1,1-Trichloroethane	71-55-6	133.4	ND	5.0		ND	27
Cyclohexane	110-82-7	84.16	ND	5.0		ND	17
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	5.0		ND	23
Carbon tetrachloride	56-23-5	153.8	ND	5.0		ND	31
n-Heptane	142-82-5	100.2	**5.1**	5.0		**21**	20
1,2-Dichloroethane	107-06-2	98.96	ND	5.0		ND	20
Benzene	71-43-2	78.11	ND	5.0		ND	16
Trichloroethene	79-01-6	131.4	ND	5.0		ND	27
1,2-Dichloropropane	78-87-5	113.0	ND	5.0		ND	23
Methyl Methacrylate	80-62-6	100.12	ND	5.0		ND	20
Bromodichloromethane	75-27-4	163.8	ND	5.0		ND	33
1,4-Dioxane	123-91-1	88.12	ND	5.0		ND	18
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	5.0		ND	20
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	5.0		ND	23
Toluene	108-88-3	92.14	**7.2**	5.0		**27**	19
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	5.0		ND	23
1,1,2-Trichloroethane	79-00-5	133.4	ND	5.0		ND	27
2-Hexanone(MBK)	591-78-6	100.1	ND	5.0		ND	20
Tetrachloroethene	127-18-4	165.8	ND	5.0		ND	34
Dibromochloromethane	124-48-1	208.3	ND	5.0		ND	43
1,2-Dibromoethane	106-93-4	187.8	ND	5.0		ND	38
Chlorobenzene	108-90-7	112.6	ND	5.0		ND	23
Ethylbenzene	100-41-4	106.2	ND	5.0		ND	22
Xylene (p,m)	1330-20-7	106.2	ND	10		ND	43
Xylene (Ortho)	95-47-6	106.2	ND	5.0		ND	22
Styrene	100-42-5	104.1	ND	5.0		ND	21
Isopropylbenzene (cumene)	98-82-8	120.19	ND	5.0		ND	25
Bromoform	75-25-2	252.8	ND	5.0		ND	52
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	5.0		ND	34

EMSL Order: 491400228
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Sample Vol(ml): 32
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0369

Analysis Date: 04/05/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	5.0		ND	25
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	5.0		ND	25
2-Chlorotoluene	95-49-8	126.6	ND	5.0		ND	26
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	5.0		ND	25
1,3-Dichlorobenzene	541-73-1	147.0	ND	5.0		ND	30
1,4-Dichlorobenzene	106-46-7	147.0	ND	5.0		ND	30
Benzyl chloride	100-44-7	126.0	ND	5.0		ND	26
1,2-Dichlorobenzene	95-50-1	147.0	ND	5.0		ND	30
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	5.0		ND	37
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	5.0		ND	53
Naphthalene	91-20-3	128.17	ND	5.0		ND	26

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	11.4	10	114%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0004RE
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-4

Lab File ID: K9406.D
Sample Vol(ml): 32
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E0369

Analysis Date: 04/05/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	**11**	JN	**20**	4.73
Silanol, trimethyl-	001066-40-6	90	**38**	JN	**140**	12.04
Pentanal	000110-62-3	86	**19**	JN	**68**	19.41
Hexanal	000066-25-1	100	**17**	JN	**71**	22.64
Substituted Cyclohexane		92	**19**	J	**71**	22.93
Unknown hydrocarbon		92	**15**	J	**56**	23.31
Nonane	000111-84-2	128	**12**	JN	**63**	24.00
Substituted Cyclohexane		92	**13**	J	**50**	24.95
Unknown hydrocarbon		92	**14**	J	**54**	25.10
Unknown		92	**32**	J	**120**	25.47
Unknown hydrocarbon		92	**11**	J	**43**	26.25
Decane	000124-18-5	142	**17**	JN	**100**	26.32
Substituted Cyclohexane		92	**11**	J	**42**	26.55
Unknown hydrocarbon		92	**15**	J	**55**	26.74
Undecane	001120-21-4	156	**23**	JN	**150**	28.36
Substituted Cyclohexane		92	**16**	J	**58**	28.64
Unknown Substituted Naphthalene		92	**15**	J	**55**	28.93
Dodecane	000112-40-3	170	**13**	JN	**93**	30.22
Unknown Substituted Naphthalene		92	**12**	J	**45**	30.33

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.

B = Compound also found in method blank.

J= Estimated value based on a 1:1 response to internal standard.

N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0005
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-5

Lab File ID: K9379.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E15349

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	10		ND	24
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	5.0		ND	25
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	5.0		ND	35
Chloromethane	74-87-3	50.49	ND	5.0		ND	10
n-Butane	106-97-8	58.12	ND	5.0		ND	12
Vinyl chloride	75-01-4	62.50	ND	5.0		ND	13
1,3-Butadiene	106-99-0	54.09	ND	5.0		ND	11
Bromomethane	74-83-9	94.94	ND	5.0		ND	19
Chloroethane	75-00-3	64.52	ND	5.0		ND	13
Ethanol	64-17-5	46.07	**28**	5.0		**52**	9.4
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	5.0		ND	22
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	5.0		ND	28
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	ND	5.0		ND	12
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	5.0		ND	38
Acetone	67-64-1	58.08	**180**	5.0		**420**	12
1,1-Dichloroethene	75-35-4	96.94	ND	5.0		ND	20
Acetonitrile	75-05-8	41.00	ND	5.0		ND	8.4
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	5.0		ND	15
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	5.0		ND	22
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	5.0		ND	16
Carbon disulfide	75-15-0	76.14	ND	5.0		ND	16
Methylene chloride	75-09-2	84.94	ND	5.0		ND	17
Acrylonitrile	107-13-1	53.00	ND	5.0		ND	11
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	5.0		ND	18
trans-1,2-Dichloroethene	156-60-5	96.94	ND	5.0		ND	20
n-Hexane	110-54-3	86.17	ND	5.0		ND	18
1,1-Dichloroethane	75-34-3	98.96	ND	5.0		ND	20
Vinyl acetate	108-05-4	86.00	ND	5.0		ND	18
2-Butanone(MEK)	78-93-3	72.10	ND	5.0		ND	15
cis-1,2-Dichloroethene	156-59-2	96.94	ND	5.0		ND	20
Ethyl acetate	141-78-6	88.10	ND	5.0		ND	18

EMSL Order: 491400228
EMSL Sample ID: 491400228-0005
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-5

Lab File ID: K9379.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E15349

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	5.0		ND	24
Tetrahydrofuran	109-99-9	72.11	ND	5.0		ND	15
1,1,1-Trichloroethane	71-55-6	133.4	ND	5.0		ND	27
Cyclohexane	110-82-7	84.16	ND	5.0		ND	17
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	5.0		ND	23
Carbon tetrachloride	56-23-5	153.8	ND	5.0		ND	31
n-Heptane	142-82-5	100.2	ND	5.0		ND	20
1,2-Dichloroethane	107-06-2	98.96	ND	5.0		ND	20
Benzene	71-43-2	78.11	ND	5.0		ND	16
Trichloroethene	79-01-6	131.4	ND	5.0		ND	27
1,2-Dichloropropane	78-87-5	113.0	ND	5.0		ND	23
Methyl Methacrylate	80-62-6	100.12	ND	5.0		ND	20
Bromodichloromethane	75-27-4	163.8	ND	5.0		ND	33
1,4-Dioxane	123-91-1	88.12	ND	5.0		ND	18
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	5.0		ND	20
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	5.0		ND	23
Toluene	108-88-3	92.14	ND	5.0		ND	19
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	5.0		ND	23
1,1,2-Trichloroethane	79-00-5	133.4	ND	5.0		ND	27
2-Hexanone(MBK)	591-78-6	100.1	ND	5.0		ND	20
Tetrachloroethene	127-18-4	165.8	ND	5.0		ND	34
Dibromochloromethane	124-48-1	208.3	ND	5.0		ND	43
1,2-Dibromoethane	106-93-4	187.8	ND	5.0		ND	38
Chlorobenzene	108-90-7	112.6	ND	5.0		ND	23
Ethylbenzene	100-41-4	106.2	ND	5.0		ND	22
Xylene (p,m)	1330-20-7	106.2	ND	10		ND	43
Xylene (Ortho)	95-47-6	106.2	ND	5.0		ND	22
Styrene	100-42-5	104.1	ND	5.0		ND	21
Isopropylbenzene (cumene)	98-82-8	120.19	ND	5.0		ND	25
Bromoform	75-25-2	252.8	ND	5.0		ND	52
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	5.0		ND	34

