City of Bothell™

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LETTER OF TRANSMITTAL

Date: February 26, 2016

Company: Department of Ecology
Attn: Sunny Becker NWRO Toxics
Address: Cleanup Program 3190 - 160th SE
Bellevue, WA 98008

From: Nduta Mbuthia, Project Engineer, Capital Projects Division

Attached please find: Electronic copy of:-

1) Letter Report (2/26/2016) - SOIL GAS SURVEY/ SOURCE INVESTIGATION for Riverside HVOC Site

☐ For your information/files	☐ For your action
☒ At your request	☐ Approved as noted
☐ Returned for correction	☐ Please return all copies
☐ Other:	

Comments:

February 26, 2016
HWA Project No. 2007 098- 2012

Ms. Sunny Becker
Washington Department of Ecology
Toxics Cleanup Program, Northwest Regional Office
3190 - 160th SE Bellevue, WA 98008

Subject: **SOIL GAS SURVEY/ SOURCE INVESTIGATION**
Riverside HVOC Site
Bothell, Washington

Dear Ms. Becker:

This letter describes the results of a passive soil gas survey conducted at the Riverside halogenated volatile organic compound (HVOC) site. Based on discussions with Ecology in November 2015, a phased approach would be utilized to conduct the soil gas survey, with the first phase focusing on areas to the south of the SR522 highway. The need for a second phase (in areas further north) would then be made after evaluation of the results from the first phase. HWA conducted the first phase of the soil gas investigation per the approved work plan dated October 13, 2015 (HWA Soil Gas Survey/Source Investigation Memo, 2015).

Introduction

The first phase of exploration was conducted in January and February 2016, and included installation and analysis of 35 passive soil gas samplers at the south part of the Riverside HVOC Site. Figure 1 shows the exploration plan. The second planned phase includes areas north of the Riverside HVOC Site.

Objectives

The objectives of the soil gas survey were:

1) To determine if a source of the HVOCs in ground water at the Bothell Riverside HVOC site can be located, either on or upgradient (north) of the Bothell Riverside HVOC site as currently defined.
2) To further delineate the groundwater plume

Methods

The passive diffusion soil gas survey entails placement of small (1/2" diameter) containers into drilled holes in the ground (3 feet deep), and spaced approximately 15 feet apart. The containers are filled with sorbent material and fitted with gas-permeable caps, allowing soil gas to migrate into the container and trap any HVOCs in the soil gas over the time period they are left in the ground. Analysis of the samplers indicates the relative concentration of HVOCs in soil gas over a large area, allowing contouring of the data and evaluation of hot spots or potential source areas.

HWA installed 35 diffusion samplers at the locations shown on Figure 1 on January 11, 2016. A hand-operated electric roto-hammer drill was used to advance half-inch diameter holes to 3 feet deep. The top 12 inches of each hole as drilled to ¾ inch diameter to accommodate the sampler.

After 18 days, the containers were removed, capped, and sent to a laboratory for analysis of HVOCs. Each hole was backfilled with bentonite, and the surface plugged with soil or cold patch asphalt, to match surrounding ground surface.

Results

Table 1 summarizes the analytical results, with only detected HVOCs shown. Appendix A contains the lab reports and a complete list of analytes tested for. Results are given in nanograms (ng) of HVOC detected on the sorbent media. Because there is no known quantity of soil, ground water or soil gas that is measured, the results are considered relative. Results can not be used to establish compliance with soil or ground water cleanup levels, and follow-up soil or ground water sampling using conventional methods is typically employed to investigate hot spots in an attempt to locate the potential source.

The predominant HVOC detected was tetrachloroethene (PCE) which is the main contaminant of concern a the Site. PCE was detected in 12 of the 35 sample locations. Trichloroethene and cis-1,2-dichloroethene were both detected in 1 of the 35 sample locations. Trichlorofluoromethane (Freon 11) was detected in two of the 35 sample locations, where no other HVOCs were detected. The Freon detections are likely laboratory contaminants and not related to the Site.

The pattern of PCE detections suggest the highest relative PCE concentrations at the northeast end of the Phase I study area, upgradient of the ground water treatment system. The highest detection was at location 4, the most northeast location. These results suggest elevated PCE concentrations and a potential source area or migration pathway from a more distant source are present somewhere north of the Phase I study area, and possibly on or around the Phase II study area.

Recommendations

Based on the results of this Phase I study, we recommend proceeding with the Phase II soil gas study.

Table 1
Passive Soil Gas HVOC results
All values in ng (relative concentrations)

Sample	Tetrachloro-ethene	Trichloro-ethene	cis-1,2-Dichloro-ethene	Trichloro-fluoromethane (Freon 11)
PSG-1	**8 J**	<10	<10	<25
PSG-2	<10	<10	<10	<25
PSG-3	<10	<10	<10	<25
PSG-4	**533**	<10	<10	<25
PSG-5	**12**	<10	<10	<25
PSG-6	**12**	<10	<10	<25
PSG-7	<10	<10	<10	<25
PSG-8	**17**	**15**	**10 J**	<25
PSG-9	**56**	<10	<10	<25
PSG-10	**9 J**	<10	<10	<25
PSG-11	<10	<10	<10	<25
PSG-12	<10	<10	<10	<25
PSG-13	<10	<10	<10	<25
PSG-14	<10	<10	<10	<25
PSG-15	**7 J**	<10	<10	<25
PSG-16	**6 J**	<10	<10	<25
PSG-17	<10	<10	<10	<25
PSG-18	**5 J**	<10	<10	<25
PSG-19	<10	<10	<10	<25
PSG-20	<10	<10	<10	<25
PSG-21	<10	<10	<10	<25
PSG-22	<10	<10	<10	<25
PSG-23	<10	<10	<10	<25
PSG-24	<10	<10	<10	<25
PSG-25	<10	<10	<10	<25
PSG-26	<10	<10	<10	<25
PSG-27	<10	<10	<10	<25
PSG-28	**29**	<10	<10	<25
PSG-29	<10	<10	<10	**28**
PSG-30	<10	<10	<10	**33**
PSG-31	<10	<10	<10	<25
PSG-32	**8 J**	<10	<10	<25
PSG-33	<10	<10	<10	<25
PSG-34	<10	<10	<10	<25
PSG-35	<10	<10	<10	<25

J = Values below limit of quantitation but above limit of detection
No other HVOCs detected, see Appendix A for complete list