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0005
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-5

Lab File ID: K9379.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E15349

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	5.0		ND	25
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	5.0		ND	25
2-Chlorotoluene	95-49-8	126.6	ND	5.0		ND	26
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	5.0		ND	25
1,3-Dichlorobenzene	541-73-1	147.0	ND	5.0		ND	30
1,4-Dichlorobenzene	106-46-7	147.0	ND	5.0		ND	30
Benzyl chloride	100-44-7	126.0	ND	5.0		ND	26
1,2-Dichlorobenzene	95-50-1	147.0	ND	5.0		ND	30
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	5.0		ND	37
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	5.0		ND	53
Naphthalene	91-20-3	128.17	ND	5.0		ND	26

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	10.5	10	105%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0005
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: SUBSLAB-5

Lab File ID: K9379.D
Sample Vol(ml): 25
Dilution Factor: 10

Sampling Date: 03/19/2014
Canister ID: E15349

Analysis Date: 04/04/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
No TIC Compounds Reported						

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.
B = Compound also found in method blank.
J= Estimated value based on a 1:1 response to internal standard.
N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0006
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: AMBIENT-OUT

Lab File ID: K9350.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: E15642

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	1.0		ND	2.4
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	0.50		ND	2.5
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	0.50		ND	3.5
Chloromethane	74-87-3	50.49	**0.60**	0.50		**1.2**	1.0
n-Butane	106-97-8	58.12	**0.81**	0.50		**1.9**	1.2
Vinyl chloride	75-01-4	62.50	ND	0.50		ND	1.3
1,3-Butadiene	106-99-0	54.09	ND	0.50		ND	1.1
Bromomethane	74-83-9	94.94	ND	0.50		ND	1.9
Chloroethane	75-00-3	64.52	ND	0.50		ND	1.3
Ethanol	64-17-5	46.07	**2.7**	0.50		**5.0**	0.94
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	0.50		ND	2.2
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	0.50		ND	2.8
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**0.88**	0.50		**2.2**	1.2
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	0.50		ND	3.8
Acetone	67-64-1	58.08	**3.3**	0.50		**7.7**	1.2
1,1-Dichloroethene	75-35-4	96.94	ND	0.50		ND	2.0
Acetonitrile	75-05-8	41.00	ND	0.50		ND	0.84
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	0.50		ND	1.5
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	0.50		ND	2.2
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	0.50		ND	1.6
Carbon disulfide	75-15-0	76.14	ND	0.50		ND	1.6
Methylene chloride	75-09-2	84.94	ND	0.50		ND	1.7
Acrylonitrile	107-13-1	53.00	ND	0.50		ND	1.1
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	0.50		ND	1.8
trans-1,2-Dichloroethene	156-60-5	96.94	ND	0.50		ND	2.0
n-Hexane	110-54-3	86.17	ND	0.50		ND	1.8
1,1-Dichloroethane	75-34-3	98.96	ND	0.50		ND	2.0
Vinyl acetate	108-05-4	86.00	ND	0.50		ND	1.8
2-Butanone(MEK)	78-93-3	72.10	ND	0.50		ND	1.5
cis-1,2-Dichloroethene	156-59-2	96.94	ND	0.50		ND	2.0
Ethyl acetate	141-78-6	88.10	ND	0.50		ND	1.8

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0006
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: AMBIENT-OUT

Lab File ID: K9350.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: E15642

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	0.50		ND	2.4
Tetrahydrofuran	109-99-9	72.11	ND	0.50		ND	1.5
1,1,1-Trichloroethane	71-55-6	133.4	ND	0.50		ND	2.7
Cyclohexane	110-82-7	84.16	ND	0.50		ND	1.7
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	0.50		ND	2.3
Carbon tetrachloride	56-23-5	153.8	ND	0.50		ND	3.1
n-Heptane	142-82-5	100.2	ND	0.50		ND	2.0
1,2-Dichloroethane	107-06-2	98.96	ND	0.50		ND	2.0
Benzene	71-43-2	78.11	ND	0.50		ND	1.6
Trichloroethene	79-01-6	131.4	ND	0.50		ND	2.7
1,2-Dichloropropane	78-87-5	113.0	ND	0.50		ND	2.3
Methyl Methacrylate	80-62-6	100.12	ND	0.50		ND	2.0
Bromodichloromethane	75-27-4	163.8	ND	0.50		ND	3.3
1,4-Dioxane	123-91-1	88.12	ND	0.50		ND	1.8
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	0.50		ND	2.0
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	0.50		ND	2.3
Toluene	108-88-3	92.14	ND	0.50		ND	1.9
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	0.50		ND	2.3
1,1,2-Trichloroethane	79-00-5	133.4	ND	0.50		ND	2.7
2-Hexanone(MBK)	591-78-6	100.1	ND	0.50		ND	2.0
Tetrachloroethene	127-18-4	165.8	ND	0.50		ND	3.4
Dibromochloromethane	124-48-1	208.3	ND	0.50		ND	4.3
1,2-Dibromoethane	106-93-4	187.8	ND	0.50		ND	3.8
Chlorobenzene	108-90-7	112.6	ND	0.50		ND	2.3
Ethylbenzene	100-41-4	106.2	ND	0.50		ND	2.2
Xylene (p,m)	1330-20-7	106.2	ND	1.0		ND	4.3
Xylene (Ortho)	95-47-6	106.2	ND	0.50		ND	2.2
Styrene	100-42-5	104.1	ND	0.50		ND	2.1
Isopropylbenzene (cumene)	98-82-8	120.19	ND	0.50		ND	2.5
Bromoform	75-25-2	252.8	ND	0.50		ND	5.2
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	0.50		ND	3.4

EMSL Order: 491400228
EMSL Sample ID: 491400228-0006
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: AMBIENT-OUT

Lab File ID: K9350.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: E15642

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	0.50		ND	2.5
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	0.50		ND	2.5
2-Chlorotoluene	95-49-8	126.6	ND	0.50		ND	2.6
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	0.50		ND	2.5
1,3-Dichlorobenzene	541-73-1	147.0	ND	0.50		ND	3.0
1,4-Dichlorobenzene	106-46-7	147.0	ND	0.50		ND	3.0
Benzyl chloride	100-44-7	126.0	ND	0.50		ND	2.6
1,2-Dichlorobenzene	95-50-1	147.0	ND	0.50		ND	3.0
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	0.50		ND	3.7
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	0.50		ND	5.3
Naphthalene	91-20-3	128.17	ND	0.50		ND	2.6

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	10.7	10	107%

Qualifier Definitions

B = Compound also found in method blank.
E= Estimated concentration exceeding upper calibration range.
D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0006
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: AMBIENT-OUT

Lab File ID: K9350.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: E15642

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	**1.4**	JN	**2.5**	4.73

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.

B = Compound also found in method blank.

J= Estimated value based on a 1:1 response to internal standard.

N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0007
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-1

Lab File ID: K9351.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2266

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	1.0		ND	2.4
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	0.50		ND	2.5
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	0.50		ND	3.5
Chloromethane	74-87-3	50.49	**0.64**	0.50		**1.3**	1.0
n-Butane	106-97-8	58.12	**13**	0.50		**31**	1.2
Vinyl chloride	75-01-4	62.50	ND	0.50		ND	1.3
1,3-Butadiene	106-99-0	54.09	**3.1**	0.50		**6.8**	1.1
Bromomethane	74-83-9	94.94	ND	0.50		ND	1.9
Chloroethane	75-00-3	64.52	ND	0.50		ND	1.3
Ethanol	64-17-5	46.07	**43**	0.50	E	**80**	0.94
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	0.50		ND	2.2
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	**0.55**	0.50		**3.1**	2.8
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**3.9**	0.50		**10**	1.2
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	0.50		ND	3.8
Acetone	67-64-1	58.08	**17**	0.50		**41**	1.2
1,1-Dichloroethene	75-35-4	96.94	ND	0.50		ND	2.0
Acetonitrile	75-05-8	41.00	ND	0.50		ND	0.84
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	0.50		ND	1.5
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	0.50		ND	2.2
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	0.50		ND	1.6
Carbon disulfide	75-15-0	76.14	ND	0.50		ND	1.6
Methylene chloride	75-09-2	84.94	ND	0.50		ND	1.7
Acrylonitrile	107-13-1	53.00	ND	0.50		ND	1.1
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	0.50		ND	1.8
trans-1,2-Dichloroethene	156-60-5	96.94	ND	0.50		ND	2.0
n-Hexane	110-54-3	86.17	**1.4**	0.50		**4.8**	1.8
1,1-Dichloroethane	75-34-3	98.96	ND	0.50		ND	2.0
Vinyl acetate	108-05-4	86.00	ND	0.50		ND	1.8
2-Butanone(MEK)	78-93-3	72.10	**1.1**	0.50		**3.1**	1.5
cis-1,2-Dichloroethene	156-59-2	96.94	ND	0.50		ND	2.0
Ethyl acetate	141-78-6	88.10	ND	0.50		ND	1.8

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0007
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-1

Lab File ID: K9351.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2266

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	0.50		ND	2.4
Tetrahydrofuran	109-99-9	72.11	ND	0.50		ND	1.5
1,1,1-Trichloroethane	71-55-6	133.4	ND	0.50		ND	2.7
Cyclohexane	110-82-7	84.16	ND	0.50		ND	1.7
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	0.50		ND	2.3
Carbon tetrachloride	56-23-5	153.8	ND	0.50		ND	3.1
n-Heptane	142-82-5	100.2	**0.83**	0.50		**3.4**	2.0
1,2-Dichloroethane	107-06-2	98.96	ND	0.50		ND	2.0
Benzene	71-43-2	78.11	**2.0**	0.50		**6.3**	1.6
Trichloroethene	79-01-6	131.4	ND	0.50		ND	2.7
1,2-Dichloropropane	78-87-5	113.0	ND	0.50		ND	2.3
Methyl Methacrylate	80-62-6	100.12	ND	0.50		ND	2.0
Bromodichloromethane	75-27-4	163.8	ND	0.50		ND	3.3
1,4-Dioxane	123-91-1	88.12	ND	0.50		ND	1.8
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	0.50		ND	2.0
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	0.50		ND	2.3
Toluene	108-88-3	92.14	**2.2**	0.50		**8.3**	1.9
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	0.50		ND	2.3
1,1,2-Trichloroethane	79-00-5	133.4	ND	0.50		ND	2.7
2-Hexanone(MBK)	591-78-6	100.1	ND	0.50		ND	2.0
Tetrachloroethene	127-18-4	165.8	ND	0.50		ND	3.4
Dibromochloromethane	124-48-1	208.3	ND	0.50		ND	4.3
1,2-Dibromoethane	106-93-4	187.8	ND	0.50		ND	3.8
Chlorobenzene	108-90-7	112.6	ND	0.50		ND	2.3
Ethylbenzene	100-41-4	106.2	ND	0.50		ND	2.2
Xylene (p,m)	1330-20-7	106.2	**2.2**	1.0		**9.5**	4.3
Xylene (Ortho)	95-47-6	106.2	**1.1**	0.50		**4.6**	2.2
Styrene	100-42-5	104.1	ND	0.50		ND	2.1
Isopropylbenzene (cumene)	98-82-8	120.19	ND	0.50		ND	2.5
Bromoform	75-25-2	252.8	ND	0.50		ND	5.2
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	0.50		ND	3.4

EMSL Order: 491400228
EMSL Sample ID: 491400228-0007
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-1

Lab File ID: K9351.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2266

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	**1.8**	0.50		**8.7**	2.5
1,3,5-Trimethylbenzene	108-67-8	120.2	**2.2**	0.50		**11**	2.5
2-Chlorotoluene	95-49-8	126.6	ND	0.50		ND	2.6
1,2,4-Trimethylbenzene	95-63-6	120.2	**4.3**	0.50		**21**	2.5
1,3-Dichlorobenzene	541-73-1	147.0	ND	0.50		ND	3.0
1,4-Dichlorobenzene	106-46-7	147.0	ND	0.50		ND	3.0
Benzyl chloride	100-44-7	126.0	ND	0.50		ND	2.6
1,2-Dichlorobenzene	95-50-1	147.0	ND	0.50		ND	3.0
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	0.50		ND	3.7
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	0.50		ND	5.3
Naphthalene	91-20-3	128.17	ND	0.50		ND	2.6

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	11.2	10	112%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Sample ID: 491400228-0007
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-1

Sampling Date: 03/19/2014
Canister ID: HD2266

Lab File ID: K9351.D
Sample Vol(ml): 250
Dilution Factor: 1

Analysis Date: 04/02/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	**120**	JN	**210**	4.73
Isobutane	000075-28-5	58	**6.8**	JN	**16**	5.14
Acetaldehyde	000075-07-0	44	**5.1**	JN	**9.1**	5.92
Butane, 2-methyl-	000078-78-4	72	**4.4**	JN	**13**	6.88
Unknown hydrocarbon		92	**2.7**	J	**10**	23.07
Unknown hydrocarbon		92	**3.1**	J	**12**	23.32
Nonane	000111-84-2	128	**14**	JN	**76**	24.02
Unknown hydrocarbon		92	**3.4**	J	**13**	24.81
Substituted Cyclohexane		92	**3.8**	J	**14**	24.96
Unknown		92	**15**	J	**56**	25.48
Unknown hydrocarbon		92	**3.7**	J	**14**	25.71
Decane	000124-18-5	142	**20**	JN	**120**	26.32
Substituted Cyclohexane		92	**3.2**	J	**12**	26.55
Cyclohexane, butyl-	001678-93-9	140	**2.7**	JN	**16**	27.74
D-Limonene	005989-27-5	136	**2.5**	JN	**14**	27.98
Undecane	001120-21-4	156	**12**	JN	**77**	28.36
Substituted Cyclohexane		92	**2.6**	J	**9.9**	28.64
Dodecane	000112-40-3	170	**5.8**	JN	**40**	30.22

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.

B = Compound also found in method blank.