REFERENCES

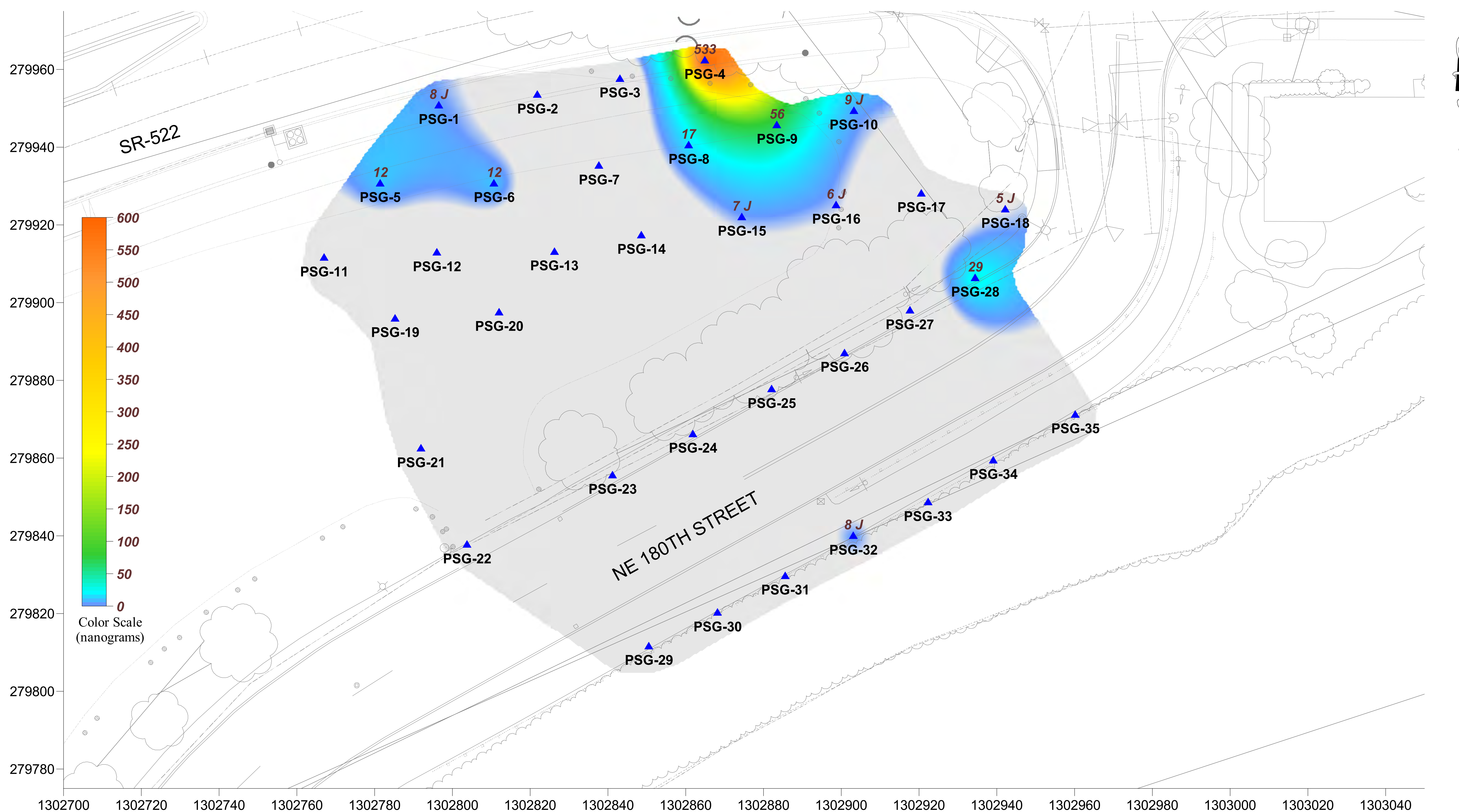
HWA, 2015. *Soil Gas Survey/ Source Investigation, Riverside HVOC Site, Bothell, Washington,* October 13, 2015

Please feel free to contact me if you have any questions or need additional information.

Sincerely,
HWA GEOSCIENCES INC.

Arnie Sugar, LG, LHG
Principal Hydrogeologist

Attachments:
Figure 1 - Soil gas survey exploration plan
Appendix A - Beacon report and laboratory reports



BEACON ENVIRONMENTAL SERVICES, INC.
2203A Commerce Road, Suite 1, Forest Hill, MD 21050 USA
www.Beacon-USA.com 1-410-838-8780
Beacon Project No. 3177.2, February 2016

LEGEND

7 J NANOGRAMS/SAMPLER (J = Estimated Value)

▲ PSG-8 PASSIVE SOIL-GAS SAMPLE LOCATION

Scale in Feet

0 25 50

Figure 1
Passive Soil-Gas Survey
Tetrachloroethene

Bothell/Riverside
Bothell, WA

The Leaders in Soil Gas Surveys
and Vapor Intrusion Monitoring

HWA GeoSciences, Inc.
21312 30th Drive SE, Ste 110
Bothell, WA 98021
Attn: Mr. Arnie Sugar

Passive Soil Gas Survey – Analytical Report
Date: February 26, 2016

Beacon Project No. 3177.2

Project Reference:	Bothell/Riverside, Bothell, WA
Samplers Installed:	January 11 and 12, 2016
Samplers Retrieved:	January 29, 2016
Samples Received:	February 2, 2016
Analyses Completed:	February 4, 2016
Laboratory Data Issued:	February 9, 2016

EPA Method 8260C
All samples were successfully analyzed using thermal desorption-gas chromatography/mass spectrometry (TD-GC/MS) instrumentation to target a custom compound list following EPA Method 8260C. Laboratory results are reported in nanograms (ng) of specific compound per sample.

Laboratory QA/QC procedures included internal standards, surrogates, and blanks based on EPA Method 8260C. Analyses and reporting were in accordance with BEACON's Quality Assurance Project Plan.

Reporting limits
The reporting limit (RL) is 10 nanograms (ng) for vinyl chloride, 1,1-dichloroethene, trans-1,2-dichloroethene, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene; and 25 ng for the remaining individual compounds. **Table 1** provides survey results in nanograms per sampler by sample-point number and compound name. For the six (6) compounds listed above, measurements below the limit of quantitation (10 ng) but above the limit of detection (5 ng) are flagged with a “J.” The RLs represent a baseline above which results exceed laboratory-determined limits of precision and accuracy. Any field sample measurements above the upper calibration standard are estimated; however, these values are reported without qualifiers because all reported measurements are relative to each other and are appropriate to meet the survey objectives of locating source areas and vapor intrusion pathways and defining the lateral extent of contamination.

Calibration Verification
The continuing calibration verification (CCV) values for the calibration check compounds were all within ±20% of the true values as defined by the initial five-point calibration and met the requirements specified in Beacon Environmental’s Quality Assurance Project Plan.