J= Estimated value based on a 1:1 response to internal standard.

N= Presumptive evidence of compound based on library match.

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0008
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-2
Sampling Date: 03/19/2014
Canister ID: HD1461

Lab File ID: K9352.D
Sample Vol(ml): 250
Dilution Factor: 1
Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	1.0		ND	2.4
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	0.50		ND	2.5
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	0.50		ND	3.5
Chloromethane	74-87-3	50.49	**0.58**	0.50		**1.2**	1.0
n-Butane	106-97-8	58.12	**8.8**	0.50		**21**	1.2
Vinyl chloride	75-01-4	62.50	ND	0.50		ND	1.3
1,3-Butadiene	106-99-0	54.09	**2.0**	0.50		**4.4**	1.1
Bromomethane	74-83-9	94.94	ND	0.50		ND	1.9
Chloroethane	75-00-3	64.52	ND	0.50		ND	1.3
Ethanol	64-17-5	46.07	**27**	0.50		**50**	0.94
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	0.50		ND	2.2
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	0.50		ND	2.8
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**1.4**	0.50		**3.3**	1.2
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	0.50		ND	3.8
Acetone	67-64-1	58.08	**6.6**	0.50		**16**	1.2
1,1-Dichloroethene	75-35-4	96.94	ND	0.50		ND	2.0
Acetonitrile	75-05-8	41.00	ND	0.50		ND	0.84
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	0.50		ND	1.5
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	0.50		ND	2.2
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	0.50		ND	1.6
Carbon disulfide	75-15-0	76.14	ND	0.50		ND	1.6
Methylene chloride	75-09-2	84.94	ND	0.50		ND	1.7
Acrylonitrile	107-13-1	53.00	ND	0.50		ND	1.1
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	0.50		ND	1.8
trans-1,2-Dichloroethene	156-60-5	96.94	ND	0.50		ND	2.0
n-Hexane	110-54-3	86.17	**1.2**	0.50		**4.3**	1.8
1,1-Dichloroethane	75-34-3	98.96	ND	0.50		ND	2.0
Vinyl acetate	108-05-4	86.00	ND	0.50		ND	1.8
2-Butanone(MEK)	78-93-3	72.10	**0.66**	0.50		**2.0**	1.5
cis-1,2-Dichloroethene	156-59-2	96.94	ND	0.50		ND	2.0
Ethyl acetate	141-78-6	88.10	ND	0.50		ND	1.8

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0008
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-2

Sampling Date: 03/19/2014
Canister ID: HD1461

Lab File ID: K9352.D
Sample Vol(ml): 250
Dilution Factor: 1

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	0.50		ND	2.4
Tetrahydrofuran	109-99-9	72.11	ND	0.50		ND	1.5
1,1,1-Trichloroethane	71-55-6	133.4	ND	0.50		ND	2.7
Cyclohexane	110-82-7	84.16	ND	0.50		ND	1.7
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	0.50		ND	2.3
Carbon tetrachloride	56-23-5	153.8	ND	0.50		ND	3.1
n-Heptane	142-82-5	100.2	**0.74**	0.50		**3.0**	2.0
1,2-Dichloroethane	107-06-2	98.96	ND	0.50		ND	2.0
Benzene	71-43-2	78.11	**1.1**	0.50		**3.6**	1.6
Trichloroethene	79-01-6	131.4	ND	0.50		ND	2.7
1,2-Dichloropropane	78-87-5	113.0	ND	0.50		ND	2.3
Methyl Methacrylate	80-62-6	100.12	ND	0.50		ND	2.0
Bromodichloromethane	75-27-4	163.8	ND	0.50		ND	3.3
1,4-Dioxane	123-91-1	88.12	ND	0.50		ND	1.8
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	0.50		ND	2.0
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	0.50		ND	2.3
Toluene	108-88-3	92.14	**1.1**	0.50		**4.0**	1.9
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	0.50		ND	2.3
1,1,2-Trichloroethane	79-00-5	133.4	ND	0.50		ND	2.7
2-Hexanone(MBK)	591-78-6	100.1	ND	0.50		ND	2.0
Tetrachloroethene	127-18-4	165.8	ND	0.50		ND	3.4
Dibromochloromethane	124-48-1	208.3	ND	0.50		ND	4.3
1,2-Dibromoethane	106-93-4	187.8	ND	0.50		ND	3.8
Chlorobenzene	108-90-7	112.6	ND	0.50		ND	2.3
Ethylbenzene	100-41-4	106.2	ND	0.50		ND	2.2
Xylene (p,m)	1330-20-7	106.2	ND	1.0		ND	4.3
Xylene (Ortho)	95-47-6	106.2	ND	0.50		ND	2.2
Styrene	100-42-5	104.1	ND	0.50		ND	2.1
Isopropylbenzene (cumene)	98-82-8	120.19	ND	0.50		ND	2.5
Bromoform	75-25-2	252.8	ND	0.50		ND	5.2
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	0.50		ND	3.4

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http://www.EMSL.com TO-15_Lab@emsl.com

EMSL Order: 491400228
EMSL Sample ID: 491400228-0008
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-2

Sampling Date: 03/19/2014
Canister ID: HD1461

Lab File ID: K9352.D
Sample Vol(ml): 250
Dilution Factor: 1

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	0.50		ND	2.5
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	0.50		ND	2.5
2-Chlorotoluene	95-49-8	126.6	ND	0.50		ND	2.6
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	0.50		ND	2.5
1,3-Dichlorobenzene	541-73-1	147.0	ND	0.50		ND	3.0
1,4-Dichlorobenzene	106-46-7	147.0	ND	0.50		ND	3.0
Benzyl chloride	100-44-7	126.0	ND	0.50		ND	2.6
1,2-Dichlorobenzene	95-50-1	147.0	ND	0.50		ND	3.0
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	0.50		ND	3.7
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	0.50		ND	5.3
Naphthalene	91-20-3	128.17	ND	0.50		ND	2.6

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	10.3	10	103%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0008
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-2

Lab File ID: K9352.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD1461

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	**75**	JN	**140**	4.73
Isobutane	000075-28-5	58	**4.7**	JN	**11**	5.14
Acetaldehyde	000075-07-0	44	**5.6**	JN	**10**	5.92
Butane, 2-methyl-	000078-78-4	72	**2.8**	JN	**8.2**	6.89
Pentane	000109-66-0	72	**4.7**	JN	**14**	7.66
Pentane, 2-methyl-	000107-83-5	86	**1.4**	JN	**4.9**	10.83
1-Hexene	000592-41-6	84	**3**	JN	**10**	12.76
Octane	000111-65-9	114	**1.5**	JN	**7.2**	21.26
Nonane	000111-84-2	128	**3.5**	JN	**18**	24.01
Cyclohexane, propyl-	001678-92-8	126	**2.9**	JN	**15**	25.48
Decane	000124-18-5	142	**5**	JN	**29**	26.32
Undecane	001120-21-4	156	**3.3**	JN	**21**	28.36
Dodecane	000112-40-3	170	**4.8**	JN	**33**	30.21
Unknown hydrocarbon		92	**1.9**	J	**7.1**	30.31
Unknown alkene		92	**3.7**	J	**14**	30.45
Unknown alkene		92	**2.1**	J	**7.8**	30.71

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.

B = Compound also found in method blank.

J= Estimated value based on a 1:1 response to internal standard.