Method Blanks/Trip Blanks
Laboratory method blanks are run with each sample batch to identify contamination present in the laboratory. If contamination is detected on a method blank, measurements of identical compounds in that sample batch are flagged in the laboratory report. The laboratory method blank analyzed in connection with the present samples revealed no contamination.

The trip blank is a sampler prepared, transported, and analyzed with other samples but intentionally not exposed. Any target compounds identified on the trip blanks are reported in the laboratory data. The analysis of the trip blank (labeled Trip-1 in **Table 1**) reported none of the targeted compounds.

Passive Soil-Gas Survey Notes
When sample locations are covered with or near the edge of an artificial surface (*e.g.*, asphalt or concrete), the concentrations of compounds in soil gas are often significantly higher than the concentrations would be if the surfacing were not present. Thus, a reading taken below or near an impermeable surface is much higher than it would be in the absence of such a cap. Therefore, the sample location conditions should be evaluated when comparing results between locations.

Survey findings are exclusive to this project and when the spatial relationships are compared with results of other BEACON Surveys it is necessary to incorporate survey and site information from both investigations (*e.g.*, depth to sources, soil types, porosity, soil moisture, presence of impervious surfacing, sample collection times). BEACON recommends the guidelines stated in **Attachment 1** to establish a relationship between reported soil-gas measurements and actual subsurface contaminant concentrations, which will indicate those measurements representing significant subsurface contamination.

BEACON's passive soil-gas samplers are prepared with two sets of adsorbent cartridges for subsequent duplicate or confirmatory sample analysis. At HWA GeoScience's request, duplicate analysis was performed for one (1) field sample, designated "Dup" following the sample number. When comparing quantitative results, a duplicate correspondence should be considered when the relative percent difference (RPD) between the two samples is less than or equal to 100%. For the purpose of calculating correspondences, all non-detections should be assigned, as a baseline value, the RL for the specific contaminant. No target compounds were reported on the field sample or the duplicate.

Project Details
Samplers were deployed on January 11 and 12, 2016, and were retrieved on January 29, 2016. **Attachment 2** describes standard field procedures. Individual deployment and retrieval times will be found in the Chain of Custody Form (**Attachment 3**).

Thirty-five (35) field samples, one (1) field sample duplicate, and one (1) trip blank were received by BEACON on February 2, 2016. Adsorbent cartridges from the passive samplers were thermally desorbed, then analyzed using gas chromatography/mass spectrometry (GC/MS) equipment, in accordance with EPA Method 8260C, as described in **Attachment 4**. BEACON's laboratory analyzed each sample for the targeted compounds; analyses were completed on February 4, 2016. Following a laboratory review, results were provided to HWA GeoSciences on February 9, 2016.

Sample locations are shown on **Figure 1**. The following table lists frequency of detections based on the number of field samples analyzed, the reporting limit, and the maximum value for tetrachloroethene. The table also includes the transformation and interpolation method for the compound distribution map provided.

Figure No.	**2**
Compound	Tetrachloroethene
Frequency	12
Reporting Limit (nanograms)	10
Max Value (nanograms)	533
Transformation Method	Log
Interpolation Method	Kriging

Attachments:

- **-1-** Applying Results From Passive Soil-Gas Surveys
- **-2-** Field Procedures
- **-3-** Chain-of-Custody Form
- **-4-** Laboratory Procedures

ALL DATA MEET REQUIREMENTS AS SPECIFIED IN THE BEACON ENVIRONMENTAL SERVICES, INC. QUALITY ASSURANCE PROJECT PLAN AND THE RESULTS RELATE ONLY TO THE SAMPLES REPORTED. BEACON ENVIRONMENTAL SERVICES IS ACCREDITED TO ISO/IEC 17025:2005, AND THE WORK PERFORMED WAS IN ACCORDANCE WITH ISO/IEC 17025:2005 REQUIREMENTS, WITH THE EXCEPTION THAT SAMPLES WERE ANALYZED WITHIN A 24-HOUR TUNE WINDOW. THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF THE LABORATORY. RELEASE OF THE DATA CONTAINED IN THIS DATA PACKAGE HAS BEEN AUTHORIZED BY THE LABORATORY DIRECTOR OR HIS SIGNEE, AS VERIFIED BY THE FOLLOWING SIGNATURES:

Steven C. Thornley
Laboratory Director

Patti J. Riggs
Quality Manager

Table 1

Beacon Environmental Services, Inc.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA

Analysis by EPA Method 8260C

Client Sample ID:	mb160203s	Trip 1	PSG-1	PSG-2	PSG-3	PSG-4
Project Number:		3177.2	3177.2	3177.2	3177.2	3177.2
Lab File ID:	S16020304	S16020306	S16020307	S16020308	S16020309	S16020310
Received Date:		2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016
Analysis Date:	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016
Analysis Time:	12:19	13:03	13:25	13:46	14:08	14:29
Matrix:			Soil Gas	Soil Gas	Soil Gas	Soil Gas
Units:	ng	ng	ng	ng	ng	ng
COMPOUNDS						
Vinyl Chloride	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (Freon 11)	<25	<25	<25	<25	<25	<25
1,1-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichlorotrifluoroethane (Fr.113)	<25	<25	<25	<25	<25	<25
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<25	<25	<25	<25	<25	<25
cis-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
Chloroform	<25	<25	<25	<25	<25	<25
1,2-Dichloroethane	<25	<25	<25	<25	<25	<25
1,1,1-Trichloroethane	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	<25	<25	<25	<25	<25	<25
Trichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<25	<25	<25	<25	<25	<25
Tetrachloroethene	<10	<10	**8 J**	<10	<10	**533**
1,1,1,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25
1,1,2,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25

Results in nanograms (ng). J = Values below limit of quantitation (LOQ) but above limit of detection (LOD). B = Detected in method blank.