N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0009
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-3

Lab File ID: K9353.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2775

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	1.0		ND	2.4
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	0.50		ND	2.5
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	0.50		ND	3.5
Chloromethane	74-87-3	50.49	**0.59**	0.50		**1.2**	1.0
n-Butane	106-97-8	58.12	**8.6**	0.50		**21**	1.2
Vinyl chloride	75-01-4	62.50	ND	0.50		ND	1.3
1,3-Butadiene	106-99-0	54.09	**2.1**	0.50		**4.7**	1.1
Bromomethane	74-83-9	94.94	ND	0.50		ND	1.9
Chloroethane	75-00-3	64.52	ND	0.50		ND	1.3
Ethanol	64-17-5	46.07	**43**	0.50	E	**81**	0.94
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	0.50		ND	2.2
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	0.50		ND	2.8
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**1.9**	0.50		**4.7**	1.2
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	0.50		ND	3.8
Acetone	67-64-1	58.08	**6.7**	0.50		**16**	1.2
1,1-Dichloroethene	75-35-4	96.94	ND	0.50		ND	2.0
Acetonitrile	75-05-8	41.00	ND	0.50		ND	0.84
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	0.50		ND	1.5
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	0.50		ND	2.2
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	0.50		ND	1.6
Carbon disulfide	75-15-0	76.14	ND	0.50		ND	1.6
Methylene chloride	75-09-2	84.94	ND	0.50		ND	1.7
Acrylonitrile	107-13-1	53.00	ND	0.50		ND	1.1
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	0.50		ND	1.8
trans-1,2-Dichloroethene	156-60-5	96.94	ND	0.50		ND	2.0
n-Hexane	110-54-3	86.17	**1.3**	0.50		**4.4**	1.8
1,1-Dichloroethane	75-34-3	98.96	ND	0.50		ND	2.0
Vinyl acetate	108-05-4	86.00	ND	0.50		ND	1.8
2-Butanone(MEK)	78-93-3	72.10	**0.63**	0.50		**1.9**	1.5
cis-1,2-Dichloroethene	156-59-2	96.94	ND	0.50		ND	2.0
Ethyl acetate	141-78-6	88.10	ND	0.50		ND	1.8

EMSL Order: 491400228
EMSL Sample ID: 491400228-0009
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-3

Lab File ID: K9353.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2775

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	0.50		ND	2.4
Tetrahydrofuran	109-99-9	72.11	ND	0.50		ND	1.5
1,1,1-Trichloroethane	71-55-6	133.4	ND	0.50		ND	2.7
Cyclohexane	110-82-7	84.16	ND	0.50		ND	1.7
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	0.50		ND	2.3
Carbon tetrachloride	56-23-5	153.8	ND	0.50		ND	3.1
n-Heptane	142-82-5	100.2	**0.79**	0.50		**3.3**	2.0
1,2-Dichloroethane	107-06-2	98.96	ND	0.50		ND	2.0
Benzene	71-43-2	78.11	**1.2**	0.50		**3.8**	1.6
Trichloroethene	79-01-6	131.4	ND	0.50		ND	2.7
1,2-Dichloropropane	78-87-5	113.0	ND	0.50		ND	2.3
Methyl Methacrylate	80-62-6	100.12	ND	0.50		ND	2.0
Bromodichloromethane	75-27-4	163.8	ND	0.50		ND	3.3
1,4-Dioxane	123-91-1	88.12	ND	0.50		ND	1.8
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	0.50		ND	2.0
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	0.50		ND	2.3
Toluene	108-88-3	92.14	**0.93**	0.50		**3.5**	1.9
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	0.50		ND	2.3
1,1,2-Trichloroethane	79-00-5	133.4	ND	0.50		ND	2.7
2-Hexanone(MBK)	591-78-6	100.1	ND	0.50		ND	2.0
Tetrachloroethene	127-18-4	165.8	ND	0.50		ND	3.4
Dibromochloromethane	124-48-1	208.3	ND	0.50		ND	4.3
1,2-Dibromoethane	106-93-4	187.8	ND	0.50		ND	3.8
Chlorobenzene	108-90-7	112.6	ND	0.50		ND	2.3
Ethylbenzene	100-41-4	106.2	ND	0.50		ND	2.2
Xylene (p,m)	1330-20-7	106.2	ND	1.0		ND	4.3
Xylene (Ortho)	95-47-6	106.2	ND	0.50		ND	2.2
Styrene	100-42-5	104.1	ND	0.50		ND	2.1
Isopropylbenzene (cumene)	98-82-8	120.19	ND	0.50		ND	2.5
Bromoform	75-25-2	252.8	ND	0.50		ND	5.2
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	0.50		ND	3.4

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0009
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-3

Lab File ID: K9353.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2775

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	0.50		ND	2.5
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	0.50		ND	2.5
2-Chlorotoluene	95-49-8	126.6	ND	0.50		ND	2.6
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	0.50		ND	2.5
1,3-Dichlorobenzene	541-73-1	147.0	ND	0.50		ND	3.0
1,4-Dichlorobenzene	106-46-7	147.0	ND	0.50		ND	3.0
Benzyl chloride	100-44-7	126.0	ND	0.50		ND	2.6
1,2-Dichlorobenzene	95-50-1	147.0	ND	0.50		ND	3.0
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	0.50		ND	3.7
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	0.50		ND	5.3
Naphthalene	91-20-3	128.17	ND	0.50		ND	2.6

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	10.2	10	102%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0009
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-3
Lab File ID: K9353.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2775
Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	**80**	JN	**140**	4.73
Isobutane	000075-28-5	58	**5**	JN	**12**	5.14
Acetaldehyde	000075-07-0	44	**11**	JN	**20**	5.92
Butane, 2-methyl-	000078-78-4	72	**2.8**	JN	**8.1**	6.88
Pentane	000109-66-0	72	**5**	JN	**15**	7.66
Unknown hydrocarbon		92	**3.9**	J	**15**	10.84
Unknown hydrocarbon		92	**1.4**	J	**5.2**	11.88
1-Hexene	000592-41-6	84	**5.3**	JN	**18**	12.76
Nonane	000111-84-2	128	**3.1**	JN	**16**	24.01
Unknown		92	**2.2**	J	**8.2**	25.48
Decane	000124-18-5	142	**3.9**	JN	**23**	26.31
Undecane	001120-21-4	156	**2.7**	JN	**17**	28.36
Dodecane	000112-40-3	170	**5.1**	JN	**35**	30.22
Unknown alkene		92	**2.2**	J	**8.1**	30.30
Unknown alkene		92	**4.7**	J	**18**	30.45
Unknown alkene		92	**2.5**	J	**9.2**	30.70
Tridecane	000629-50-5	184	**1.2**	JN	**9**	32.06

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.
B = Compound also found in method blank.
J= Estimated value based on a 1:1 response to internal standard.
N= Presumptive evidence of compound based on library match.