Table 1

Beacon Environmental Services, Inc.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA

Analysis by EPA Method 8260C

Client Sample ID:	PSG-5	PSG-6	PSG-7	PSG-8	PSG-9	PSG-10
Project Number:	3177.2	3177.2	3177.2	3177.2	3177.2	3177.2
Lab File ID:	S16020311	S16020312	S16020313	S16020314	S16020315	S16020316
Received Date:	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016
Analysis Date:	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016
Analysis Time:	14:51	15:12	15:34	15:56	16:17	16:39
Matrix:	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Units:	ng	ng	ng	ng	ng	ng
COMPOUNDS						
Vinyl Chloride	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (Freon 11)	<25	<25	<25	<25	<25	<25
1,1-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichlorotrifluoroethane (Fr.113)	<25	<25	<25	<25	<25	<25
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<25	<25	<25	<25	<25	<25
cis-1,2-Dichloroethene	<10	<10	<10	**10 J**	<10	<10
Chloroform	<25	<25	<25	<25	<25	<25
1,2-Dichloroethane	<25	<25	<25	<25	<25	<25
1,1,1-Trichloroethane	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	<25	<25	<25	<25	<25	<25
Trichloroethene	<10	<10	<10	**15**	<10	<10
1,1,2-Trichloroethane	<25	<25	<25	<25	<25	<25
Tetrachloroethene	**12**	**12**	<10	**17**	**56**	**9 J**
1,1,1,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25
1,1,2,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25

Results in nanograms (ng). J = Values below limit of quantitation (LOQ) but above limit of detection (LOD). B = Detected in method blank.

Table 1

Beacon Environmental Services, Inc.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA

Analysis by EPA Method 8260C

Client Sample ID:	PSG-11	PSG-12	PSG-13	PSG-14	PSG-15	PSG-16
Project Number:	3177.2	3177.2	3177.2	3177.2	3177.2	3177.2
Lab File ID:	S16020317	S16020318	S16020319	S16020320	S16020321	S16020322
Received Date:	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016
Analysis Date:	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016
Analysis Time:	17:01	17:23	17:44	18:06	18:27	18:49
Matrix:	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Units:	ng	ng	ng	ng	ng	ng
COMPOUNDS						
Vinyl Chloride	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (Freon 11)	<25	<25	<25	<25	<25	<25
1,1-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichlorotrifluoroethane (Fr.113)	<25	<25	<25	<25	<25	<25
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<25	<25	<25	<25	<25	<25
cis-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
Chloroform	<25	<25	<25	<25	<25	<25
1,2-Dichloroethane	<25	<25	<25	<25	<25	<25
1,1,1-Trichloroethane	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	<25	<25	<25	<25	<25	<25
Trichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<25	<25	<25	<25	<25	<25
Tetrachloroethene	<10	<10	<10	<10	**7 J**	**6 J**
1,1,1,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25
1,1,2,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25

Results in nanograms (ng). J = Values below limit of quantitation (LOQ) but above limit of detection (LOD). B = Detected in method blank.

Table 1

Beacon Environmental Services, Inc.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA

Analysis by EPA Method 8260C

Client Sample ID:	PSG-17	PSG-18	PSG-19	PSG-20	PSG-21	PSG-22
Project Number:	3177.2	3177.2	3177.2	3177.2	3177.2	3177.2
Lab File ID:	S16020323	S16020324	S16020325	S16020326	S16020327	S16020328
Received Date:	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016
Analysis Date:	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016
Analysis Time:	19:11	19:32	19:54	20:16	20:38	20:59
Matrix:	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Units:	ng	ng	ng	ng	ng	ng
COMPOUNDS						
Vinyl Chloride	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (Freon 11)	<25	<25	<25	<25	<25	<25
1,1-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichlorotrifluoroethane (Fr.113)	<25	<25	<25	<25	<25	<25
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<25	<25	<25	<25	<25	<25
cis-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
Chloroform	<25	<25	<25	<25	<25	<25
1,2-Dichloroethane	<25	<25	<25	<25	<25	<25
1,1,1-Trichloroethane	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	<25	<25	<25	<25	<25	<25
Trichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<25	<25	<25	<25	<25	<25
Tetrachloroethene	<10	**5 J**	<10	<10	<10	<10
1,1,1,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25
1,1,2,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25

Results in nanograms (ng). J = Values below limit of quantitation (LOQ) but above limit of detection (LOD). B = Detected in method blank.

Table 1

Beacon Environmental Services, Inc.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA

Analysis by EPA Method 8260C

Client Sample ID:	PSG-23	PSG-24	PSG-25	PSG-26	PSG-27	PSG-27 Dup
Project Number:	3177.2	3177.2	3177.2	3177.2	3177.2	3177.2
Lab File ID:	S16020329	S16020330	S16020331	S16020332	S16020333	S16020334
Received Date:	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016
Analysis Date:	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016	2/3/2016
Analysis Time:	21:21	21:42	22:05	22:26	22:48	23:09
Matrix:	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Units:	ng	ng	ng	ng	ng	ng
COMPOUNDS						
Vinyl Chloride	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (Freon 11)	<25	<25	<25	<25	<25	<25
1,1-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichlorotrifluoroethane (Fr.113)	<25	<25	<25	<25	<25	<25
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<25	<25	<25	<25	<25	<25
cis-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
Chloroform	<25	<25	<25	<25	<25	<25
1,2-Dichloroethane	<25	<25	<25	<25	<25	<25
1,1,1-Trichloroethane	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	<25	<25	<25	<25	<25	<25
Trichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<25	<25	<25	<25	<25	<25
Tetrachloroethene	<10	<10	<10	<10	<10	<10
1,1,1,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25
1,1,2,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25

Results in nanograms (ng). J = Values below limit of quantitation (LOQ) but above limit of detection (LOD). B = Detected in method blank.

Table 1

Beacon Environmental Services, Inc.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA

Analysis by EPA Method 8260C

Client Sample ID:	PSG-28	PSG-29	PSG-30	PSG-31	PSG-32	PSG-33
Project Number:	3177.2	3177.2	3177.2	3177.2	3177.2	3177.2
Lab File ID:	S16020335	S16020336	S16020337	S16020338	S16020339	S16020340
Received Date:	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016	2/2/2016
Analysis Date:	2/3/2016	2/3/2016	2/4/2016	2/4/2016	2/4/2016	2/4/2016
Analysis Time:	23:31	23:53	0:15	0:37	0:59	1:21
Matrix:	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas	Soil Gas
Units:	ng	ng	ng	ng	ng	ng
COMPOUNDS						
Vinyl Chloride	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (Freon 11)	<25	**28**	**33**	<25	<25	<25
1,1-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichlorotrifluoroethane (Fr.113)	<25	<25	<25	<25	<25	<25
trans-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	<25	<25	<25	<25	<25	<25
cis-1,2-Dichloroethene	<10	<10	<10	<10	<10	<10
Chloroform	<25	<25	<25	<25	<25	<25
1,2-Dichloroethane	<25	<25	<25	<25	<25	<25
1,1,1-Trichloroethane	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	<25	<25	<25	<25	<25	<25
Trichloroethene	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	<25	<25	<25	<25	<25	<25
Tetrachloroethene	**29**	<10	<10	<10	**8 J**	<10
1,1,1,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25
1,1,2,2-Tetrachloroethane	<25	<25	<25	<25	<25	<25

Results in nanograms (ng). J = Values below limit of quantitation (LOQ) but above limit of detection (LOD). B = Detected in method blank.