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0010
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-4

Lab File ID: K9354.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2780

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	1.0		ND	2.4
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	0.50		ND	2.5
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	0.50		ND	3.5
Chloromethane	74-87-3	50.49	**0.52**	0.50		**1.1**	1.0
n-Butane	106-97-8	58.12	**4.9**	0.50		**12**	1.2
Vinyl chloride	75-01-4	62.50	ND	0.50		ND	1.3
1,3-Butadiene	106-99-0	54.09	**0.99**	0.50		**2.2**	1.1
Bromomethane	74-83-9	94.94	ND	0.50		ND	1.9
Chloroethane	75-00-3	64.52	ND	0.50		ND	1.3
Ethanol	64-17-5	46.07	**18**	0.50		**35**	0.94
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	0.50		ND	2.2
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	0.50		ND	2.8
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**110**	0.50	E	**260**	1.2
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	0.50		ND	3.8
Acetone	67-64-1	58.08	**9.3**	0.50		**22**	1.2
1,1-Dichloroethene	75-35-4	96.94	ND	0.50		ND	2.0
Acetonitrile	75-05-8	41.00	ND	0.50		ND	0.84
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	0.50		ND	1.5
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	0.50		ND	2.2
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	0.50		ND	1.6
Carbon disulfide	75-15-0	76.14	ND	0.50		ND	1.6
Methylene chloride	75-09-2	84.94	ND	0.50		ND	1.7
Acrylonitrile	107-13-1	53.00	ND	0.50		ND	1.1
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	0.50		ND	1.8
trans-1,2-Dichloroethene	156-60-5	96.94	ND	0.50		ND	2.0
n-Hexane	110-54-3	86.17	**19**	0.50		**68**	1.8
1,1-Dichloroethane	75-34-3	98.96	ND	0.50		ND	2.0
Vinyl acetate	108-05-4	86.00	ND	0.50		ND	1.8
2-Butanone(MEK)	78-93-3	72.10	**1.0**	0.50		**3.0**	1.5
cis-1,2-Dichloroethene	156-59-2	96.94	ND	0.50		ND	2.0
Ethyl acetate	141-78-6	88.10	ND	0.50		ND	1.8

EMSL Order: 491400228
EMSL Sample ID: 491400228-0010
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-4

Lab File ID: K9354.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2780

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	0.50		ND	2.4
Tetrahydrofuran	109-99-9	72.11	**0.60**	0.50		**1.8**	1.5
1,1,1-Trichloroethane	71-55-6	133.4	ND	0.50		ND	2.7
Cyclohexane	110-82-7	84.16	ND	0.50		ND	1.7
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	0.50		ND	2.3
Carbon tetrachloride	56-23-5	153.8	ND	0.50		ND	3.1
n-Heptane	142-82-5	100.2	ND	0.50		ND	2.0
1,2-Dichloroethane	107-06-2	98.96	ND	0.50		ND	2.0
Benzene	71-43-2	78.11	**1.3**	0.50		**4.0**	1.6
Trichloroethene	79-01-6	131.4	ND	0.50		ND	2.7
1,2-Dichloropropane	78-87-5	113.0	ND	0.50		ND	2.3
Methyl Methacrylate	80-62-6	100.12	ND	0.50		ND	2.0
Bromodichloromethane	75-27-4	163.8	ND	0.50		ND	3.3
1,4-Dioxane	123-91-1	88.12	ND	0.50		ND	1.8
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	0.50		ND	2.0
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	0.50		ND	2.3
Toluene	108-88-3	92.14	ND	0.50		ND	1.9
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	0.50		ND	2.3
1,1,2-Trichloroethane	79-00-5	133.4	ND	0.50		ND	2.7
2-Hexanone(MBK)	591-78-6	100.1	ND	0.50		ND	2.0
Tetrachloroethene	127-18-4	165.8	ND	0.50		ND	3.4
Dibromochloromethane	124-48-1	208.3	ND	0.50		ND	4.3
1,2-Dibromoethane	106-93-4	187.8	ND	0.50		ND	3.8
Chlorobenzene	108-90-7	112.6	ND	0.50		ND	2.3
Ethylbenzene	100-41-4	106.2	ND	0.50		ND	2.2
Xylene (p,m)	1330-20-7	106.2	ND	1.0		ND	4.3
Xylene (Ortho)	95-47-6	106.2	ND	0.50		ND	2.2
Styrene	100-42-5	104.1	ND	0.50		ND	2.1
Isopropylbenzene (cumene)	98-82-8	120.19	ND	0.50		ND	2.5
Bromoform	75-25-2	252.8	ND	0.50		ND	5.2
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	0.50		ND	3.4

EMSL Analytical, Inc.
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http://www.EMSL.com TO-15_Lab@emsl.com

EMSL Order: 491400228
EMSL Sample ID: 491400228-0010
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-4

Lab File ID: K9354.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2780

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	0.50		ND	2.5
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	0.50		ND	2.5
2-Chlorotoluene	95-49-8	126.6	ND	0.50		ND	2.6
1,2,4-Trimethylbenzene	95-63-6	120.2	ND	0.50		ND	2.5
1,3-Dichlorobenzene	541-73-1	147.0	ND	0.50		ND	3.0
1,4-Dichlorobenzene	106-46-7	147.0	ND	0.50		ND	3.0
Benzyl chloride	100-44-7	126.0	ND	0.50		ND	2.6
1,2-Dichlorobenzene	95-50-1	147.0	ND	0.50		ND	3.0
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	0.50		ND	3.7
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	0.50		ND	5.3
Naphthalene	91-20-3	128.17	ND	0.50		ND	2.6

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	10.1	10	101%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0010
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-4

Lab File ID: K9354.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2780

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	**34**	JN	**62**	4.73
Butane, 2,2-dimethyl-	000075-83-2	86	**59**	JN	**210**	8.99
Pentane, 2-methyl-	000107-83-5	86	**1000**	JN	**3500**	10.86
Pentane, 3-methyl-	000096-14-0	86	**360**	JN	**1300**	11.89

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.

B = Compound also found in method blank.

J= Estimated value based on a 1:1 response to internal standard.

N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0011
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-5

Lab File ID: K9355.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2309

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Propylene	115-07-1	58.08	ND	1.0		ND	2.4
Freon 12(Dichlorodifluoromethane)	75-71-8	120.9	ND	0.50		ND	2.5
Freon 114(1,2-Dichlorotetrafluoroethan	76-14-2	170.9	ND	0.50		ND	3.5
Chloromethane	74-87-3	50.49	**0.61**	0.50		**1.3**	1.0
n-Butane	106-97-8	58.12	**7.8**	0.50		**18**	1.2
Vinyl chloride	75-01-4	62.50	ND	0.50		ND	1.3
1,3-Butadiene	106-99-0	54.09	**1.7**	0.50		**3.7**	1.1
Bromomethane	74-83-9	94.94	ND	0.50		ND	1.9
Chloroethane	75-00-3	64.52	ND	0.50		ND	1.3
Ethanol	64-17-5	46.07	**22**	0.50		**42**	0.94
Bromoethene(Vinyl bromide)	593-60-2	106.9	ND	0.50		ND	2.2
Freon 11(Trichlorofluoromethane)	75-69-4	137.4	ND	0.50		ND	2.8
Isopropyl alcohol(2-Propanol)	67-63-0	60.10	**3.4**	0.50		**8.4**	1.2
Freon 113(1,1,2-Trichlorotrifluoroethan	76-13-1	187.4	ND	0.50		ND	3.8
Acetone	67-64-1	58.08	**7.5**	0.50		**18**	1.2
1,1-Dichloroethene	75-35-4	96.94	ND	0.50		ND	2.0
Acetonitrile	75-05-8	41.00	ND	0.50		ND	0.84
Tertiary butyl alcohol(TBA)	75-65-0	74.12	ND	0.50		ND	1.5
Bromoethane(Ethyl bromide)	74-96-4	108.0	ND	0.50		ND	2.2
3-Chloropropene(Allyl chloride)	107-05-1	76.53	ND	0.50		ND	1.6
Carbon disulfide	75-15-0	76.14	ND	0.50		ND	1.6
Methylene chloride	75-09-2	84.94	ND	0.50		ND	1.7
Acrylonitrile	107-13-1	53.00	ND	0.50		ND	1.1
Methyl-tert-butyl ether(MTBE)	1634-04-4	88.15	ND	0.50		ND	1.8
trans-1,2-Dichloroethene	156-60-5	96.94	ND	0.50		ND	2.0
n-Hexane	110-54-3	86.17	**1.0**	0.50		**3.6**	1.8
1,1-Dichloroethane	75-34-3	98.96	ND	0.50		ND	2.0
Vinyl acetate	108-05-4	86.00	ND	0.50		ND	1.8
2-Butanone(MEK)	78-93-3	72.10	**0.64**	0.50		**1.9**	1.5
cis-1,2-Dichloroethene	156-59-2	96.94	ND	0.50		ND	2.0
Ethyl acetate	141-78-6	88.10	ND	0.50		ND	1.8