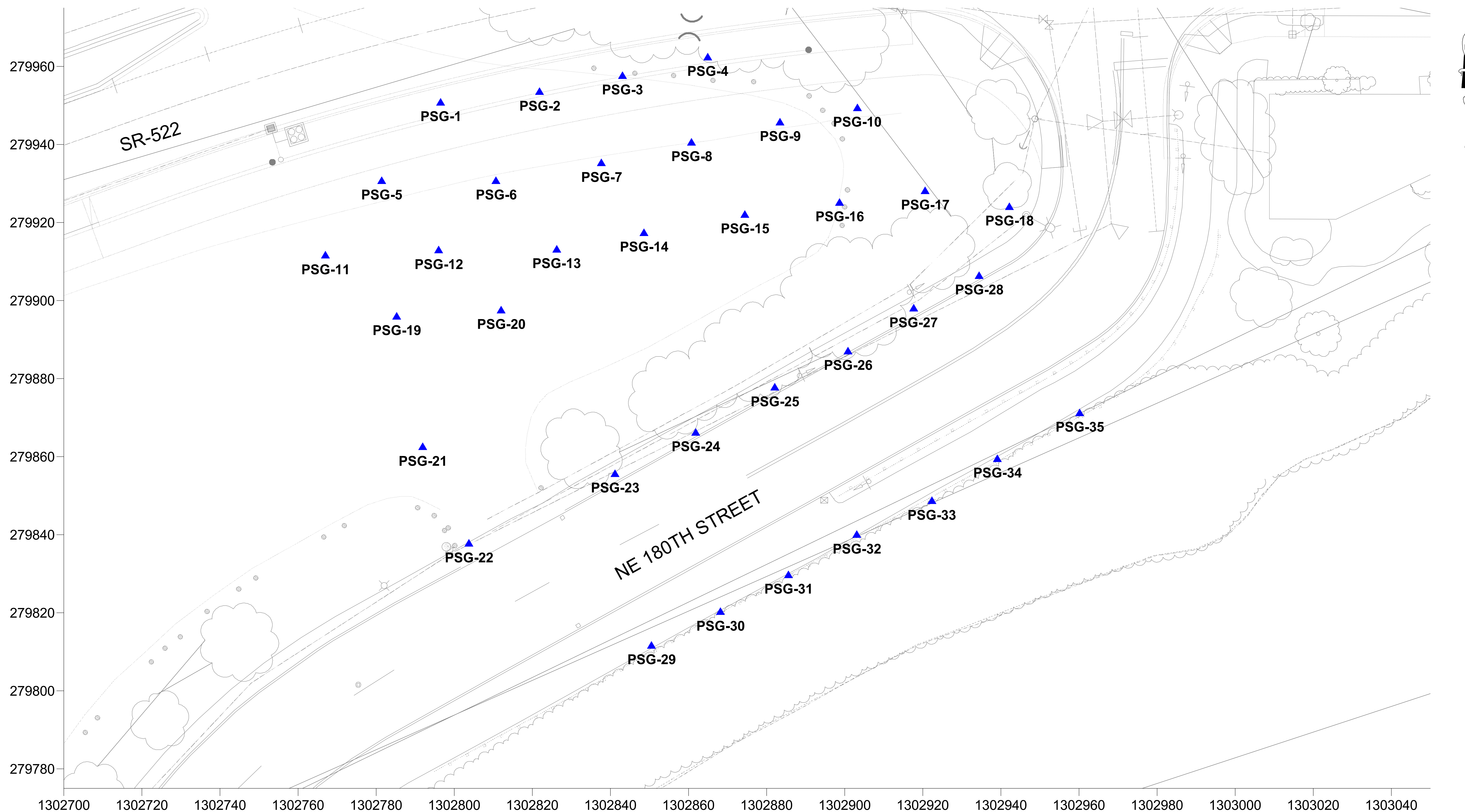
Table 1

Beacon Environmental Services, Inc.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA

Analysis by EPA Method 8260C

Client Sample ID:	PSG-34	PSG-35
Project Number:	3177.2	3177.2
Lab File ID:	S16020341	S16020342
Received Date:	2/2/2016	2/2/2016
Analysis Date:	2/4/2016	2/4/2016
Analysis Time:	1:42	2:04
Matrix:	Soil Gas	Soil Gas
Units:	ng	ng
COMPOUNDS		
Vinyl Chloride	<10	<10
Trichlorofluoromethane (Freon 11)	<25	<25
1,1-Dichloroethene	<10	<10
1,1,2-Trichlorotrifluoroethane (Fr.113)	<25	<25
trans-1,2-Dichloroethene	<10	<10
1,1-Dichloroethane	<25	<25
cis-1,2-Dichloroethene	<10	<10
Chloroform	<25	<25
1,2-Dichloroethane	<25	<25
1,1,1-Trichloroethane	<25	<25
Carbon Tetrachloride	<25	<25
Trichloroethene	<10	<10
1,1,2-Trichloroethane	<25	<25
Tetrachloroethene	<10	<10
1,1,1,2-Tetrachloroethane	<25	<25
1,1,2,2-Tetrachloroethane	<25	<25

Results in nanograms (ng). J = Values below limit of quantitation (LOQ) but above limit of detection (LOD). B = Detected in method blank.



BEACON ENVIRONMENTAL SERVICES, INC.

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Beacon Project No. 3177.2, February 2016

LEGEND

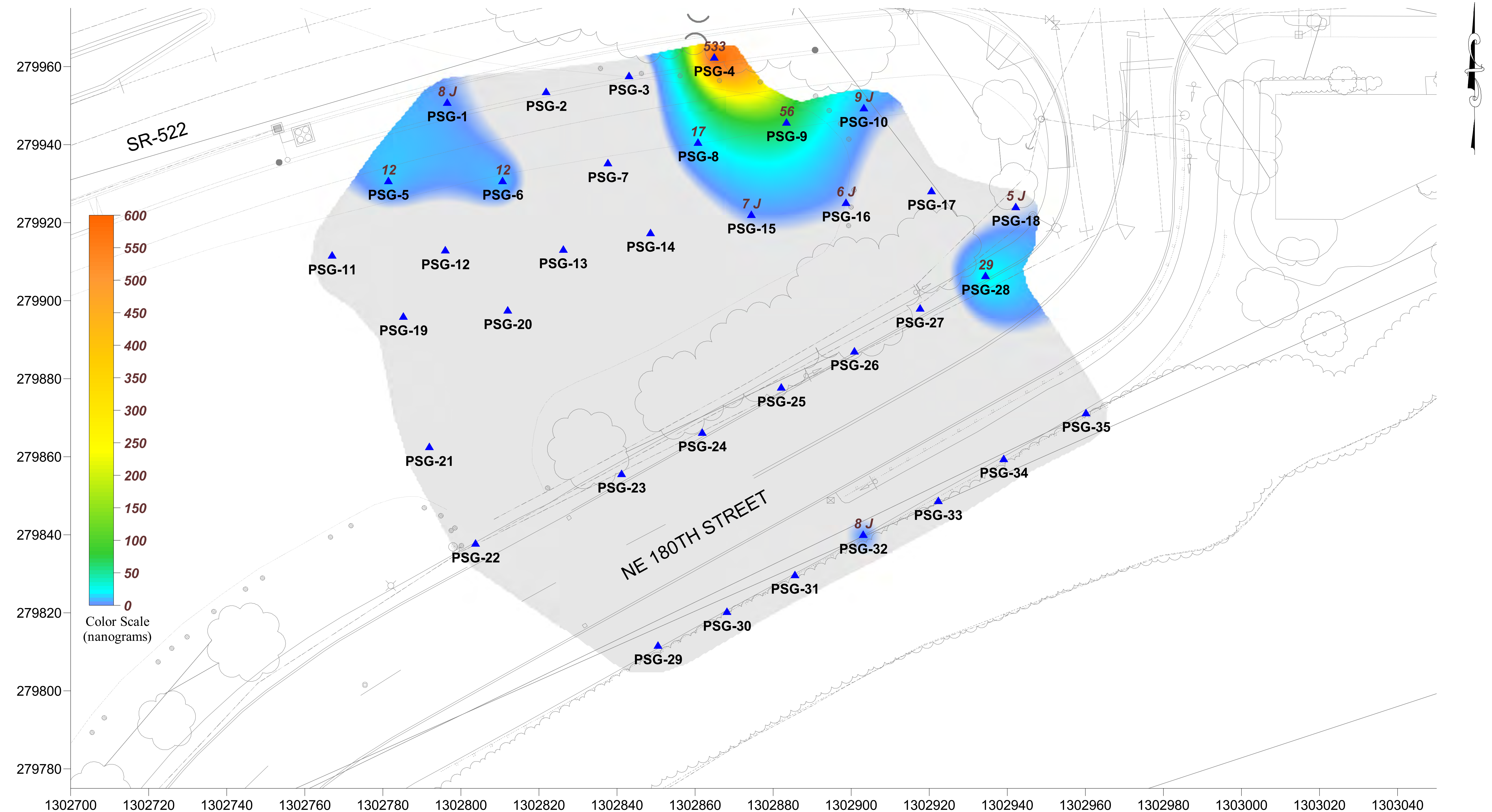
▲ PSG-8 PASSIVE SOIL-GAS SAMPLE LOCATION

Scale in Feet

0 25 50

Figure 1
Passive Soil-Gas Survey Sample Locations

Bothell/Riverside
Bothell, WA



LEGEND

7 J NANOGRAMS/SAMPLER (J = Estimated Value)

▲ PSG-8 PASSIVE SOIL-GAS SAMPLE LOCATION

Scale in Feet

0 25 50

Figure 2
Passive Soil-Gas Survey
Tetrachloroethene

Bothell/Riverside
Bothell, WA

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Beacon Project No. 3177.2, February 2016

Attachments

Attachment 1

APPLYING RESULTS FROM
PASSIVE SOIL-GAS SURVEYS

The utility of soil-gas surveys is directly proportional to their accuracy in reflecting and representing changes in the subsurface concentrations of source compounds. Passive soil-gas survey results are the mass collected from the vapor-phase emanating from the source(s). The vapor-phase is merely a fractional trace of the source(s) and, as a matter of convenience, the units used in reporting detection values from passive soil-gas surveys are smaller than those employed for source-compound concentrations.

Passive soil gas data are reported in mass of compounds identified per sample location (e.g., nanograms (ng) or micrograms (µg) per sampler). Results from a passive soil gas survey typically are then used to guide where follow-on intrusive samples should be collected to obtain corresponding concentrations of the contaminants in soil, soil gas, and/or groundwater, as well as eliminate those areas where intrusive samples are not required. It is not practical to report passive soil gas data as concentration because the sampler's uptake rates of the compounds are often greater than the replenishment rates of the compounds around the sampler, which results in low bias measurements, and the replenishment rates will be dependent on several factors that include, at a minimum, soil gas concentrations, soil porosity and permeability, and soil moisture level.

Whatever the relative concentrations of source and associated soil gas, best results are realized when the ratio of soil-gas measurements to actual subsurface concentrations remains as close to constant as the real world permits. It is the reliability and consistency of this ratio, not the particular units of mass (*e.g.*, nanograms) that determine usefulness. Thus, BEACON emphasizes the necessity of conducting — at minimum — follow-on intrusive sampling in areas that show relatively high soil-gas measurements to obtain corresponding concentrations of soil and groundwater contaminants. These correspondent values furnish the basis for approximating a relationship. For extrapolating passive soil gas results to vapor intrusion evaluations, we recommend a minimum of three passive soil gas locations be converted to a shallow vapor well then sampled using an active soil gas method. Once a relationship is established, it can be used in conjunction with the remaining soil-gas measurements to estimate subsurface contaminant concentrations across the survey field. (See www.beacon-usa.com/passivesoilgas.html, Publication 1: *Mass to Concentration Tie-In for PSG Surveys* and Publication 4: *Groundwater and PSG Correlation*.) It is important to keep in mind, however, that specific conditions at individual sample points, including soil porosity and permeability, depth to contamination, and perched ground water, can have an impact on soil-gas measurements at those locations.

When passive soil-gas surveys are utilized as described above, the data provide information that can yield substantial savings in drilling costs and in time. They furnish, among other things, a checklist of compounds expected at each survey location and help to determine how and where drilling budgets can most effectively be spent. Passive soil-gas surveys can also be used as a remediation or general site monitoring tool that can be implemented on a quarterly, semi-annual or annual basis.

Attachment 2

FIELD PROCEDURES FOR
PASSIVE SOIL-GAS SURVEYS

The following field procedures are routinely used during a BEACON Passive Soil-Gas Survey. Modifications can be and are incorporated from time to time in response to individual project requirements. In all instances, BEACON adheres to EPA-approved Quality Assurance and Quality Control practices.