EMSL Order: 491400228
EMSL Sample ID: 491400228-0011
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-5

Sampling Date: 03/19/2014
Canister ID: HD2309

Lab File ID: K9355.D
Sample Vol(ml): 250
Dilution Factor: 1

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
Chloroform	67-66-3	119.4	ND	0.50		ND	2.4
Tetrahydrofuran	109-99-9	72.11	ND	0.50		ND	1.5
1,1,1-Trichloroethane	71-55-6	133.4	ND	0.50		ND	2.7
Cyclohexane	110-82-7	84.16	ND	0.50		ND	1.7
2,2,4-Trimethylpentane(Isooctane)	540-84-1	114.2	ND	0.50		ND	2.3
Carbon tetrachloride	56-23-5	153.8	ND	0.50		ND	3.1
n-Heptane	142-82-5	100.2	**0.66**	0.50		**2.7**	2.0
1,2-Dichloroethane	107-06-2	98.96	ND	0.50		ND	2.0
Benzene	71-43-2	78.11	**1.1**	0.50		**3.4**	1.6
Trichloroethene	79-01-6	131.4	ND	0.50		ND	2.7
1,2-Dichloropropane	78-87-5	113.0	ND	0.50		ND	2.3
Methyl Methacrylate	80-62-6	100.12	ND	0.50		ND	2.0
Bromodichloromethane	75-27-4	163.8	ND	0.50		ND	3.3
1,4-Dioxane	123-91-1	88.12	ND	0.50		ND	1.8
4-Methyl-2-pentanone(MIBK)	108-10-1	100.2	ND	0.50		ND	2.0
cis-1,3-Dichloropropene	10061-01-5	111.0	ND	0.50		ND	2.3
Toluene	108-88-3	92.14	**1.0**	0.50		**3.9**	1.9
trans-1,3-Dichloropropene	10061-02-6	111.0	ND	0.50		ND	2.3
1,1,2-Trichloroethane	79-00-5	133.4	ND	0.50		ND	2.7
2-Hexanone(MBK)	591-78-6	100.1	ND	0.50		ND	2.0
Tetrachloroethene	127-18-4	165.8	ND	0.50		ND	3.4
Dibromochloromethane	124-48-1	208.3	ND	0.50		ND	4.3
1,2-Dibromoethane	106-93-4	187.8	ND	0.50		ND	3.8
Chlorobenzene	108-90-7	112.6	ND	0.50		ND	2.3
Ethylbenzene	100-41-4	106.2	ND	0.50		ND	2.2
Xylene (p,m)	1330-20-7	106.2	ND	1.0		ND	4.3
Xylene (Ortho)	95-47-6	106.2	ND	0.50		ND	2.2
Styrene	100-42-5	104.1	ND	0.50		ND	2.1
Isopropylbenzene (cumene)	98-82-8	120.19	ND	0.50		ND	2.5
Bromoform	75-25-2	252.8	ND	0.50		ND	5.2
1,1,2,2-Tetrachloroethane	79-34-5	167.9	ND	0.50		ND	3.4

EMSL Order: 491400228
EMSL Sample ID: 491400228-0011
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-5

Lab File ID: K9355.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2309

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Target Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Target Compounds	CAS#	MW	Result ppbv	RL ppbv	Q	Result ug/m3	RL ug/m3
4-Ethyltoluene	622-96-8	120.2	ND	0.50		ND	2.5
1,3,5-Trimethylbenzene	108-67-8	120.2	ND	0.50		ND	2.5
2-Chlorotoluene	95-49-8	126.6	ND	0.50		ND	2.6
1,2,4-Trimethylbenzene	95-63-6	120.2	**0.65**	0.50		**3.2**	2.5
1,3-Dichlorobenzene	541-73-1	147.0	ND	0.50		ND	3.0
1,4-Dichlorobenzene	106-46-7	147.0	ND	0.50		ND	3.0
Benzyl chloride	100-44-7	126.0	ND	0.50		ND	2.6
1,2-Dichlorobenzene	95-50-1	147.0	ND	0.50		ND	3.0
1,2,4-Trichlorobenzene	120-82-1	181.5	ND	0.50		ND	3.7
Hexachloro-1,3-butadiene	87-68-3	260.8	ND	0.50		ND	5.3
Naphthalene	91-20-3	128.17	ND	0.50		ND	2.6

ND = Non Detect

Surrogate	Result	Spike	Recovery
4-Bromofluorobenzene	10.0	10	100%

Qualifier Definitions

B = Compound also found in method blank.

E= Estimated concentration exceeding upper calibration range.

D= Result reported from diluted analysis.

NJDEP Certification #: 03036

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EMSL Order: 491400228
EMSL Sample ID: 491400228-0011
Received Date: 03/21/2014
Report Date: 04/07/2014

Project: 12014.000048.00
Client Sample ID: INDOOR-5

Lab File ID: K9355.D
Sample Vol(ml): 250
Dilution Factor: 1

Sampling Date: 03/19/2014
Canister ID: HD2309

Analysis Date: 04/03/2014
Instrument ID: 5973K
Analyst Initials: KW

Tentatively Identified Compound Results Summary

USEPA: 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), January 1999, (EPA/625/R-96/010b).

Tentatively Identified Compounds	CAS#	MW(1)	Result ppbv	Q	Result ug/m3	Retention Time
Propane	000074-98-6	44	53	JN	96	4.73
Isobutane	000075-28-5	58	3.7	JN	8.8	5.14
Acetaldehyde	000075-07-0	44	3.3	JN	5.9	5.93
Butane, 2-methyl-	000078-78-4	72	2.3	JN	6.7	6.88
Pentane	000109-66-0	72	3.8	JN	11	7.66
Pentane, 2-methyl-	000107-83-5	86	3.1	JN	11	10.84
Pentane, 3-methyl-	000096-14-0	86	1.2	JN	4.3	11.87
1-Hexene	000592-41-6	84	1.9	JN	6.4	12.76
Octane	000111-65-9	114	1.5	JN	7.1	21.26
Unknown hydrocarbon		92	4.7	J	18	24.00
Unknown		92	4.3	J	16	25.48
Decane	000124-18-5	142	6.3	JN	36	26.32
Undecane	001120-21-4	156	3.9	JN	25	28.36
Dodecane	000112-40-3	170	3.9	JN	27	30.21
Unknown alkene		92	1.4	J	5.4	30.30
Unknown alkene		92	2.7	J	10	30.45
Unknown alkene		92	1.4	J	5.4	30.71

Qualifier Definitions

(1) = If unknown, MW is assigned as equivalent Toluene (92) for ug/m3 conversion purposes.

B = Compound also found in method blank.

J= Estimated value based on a 1:1 response to internal standard.

N= Presumptive evidence of compound based on library match.