A. Field personnel carry a BESURE Sample Collection Kit™ and support equipment to the site and deploy the passive samplers in a prearranged survey pattern. A passive sampler consists of a borosilicate glass vial containing hydrophobic adsorbent cartridges with a length of wire attached to the vial for retrieval. Although samplers require only one person for emplacement and retrieval, the specific number of field personnel required depends upon the scope and schedule of the project. Each Sampler emplacement generally takes less than two minutes.

B. At each survey point a field technician clears vegetation as needed and, using a hammer drill with a 1″- to 1½″-diameter bit, creates a hole 12 to 14 inches deep. [Note: For locations covered with asphalt, concrete, or gravel surfacing, the field technician drills a 1″- to 1½″-diameter hole through the surfacing to the soils beneath]. The technician then, using a hammer drill with a ½″ diameter bit, creates a hole three-feet deep. The hole is then sleeved with a 1″-diameter metal sleeve.

C. The technician then removes the solid plastic cap from a sampler and replaces it with a Sampling Cap (a plastic cap with a hole covered by screen meshing). The technician inserts the sampler, with the Sampling Cap end facing down, into the hole (**see attached figure**). The sampler is then covered with an aluminum foil plug and soils for uncapped locations or, for capped locations, an aluminum foil plug and a concrete patch. The sampler's location, time and date of emplacement, and other relevant information are recorded on the Field Deployment Form.

D. One or more trip blanks are included as part of the quality-control procedures.

E. Once all the samplers have been deployed, field personnel schedule sampler recovery and depart, taking all other equipment and materials with them.

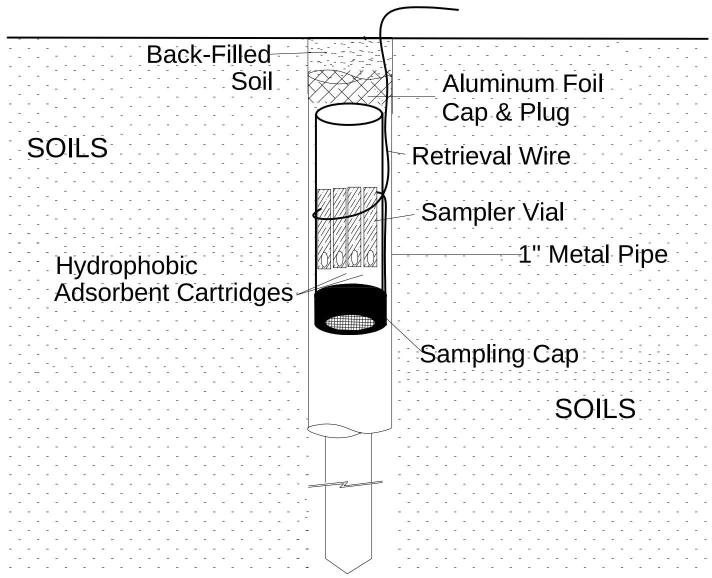
F. Field personnel retrieve the samplers at the end of the exposure period. At each location, a field technician withdraws the sampler from its hole, removes the retrieval wire, and wipes the outside of the vial clean using gauze cloth; following removal of the Sampling Cap, the threads of the vial are also cleaned. A solid plastic cap is screwed onto the vial and the sample location number is written on the label. The technician then records sample-point location, date, time, etc. on the Field Deployment Form.

G. Sampling holes are refilled with soil, sand, or other suitable material. If samplers have been installed through asphalt or concrete, the hole is filled to grade with a plug of cold patch or cement.

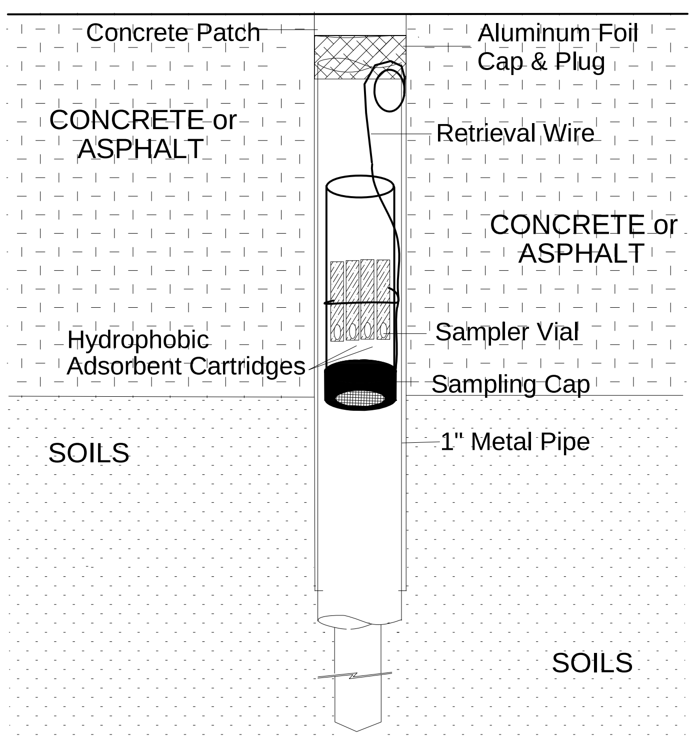
H. Following retrieval, field personnel ship or transport the passive samplers to BEACON's laboratory.

BEACON'S PASSIVE SOIL-GAS SAMPLER

DEPLOYMENT THROUGH SOILS



DEPLOYMENT THROUGH AN ASPHALT/CONCRETE CAP



Attachment 3

Chain of Custody Form

BEACON ENVIRONMENTAL SERVICES, INC.
2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA
P: 1-410-838-8780 | F: 1-410-838-8740

CHAIN-OF-CUSTODY
PASSIVE SOIL-GAS SAMPLES

Project Information		Client Information		
Beacon Project No.:	3177.2	Company Name:	HWA Geosciences	Client PO No.:
Site Name:	~~Riverside~~ Bothell / Riverside	Office Location:	Bothell, WA	2007-098-2036
Site Location:	Bothell, WA	Samples Submitted By:	Arnie Sugar	Expedited Turnaround Time
Analytical Method:	U.S. EPA Method 8260C	Contact Phone No.:	(425) 774-0106	☐ Rush (Specify): ____ days
Target Compounds:	HVOC			

Field Sample ID	Date Emplaced: 1-11-15 / Time Emplaced	Date Retrieved: 1-29-16 / Time Retrieved	Sampling Hole Depth (inches)	Type of Surface (Soil/Asphalt/ Concrete/Gravel)	Optional Sample Information (e.g., Description of Sample Location, Sample Condition, PID/FID Readings)
PSG-29	11:17	14:33	36"	Soil	
PSG-30	11:35	14:37	↓	↓	
PSG-31	11:42	14:42	↓	↓	
PSG-32	12:05	14:46	↓	↓	
PSG-33	12:16	14:51	↓	↓	
PSG-34	12:28	14:55	↓	↓	
PSG-35	12:38	~~14~~ 15:00	↓	↓	
PSG-18	12:45	15:04	↓	↓	
PSG-28	12:53	15:09	↓	↓	
PSG-17	13:05	15:13	↓	↓	
PSG-27	13:16	15:18	↓	↓	
PSG-26	13:25	15:23	↓	↓	
PSG-25	13:36	15:28	↓	↓	
PSG-24	13:46	15:32	↓	↓	
PSG-23	13:52	15:37	36"	Soil	

Special Notes/Instructions:

Shipment of Field Kit to Laboratory — Custody Seal # 4607124 **Intact?** (Y) N

Relinquished by:	Date/Time	Courier	Received by:	Date/Time
Austin York [signature]	1-31-16 / 1830	Fedex	[signature]	2.2.16 11:45

BEACON ENVIRONMENTAL SERVICES, INC.

CHAIN-OF-CUSTODY
PASSIVE SOIL-GAS SAMPLES

2203A Commerce Road, Suite 1
Forest Hill, MD 21050 USA
P: 1-410-838-8780 | F: 1-410-838-8740

Project Information		Client Information		
Beacon Project No.:	3177.2	Company Name:	HWA Geosciences	Client PO No.:
Site Name:	Bothell / Riverside	Office Location:	Bothell, WA	2007-098-2036
Site Location:	Bothell, WA	Samples Submitted By:	Arnie Sugar	Expedited Turnaround Time
Analytical Method:	U.S. EPA Method 8260C	Contact Phone No.:	(425) 774-0106	☐ Rush (Specify): ____ days
Target Compounds:	HVOC			

Field Sample ID	Date Emplaced: 1-11-15	Date Retrieved	Sampling Hole Depth (inches)	Type of Surface (Soil/Asphalt/ Concrete/Gravel)	Optional Sample Information (e.g., Description of Sample Location, Sample Condition, PID/FID Readings)
	Time Emplaced	Time Retrieved			
PSG-22	14:01	15:41	36"	Soil	
PSG-21	14:10	15:46	↓	↓	
PSG-11	14:22	15:51	↓	↓	
PSG-12	14:34	15:56	↓	↓	
PSG-19	14:42	16:00	↓	↓	
PSG-13	14:50	16:05	↓	↓	
PSG-20	14:59	16:09	↓	↓	
PSG-14	15:09	16:13	↓	↓	
PSG-15	15:20	16:18	↓	↓	
PSG-16	15:30	16:22	↓	↓	
PSG-10	15:41	16:26	↓	↓	
PSG-9	15:50	16:31	↓	↓	
PSG-8	15:58	16:36	↓	↓	
PSG-7	16:10	16:40	↓	↓	
PSG-6	17:30	16:45	36"	Soil	

Special Notes/Instructions:

Shipment of Field Kit to Laboratory — Custody Seal # 4607124 **Intact?** (Y) N

Relinquished by:	Date/Time	Courier	Received by:	Date/Time
Austin York / [illegible]	1-31-16 / 1830		[illegible signature]	2-2-16 11:45

BEACON ENVIRONMENTAL SERVICES, INC.

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Forest Hill, MD 21050 USA
P: 1-410-838-8780 | F: 1-410-838-8740

CHAIN-OF-CUSTODY
PASSIVE SOIL-GAS SAMPLES

Project Information		Client Information		
Beacon Project No.:	3177.2	Company Name:	HWA Geosciences	Client PO No.:
Site Name:	Bothell / Riverside	Office Location:	Bothell, WA	2007-098 2036
Site Location:	Bothell, WA	Samples Submitted By:	Arnie Sugar	Expedited Turnaround Time
Analytical Method:	U.S. EPA Method 8260C	Contact Phone No.:	(425) 774-0106	☐ Rush (Specify): ____ days
Target Compounds:	HVOCs			

Field Sample ID	Date Emplaced: 1-12-15	Date Retrieved:	Sampling Hole Depth (inches)	Type of Surface (Soil/Asphalt/ Concrete/Gravel)	Optional Sample Information (e.g., Description of Sample Location, Sample Condition, PID/FID Readings)
	Time Emplaced	Time Retrieved			
PSG-5	8:40	16:49	36"	Soil	
PSG-1	8:48	16:54	↓	↓	
PSG-2	8:55	16:59	↓	↓	
PSG-3	8:59	17:04	↓	↓	
PSG-4	9:10	17:09	36"	Soil	
Trip 1	NA	NA	NA	NA	

Special Notes/Instructions:

Shipment of Field Kit to Laboratory — Custody Seal # 4607124 **Intact?** (Y) N

Relinquished by:	Date/Time	Courier	Received by:	Date/Time
[illegible] / Aaron York	1-31-16 / 1830		[illegible]	2-2-16 @ 11:45

Page 3 of 3

Attachment 4

LABORATORY PROCEDURES
FOR PASSIVE SOIL-GAS SAMPLES

Following are laboratory procedures used with BEACON Passive Soil-Gas Surveys, a screening technology for expedited site investigation. After exposure, adsorbent cartridges from the passive samplers are analyzed using U.S. EPA Method 8260C as a guidance document, a capillary gas chromatographic/mass spectrometric method, modified to accommodate high temperature thermal desorption of the adsorbent cartridges and to meet the objectives of reporting semi-quantitative data. This procedure is summarized as follows:

A. The adsorbent cartridges are loaded with internal standards and surrogates prior to loading the autosampler with the cartridges. The loaded cartridges are purged in a helium flow. Then the cartridges are thermally desorbed in a helium flow onto a focusing trap. Any analytes in the helium stream are adsorbed onto a focusing trap.

B. Following trap focusing, the trap is thermally desorbed onto a Rxi-624Sil MS 20m, 0.18 mm ID, 1.00 micron filament thickness capillary column.

C. The GC/MS is scanned between 35 and 270 Atomic Mass Units (AMU) at 3.12 scans per second.

D. BFB tuning criteria and the initial five-point calibration procedures are those stated in method SW846-8260C. System performance and calibration check criteria are met prior to analysis of samples. A laboratory method blank is analyzed after the daily standard to determine that the system is contaminant-free.

E. The instrumentation used for these analyses includes:

- Agilent 7890-5975c Gas Chromatograph/Mass Spectrometer; and
- Markes TD100 thermal desorption system.