NJDEP Certification #: 03036

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USEPA TO-15

6L

External Chain of Custody/ Field Test Data Sheet

EMSL Analytical, Inc.
200 Route 130 North
Cinnaminson, NJ 08077
Ph. (800) 220-3675
Fax (856) 786-0327

EMSL Order Number (Lab Use Only): 491400228

Report To Contact Name: SPENCER PIZZANI	Bill To Company: BUREAU VERITAS	Sampled By (Sign):	
Company Name: BUREAU VERITAS	Attention To: ACCOUNTS PAYABLE	Sampled By (Name): SPENCER PIZZANI	
Address 1: 110 FIELDCREST AVE, 4th FLOOR	Address 1: 95 OAKWOOD DR	Total # of Samples: 6	
Address 2: EDISON NJ 08837	Address 2: LAKE ZURICH, IL 60047	Date Shipped: 20 MAR 2014	
Phone No.: 17322256040 Fax:	Phone No.: Fax:	Sample Collection Zip Code: 14750	
Email Results To: SPENCER.PIZZANI@US.BUREAUVERITAS.COM	Project Name: 12014.000048.00	Purchase Order:	

Turnaround Time (in Business Days): ☐ 5 Day ☐ 2 Day ☐ 4 Day ☐ 1 Day ☒ 10 Day Standard ☐ 3 Day ☐ Other

Reporting Format: ☐ Results Only (Standard Lab Report) ☒ Full Deliverables (Surcharge may apply) NYS DEC ☐ Other

Field Use - All Information Required!

Lab Use Only

Client Field Sample Identification	Sampling Start Information Barometric Pres. ("Hg): 29.81 Start Date	Time (24 hr clock)	Canister Pressure ("Hg)	Interior Temp. (F)	Sampling Stop Information Barometric Pres. ("Hg): 29.76 Stop Date	Time (24 hr clock)	Canister Pressure ("Hg)	Interior Temp. (F)	Canister Information Canister ID	Size (L)	Can Cert Batch ID	Outgoing Pressure ("Hg)	Incoming Pressure ("Hg)	Flow Contoller Reg. ID	Cal Flow (ml/min)	Analysis USEPA TO-15	NJDEP LLTO-15	LIBRARY SEARCH	Other (Specify)	Matrix Indoor/[✓ Ambient] Air	~~Soil Gas~~ SUB SLAB	Landfill/ Vent
SUBSLAB-1	19 MAR	~~1340~~ 1412	-29	~65	19 MAR	1504	-7	~75	E15518	6	C2890	-29.8	-7.6	3572	82.2	X					X	
-2	↓	1415	-31	↓	↓	1513	-7	~75	0419	↓	↓	↓	-6.8	3730	83.7	X					X	
-3		1421	-29			1526	-7	~75	0385				-8.2	6000	85.7	X					X	
-4		1441	-26.5			1534	-7	~75	0369				-8.0	5963	83.5	X					X	
-5		1449	-27			1543	-6.5	~75	15349				-7.8	5960	85.3	X					X	
AMBIENT-OUT		1340	-27	48out		1435	4	48out	15642				-5.6	5959	85.4	X				X		

EMSL Sample Identifier

Comments:

Lab Canister Certification
Analyst Signature (TO-15):

Relinquished by:	Date/ Time	Received by:	Date/ Time	Affixed Seal #	Reason for Exchange (circle appropriate)
	3/15/14 1105		03-17-14 11:35		Shipping [✓ Courier] Receiving Sampling Other:
	03-17-14 13:34		3/17/14 1335		Shipping Courier Receiving [✓ Sampling] Other:
	3/20/14	coc	3/21/14 7:04		Shipping Courier Receiving Sampling [✓ Other]: LAB
	3/21/14 7:06		3.20.14 6:15AM		Shipping Courier Receiving Sampling Other:
		NM			Shipping Courier Receiving Sampling Other:

3/2?/14 1535

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AN

EMSL ANALYTICAL, INC.
LABORATORY•PRODUCTS•TRAINING

USEPA TO-15
External Chain of Custody/ Field Test Data Sheet

SMALL

EMSL Analytical, Inc.
200 Route 130 North
Cinnaminson, NJ 08077
Ph. (800) 220-3675
Fax (856) 786-0327

EMSL Order Number (Lab Use Only): 491400228

Report To Contact Name:	SPENCER PIZZANI	**Bill To Company:**	BUREAU VERITAS	**Sampled By (Sign):**	
Company Name:	BUREAU VERITAS	**Attention To:**	ACCOUNTS PAYABLE	**Sampled By (Name):**	SPENCER PIZZANI
Address 1:	110 FIELDCREST AVE, 4th FLOOR	**Address 1:**	95 OAKWOOD DRIVE	**Total # of Samples:**	5
Address 2:	EDISON, NJ 08837	**Address 2:**	LAKE ZURICH, IL 60047	**Date Shipped:**	20 MAR 2014
Phone No. :	1732 225 6040 Fax :	**Phone No.:**	Fax :	**Sample Collection Zip Code:**	14750
Email Results To:	SPENCER.PIZZANI@US BUREAUVERITAS.com	**Project Name:**	12014.000048.00	**Purchase Order:**	

Turnaround Time (in Business Days): ☒ 10 Day Standard ☐ 5 Day ☐ 4 Day ☐ 3 Day ☐ 2 Day ☐ 1 Day ☐ Other

Reporting Format: ☐ Results Only (Standard Lab Report) ☒ Full Deliverables (Surcharge may apply) NYSDEC ☐ Other

EMSL Sample Identifier

Field Use - All Information Required! | **Lab Use Only**

Sampling Start Information — Barometric Pres. ("Hg): 29.81
Sampling Stop Information — Barometric Pres. ("Hg): 29.76

Client Field Sample Identification	Start Date	Time (24 hr clock)	Canister Pressure ("Hg)	Interior Temp. (F)	Stop Date	Time (24 hr clock)	Canister Pressure ("Hg)	Interior Temp. (F)	Canister ID	Size (L)	Can Cert Batch ID	Outgoing Pressure ("Hg)	Incoming Pressure ("Hg)	Flow Contoller Reg. ID	Flow Contoller Cal Flow (ml/min)	Analysis: USEPA TO-15	Analysis: NJDEP LLTO-15	Analysis: LIBRARY SEARCH	Analysis: Other (Specify)	Matrix: [✓ Indoor]/Ambient Air	Matrix: Soil Gas	Matrix: Landfill/ Vent
INDOOR -1	19 MAR	1344	-28	~65	19 MAR	1423	<1	~75	HD2266	1.4	H0206	-30.0	-2.0	3526	20.0	X				X		
-2	↓	1351	-26.5	↓	↓	1424	<1	↓	1461	↓	↓	↓	-2.0	3716	19.8	X				X		
-3	↓	1355	-30	↓	↓	1425	3	↓	2775	↓	↓	↓	-4.0	3654	19.8	X				X		
-4	↓	1358	-29	↓	↓	1425	4	↓	2780	↓	↓	↓	-5.0	3686	19.6	X				X		
-5	↓	1404	-30	↓	↓	1433	4.5	↓	2309	↓	↓	↓	-5.0	5999	19.9	X				X		

Comments:

Lab Canister Certification
Analyst Signature (TO-15):

Relinquished by:	Date/ Time	Received by:	Date/ Time	Affixed Seal #	Reason for Exchange (circle appropriate)
	3/15/14 1105		03-17-14 11:35		Shipping [✓ Courier] Receiving Sampling Other:
	03-17-14 13:34		3/17/14 1335		Shipping Courier Receiving [✓ Sampling] Other:
	20 MAR 14				Shipping Courier Receiving Sampling [✓ Other]: LAB
			3/27/14 1535		Shipping Courier Receiving Sampling [✓ Other]: AN
					Shipping Courier Receiving Sampling Other: