Passive Sampling Comparability Study
Boeing Auburn Facility
Auburn, Washington

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Prepared for

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LIST OF ABBREVIATIONS AND ACRONYMS

Boeing	The Boeing Company
cis-1,2-DCE	cis-1,2-dichloroethene
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
LAI	Landau Associates, Inc.
LOQ	limit of quantitation
µg/L	micrograms per liter
NA	natural attenuation
PCE	tetrachloroethene
PDB	passive diffusion bag
QA	quality assurance
QAPP	Quality Assurance Project Plan
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SIM	selected ion monitoring
TCE	trichloroethene
VC	vinyl chloride
VOA	volatile organic analysis
VOC	volatile organic compound

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1.0 INTRODUCTION

This report presents the results of a comparability study involving groundwater sampling of volatile organic compounds (VOCs) using two methods: conventional low-flow (purge and sample) and passive diffusion bags (PDBs; Vroblesky 2001; ITRC 2006). The groundwater samples were collected from select groundwater monitoring wells as part of the Site-wide Phase VI Interim Groundwater Monitoring Program being conducted at and near The Boeing Company (Boeing) Auburn Facility Site in Auburn, Washington[1]. Figure 1 presents the Site location.

In November 2015, Boeing proposed a program to transition a majority of Site monitoring wells from low-flow sampling methods to passive sampling using PDBs (proposal; LAI 2015). Passive sampling methods provide demonstrated benefits over conventional low-flow sampling techniques at sites undergoing long-term monitoring of VOCs in groundwater (Vroblesky and Peters 2000; Vroblesky 2001; Huffman 2002; ITRC 2002, 2004, 2006; NAVFAC 2013; Parsons 2003, 2005). Furthermore, passive sampling results have been found to be more representative of local aquifer concentrations than conventional low-flow results, which are more susceptible to the effects of mixing and degassing (Church 2000; Huffman 2002; ITRC 2006; Parsons 2003, 2005; Vroblesky and Peters 2000; Vroblesky 2001). A description of passive sampling methodologies and associated research is presented in the proposal (LAI 2015).

Although passive sampling using PDBs has been widely tested and accepted by researchers, scientists, and regulators (EPA 2015; ITRC 2004, 2006; Vroblesky 2001), the proposal included an initial comparability study to evaluate the comparability of passive sampling results and low-flow sampling results. In the comparability study, 23 monitoring wells were selected to be sampled using both methods in one sampling event. Washington State Department of Ecology (Ecology) approved the proposal on November 16, 2015.

In this report, results from the comparability study are evaluated to assess the comparability and representativeness of VOC concentrations resulting from low-flow and passive sampling methods at the Site. Based on the assessment, we will recommend whether additional monitoring wells should be transitioned from low-flow to passive sampling methods for future groundwater sampling.

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[1] An updated Phase VII interim groundwater monitoring program is currently under review.

2.0 PROCEDURES

To perform the comparability study, 23 monitoring wells were sampled using both passive and low-flow methods during the 4th Quarter sampling event in December 2015. Sampling locations were chosen in consultation with Ecology. Sampling locations were selected to represent spatial, stratigraphic, and water quality variability across the Site, while also having a recent history of detected concentrations equal to approximately three times the detection limit for at least one of the four most commonly detected VOCs at the Site. These VOCs are referred to herein as “VOCs of primary interest” [cis-1,2-dichloroethene (cis-1,2-DCE), tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride (VC; LAI 2015)][2]. Comparability analyses presented in this document are restricted to the four VOCs of primary interest. Monitoring wells included in the comparability study are presented on Figure 2 and identified in Table 1.

All four VOCs are analyzed using U.S. Environmental Protection Agency (EPA) Method SW 8260C (scan); additionally, at selected monitoring wells, PCE and VC are analyzed using the selected ion method (SIM), EPA Method 8260C SIM (SIM). The SIM method provides a lower limit of quantitation [LOQ; 0.020 micrograms per liter (µg/L)] than EPA Method 8260C (LOQ = 0.2 µg/L).

At each of the selected monitoring wells, a PDB was installed 14 to 21 days prior to the sampling event. During the sampling event, the PDB was withdrawn and sampled first, and then the well was sampled using conventional low-flow methods consistent with typical groundwater sampling procedures at the Site (LAI 2013a, NAVFAC 2013). At three of the selected monitoring wells, blind field duplicate samples were collected using both methods (i.e., a duplicate sample was collected from the PDB and another using the low-flow method) and the field duplicate results were employed in the data validation process (LAI 2013b).

Quality assurance (QA)/quality control procedures are provided in the quality assurance project plan (QAPP; LAI 2013b), and Site sampling procedures are described in the sampling and analysis plan (SAP; LAI 2013a). Samples collected using the two sampling methods were handled and analyzed identically in accordance with the SAP and QAPP (LAI 2013a,b, respectively). Resulting laboratory data underwent standard Site validation and QA procedures (LAI 2013b).

2.1 Passive Sampling Procedures

Passive sampling procedures were performed in accordance with the proposal (LAI 2015). Passive sampling equipment manufactured by EON Products, Inc. was obtained through Eurofins Lancaster Laboratories, Inc. PDBs used in this study were 24 inches long by 1.75 inches in diameter, and were filled with 500 milliliters of de-ionized water by the laboratory prior to shipping. To determine whether contaminants of concern were present in the laboratory-supplied de-ionized water, bag

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[2] Some of the selected monitoring locations have recent VC concentrations less than three times the detection limit for one of the specified compounds, and recent concentrations at one location have been non-detect for TCE, PCE, and cis-1,2-DCE.

blank samples were collected and analyzed. A bag blank is filled, handled, and shipped with each batch of PDBs and is sampled immediately after the PDBs are installed in wells[3]. Bag blanks were sampled and analyzed using standard Site methods and results were employed in the data validation process (LAI 2013b).

On November 11, 2015, the laboratory-filled PDBs were suspended in the screens of the selected monitoring wells using dedicated, manufacturer-provided weights, fittings, and hollow-braided 3/16 inch polyethylene tether rope. The midpoint of each PDB was positioned in the well screen at the depth of the typical low-flow sampling intake under standard Site sampling procedures (LAI 2013a). The depth to water in each well was measured prior to installing the PDB to ensure the PDB would be entirely submerged within the well screen interval.

Groundwater samples were collected during the 4th Quarter groundwater sampling event, from November 30 through December 10, 2015. At each selected well, the depth to water was measured using an electronic water level indicator. Next, the PDB was withdrawn slowly (to avoid disturbance to the well screen) and its contents were transferred to conventional volatile organic analyte (VOA) vials using a manufacturer-provided plastic straw. After filling the required number of VOAs, water remaining in the PDB was drained into a wastewater container and handled according to Site waste handling and disposal protocols (LAI 2013a). Empty PDBs were disposed of as municipal waste, and the dedicated tether and weight were lowered back into the well for anticipated future PDB sampling. VOAs filled from PDBs were labeled by appending the sample name with "PD", and were handled and analyzed using the same procedures and analytical methods as conventional low-flow samples.

2.2 Field Procedures for Low-Flow Sampling

Conventional low-flow purging and sampling was performed at each well after groundwater samples had been collected from the PDB (LAI 2015, NAVFAC 2013). Low-flow sampling was performed using peristaltic pumps and dedicated tubing according to standard Site procedures (Puls and Barcelona 1996; LAI 2013a).

2.3 Comparability Evaluation Procedures

The proposal described a multi-faceted approach to evaluate comparability study results for cis-1,2-DCE, PCE, TCE, and VC concentrations derived from the two sampling methods (LAI 2015). The comparability evaluation included statistical and graphical approaches. Results from the two sampling methods were compared as follows:

a) As groups, in order to evaluate whether the two sampling methods produce comparable results at the Site

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[3] Three batches of passive diffusion bags were ordered for the comparison study; therefore, three bag blanks were analyzed in December 2015.

b) At individual monitoring wells, to evaluate whether the two sampling methods produce comparable results at a given well.

Acceptance criteria were developed to aid in concluding whether passive sampling produces sufficiently comparable and representative results at the Site (groups), and at individual monitoring wells. Statistical testing was performed using R statistical software (R Core Team 2015) and Microsoft® Excel. Blind field duplicates were not included in the comparability evaluations, as duplicates are not mutually independent samples. If a constituent was undetected by both sampling methods at a well, the results for that analyte were omitted from comparative statistics.

2.3.1 Comparability of Grouped Results

General comparability between the two sampling methods (passive versus low-flow) was evaluated for each VOC of primary interest using summary statistics, regression analysis, and paired-sample testing.

2.3.1.1 Summary Statistics

Summary statistics (e.g., sample size, mean, minimum, median, maximum, and quartiles) were computed for grouped results from each of the two sampling methods, for each VOC. Box plots representing the maximum, minimum, and quartiles in each set were prepared to visually compare the distributions. Overlap of box plots graphed side-by-side indicate general similarity in the distributions of two groups of data.

2.3.1.2 Regression Analysis

Regression plots were prepared to complement the statistical tests for each VOC. Regression analysis involves graphing observations in one group against paired observations in another group and examining the correlation between the two groups. In this study, low-flow sampling results were plotted against passive sampling results for each well. Closely related variables will follow an approximately linear trend approaching a one to one (1:1) relationship (slope near 1), with a y-intercept near zero and a coefficient of determination (R^2) value close to 1.

2.3.1.3 Paired-Sample Testing

The paired t-test and non-parametric Wilcoxon paired-sample signed-rank (Wilcoxon) test statistically compared two groups of data in which observations are paired. The Wilcoxon test is the non-parametric counterpart of the paired t-test, used for datasets, which do not follow a normal distribution (EPA 2009). Each paired-sample test evaluates the null hypothesis (Ho) that the mean (average) difference between the two groups is zero (i.e., the groups are statistically equivalent). In this study, paired-sample testing was used to statistically analyze differences between low-flow and passive sampling results for each of the VOCs, under the null hypothesis that results from the two sampling methods are equivalent. A significance level (or alpha value, α) of 0.05 (5 percent) was selected as the criterion for rejection of the null hypothesis[4]. The relevant test statistic (e.g., t for paired t-test or W for Wilcoxon test) was calculated for each dataset, and the probability (p-value) of obtaining a result equal to, or more extreme than, the calculated test statistic was determined. If a p-value was smaller than α (0.05), the null hypothesis was rejected, and the results from the two methods were concluded to be significantly different. If the p-value was larger than α, the null hypothesis was not rejected, and it was concluded that there is no significant difference between results from the two methods.

To select the appropriate paired-sample test, results for each VOC were assessed by performing the Shapiro-Wilk normality test (EPA 2009). Datasets that did not follow a normal distribution according to the Shapiro-Wilk test were logarithmically transformed and again tested for normality. If log-transformed data also failed the Shapiro-Wilk normality assessments, the population was assumed not to follow a normal distribution, and the non-parametric Wilcoxon test was performed as the paired-sample test. All results in this study failed the Shapiro-Wilk normality test; therefore, all paired-sample testing was conducted using the Wilcoxon test. However, paired t-tests were also performed to complement the non-parametric tests.

2.3.2 Comparability of Results at Individual Monitoring Wells

Comparability at individual monitoring wells was evaluated for each VOC using Site field duplicate control limits and by visually comparing study results at each well to recent trends using concentration time series graphs.

2.3.2.1 Field Duplicate Control Limits

Comparability of results at individual wells was assessed using Site field duplicate control limits established in the QAPP (LAI 2013b). The control limits are met if results from the two methods agree within 20 percent relative percent difference (RPD), unless the sample values are within five times the LOQ, in which case the control limit interval is plus or minus the LOQ (LAI 2013b). In cases where one method yielded a detected result while the other yielded a non-detected result, the LOQ was used in place of a concentration value to perform calculations.

2.3.2.2 Concentration Time Series Trends

Low-flow results from the comparability study were appended to historical time series plots for each selected well and PDB results were added to the plot with a distinctive symbol. The time-series plots allow visual comparison of variability between the two sampling methods in the context of historical variability and contaminant signatures at each well.

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[4] Thus, there is less than 5 percent probability that the test will incorrectly conclude the two sampling methods produce significantly different results.

2.3.3 Acceptance Criteria

Using the above-described approaches, acceptance criteria were developed to assess comparability between the sampling methods (Parsons 2003). Comparability was evaluated for each VOC of primary interest. If acceptance criteria are met, further passive sampling will be proposed as described below. If acceptance criteria are not met, results will be discussed and further actions will be proposed.

2.3.3.1 Acceptance Criteria for Grouped Results

Grouped results (passive versus low-flow sampling) from the comparability study will be evaluated using acceptance criteria presented below. If acceptance criteria are met for at least two of the four VOCs of primary interest, we will conclude that passive sampling methods produce comparable results to low-flow sampling methods at the Site. The criteria are designed to help evaluate whether passive sampling is suitable for larger-scale implementation at the Site:

- Summary statistics: Comparability will be evaluated for each VOC by comparing summary statistics of results from each sampling method and examining overlap of box plots. If summary statistics indicate similarity and overlap between low-flow and passive sampling results, we will infer that the two methods produce comparable results at the Site.
- Linear regression: If correlation between passive and low-flow results show an approximately linear trend with a slope and R^2 value close to 1, we will infer that the two methods produce comparable results at the Site.
- Paired-sample testing: If the Wilcoxon test for a given VOC produces a p-value larger than the selected α (0.05), we will fail to reject the null hypothesis (i.e., results of the two methods are not significantly different). If paired-sample test results indicate no significant difference in the mean concentrations resulting from low-flow and passive sampling methods, then passive sampling will be recommended for wider implementation at the Site.

2.3.3.2 Criteria for Individual Monitoring Wells

Passive versus low-flow sampling results at individual monitoring wells in the comparability study will be evaluated using acceptance criteria presented below. The criteria are designed to help evaluate whether passive sampling is suitable for future monitoring at a specific well. At each well, if acceptance criteria are met for at least two of the four VOCs of primary interest, we will conclude that passive sampling methods are suitable for future monitoring at that well. If acceptance criteria are not met at a given well, we will discuss the results and propose appropriate actions.

- Field Duplicate Control Limits
    - RPD: For a given VOC at a given monitoring well, if either the PDB or the low-flow result is greater than five times the LOQ, then an RPD of 20 percent will be the acceptance criterion. In this case, results within 20 percent (RPD) will be deemed acceptable.
    - LOQ: For a given VOC at a given monitoring well, if both the PDB and low-flow sample results are less than or equal to five times the LOQ, a value of plus or minus the LOQ

  will be used as the acceptance criterion. In this case, results agreeing to plus or minus the LOQ will be deemed acceptable.

  - Conservative Result: At a given monitoring well where the RPD or LOQ criterion is not met, if the PDB result exceeds the low-flow result, the result will be deemed acceptable.

- Concentration Time Series: If passive sampling results fail to meet acceptance criteria defined above at a given monitoring well for two or more VOCs of primary interest, the results will be examined relative to past concentration trends as presented on time series plots. We will discuss discrepancies and develop recommendations for future sampling at that monitoring well.

3.0 RESULTS

The comparability study resulted in 23 pairs of mutually independent VOC concentrations for each selected VOC (cis-1,2-DCE, PCE, TCE, and VC). At monitoring well AGW245, all four selected VOCs were non-detect in samples from both methods, so results from AGW245 were excluded from the group statistical analyses. PCE was detected in only six of the 23 wells sampled, so the sample size for the PCE analyses is smaller (6) than the other VOCs (22). Comparability study VOC results (including field duplicate results) are presented in Appendix A.

3.1 Results of Group Comparisons

Comparability of passive versus low-flow sampling results at the Site was evaluated using summary statistics, linear regression, and paired-sample testing, in terms of acceptance criteria for grouped results developed above.

3.1.1 Summary Statistics

Summary statistics indicate that the two groups of results (passive and low-flow) are comparable for each VOC. Summary statistics are presented in Table 2 (below), and are represented graphically as box plots in Figure 3 (cis-1,2-DCE and PCE) and Figure 4 (TCE and VC).

Summary statistics indicate that there is generally close agreement between passive and low-flow sampling results at the Site for each VOC (Table 2). Box plots illustrate the agreement between sampling methods; for example, in Figure 3, the low-flow and PDB results for cis-1,2-DCE align closely with essentially equivalent median values (1.75 µg/L and 1.80 µg/L for low-flow and PDB, respectively). Box plots overlap for all four VOCs of primary interest indicating similar data distributions from each sampling method (Figures 3 and 4). Mean, median, and maximum values tend to be slightly higher in the PDB results (Table 2) suggesting that, in general, passive sampling may produce more conservative concentration results than low-flow sampling at the Site.

Table 2. Comparison Study Summary Statistics

VOCs	Cis-1,2-DCE		PCE		TCE		VC	
Sampling Method	Low-Flow	PDB	Low-Flow	PDB	Low-Flow	PDB	Low-Flow	PDB
Sample Size	22	22	6	6	22	22	22	22
Mean Concentration	1.95	2.03	0.06	0.06	3.31	3.35	0.24	0.25
Minimum Concentration	0.60	0.50	0.03	0.02	0.20	0.20	0.03	0.04
Quartile 1 Concentration	1.20	1.30	0.04	0.03	1.85	1.08	0.07	0.08
Median Concentration	1.75	1.80	0.06	0.07	2.65	2.65	0.19	0.19
Quartile 3 Concentration	2.30	2.35	0.07	0.08	4.38	4.85	0.29	0.29
Maximum Concentration	7.70	7.40	0.08	0.09	12.00	13.00	0.80	0.85

All concentrations in µg/L

3.1.2 Regression Analysis

Linear regressions of low-flow versus passive sampling results were prepared for each VOC of primary concern to complement the statistical analyses. Regression lines were plotted with concentration results and 99 percent confidence intervals, along with a 1:1 line for comparison. Figures 5 through 8 present regression plots for cis-1,2-DCE, PCE, TCE, and VC, respectively.

Each of the four VOCs show strong, positive linear correlations between the two sampling methods. Regression lines trend close to a 1:1 relationship with slope values near 1 (range from 0.91 to 1.4) and y-intercept values close to zero (range from -0.23 µg/L to 0.26 µg/L). Values of R^2 calculated in the four regressions are close to 1, ranging from 0.91 to 0.96. The majority (86 percent to 100 percent) of data for each VOC fall within 99 percent confidence intervals of the regression line. The strong correlation suggests that the two methods produce similar concentration results at the Site.

3.1.3 Paired-Sample Testing

For each VOC, paired-sample testing was performed by evaluating normality of the distribution of differences between low-flow and PDB data, then conducting the appropriate paired-sample test. None of the four VOCs of primary interest were found to follow a normal distribution under the Shapiro-Wilk test, even after performing log-transformations of each dataset. Consequently, the non-parametric Wilcoxon paired-sample test statistic was used to evaluate the null hypothesis for each

VOC. Paired t-tests were also performed to compliment the evaluation. Probability value (p-value) results of paired-sample tests are summarized in Table 3 (below).

For each of the four VOCs, the Wilcoxon test resulted in a p-value larger than α (0.05). This result leads to a failure to reject the null hypothesis. Although the Wilcoxon test was selected as the appropriate test, parametric paired-t tests for each VOC also resulted in p-values larger than α (Table 3); thus, regardless of the underlying data distribution, both parametric and non-parametric statistical tests lead to the same conclusion - a failure to reject the null hypothesis. Consequently, we conclude that mean concentrations resulting from passive sampling are not significantly different from those resulting from low-flow sampling.

Table 3. Paired-Sample Test P-Values

	Wilcoxon Signed-Rank (a,b)	Paired-T (a,b)
Cis-1,2-DCE	0.64	0.38
PCE	0.94	0.91
TCE	0.97	0.78
VC	0.87	0.55

a. For paired-T and Wilcoxon signed-rank tests, Ho = no significant difference in concentration results between sampling methods.

b. Tests were evaluated at a significance level of α=0.05

3.2 Results of Individual Monitoring Well Comparisons

Comparability between sampling methods at each of the 23 individual monitoring wells was evaluated for each VOC using the acceptance criteria for Site field duplicate control limits (LAI 2013b) and concentration time series plots described above.

3.2.1 Field Duplicate Control Limits

At each well included in the study, concentration results from the two sampling methods were compared as sample pairs. Results included one pair per well for each VOC, except for monitoring wells at which an additional analyses of PCE and VC were performed under SIM; at these wells, two pairs of results were evaluated. For PCE, 34 pairs were evaluated (23 scan pairs plus 11 SIM pairs) and for VC, 45 pairs were evaluated (23 scan pairs plus 22 SIM pairs). For sample pairs in which either method resulted in a detection greater than five times the LOQ, the paired results were evaluated based on the RPD (20 percent control limit; LAI 2013b). For sample pairs in which both the PDB and low-flow method resulted in a detection less than or equal to five times the LOQ, the paired results were evaluated based on the LOQ (plus or minus the LOQ; LAI 2013b). Table 4 presents the results for each low-flow and PDB sample pair.

3.2.1.1 Cis-1,2-Dichloroethene

Of the 23 sample pairs, 17 cis-1,2-DCE detections were evaluated using the RPD control limit and 6 were evaluated using the LOQ control limit. Two sample pairs did not agree within 20 percent RPD (AGW226 and AGW227) and one pair did not agree within the LOQ (AGW263). Of the three pairs that did not agree within the applicable control limit, the PDB result was higher than the low-flow result for two pairs (AGW226 and AGW263).

3.2.1.2 Tetrachloroethene

PCE results were determined from two analytical methods: scan (23 pairs) and SIM (11 pairs). Agreement in PCE results between all pairs was evaluated using the LOQ control limit. All results agreed within the LOQ.

3.2.1.3 Trichloroethene

Of the 23 sample pairs, 17 TCE detections were evaluated using the RPD control limit and 6 were evaluated using the LOQ control limit. Three sample pairs did not agree within 20 percent RPD (AGW227, AGW228, and AGW237); the low-flow result was higher than the PDB result for all three pairs.

3.2.1.4 Vinyl Chloride

VC results were determined from two analytical methods: scan (23 pairs), and SIM (22 pairs). All scan results agreed within the LOQ control limit. Under SIM, 14 sample pairs were evaluated using the RPD control limit and 9 were evaluated using the LOQ control limit. Two sample pairs did not agree within the RPD (AGW157 and AGW226), and one pair did not agree within the LOQ (AGW263). Of the three pairs that did not agree within the applicable control limit, the PDB result was higher than the low-flow result for two pairs (AGW226 and AGW263).

3.2.2 Concentration Time Series Trends

Concentration time series for the 23 wells included in the comparability study are presented in Appendix B. In each figure, PDB results are symbolized with a black outline to facilitate visual comparison.

Visual inspection of the concentration time series illustrates the close overall agreement in VOC results derived from low-flow and passive sampling methods. At most monitoring wells included in the study, PDB results for all four VOCs align closely with the recent trends. As suggested by the statistical comparisons presented above, a few cases of discrepancy occur. In some cases, the passive sampling result appears more comparable to recent trends than the low-flow result (e.g., AGW226, AGW263), whereas in other cases the passive sampling result appears distinct from recent trends (e.g., AGW227, AGW237).

4.0 DISCUSSION

Comparability evaluations of grouped results indicate that passive sampling produces VOC concentration results that are comparable to low-flow sampling results at the Site. Each group comparison met acceptance criteria for grouped results. Summary statistics and paired-sample testing indicate that the methods produce statistically equivalent results at the Site for each VOC of primary interest. Furthermore, linear regression results indicate a strong linear relationship between concentrations derived from the two sampling methods (R^2 ranging from 0.91 to 0.96). Based on the results of group comparisons, it appears that passive sampling methods are suitable for future groundwater monitoring at the Site.

Comparisons of results at individual wells also indicate generally consistent results between the two sampling methods. As described in Section 2.3.3.2, a passive sampling result is accepted as sufficiently comparable to low-flow at an individual well if, for at least two of the four VOCs of primary interest, a) field duplicate control limits are met or b) the PDB result exceeds the low-flow result. Acceptance criteria for individual monitoring wells were met in 22 of the 23 wells studied (96 percent acceptance). Out of 125 total VOC sample pairs compared, 116 met field duplicate control limits (93 percent), and of the 9 pairs that failed, passive sampling produced the more conservative concentration result in 4 pairs. Overall, VOC concentrations resulting from passive sampling were consistent with low-flow results in the majority of wells included in the study.

Acceptance criteria were exceeded at a single monitoring well, AGW227 (Table 4). Field duplicate control limits were exceeded for cis-1,2-DCE and TCE at AGW227. Examination of the concentration time series plot for AGW227 (Figure B-17) illustrates the difference between PDB results and recent low-flow results. The PDB result is lower (non-detect) for TCE relative to recent low-flow results near 2.5 µg/L, and the PDB result for cis-1,2-DCE (1.8 µg/L) is lower and outside the range of recent low-flow results (2.5 to 3.0 µg/L). As seen in Figure B-17, concentrations at AGW227 have followed a generally consistent, slightly declining trend since monitoring began at this location in December 2012.

5.0 RECOMMENDATIONS AND SCHEDULING

The benefits of passive sampling methods relative to conventional low-flow methods have been widely established and accepted. Passive sampling methods include considerable advantages in sustainability, safety, and costs (LAI 2015; EPA 2015; ITRC 2004, 2006; Parsons 2003; Vroblesky 2001). Comparisons of VOC concentration results derived from passive and low-flow sampling methods indicate that the two methods produce comparable results at the Site. Consequently, we recommend that monitoring wells which are sampled for only VOCs [e.g., not sampled for metals, petroleum hydrocarbons, or natural attenuation (NA) parameters[5]] be transitioned from low-flow sampling methods to passive sampling methods using PDBs[6]. We recommend that this transition be implemented during the June 2016 sampling event with PDB installations to occur at least 14 to 21 days prior to that event. A list of the monitoring wells recommended for passive sampling based on the Phase VII groundwater monitoring plan is provided in Table 1.

Based on the comparability analyses and acceptance criteria for individual wells presented above, PDB results were inconsistent with low-flow results at one monitoring well in the comparability study. Given the single passive sample, there is not sufficient data to determine whether the discrepancy relates to a sampling error, or reflects a physical characteristic of the well or aquifer. Past researchers have identified legitimate sources of inconsistency between low-flow and passive sampling methods under certain conditions, such as wells which have significant vertical flow, wells with multiple hydrogeologic intervals contributing flow to the screened interval, and wells with vertical variability in VOC concentration across the screened interval (Church 2000; Vroblesky 2001). Additional sampling at AGW227 will aid in identifying the cause of the inconsistent results at this well.

Although only AGW227 failed the acceptance criteria for individual wells, two additional wells (AGW228 and AGW237) had an RPD greater than 20 percent for one constituent (LF sample was higher in both cases) and one well (AGW226) had an RDP greater than 20 percent for two constituents but the PDB result was higher in both cases (Table 4). In a May 19, 2016 conference call between Ecology, Boeing, and LAI, Boeing agreed to do some additional study of the four above-mentioned wells. The information will potentially be useful in determining the cause of the discrepancies and identifying possible causes and solutions if other wells show discrepancies when the PDB program is implemented site wide. Boeing will collect a second set of comparison samples at all four wells: AGW226, AGW227, AGW228, and AGW237. The second set of comparison samples at these four wells will involve a test for vertical stratification of VOCs by installing two PDBs at each well, with one PDB at the same depth as the initial PDB, and a second PDB above that depth. Additionally, a low-flow sample will be collected at each of the four wells immediately after collecting

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[5] NA monitoring is sometimes performed in association with site characterization or pilot testing activities. These events are typically temporary with their duration determined in consultation with Ecology. When an NA monitoring event arises at a well, which has been transitioned to passive sampling, the well will be sampled using the low-flow method during the NA event to allow collection of NA parameters. Once NA monitoring is discontinued at the well, passive sampling methods will be resumed.

[6] Artesian wells also may not be suitable for PDB sampling methods due to concerns about controlling excess water.

samples from the two PDBs to allow further comparison of results from the two methods at these wells. Results from the second round of comparison samples will be evaluated consistent with the evaluation conducted for the initial comparison sampling event. The additional comparison sampling will be performed during the annual groundwater sampling event in June 2016. Results of the additional comparison samples will be reported to Ecology via email with a table similar to Table 4.

For site-wide implementation of the PDB program, Boeing proposes the following procedures for evaluating PDB results at the recommended wells (Table 1). PDB concentration results for cis-1,2-DCE, PCE, TCE and VC obtained from the first full-scale passive sampling (in June 2016) will be plotted on the concentration time series for each monitoring well, similar to the figures presented in Appendix B. Each PDB result will be compared to recent concentration trends at that monitoring well (time series trend comparison). If the PDB result is determined to be inconsistent with recent data and less conservative for two or more VOCs of primary concern, we will propose a plan to address the inconsistency, in consultation with Ecology. At monitoring wells where passive sampling appears to produce inconsistent and less conservative results than recent low-flow results, we anticipate recommending additional time series trend comparisons for up to two consecutive passive sampling events in order to obtain a representative set of PDB results. After the additional time series trend comparison is completed and the data evaluated, we will propose further actions to address the inconsistency, as needed. Possible approaches might include returning to conventional low-flow sampling at the selected monitoring well, or conducting a contaminant stratification test involving multiple PDBs suspended at different levels across the well screen. The results of time series trend comparisons will be documented in a technical memorandum prior to the subsequent quarterly sampling event.

The Site SAP and QAPP have been revised to include procedures specific to passive sampling. These revised documents will be submitted to Ecology as an appendix to the Remedial Investigation Report (anticipated to be submitted in July 2016). Following the June 2016 sampling event, a technical memorandum will be prepared summarizing the PDB results. The technical memorandum will present a time series trend comparison for each well sampled with a PDB.

6.0 USE OF THIS REPORT

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This document has been prepared under the supervision and direction of the following key staff.

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TJS/JWW/jrc
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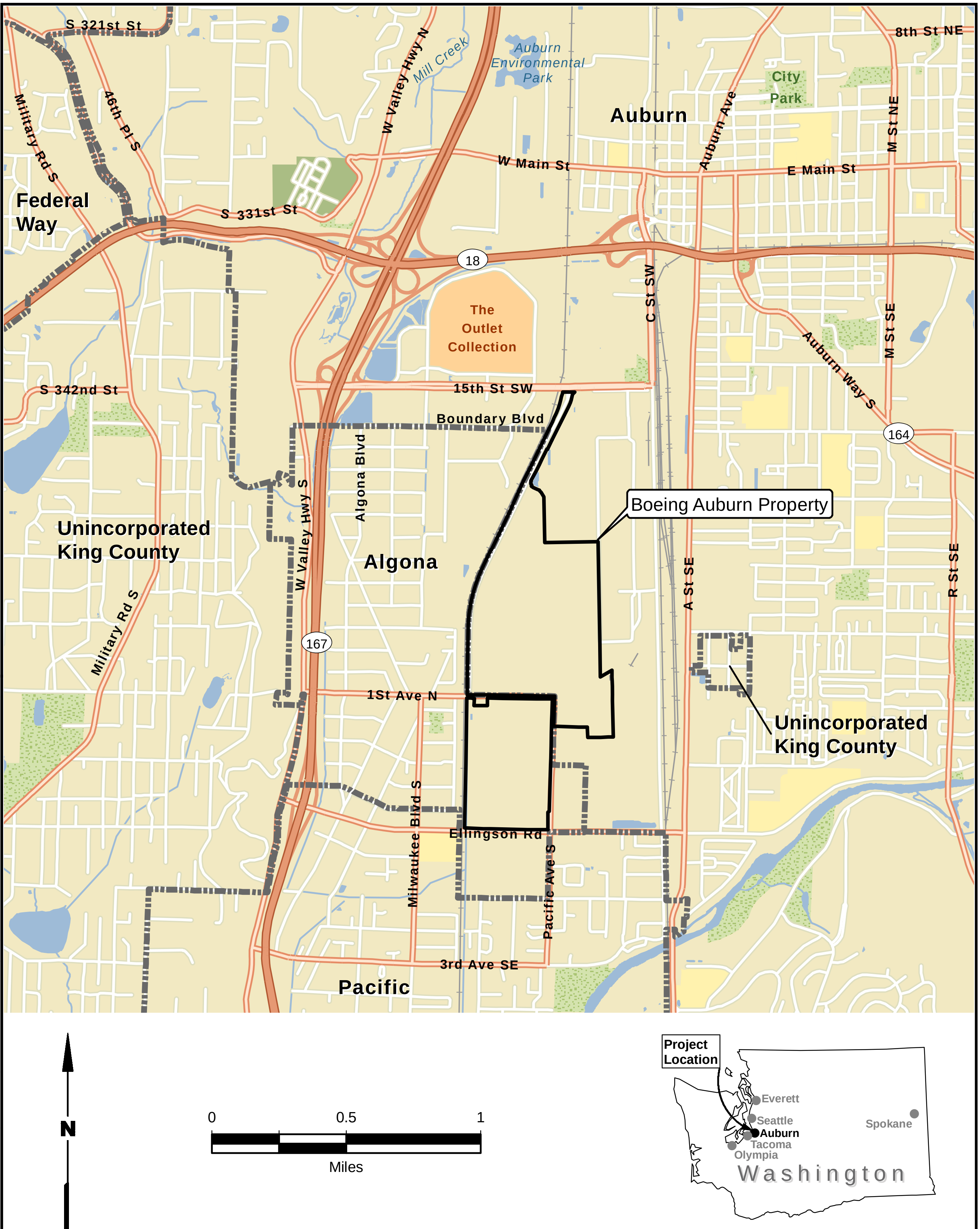

Data Source: Esri 2012

Boeing Auburn Auburn, Washington	**Vicinity Map**	Figure 1

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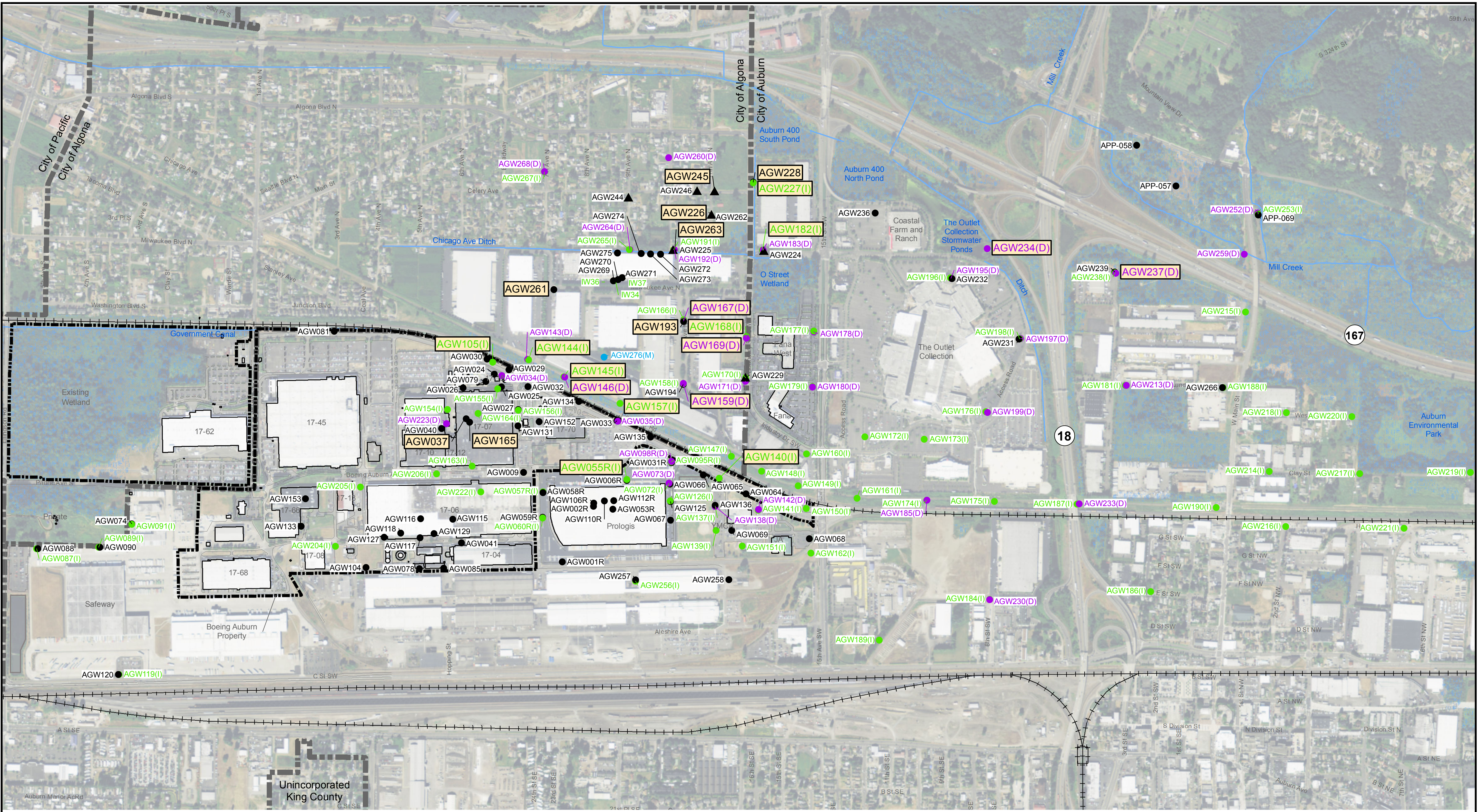
G:\Projects\025\164\110\114\Algona Drilling Work Plan\F01VicinityMap.mxd 1/31/2014 NAD 1983 StatePlane Washington North FIPS 4601 Feet



Notes

1. Well designations beginning with APP are installed and owned by WSDOT.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

▲ Offsite Water Table Well
● Shallow Monitoring Well (2 to 30 ft BGS)
(I) ● Intermediate Monitoring Well (40 to 60 ft BGS)
(D) ● Deep Monitoring Well (80 to 100 ft BGS)
(M) ● Multi-Level Well
AGW085 Initial Comparability Study Location
▨ Wetland Areas
▭ Water Bodies
— Waterways

N

0 1,000 2,000
Scale in Feet

Base map source: Geometrix 2003; Aerial Photo Source: Esri World Imagery; Parcel Data Source: King County GIS 2012

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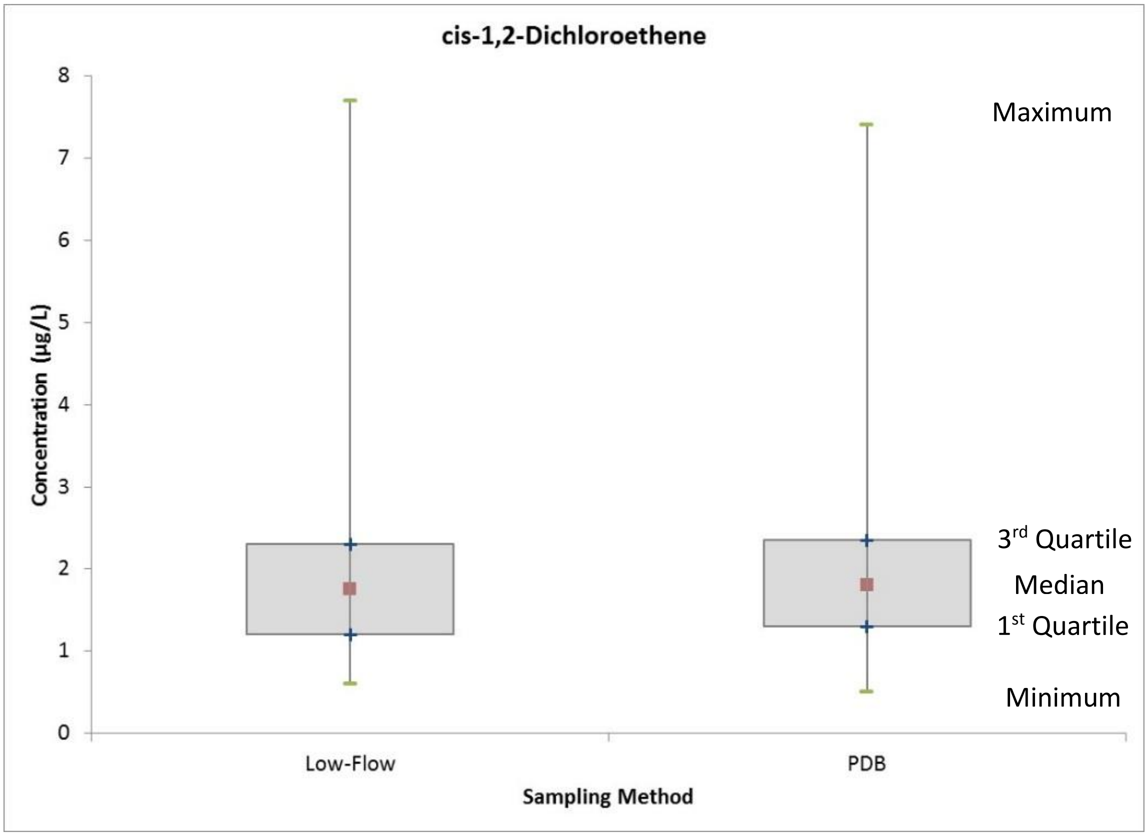
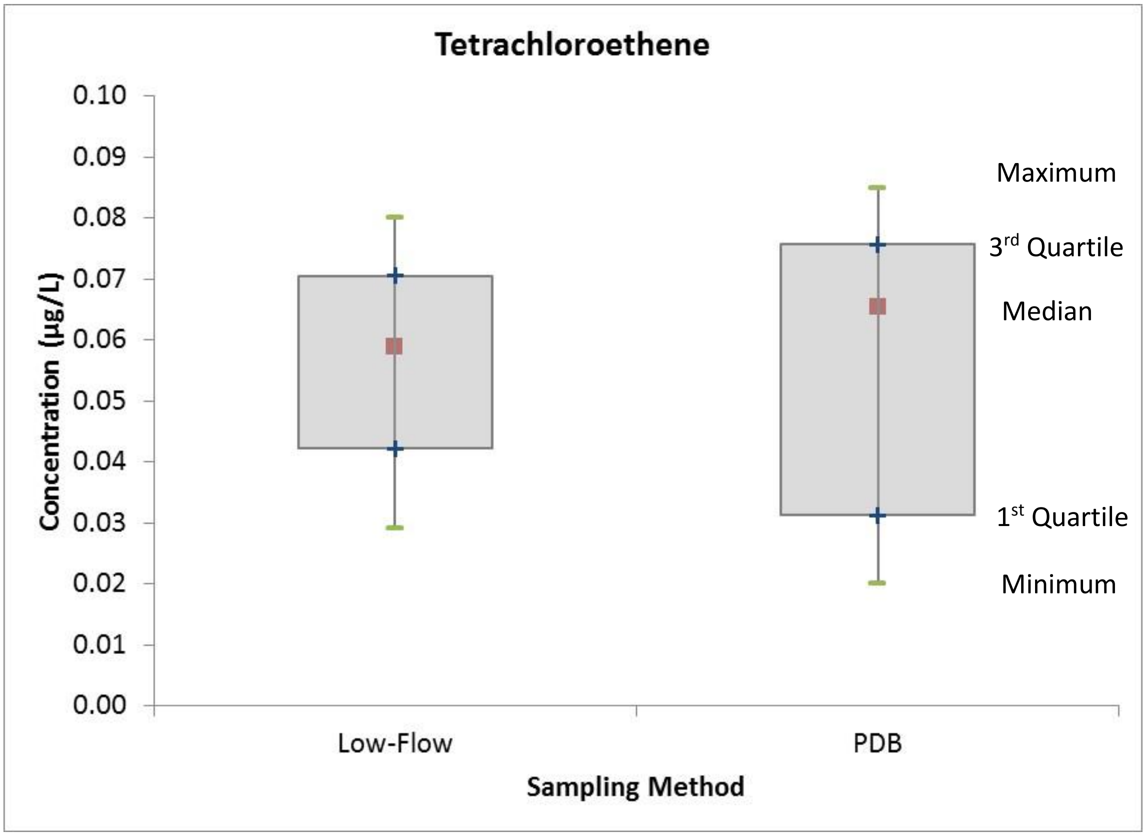
Boeing Auburn
Auburn, Washington

Monitoring Well Network and PDB Comparability Study Locations

Figure
2





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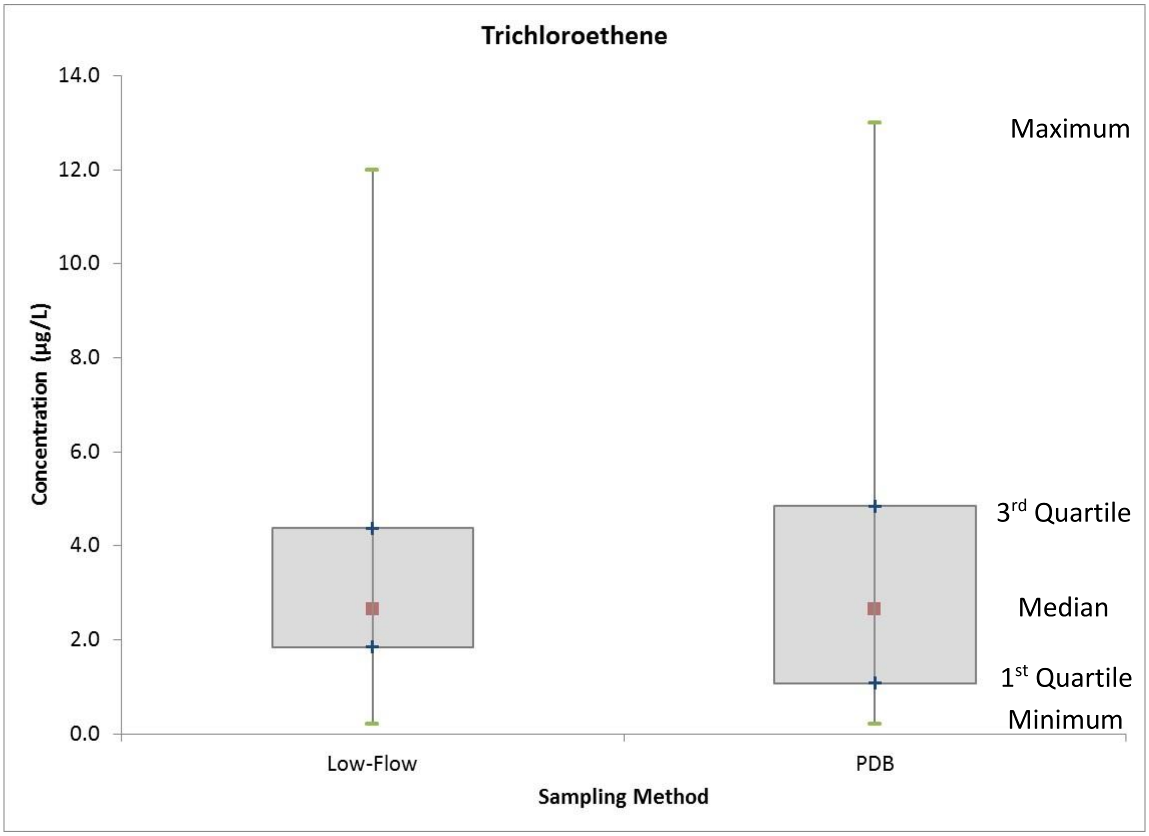
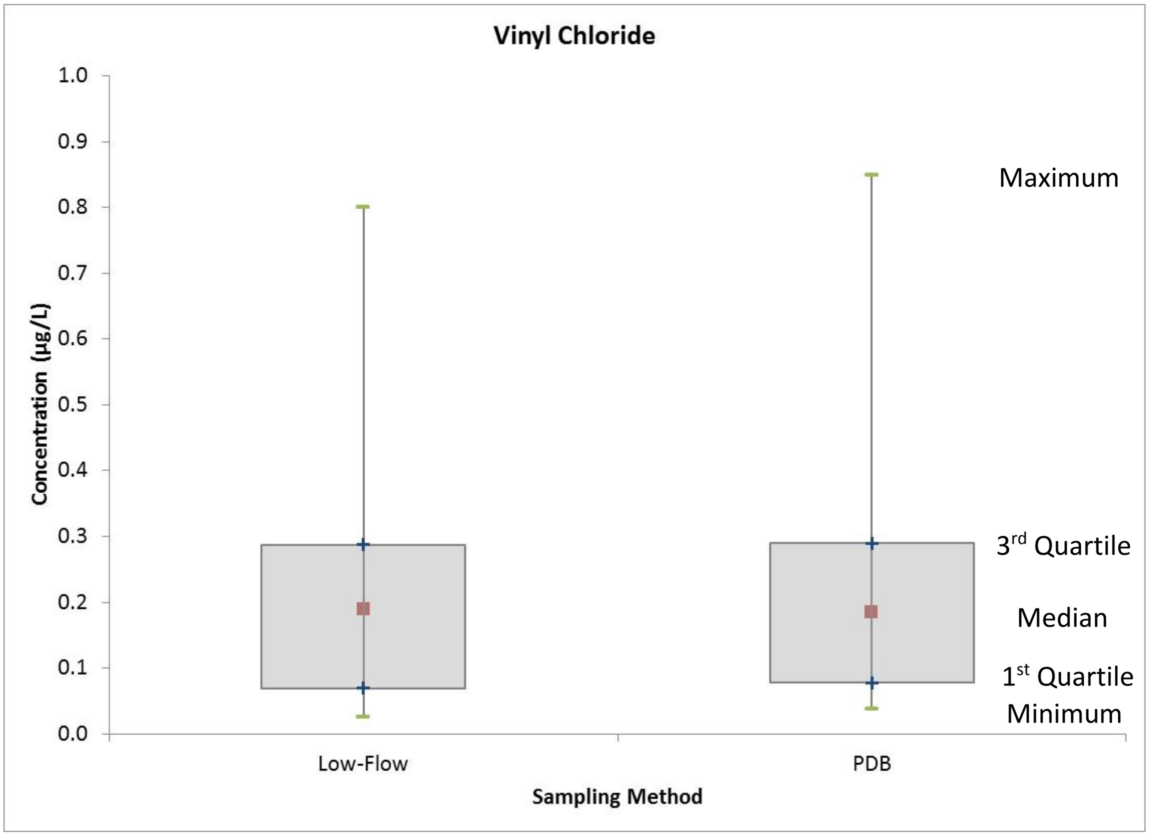
Boeing Auburn
Auburn, Washington

Box Plots
cis-1,2-Dichloroethene and Tetrachloroethene

Figure
3





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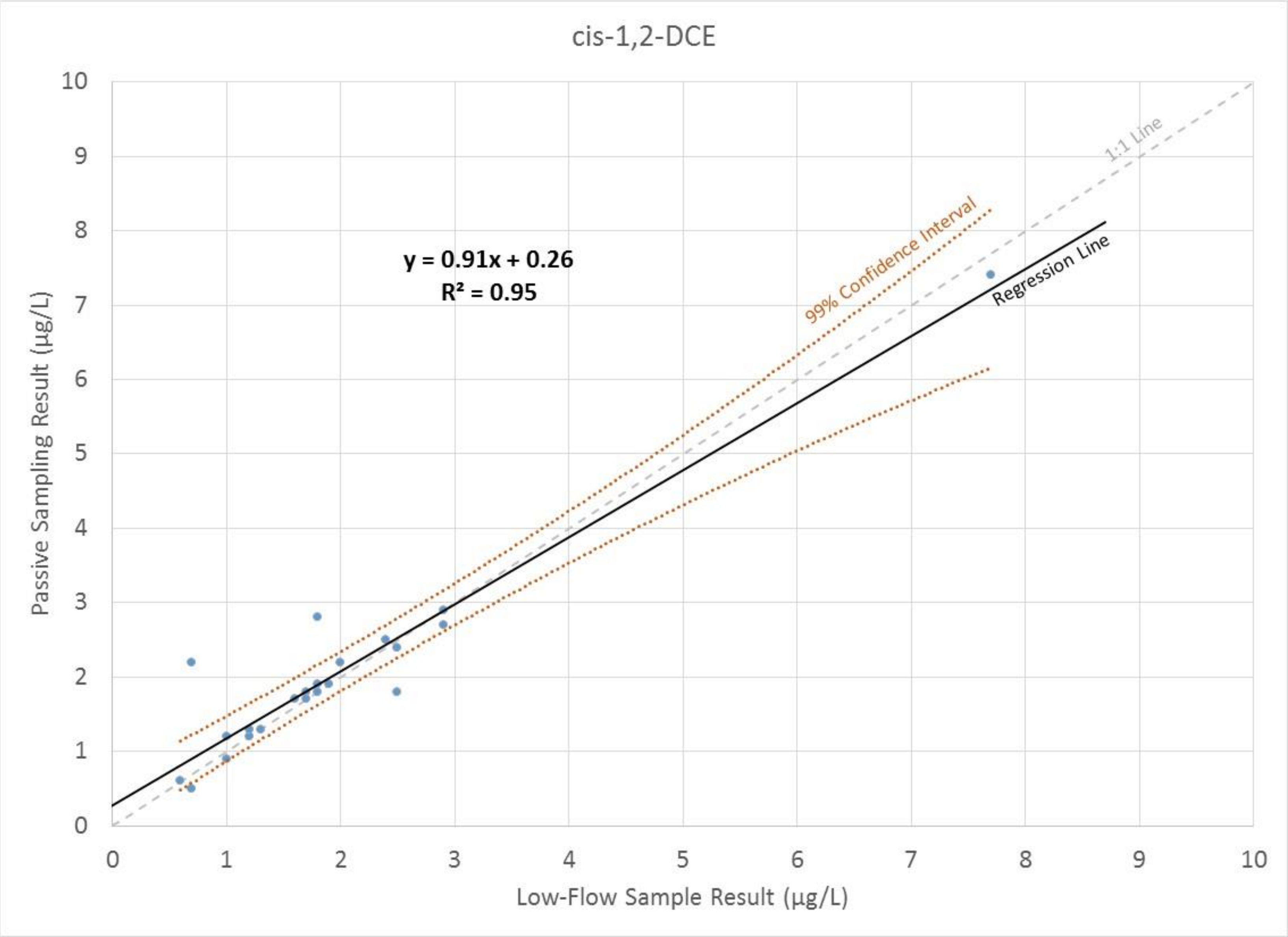
Auburn, Washington

Box Plots
Trichloroethene and Vinyl Chloride

Figure
4



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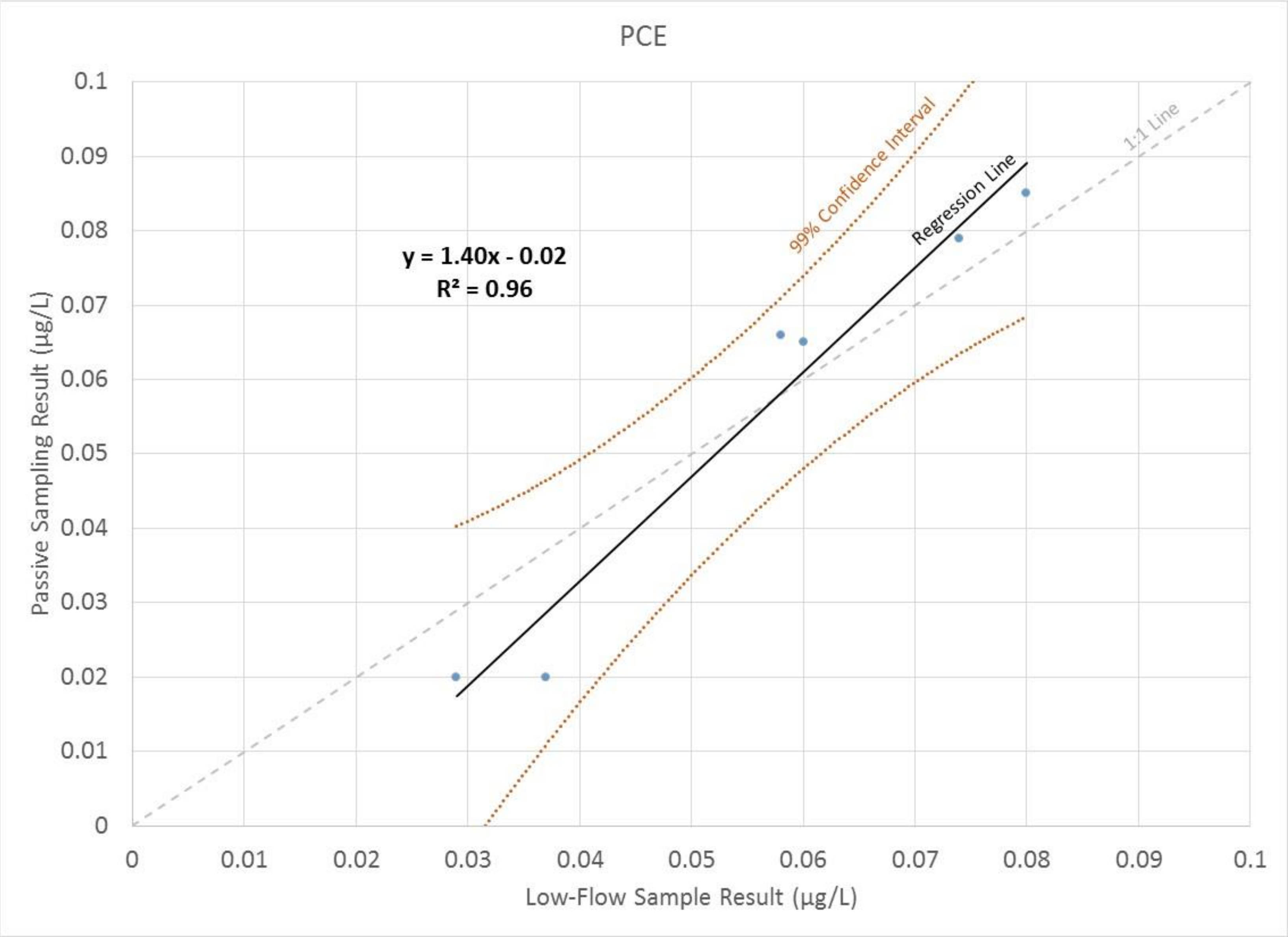
Boeing Auburn
Auburn, Washington

Linear Regression
cis-1,2-Dichloroethene

Figure
5



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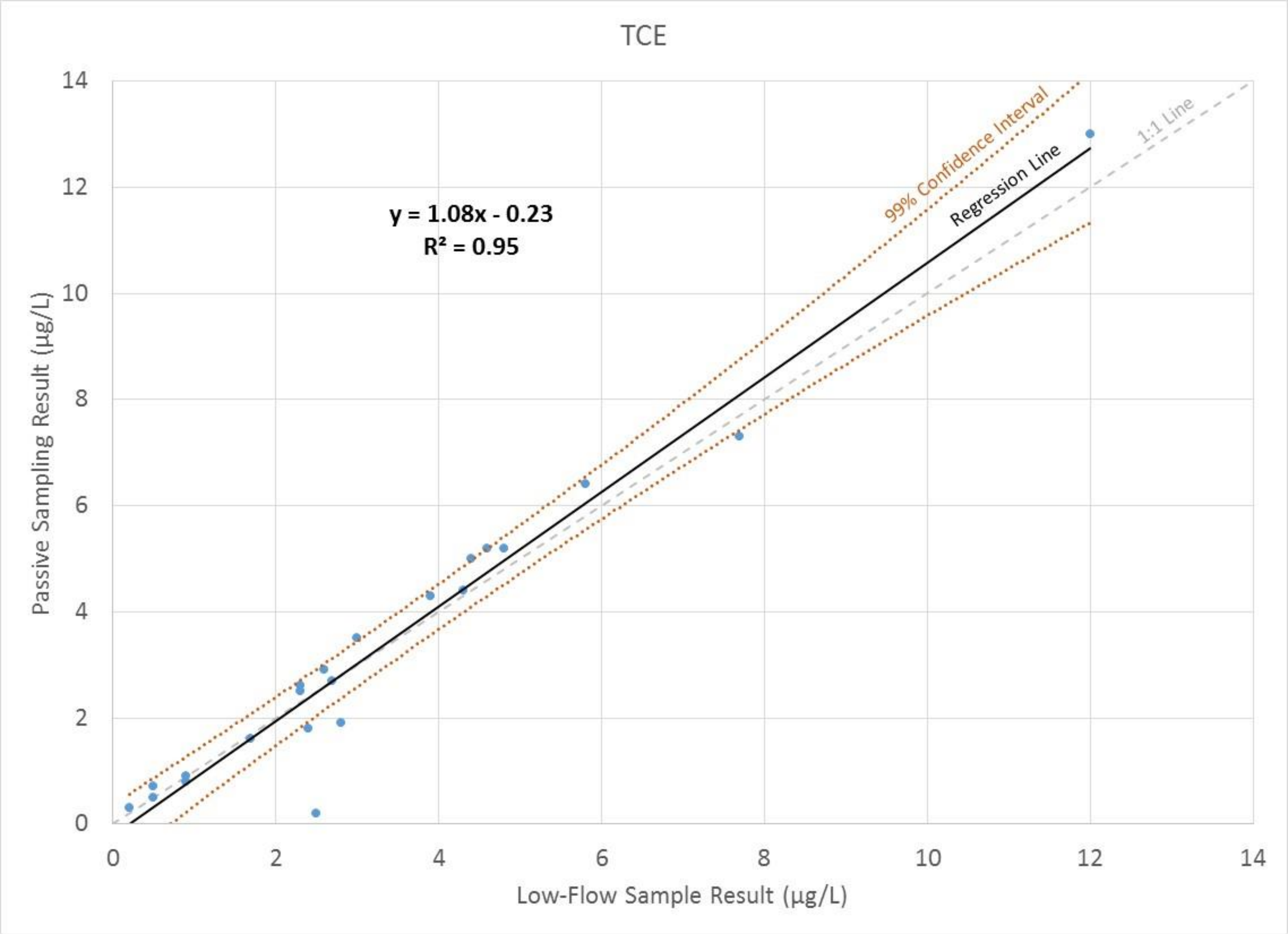
Boeing Auburn
Auburn, Washington

Linear Regression
Tetrachloroethene

Figure
6



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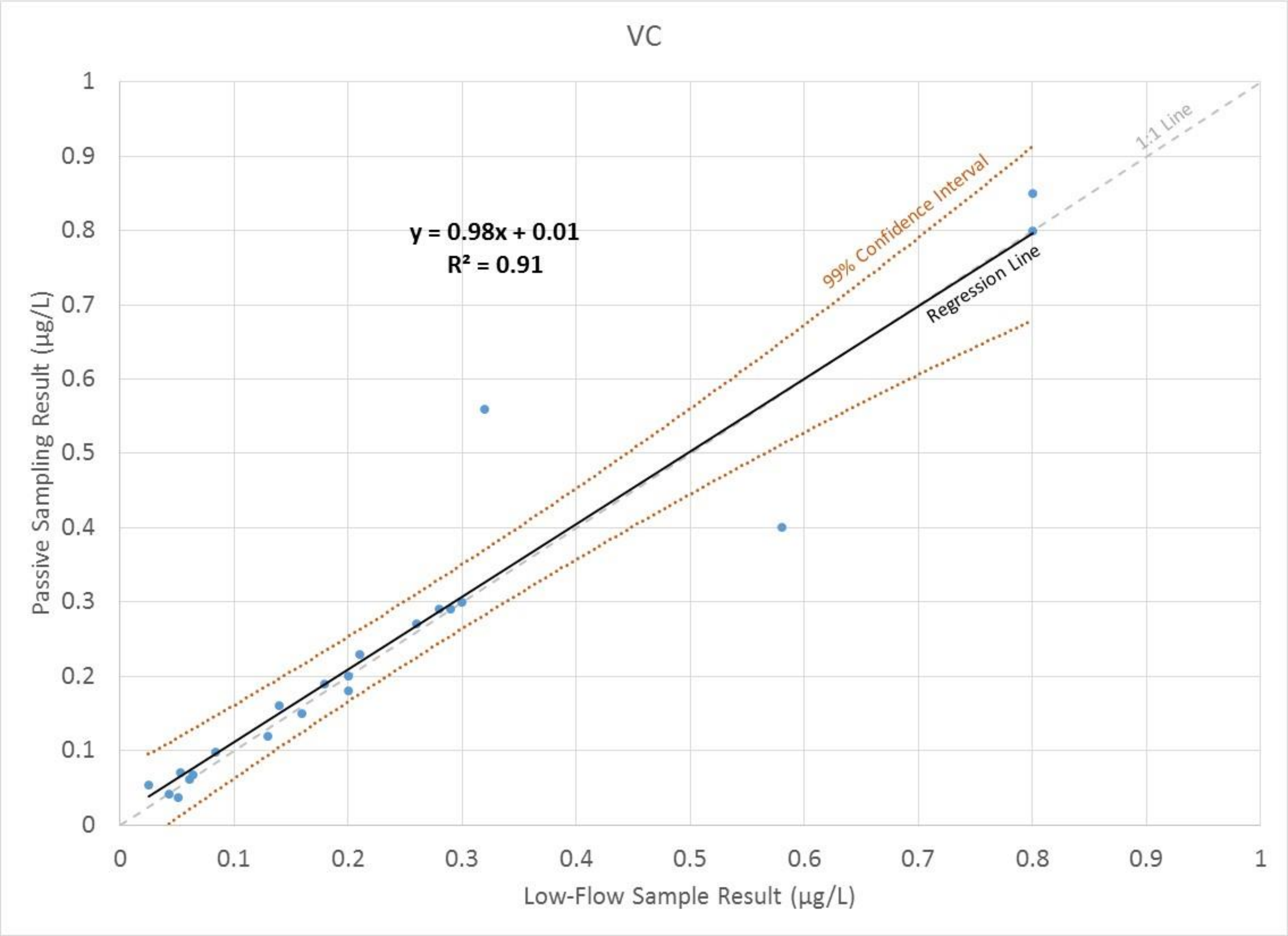
Boeing Auburn
Auburn, Washington

Linear Regression
Trichloroethene

Figure
7



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Boeing Auburn
Auburn, Washington

Linear Regression
Vinyl Chloride

Figure
8

Table 1
Proposed Passive Sampling Locations
Boeing Auburn Facility
Auburn, Washington

Well	Groundwater Depth	Phase VII Frequency	NA Monitoring (a)
AGW001R	S	SA	
AGW002R	S	SA	A
AGW006R	S	SA	
AGW009	S	A	
AGW024	S	SA	
AGW025	S	SA	
AGW026	S	SA	
AGW027	S	SA	
AGW029	S	A	
AGW030	S	A	
AGW031R	S	SA	
AGW032	S	SA	
AGW033	S	SA	
AGW034	D	A	
AGW035	D	A	
AGW037	**S**	**SA**	
AGW040	S	A	
AGW041	S	A	
AGW053R	S	SA	
AGW055R	**I**	**SA**	
AGW057R	I	SA	
AGW058R	S	A	
AGW059R	S	A	
AGW060R	I	SA	
AGW064	S	SA	
AGW065	S	A	
AGW066	S	SA	
AGW067	S	SA	
AGW068	S	A	
AGW069	S	SA	
AGW072	I	SA	
AGW073	D	SA	
AGW074	S	SA	
AGW078	S	A	
AGW079	S	SA	
AGW081	S	A	
AGW085	S	SA	
AGW087	I	SA	
AGW088	S	SA	
AGW089	I	SA	
AGW090	S	SA	
AGW091	I	SA	
AGW095R	I	SA	
AGW098R	D	SA	
AGW104	S	A	
AGW105	**I**	**SA**	
AGW106R	S	SA	A
AGW110R	S	SA	A
AGW112R	S	SA	
AGW115	S	SA	
AGW116	S	SA	
AGW117	S	SA	
AGW118	S	SA	
AGW119	I	SA	

Table 1
Proposed Passive Sampling Locations
Boeing Auburn Facility
Auburn, Washington

Well	Groundwater Depth	Phase VII Frequency	NA Monitoring (a)
AGW120	S	SA	
AGW125	S	SA	
AGW126	I	SA	
AGW127	S	A	
AGW129	S	SA	
AGW131	S	SA	
AGW133	S	A	
AGW134	S	SA	
AGW135	S	SA	
AGW136	S	SA	
AGW137	I	SA	
AGW138	D	SA	
AGW139	I	SA	
AGW140	**I**	**SA**	
AGW141	I	SA	
AGW142	D	SA	
AGW143	D	SA	
AGW144	**I**	**SA**	
AGW145	**I**	**SA**	
AGW146	**D**	**SA**	
AGW147	I	SA	
AGW148	I	SA	
AGW149	I	SA	
AGW150	I	SA	
AGW151	I	SA	
AGW152	S	SA	
AGW153	S	A	
AGW154	I	SA	
AGW155	I	SA	
AGW156	I	SA	
AGW157	**I**	**SA**	
AGW158	I	SA	
AGW159	**D**	**SA**	
AGW160	I	SA	
AGW161	I	SA	
AGW162	I	SA	
AGW163	I	SA	
AGW164	I	SA	
AGW165	**S**	**SA**	
AGW166	I	SA	
AGW167	**D**	**SA**	
AGW168	**I**	**SA**	
AGW169	**D**	**SA**	
AGW170	I	SA	
AGW171	D	SA	
AGW172	I	SA	
AGW173	I	SA	
AGW174	I	SA	
AGW175	I	SA	
AGW176	I	SA	
AGW177	I	SA	
AGW178	D	SA	
AGW179	I	SA	
AGW180	D	SA	

Table 1
Proposed Passive Sampling Locations
Boeing Auburn Facility
Auburn, Washington

Well	Groundwater Depth	Phase VII Frequency	NA Monitoring (a)
AGW181	I	SA	
AGW182	**I**	**SA**	
AGW183	D	SA	
AGW184	I	SA	
AGW185	D	SA	
AGW186	I	SA	
AGW187	I	SA	
AGW189	I	SA	
AGW190	I	SA	
AGW191	I	Q	
AGW192	D	Q	
AGW193	**S**	**SA**	
AGW194	S	SA	
AGW195	D	SA	
AGW196	I	SA	
AGW197	D	SA	
AGW198	I	SA	
AGW199	D	SA	
AGW204	I	A	
AGW205	I	A	
AGW206	I	SA	
AGW213	D	SA	
AGW219	I	SA	
AGW222	I	SA	
AGW223	D	A	
AGW224	S (WT)	A	
AGW225	S (WT)	Q	X
AGW226	**S (WT)**	**Q**	**X**
AGW227	**I**	**SA**	
AGW228	**S**	**SA**	
AGW229	S (WT)	SA	
AGW230	D	SA	
AGW231	S	SA	
AGW232	S	SA	
AGW233	D	SA	
AGW234	**D**	**SA**	
AGW236	S	SA	
AGW237	**D**	**SA**	
AGW238	I	SA	
AGW239	S	SA	
AGW244	S (WT)	SA	
AGW245	**S (WT)**	**SA**	
AGW246	S (WT)	SA	
AGW252	D	SA	
AGW253	I	A	
AGW256	I	SA	
AGW257	S	SA	
AGW258	S	SA	
AGW259	D	SA	
AGW260	D	SA	
AGW261	**S**	**SA**	
AGW262	S(WT)	Q	
AGW263	**S(WT)**	**Q**	
AGW264	D	SA	

Table 1
Proposed Passive Sampling Locations
Boeing Auburn Facility
Auburn, Washington

Well	Groundwater Depth	Phase VII Frequency	NA Monitoring (a)
AGW265	I	SA	
AGW266	S	SA	
AGW267	I	SA	
AGW268	D	SA	
AGW269	S	Q	X
AGW270	S	Q	X
AGW271	S	Q	X
AGW272	S	Q	X
AGW273	S	Q	X
AGW274	S	Q	X
AGW275	S	Q	X
APP-057	S	SA	
IW34	I	Q	X
IW36	I	Q	X
IW37	I	Q	X

Groundwater Depth

D = Deep Zone
I = Intermediate Zone
S = Shallow Zone
S (WT) = Water table

Frequency

A = Annually (June)
Q = Quarterly (March, June, September, December)
SA = Semiannually (June and December)
X = Same as Phase VII Frequency

Note

Red text denotes well included in comparability study.

a. Natural attenuation (NA) parameters include any or all of: ethene/ethane/methane, sulfate, total organic carbon, and dissolved oxygen/oxidation reduction potential/iron II field measurements. Wells monitored for NA parameters will be sampled using low-flow methods until NA monitoring is discontinued.

Table 4
Field Duplicate Control Limit Comparisons
Boeing Auburn Facility
Auburn, Washington

Analytical Method		**8260C**				**8260C SIM**	
Constituent		**cis-1,2-DCE**	**PCE**	**TCE**	**VC**	**PCE**	**VC**
Units		**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Limit of Quantitation (LOQ)		**0.2**	**0.2**	**0.2**	**0.2**	**0.020**	**0.020**
5 x LOQ		**1**	**1**	**1**	**1**	**0.1**	**0.1**
Well ID	**Sampling Method**						
AGW037	LF	1.2	0.2 U	2.3	0.2 U	0.08	0.2
AGW037	PDB	1.2	0.2 U	2.5	0.2 U	0.085	0.18
	Criterion	RPD 0%	LOQ Pass	RPD 8%	LOQ Pass	LOQ Pass	RPD 11%
AGW055R	LF	0.7	0.2 U	0.5	0.2 U	-	0.051
AGW055R	PDB	0.5	0.2 U	0.5	0.2 U	-	0.037
	Criterion	LOQ Pass	LOQ Pass	LOQ Pass	LOQ Pass		LOQ Pass
AGW105	LF	0.6	0.2 U	0.9	0.8	-	0.8
AGW105	PDB	0.6	0.2 U	0.9	0.8	-	0.85
	Criterion	LOQ Pass	LOQ Pass	LOQ Pass	LOQ Pass		RPD 6%
AGW140	LF	2.9	0.2 U	4.3	0.2 U	-	0.21
AGW140	PDB	2.7	0.2 U	4.4	0.2	-	0.23
	Criterion	RPD 7%	LOQ Pass	RPD 2%	LOQ Pass		RPD 9%
AGW144	LF	1.9	0.2 U	0.9	0.3	-	0.26
AGW144	PDB	1.9	0.2 U	0.8	0.3	-	0.27
	Criterion	RPD 0%	LOQ Pass	LOQ Pass	LOQ Pass		RPD 4%
AGW145	LF	7.7	0.2 U	12	0.8	-	-
AGW145	PDB	7.4	0.2 U	13	0.8	-	-
	Criterion	RPD 4%	LOQ Pass	RPD 8%	LOQ Pass		
AGW146	LF	1.8	0.2 U	3.9	0.2 U	-	0.13
AGW146	PDB	1.8	0.2 U	4.3	0.2 U	-	0.12
	Criterion	RPD 0%	LOQ Pass	RPD 10%	LOQ Pass		RPD 8%
AGW157	LF	2	0.2 U	2.7	0.6	0.029	0.58
AGW157	PDB	2.2	0.2 U	2.7	0.4	0.02 U	0.4
	Criterion	RPD 10%	LOQ Pass	RPD 0%	LOQ Pass	LOQ Pass	**RPD 37%**
AGW159	LF	1	0.2 U	4.4	0.2 U	0.058	0.14
AGW159	PDB	1.2	0.2 U	5	0.2 U	0.066	0.16
	Criterion	LOQ Pass	LOQ Pass	RPD 13%	LOQ Pass	LOQ Pass	RPD 13%
AGW165	LF	1.2	0.2 U	2.3	0.2 U	0.06	0.16
AGW165	PDB	1.3	0.2 U	2.6	0.2 U	0.065	0.15
	Criterion	RPD 8%	LOQ Pass	RPD 12%	LOQ Pass	LOQ Pass	RPD 6%
AGW167	LF	2.4	0.2 U	4.8	0.2 U	-	0.18
AGW167	PDB	2.5	0.2 U	5.2	0.2 U	-	0.19
	Criterion	RPD 4%	LOQ Pass	RPD 8%	LOQ Pass		RPD 5%
AGW168	LF	1.7	0.2 U	4.6	0.2 U	0.02 U	0.064
AGW168	PDB	1.8	0.2 U	5.2	0.2 U	0.02 U	0.068
	Criterion	RPD 6%	LOQ Pass	RPD 12%	LOQ Pass	LOQ Pass	LOQ Pass
AGW169	LF	1.6	0.2 U	5.8	0.2 U	-	0.061
AGW169	PDB	1.7	0.2 U	6.4	0.2 U	-	0.062
	Criterion	RPD 6%	LOQ Pass	RPD 10%	LOQ Pass		LOQ Pass
AGW182	LF	2.5	0.2 U	1.7	0.2 U	0.02 U	0.2
AGW182	PDB	2.4	0.2 U	1.6	0.2 U	0.02 U	0.2
	Criterion	RPD 4%	LOQ Pass	RPD 6%	LOQ Pass	LOQ Pass	RPD 0%
AGW193	LF	1.8	0.2 U	3	0.3	0.074	0.28

Table 4
Field Duplicate Control Limit Comparisons
Boeing Auburn Facility
Auburn, Washington

Analytical Method		8260C				8260C SIM	
Constituent		cis-1,2-DCE	PCE	TCE	VC	PCE	VC
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Limit of Quantitation (LOQ)		0.2	0.2	0.2	0.2	0.020	0.020
5 x LOQ		1	1	1	1	0.1	0.1
Well ID	Sampling Method						
AGW193	PDB	1.9	0.2 U	3.5	0.3	0.079	0.29
	Criterion	RPD 5%	LOQ Pass	RPD 15%	LOQ Pass	LOQ Pass	RPD 4%
AGW226	LF	1.8	0.2 U	0.5	0.4	-	0.32
AGW226	PDB	2.8	0.2 U	0.7	0.5	-	0.56
	Criterion	**RPD 43%**	LOQ Pass	LOQ Pass	LOQ Pass		**RPD 55%**
AGW227	LF	2.5	0.2 U	2.5	0.3	-	0.29
AGW227	PDB	1.8	0.2 U	0.2	0.3	-	0.29
	Criterion	**RPD 33%**	LOQ Pass	**RPD 170%**	LOQ Pass		RPD 0%
AGW228	LF	2.9	0.2 U	2.8	0.3	-	0.3
AGW228	PDB	2.9	0.2 U	1.9	0.3	-	0.3
	Criterion	RPD 0%	LOQ Pass	**RPD 38%**	LOQ Pass		RPD 0%
AGW234	LF	1.7	0.2 U	7.7	0.2 U	-	0.053
AGW234	PDB	1.7	0.2 U	7.3	0.2 U	-	0.071
	Criterion	RPD 0%	LOQ Pass	RPD 5%	LOQ Pass		LOQ Pass
AGW237	LF	1	0.2 U	2.4	0.2 U	0.037	0.043
AGW237	PDB	0.9	0.2 U	1.8	0.2 U	0.02 U	0.042
	Criterion	LOQ Pass	LOQ Pass	**RPD 29%**	LOQ Pass	LOQ Pass	LOQ Pass
AGW245	LF	0.2 U	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U
AGW245	PDB	0.2 U	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U
	Criterion	LOQ Pass	LOQ Pass	LOQ Pass	LOQ Pass	LOQ Pass	LOQ Pass
AGW261	LF	1.3	0.2 U	2.6	0.2 U	0.02 U	0.084
AGW261	PDB	1.3	0.2 U	2.9	0.2 U	0.02 U	0.098
	Criterion	RPD 0%	LOQ Pass	RPD 11%	LOQ Pass	LOQ Pass	LOQ Pass
AGW263	LF	0.7	0.2 U	0.2 U	0.2 U	0.02 U	0.025
AGW263	PDB	2.2	0.2 U	0.3	0.2 U	0.02 U	0.054
	Criterion	**LOQ Fail**	LOQ Pass	LOQ Pass	LOQ Pass	LOQ Pass	**LOQ Fail**

Abbreviations/Acronyms

LF = Low-flow sample
LOQ = Limit of Quantitation. Acceptance criteria for LOQ is +/- LOQ; comparison presented as pass/fail.
RPD = Relative Percent Difference. Acceptance criteria for RPD is +/- 20 percent; comparison presented as percent difference
µg/L = micrograms per liter
PDB = Passive diffusion bag sample

Notes

Orange text indicates PDB result higher than low-flow result
Blue text indicates low-flow result higher than PDB result.

APPENDIX A

Comparability Study Analytical Results

Table A-1
Comparability Study Analytical Results
December 2015
Boeing Auburn Facility

Sample Location:	AGW037	AGW037	AGW055R	AGW055R	AGW105	AGW105	AGW140	AGW140	AGW144	AGW144	AGW145	AGW145	AGW145	AGW145	AGW146	AGW146
Zone:	Shallow	Shallow	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Int.	Deep	Deep
Sampling Method:	Low Flow	PDB	Low Flow	PDB	Low Flow	PDB	Low Flow	PDB	Low Flow	PDB	Low Flow	Low Flow	PDB	PDB	Low Flow	PDB
SDG:	1614735	1614735	1614026	1614026	1615622	1615622	1614735	1614735	1614748	1614748	1614748	1614748	1614748	1614748	1614748	1614748
Lab ID:	8162344	8162345	8158555	8158556	8167031	8167032	8162330	8162331	8162476	8162477	8162481	8162483	8162482	8162484	8162479	8162480
Sample Date:	12/3/2015	12/3/2015	12/1/2015	12/1/2015	12/7/2015	12/7/2015	12/3/2015	12/3/2015	12/4/2015	12/4/2015	12/4/2015	12/4/2015	12/4/2015	12/4/2015	12/4/2015	12/4/2015
Sample Type:	N	N	N	N	N	N	N	N	N	N	N	FD	N	FD	N	N
VOLATILES (µg/L) **Method SW8260C**																
Acetone	5.0 U	5.0 U	5.0 U	**47**	5.0 U	5.0 U	5.0 U	**49**	5.0 U	**53**	5.0 U	5.0 U	**40**	**40**	5.0 U	5.0 U
Benzene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Disulfide	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon Tetrachloride	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.2**	**0.2**	0.2 U	0.2 U	0.2 U	**0.2**	0.2 U	0.2 U	0.2 U	0.2 U
cis-1,2-Dichloroethene	**1.2**	**1.2**	**0.7**	**0.5**	**0.6**	**0.6**	**2.9**	**2.7**	**1.9**	**1.9**	**7.7**	**7.5**	**7.4**	**7.2**	**1.8**	**1.8**
trans-1,2-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.4**	**0.4**	**1.1**	**1.1**	**1.1**	**1.1**	**0.2**	**0.2**
1,2-Dichloropropane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
trans-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Ethylbenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (MIBK)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene Chloride	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Styrene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Tetrachloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Toluene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Trichloroethene	**2.3**	**2.5**	**0.5**	**0.5**	**0.9**	**0.9**	**4.3**	**4.4**	**0.9**	**0.8**	**12**	**12**	**13**	**12**	**3.9**	**4.3**
Trichlorofluoromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Acetate	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Chloride	0.2 U	0.2 U	0.2 U	0.2 U	**0.8**	**0.8**	0.2 U	**0.2**	**0.3**	**0.3**	**0.8**	**0.8**	**0.8**	**0.8**	0.2 U	0.2 U
m,p-Xylene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
VOLATILES (µg/L) **Method 8260C SIM**																
Tetrachloroethene	**0.080**	**0.085**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	**0.20**	**0.18**	**0.051**	**0.037**	**0.80**	**0.85**	**0.21**	**0.23**	**0.26**	**0.27**	--	--	--	--	**0.13**	**0.12**

Table A-1
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Sample Location:	AGW157	AGW157	AGW157	AGW157	AGW159	AGW159	AGW165	AGW165	AGW167	AGW167	AGW168	AGW168	AGW169	AGW169	AGW182	AGW182
Zone:	Int.	Int.	Int.	Int.	Deep	Deep	Shallow	Shallow	Deep	Deep	Int.	Int.	Deep	Deep	Int.	Int.
Sampling Method:	Low Flow	Low Flow	PDB	PDB	Low Flow	PDB	Low Flow	PDB	Low Flow	PDB	PDB	Low Flow	PDB	Low Flow	Low Flow	Low Flow
SDG:	1615622	1615622	1615622	1615622	1616931	1616931	1614735	1614735	1616930	1616931	1616930	1616930	1616930	1616930	1614751	1614751
Lab ID:	8167035	8167034	8167037	8167036	8174118	8174124	8162342	8162343	8174109	8174125	8174104	8174107	8174105	8174106	8162502	8162501
Sample Date:	12/7/2015	12/7/2015	12/7/2015	12/7/2015	12/9/2015	12/9/2015	12/3/2015	12/3/2015	12/9/2015	12/9/2015	12/9/2015	12/9/2015	12/9/2015	12/9/2015	12/4/2015	12/4/2015
Sample Type:	FD	N	FD	N	N	N	N	N	N	N	N	N	N	N	FD	N
VOLATILES (µg/L) **Method SW8260C**																
Acetone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	**62**	**55**	5.0 U	**58**	5.0 U	5.0 U	5.0 U
Benzene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Disulfide	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ
Carbon Tetrachloride	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
cis-1,2-Dichloroethene	**2.0**	**2.0**	**2.1**	**2.2**	**1.0**	**1.2**	**1.2**	**1.3**	**2.4**	**2.5**	**1.8**	**1.7**	**1.7**	**1.6**	**2.4**	**2.5**
trans-1,2-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.3**	**0.3**	0.2 U	0.2 U	0.2 U	0.2 U	**0.3**	**0.3**
1,2-Dichloropropane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
trans-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Ethylbenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (MIBK)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene Chloride	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Styrene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Tetrachloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Toluene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Trichloroethene	**2.7**	**2.7**	**2.8**	**2.7**	**4.4**	**5.0**	**2.3**	**2.6**	**4.8**	**5.2**	**5.2**	**4.6**	**6.4**	**5.8**	**1.6**	**1.7**
Trichlorofluoromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Acetate	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Chloride	**0.5**	**0.6**	**0.4**	**0.4**	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
m,p-Xylene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
VOLATILES (µg/L) **Method 8260C SIM**																
Tetrachloroethene	**0.027**	**0.029**	0.020 U	0.020 U	**0.058**	**0.066**	**0.060**	**0.065**	--	--	0.020 U	0.020 U	--	--	0.020 U	0.020 U
Vinyl Chloride	**0.60**	**0.58**	**0.41**	**0.40**	**0.14**	**0.16**	**0.16**	**0.15**	**0.18**	**0.19**	**0.068**	**0.064**	**0.062**	**0.061**	**0.19**	**0.20**

Table A-1
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Sample Location:	AGW182	AGW182	AGW193	AGW193	AGW226	AGW226	AGW227	AGW227	AGW228	AGW228	AGW234	AGW234	AGW237	AGW237	AGW245	AGW245
Zone:	Int.	Int.	Shallow	Shallow	Water Table	Water Table	Int.	Int.	Shallow	Shallow	Deep	Deep	Deep	Deep	Water Table	Water Table
Sampling Method:	PDB	PDB	Low Flow	PDB	Low Flow	PDB	Low Flow	PDB	PDB	Low Flow	PDB	Low Flow	PDB	Low Flow	PDB	Low Flow
SDG:	1614751	1614751	1616931	1616931	1614436	1614436	1616931	1616931	1616931	1616931	1615623	1615623	1614736	1614736	1614734	1614734
Lab ID:	8162503	8162504	8174119	8174120	8160647	8160649	8174129	8174130	8174117	8174128	8167050	8167051	8162351	8162352	8162315	8162316
Sample Date:	12/4/2015	12/4/2015	12/9/2015	12/9/2015	12/2/2015	12/2/2015	12/9/2015	12/9/2015	12/9/2015	12/9/2015	12/7/2015	12/7/2015	12/3/2015	12/3/2015	12/3/2015	12/3/2015
Sample Type:	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N
VOLATILES (µg/L)																
Method SW8260C																
Acetone			5.0 U	**50**	5.0 U	**49**	5.0 U	**54**	**48**	5.0 U	**53**	5.0 U	**43**	5.0 U	5.0 U	5.0 U
Benzene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Disulfide	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon Tetrachloride	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Chloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.6**	**0.6**	0.5 U	0.5 U
1,2-Dichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	**0.3**	**0.4**	**0.9**	**0.9**	0.2 U	0.2 U
cis-1,2-Dichloroethene	**2.4**	**2.5**	**1.8**	**1.9**	**1.8**	**2.8**	**2.5**	**1.8**	**2.9**	**2.9**	**1.7**	**1.7**	**0.9**	**1**	0.2 U	0.2 U
trans-1,2-Dichloroethene	**0.3**	**0.3**	0.2 U	0.2 U	0.2 U	0.2 U	0.3	0.2 U	**0.4**	**0.3**	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-Dichloropropane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
trans-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Ethylbenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (MIBK)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene Chloride	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Styrene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Tetrachloroethene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Toluene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Trichloroethene	**1.6**	**1.6**	**3.0**	**3.5**	**0.5**	**0.7**	**2.5**	**0.2**	**1.9**	**2.8**	**7.3**	**7.7**	**1.8**	**2.4**	0.2 U	0.2 U
Trichlorofluoromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Acetate	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Chloride	0.2 U	0.2 U	**0.3**	**0.3**	**0.4**	**0.5**	**0.3**	**0.3**	**0.3**	**0.3**	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
m,p-Xylene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
VOLATILES (µg/L)																
Method 8260C SIM																
Tetrachloroethene	0.020 U	0.020 U	**0.074**	**0.079**	--	--	--	--	--	--	--	--	0.020 U	**0.037**	0.020 U	0.020 U
Vinyl Chloride	**0.20**	**0.21**	**0.28**	**0.29**	**0.32**	**0.56**	**0.29**	**0.29**	**0.30**	**0.30**	**0.071**	**0.053**	**0.042**	**0.043**	0.020 U	0.020 U

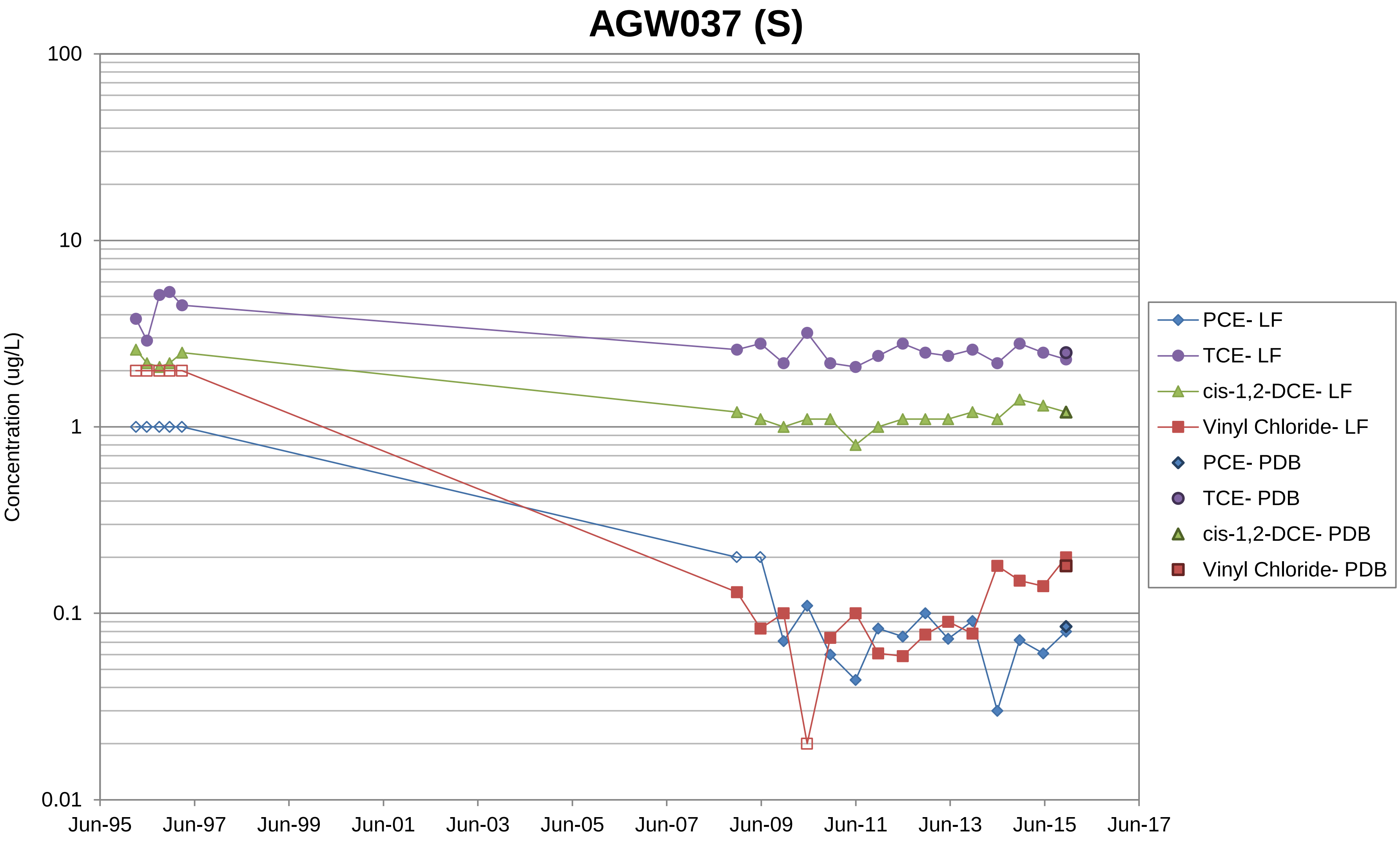
Table A-1
Comparability Study Analytical Results
December 2015
Boeing Auburn Facility
Auburn, Washington

Sample Location:	AGW261	AGW261	AGW263	AGW263
Zone:	Shallow	Shallow	Water Table	Water Table
Sampling Method:	PDB	Low Flow	Low Flow	PDB
SDG:	1614030	1614030	1619990	1619990
Lab ID:	8158620	8158621	8188817	8188818
Sample Date:	12/1/2015	12/1/2015	12/22/2015	12/22/2015
Sample Type:	N	N	N	N
VOLATILES (µg/L)				
Method SW8260C				
Acetone	**46**	5.0 U	5.0 U	**29**
Benzene	0.2 U	0.2 U	0.2 U	0.2 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	5.0 U	5.0 U	5.0 U	5.0 U
Carbon Disulfide	0.5 U	0.5 U	0.5 U	0.5 U
Carbon Tetrachloride	0.2 U	0.2 U	0.2 U	0.2 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	0.2 U	0.2 U	0.2 U	0.2 U
Chloromethane	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.2 U	0.2 U	0.2 U	0.2 U
1,1-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U
cis-1,2-Dichloroethene	**1.3**	**1.3**	**0.7**	**2.2**
trans-1,2-Dichloroethene	**0.3**	**0.2**	0.2 U	0.2 U
1,2-Dichloropropane	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U
trans-1,3-Dichloropropene	0.2 U	0.2 U	0.2 U	0.2 U
Ethylbenzene	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (MIBK)	5.0 U	5.0 U	5.0 U	5.0 U
Methylene Chloride	0.5 U	0.5 U	0.5 U	0.5 U
Styrene	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.2 U	0.2 U	0.2 U	0.2 U
Tetrachloroethene	0.2 U	0.2 U	0.2 U	0.2 U
Toluene	0.2 U	0.2 U	0.2 U	0.2 U
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	0.2 U	0.2 U	0.2 U	0.2 U
Trichloroethene	**2.9**	**2.6**	0.2 U	**0.3**
Trichlorofluoromethane	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Acetate	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Chloride	0.2 U	0.2 U	0.2 U	0.2 U
m,p-Xylene	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	0.5 U	0.5 U	0.5 U	0.5 U
VOLATILES (µg/L)				
Method 8260C SIM				
Tetrachloroethene	0.020 U	0.020 U	0.020 U	0.020 U
Vinyl Chloride	**0.098**	**0.084**	**0.025**	**0.054**

U = Indicates the compound was undetected at the reported concentration.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.
Bold = Detected compound.
PDB = Passive diffusion bag
N = Normal
FD = Field duplicate
-- = Not analyzed
Note:
Int. = Intermediate
SDG = Sample Delivery Group
SIM = Selected Ion Method
PDB = Passive Diffusion Bag
N = Normal
FD = Field Duplicate

APPENDIX B

Concentration Time Series Plots



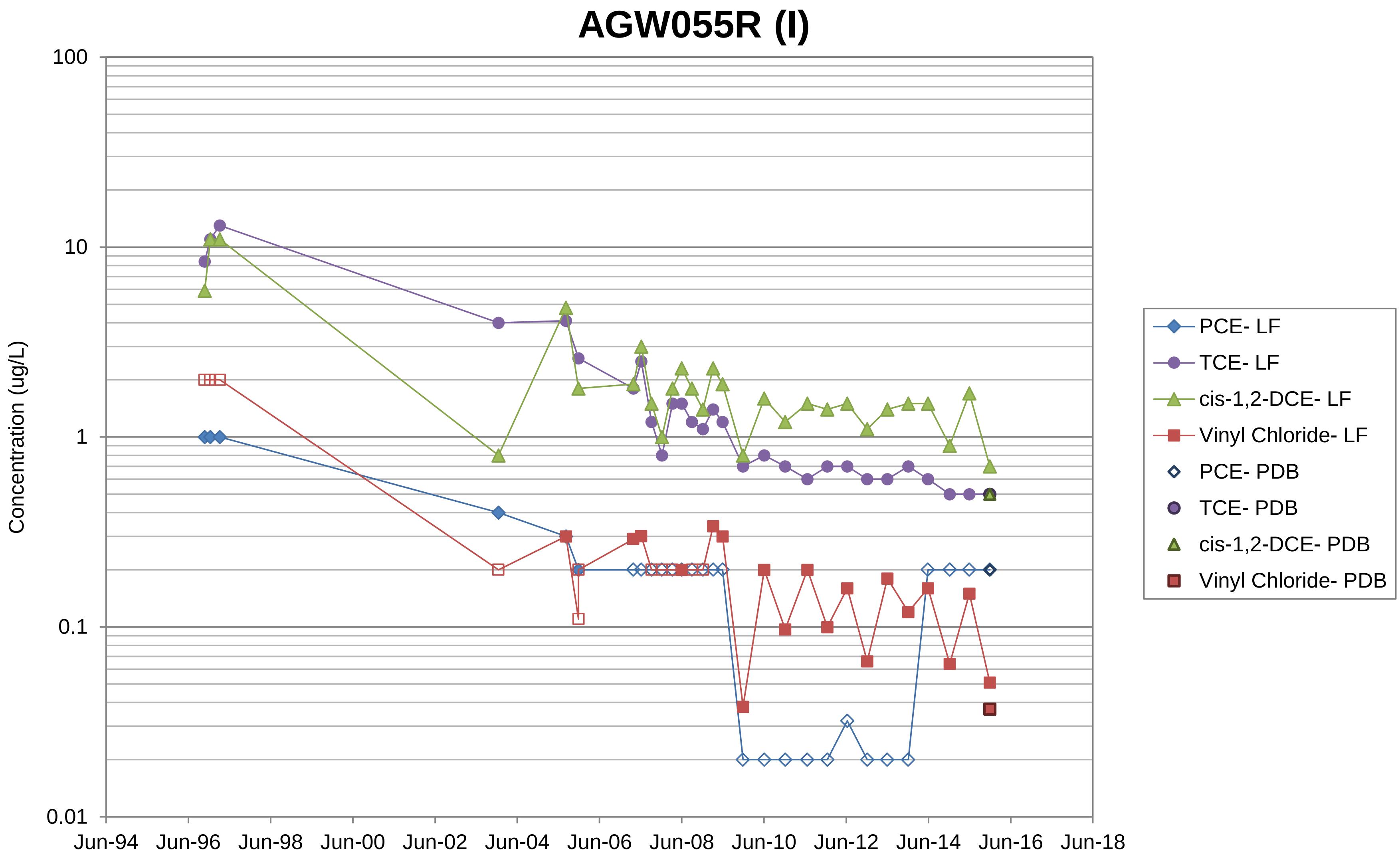
Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn Auburn, Washington	**AGW037 VOC Concentrations**	Figure B-1

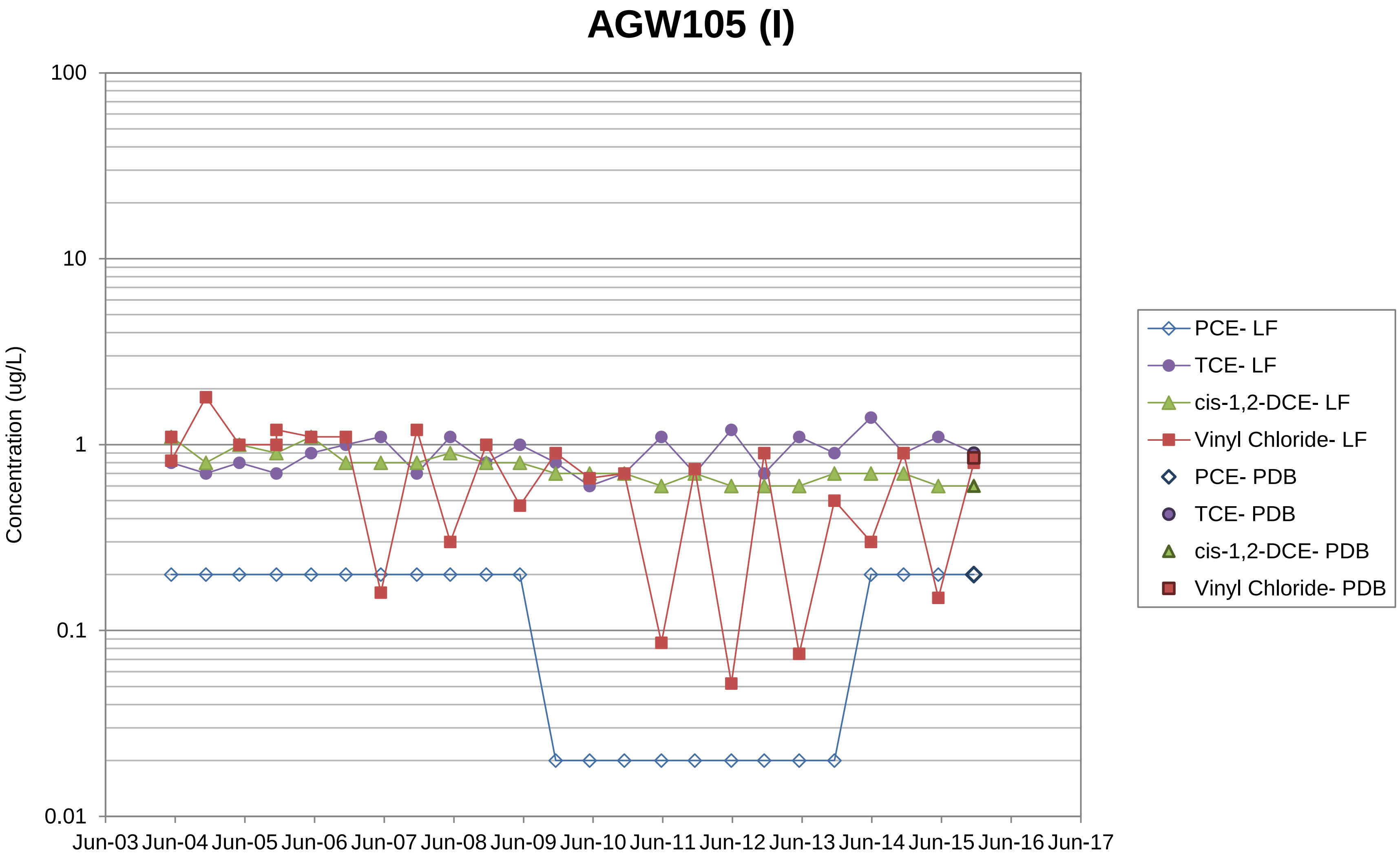


Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES	Boeing Auburn Auburn, Washington	**AGW055R VOC Concentrations**	Figure B-2



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

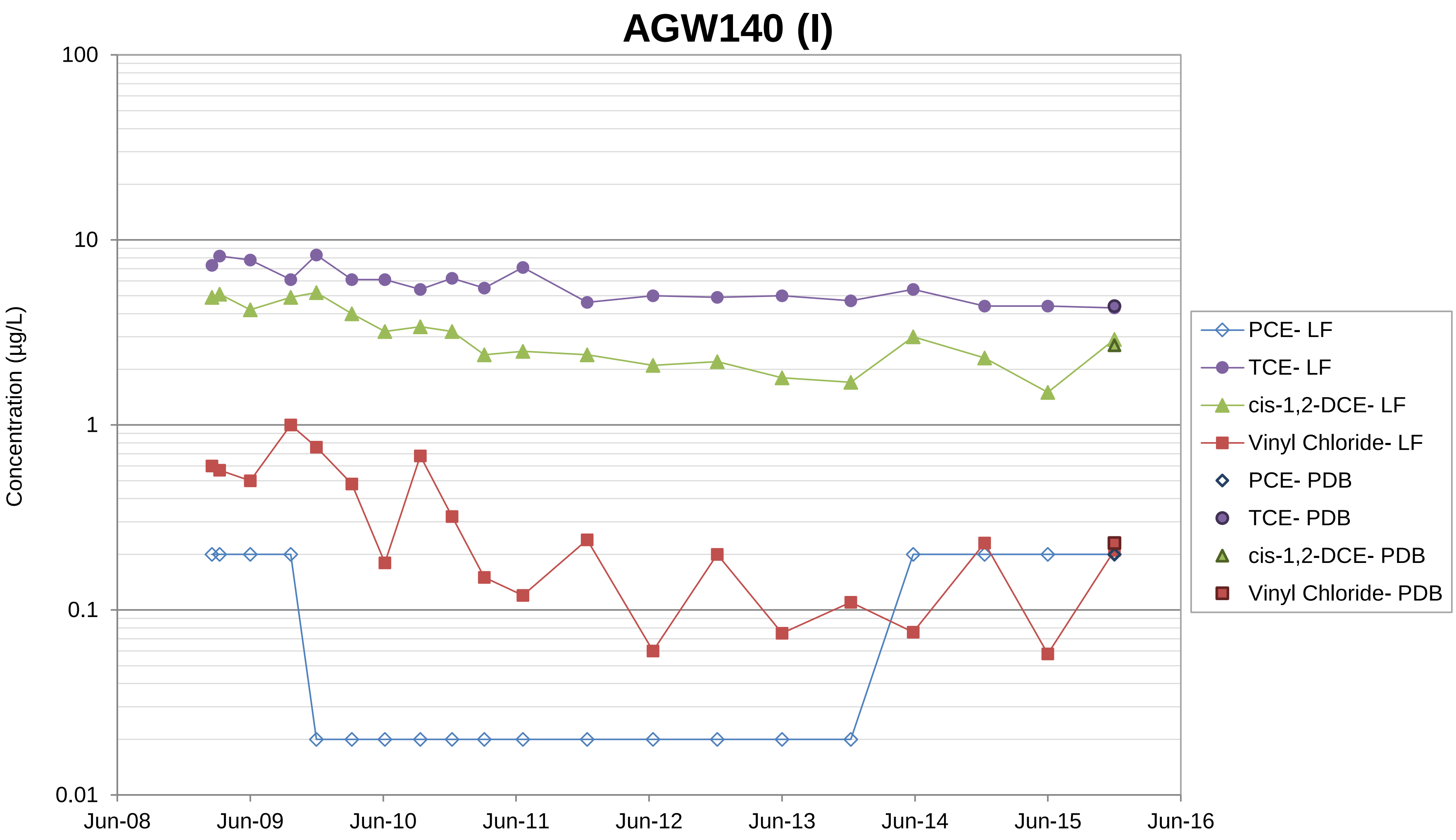
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW105 VOC Concentrations

Figure
B-3



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

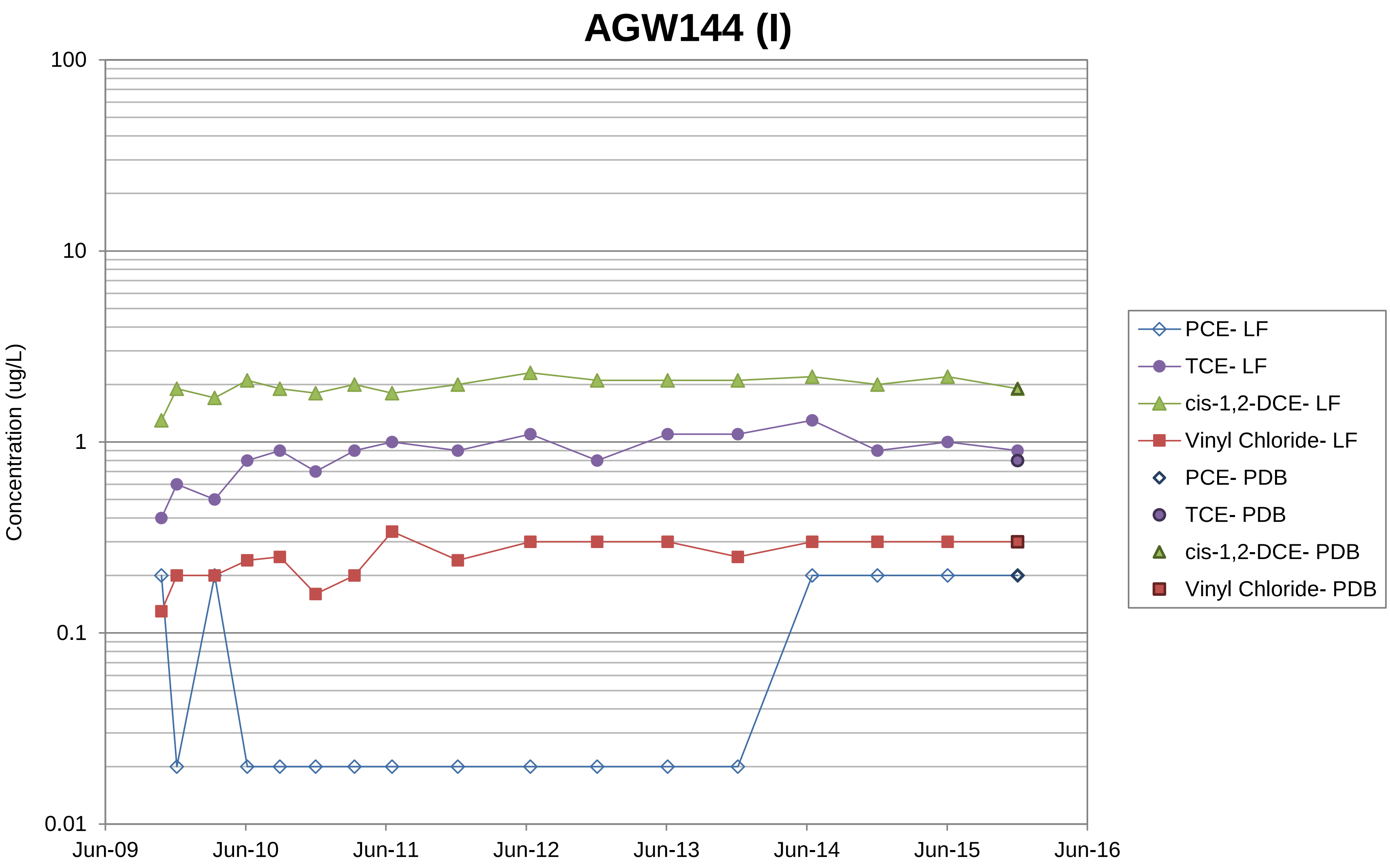
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW140 VOC Concentrations

Figure
B-4



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

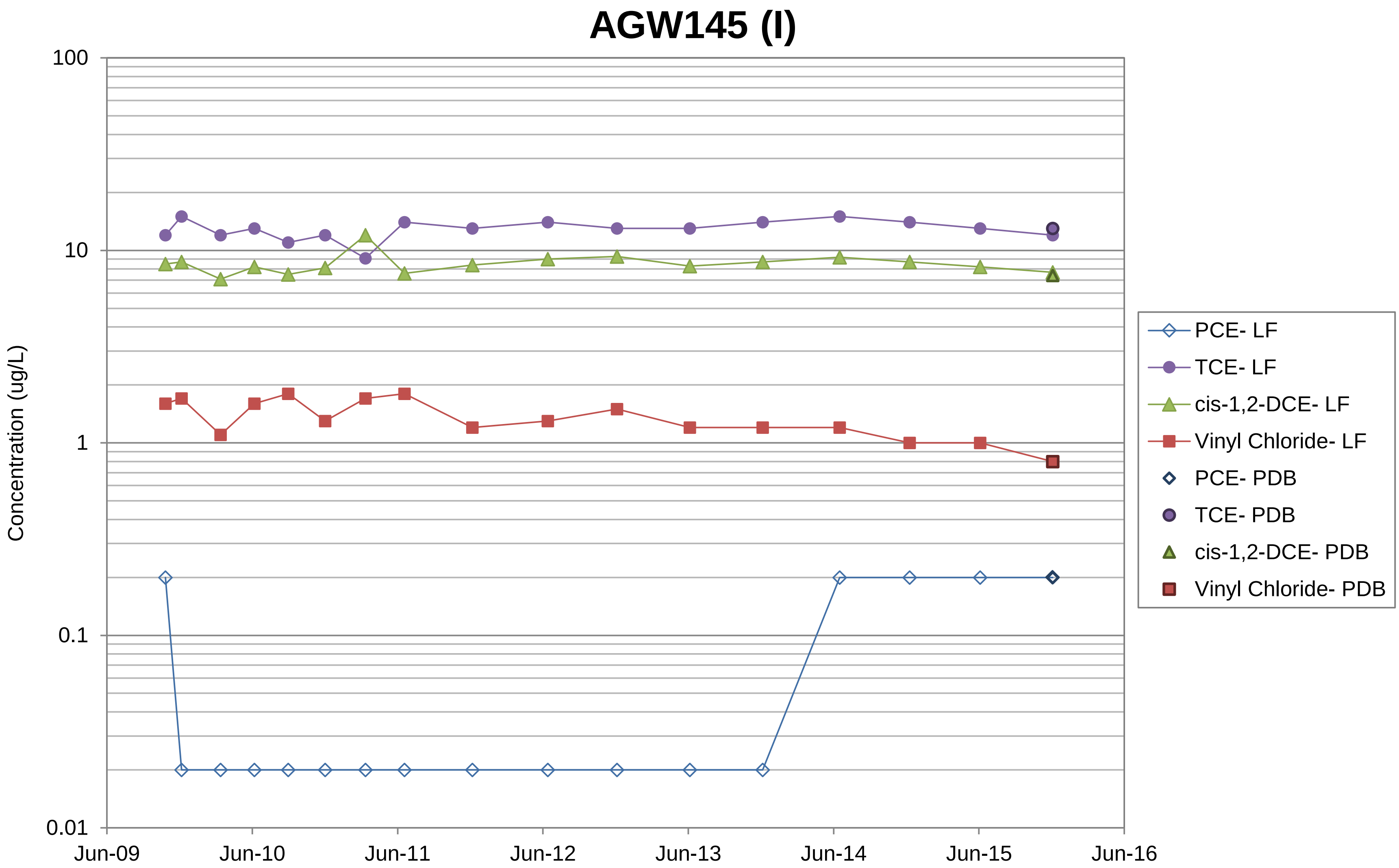
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW144 VOC Concentrations

Figure
B-5



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

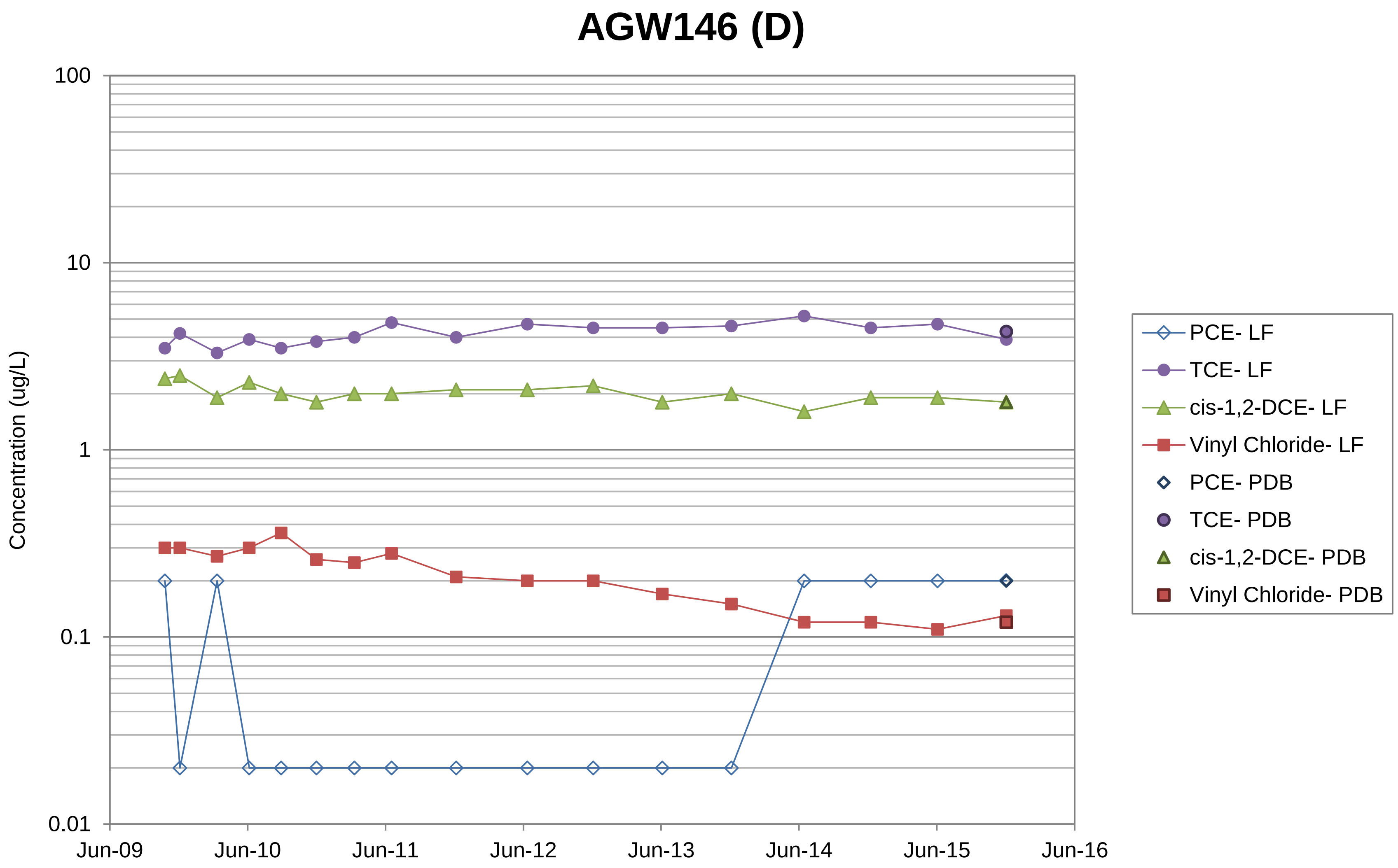
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW145 VOC Concentrations

Figure
B-6



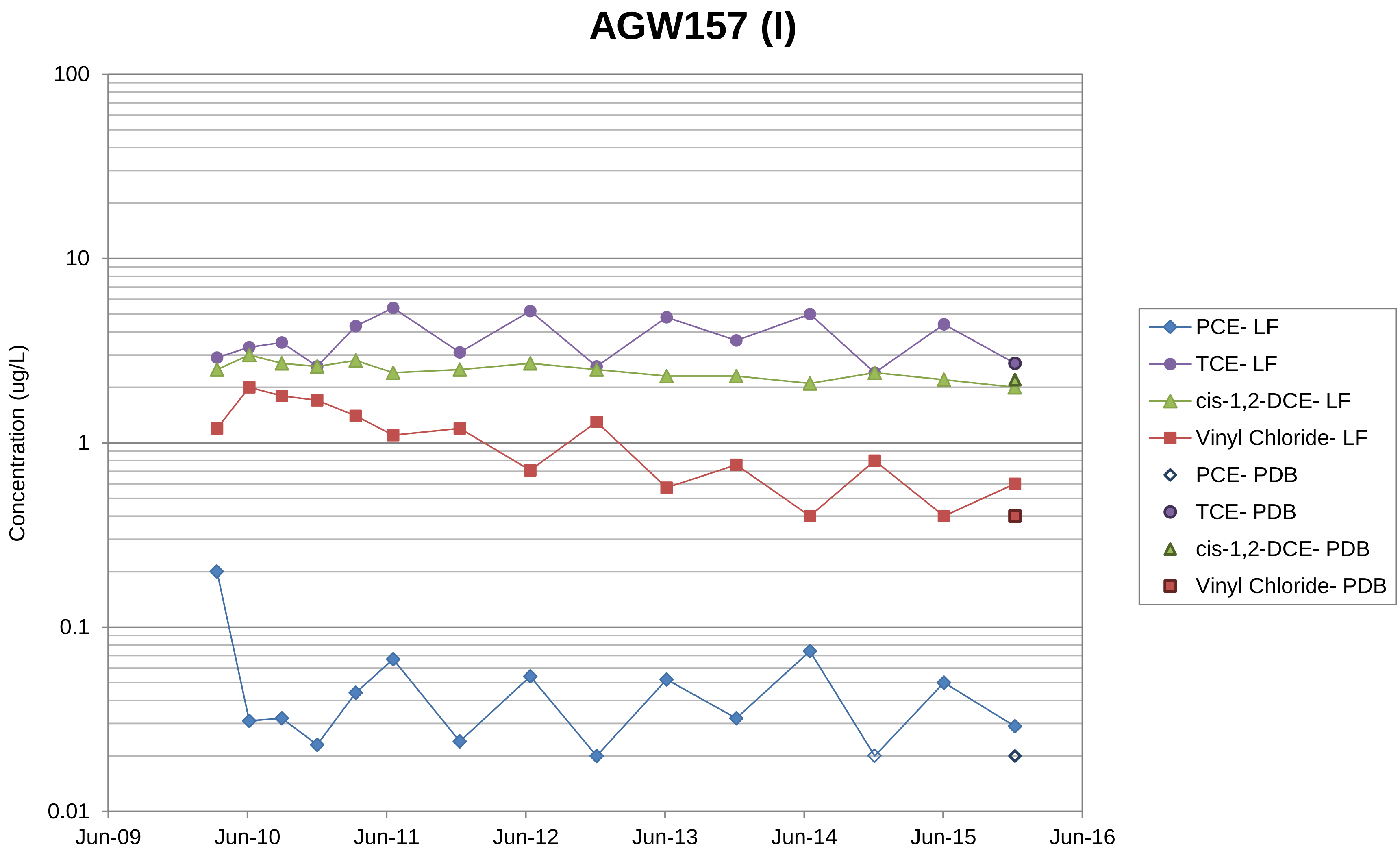
Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn Auburn, Washington	**AGW146 VOC Concentrations**	Figure B-7



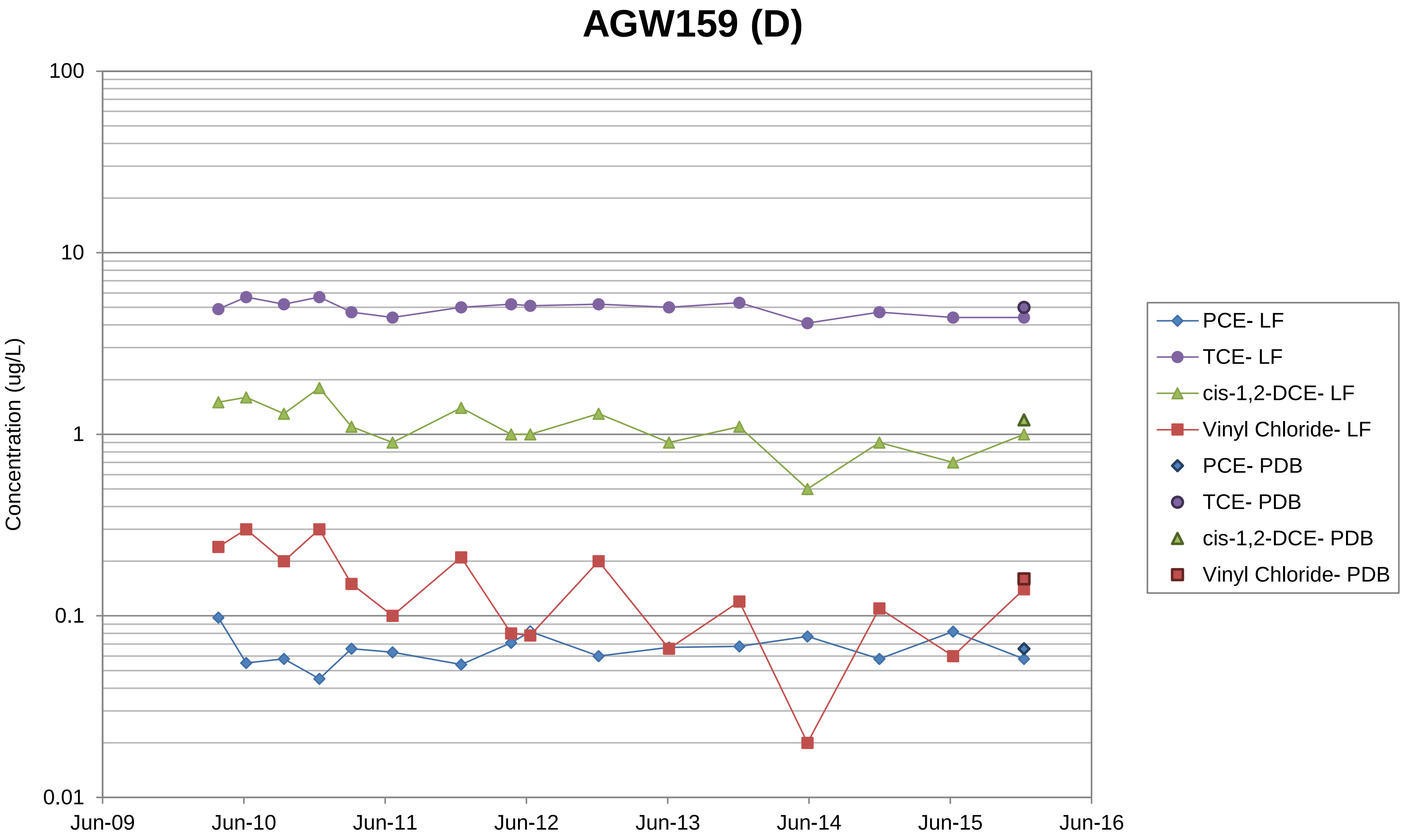
Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn Auburn, Washington	**AGW157 VOC Concentrations**	Figure B-8



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

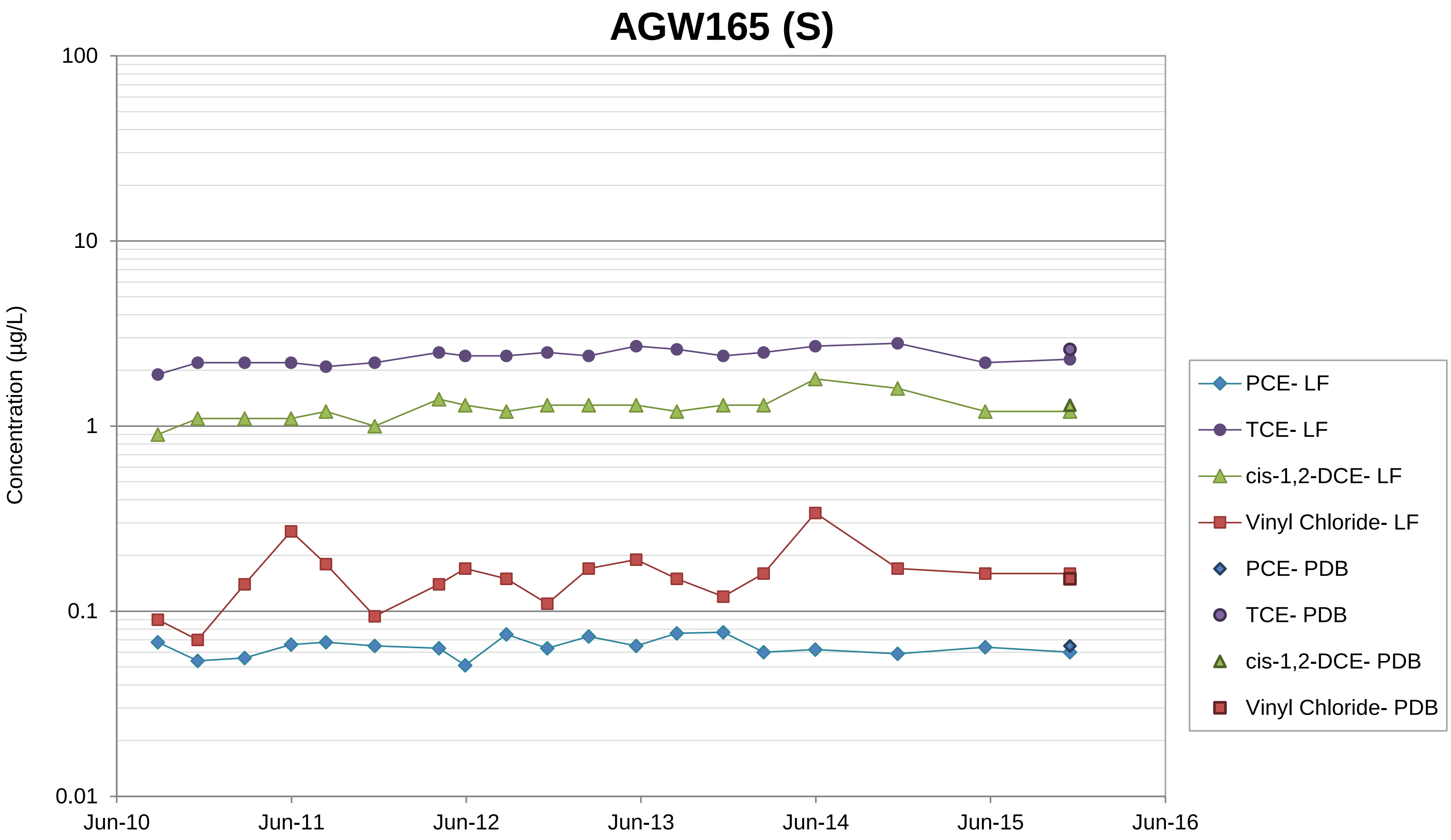
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW159 VOC Concentrations

Figure
B-9



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

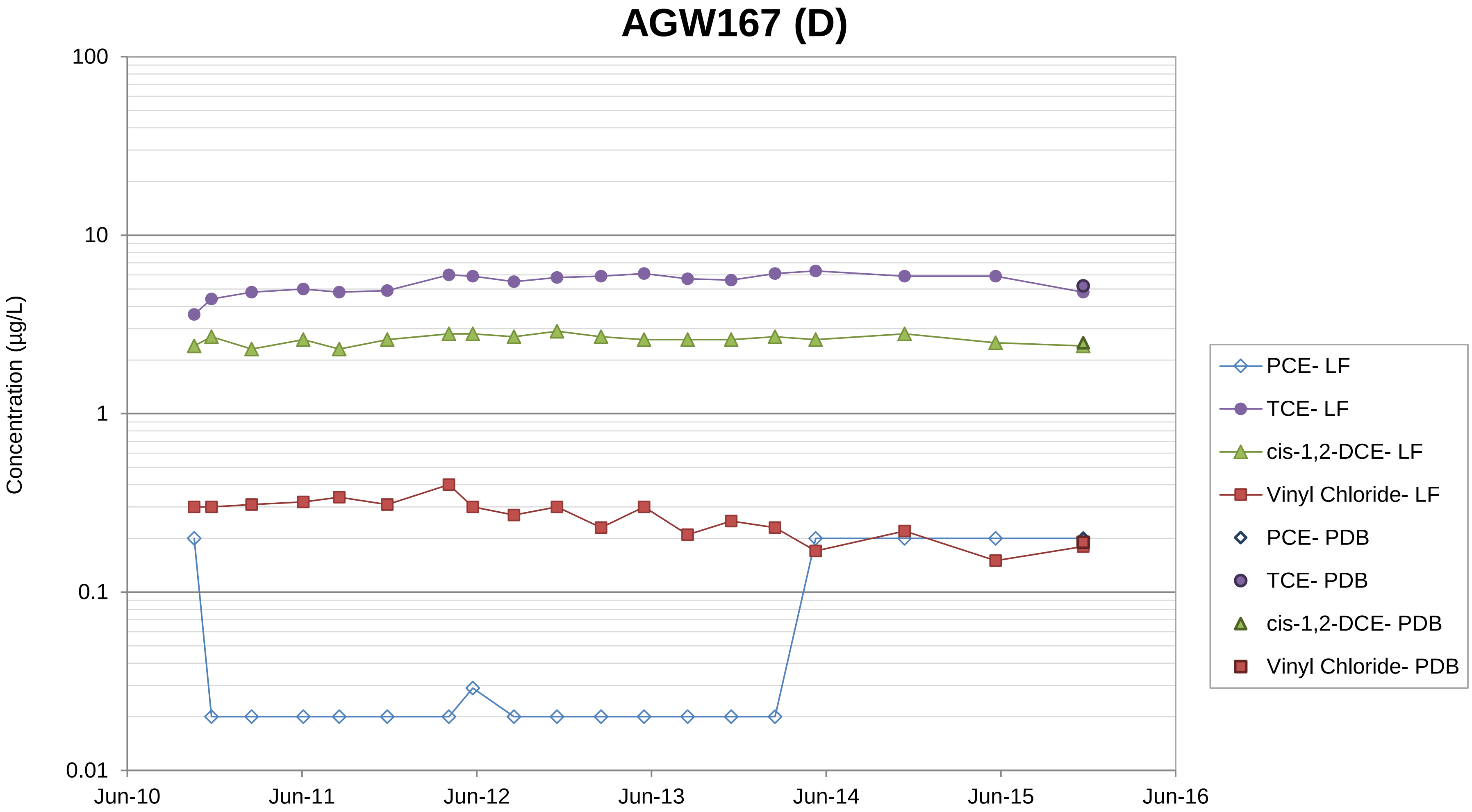
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW165 VOC Concentrations

Figure
B-10



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

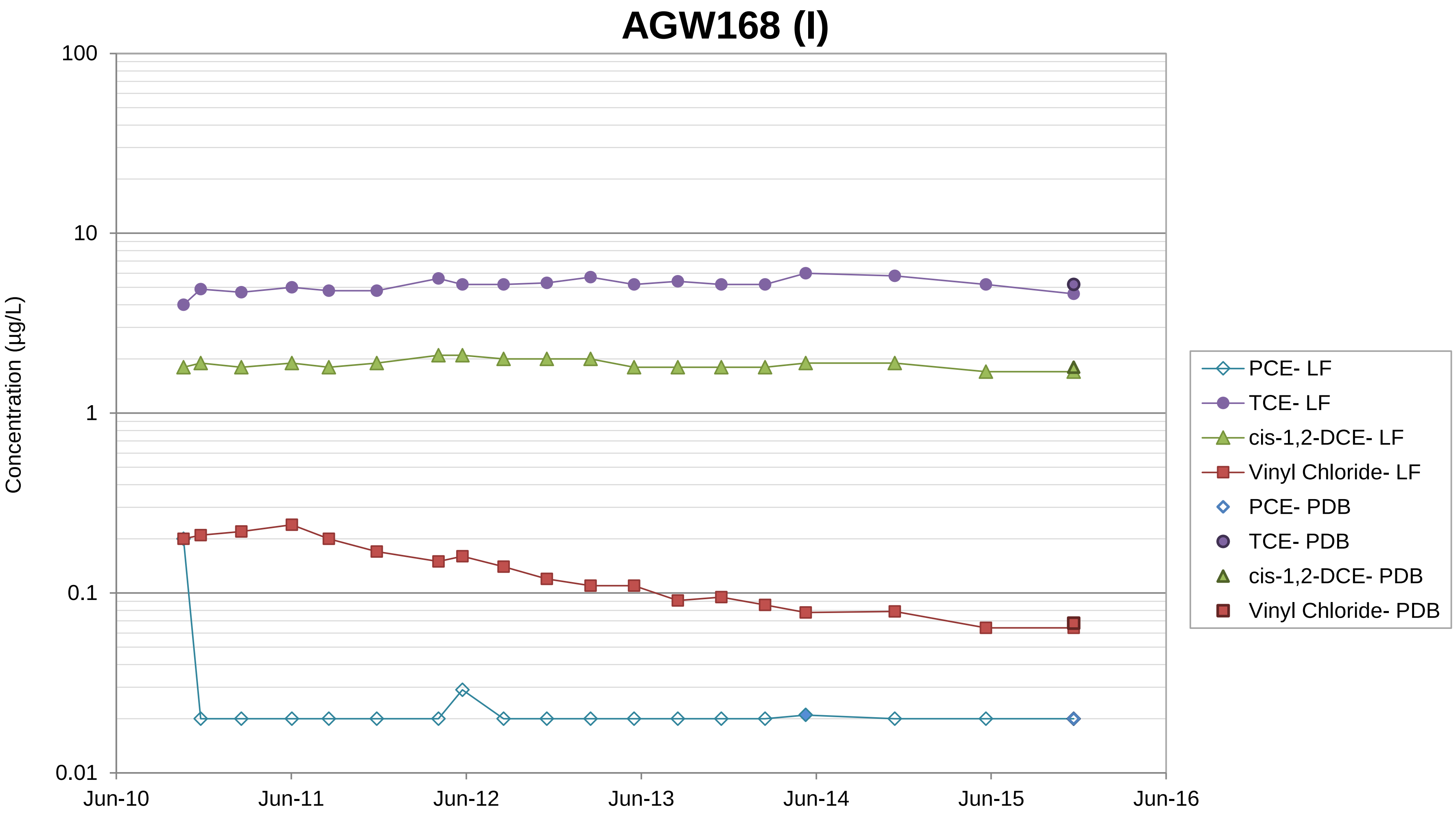
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW167 VOC Concentrations

Figure
B-11

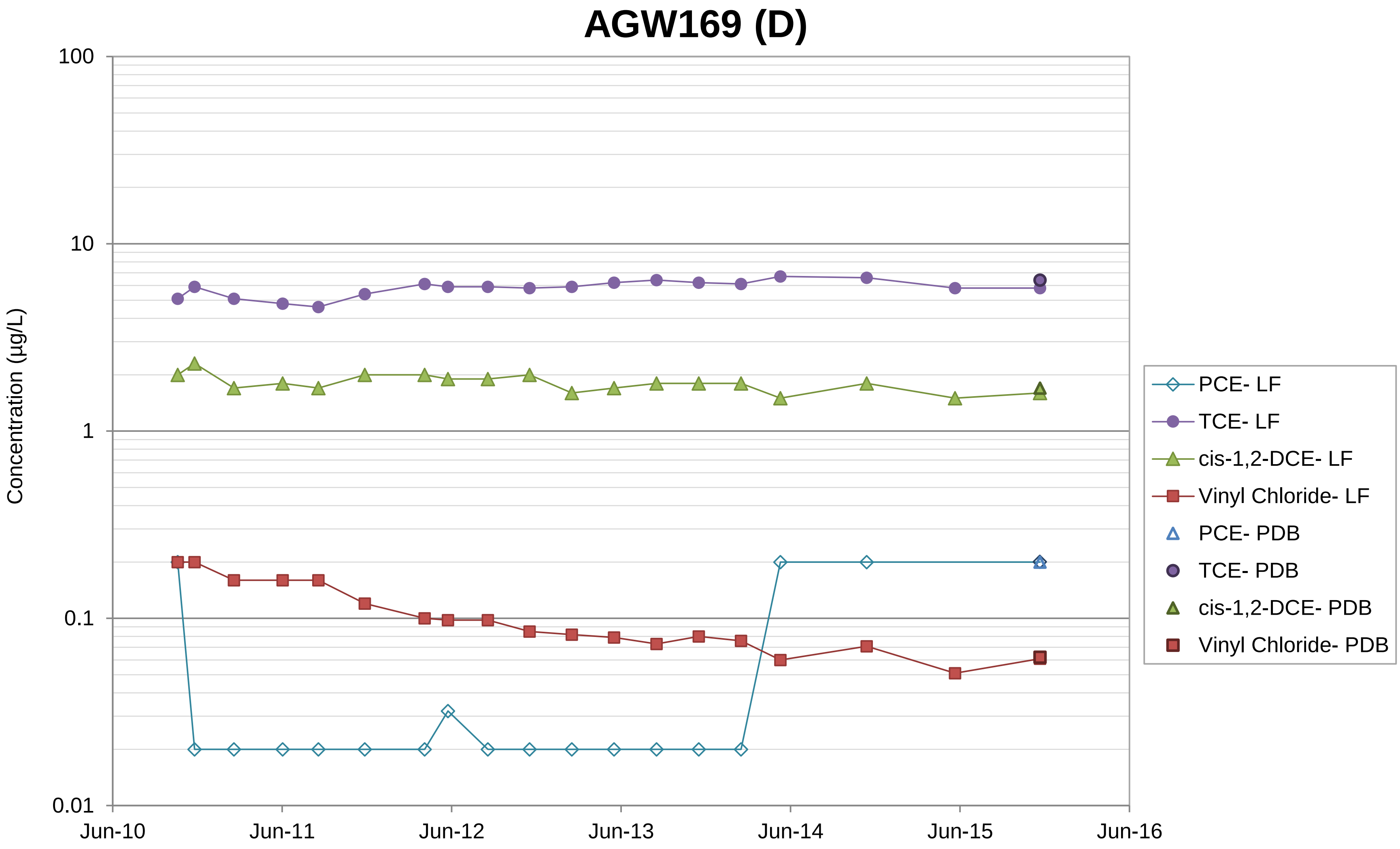


Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

Landau Associates	Boeing Auburn Auburn, Washington	**AGW168 VOC Concentrations**	Figure B-12



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

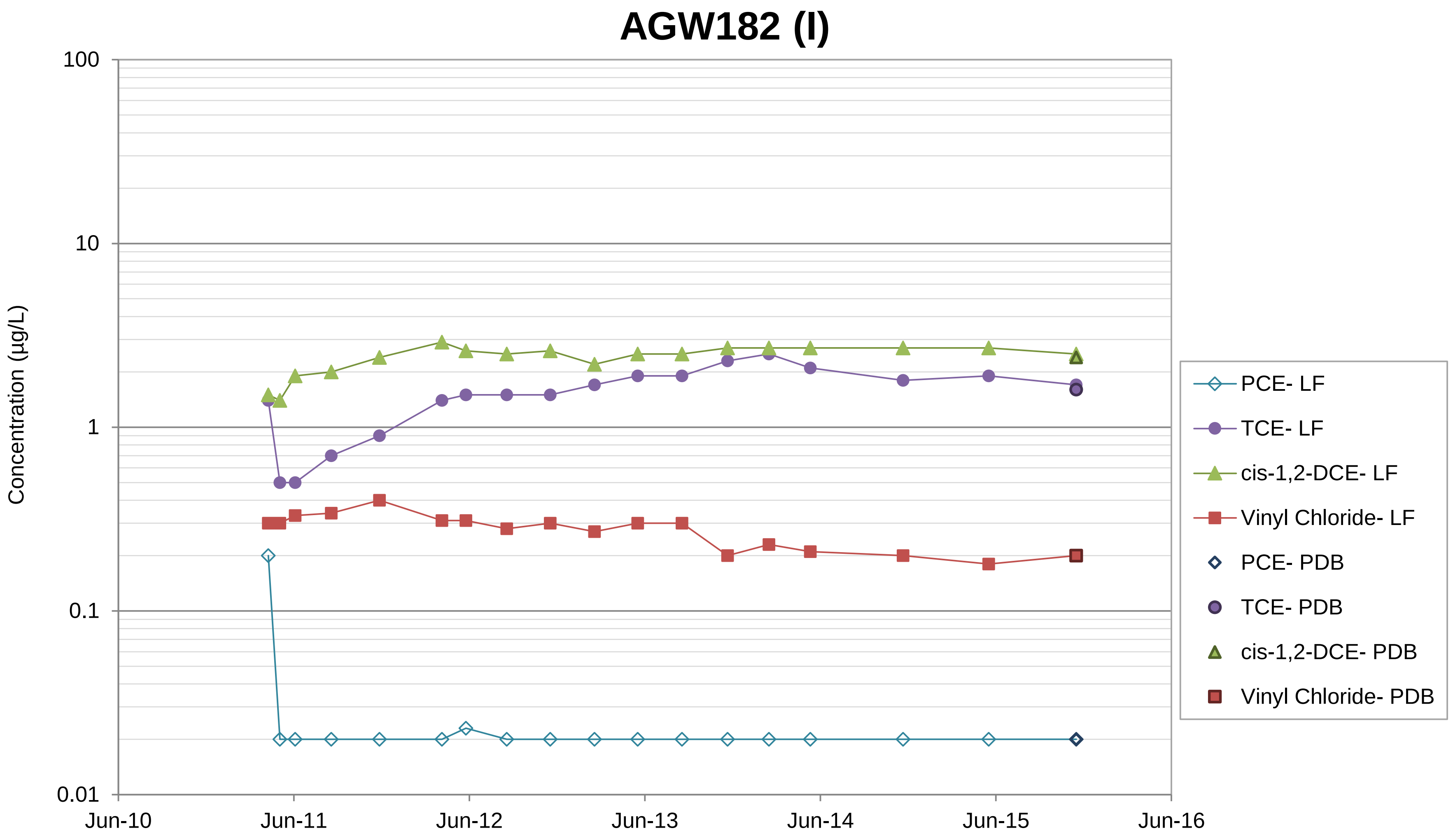
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW169 VOC Concentrations

Figure
B-13



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

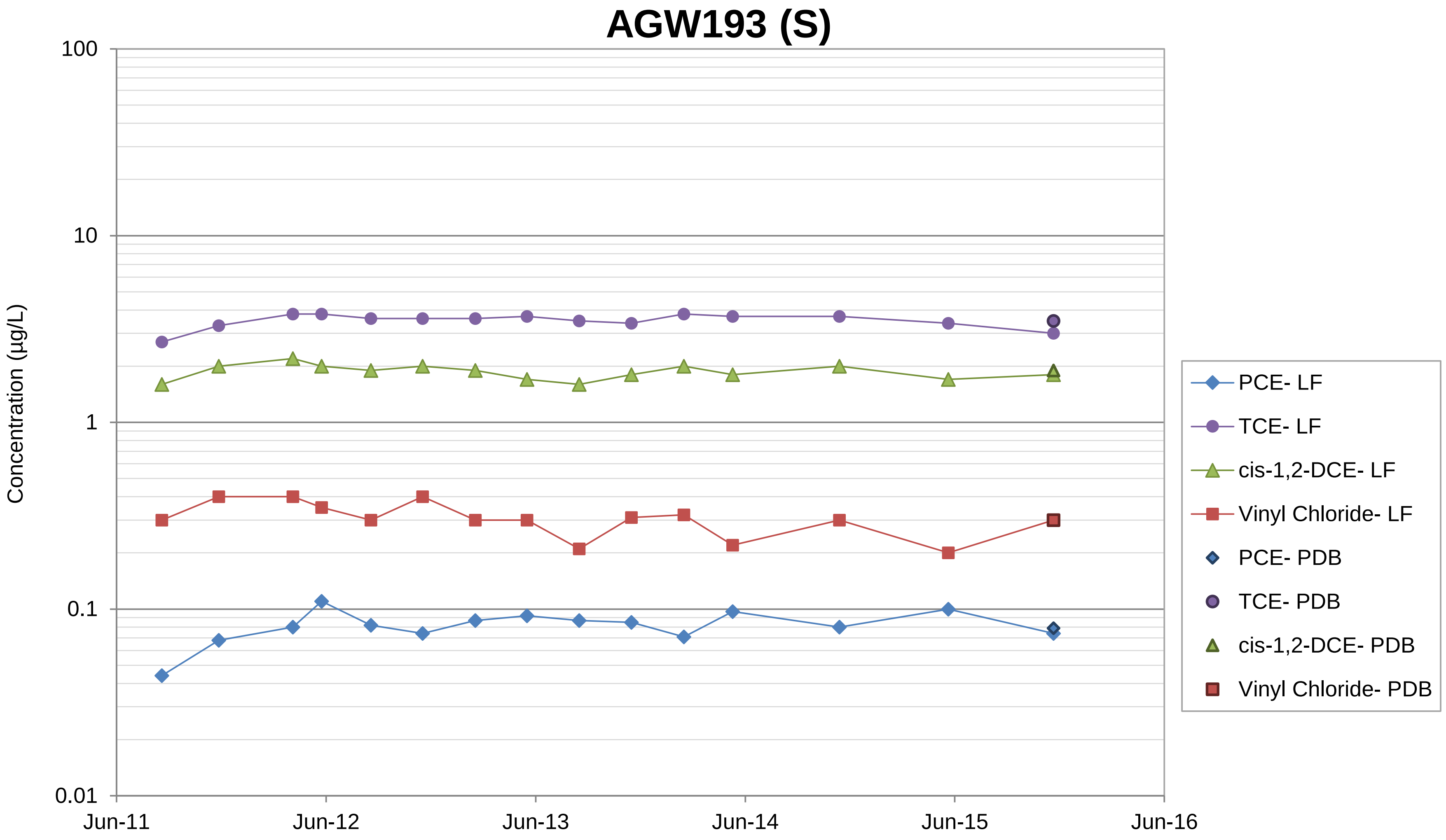
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW182 VOC Concentrations

Figure
B-14



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

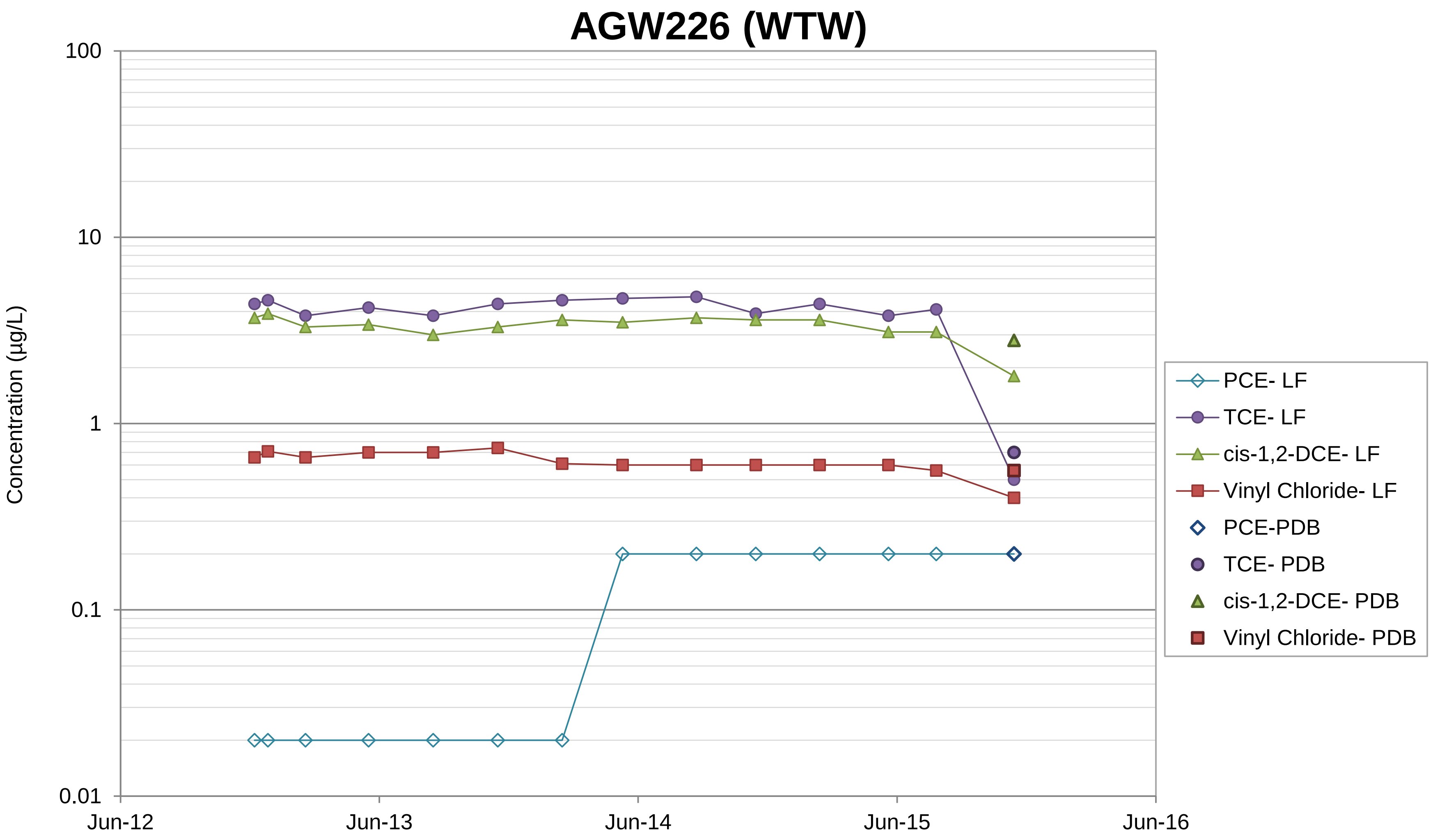
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW193 VOC Concentrations

Figure
B-15



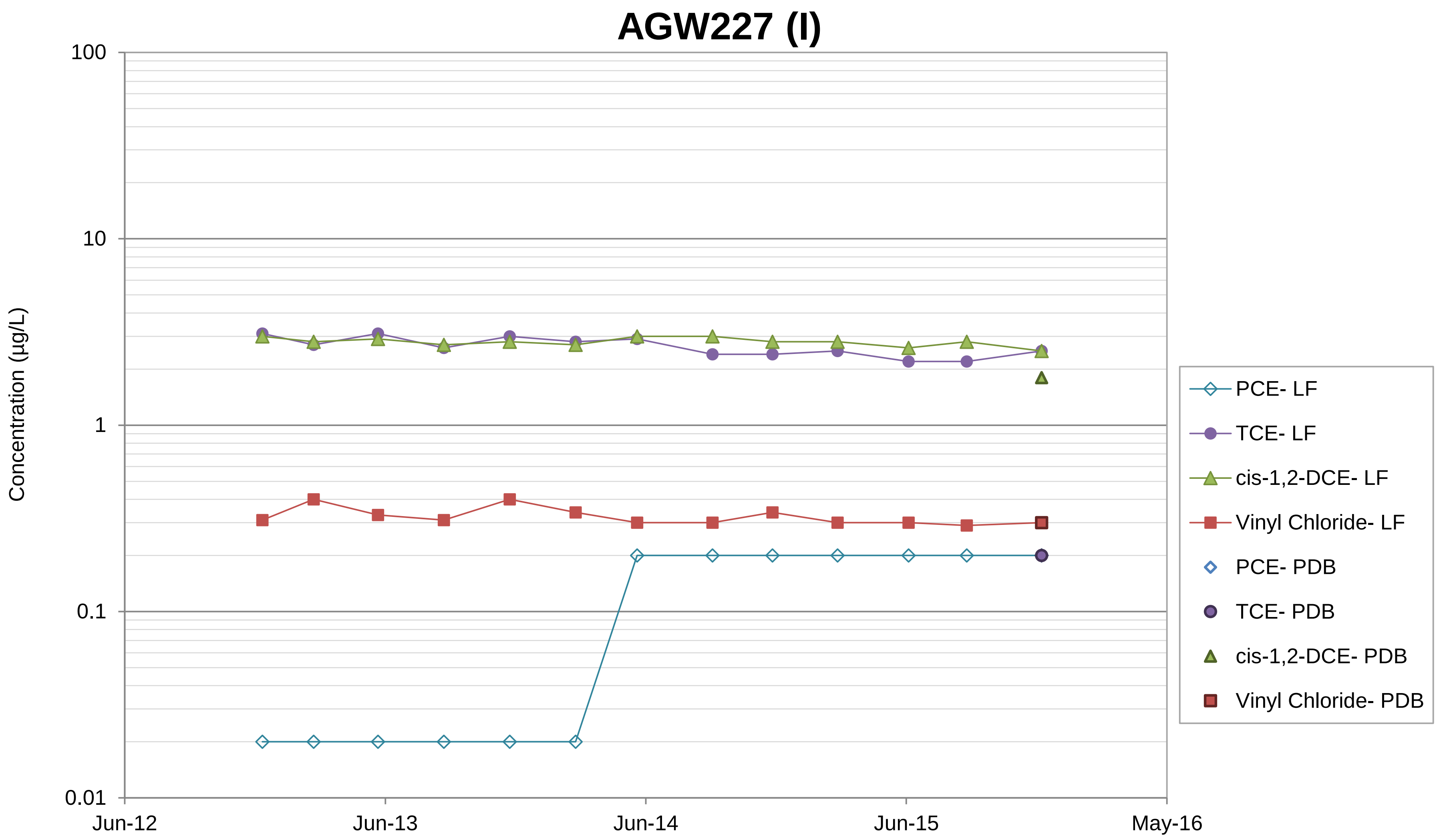
Notes:
1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.
2) Open markers shown in the legend indicate the compound has never been detected at this location.
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW226 VOC Concentrations

Figure
B-16



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

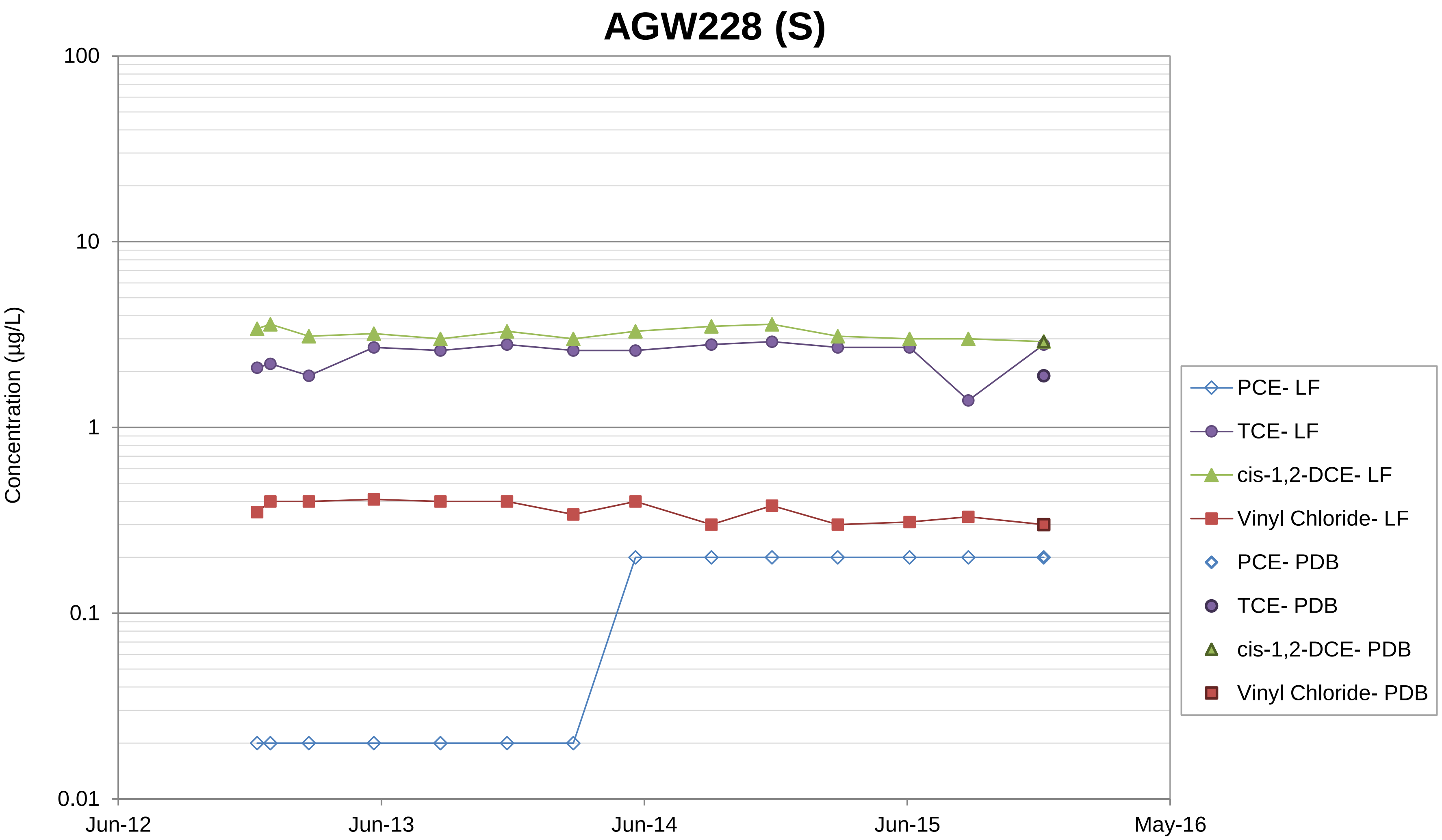
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

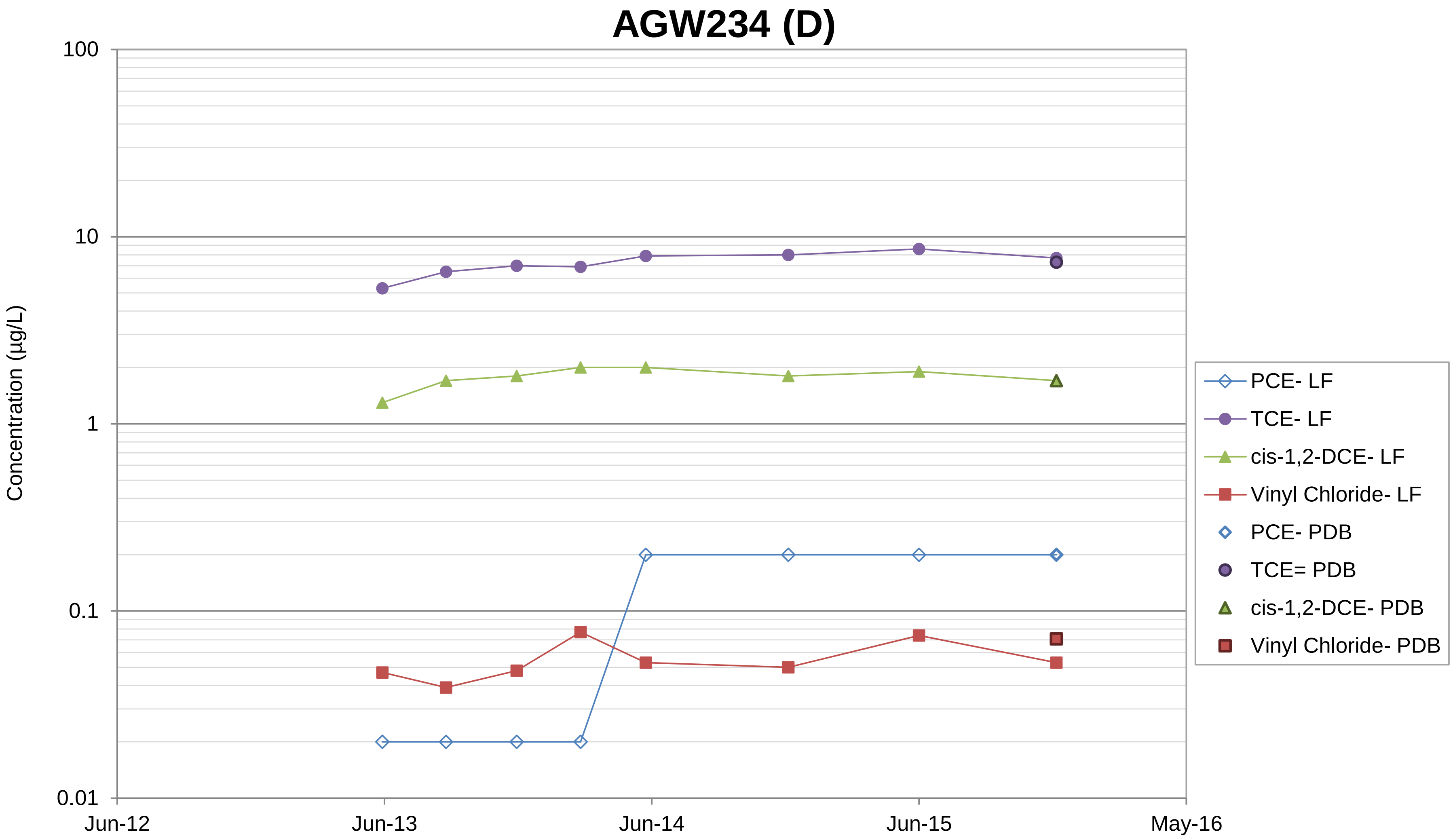
AGW227 VOC Concentrations

Figure
B-17



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.
2) Open markers shown in the legend indicate the compound has never been detected at this location.
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES	Boeing Auburn Auburn, Washington	**AGW228 VOC Concentrations**	Figure B-18



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

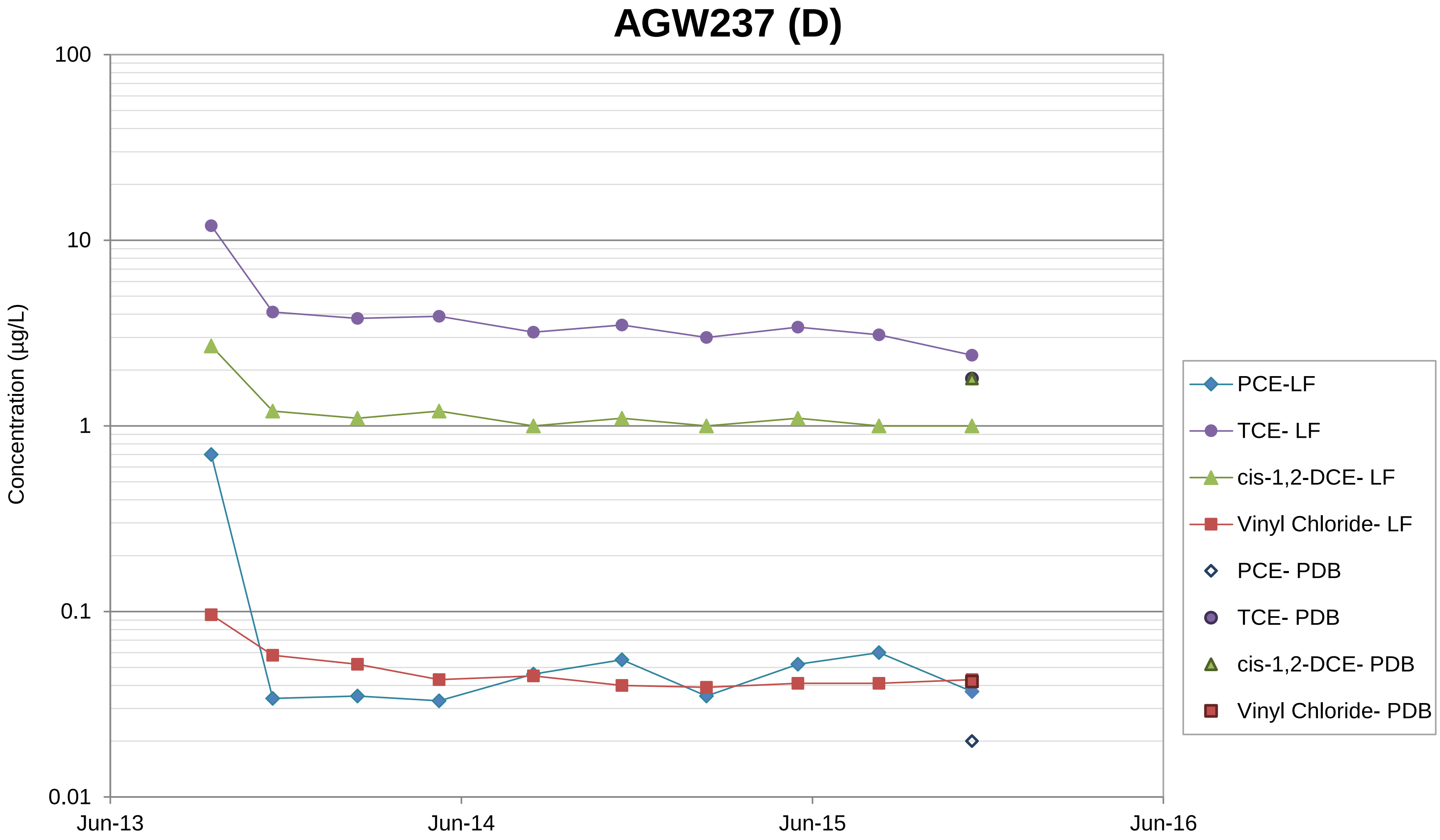
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW234 VOC Concentrations

Figure
B-19



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

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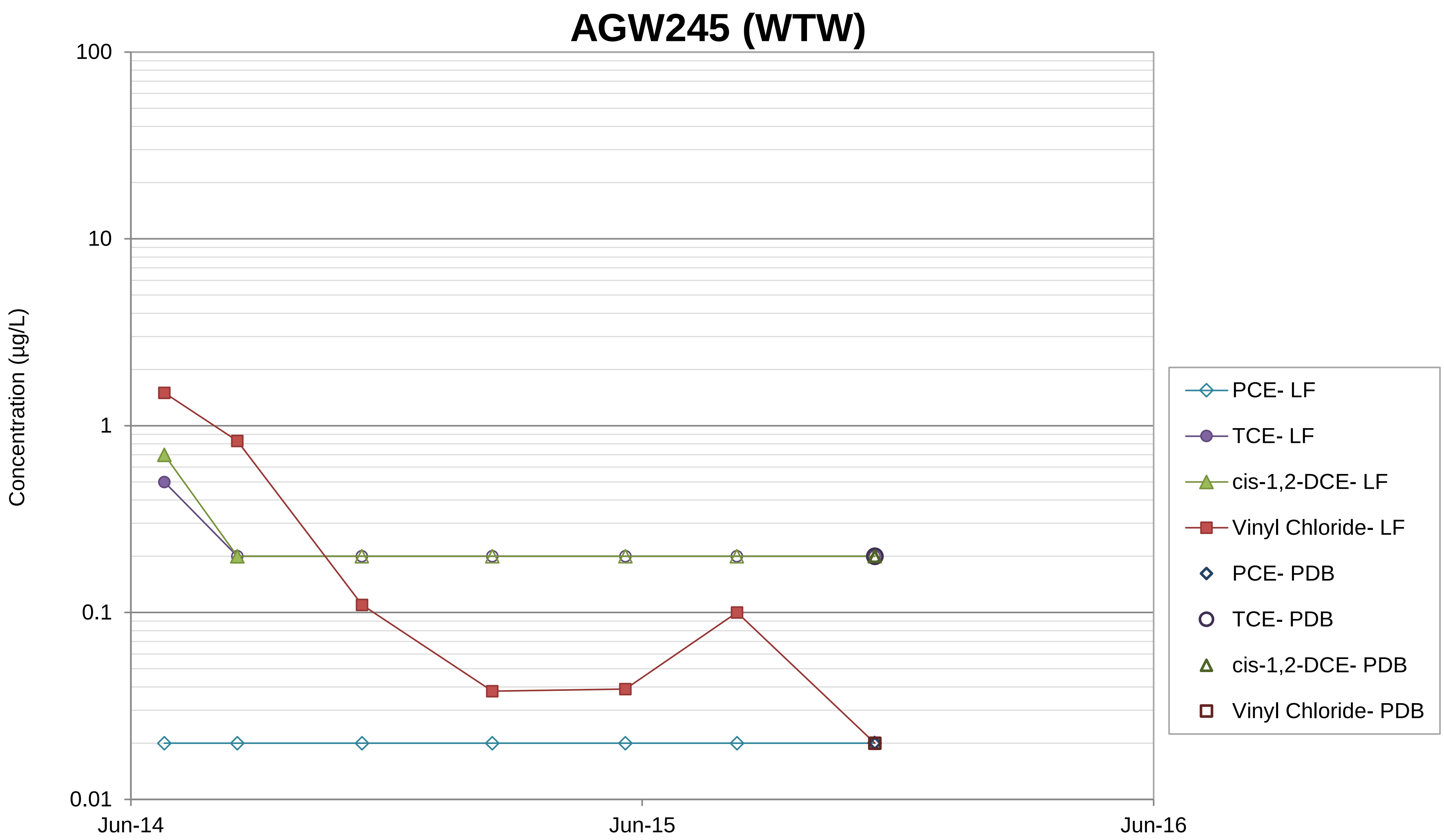
Boeing Auburn Auburn, Washington	**AGW237 VOC Concentrations**	Figure B-20

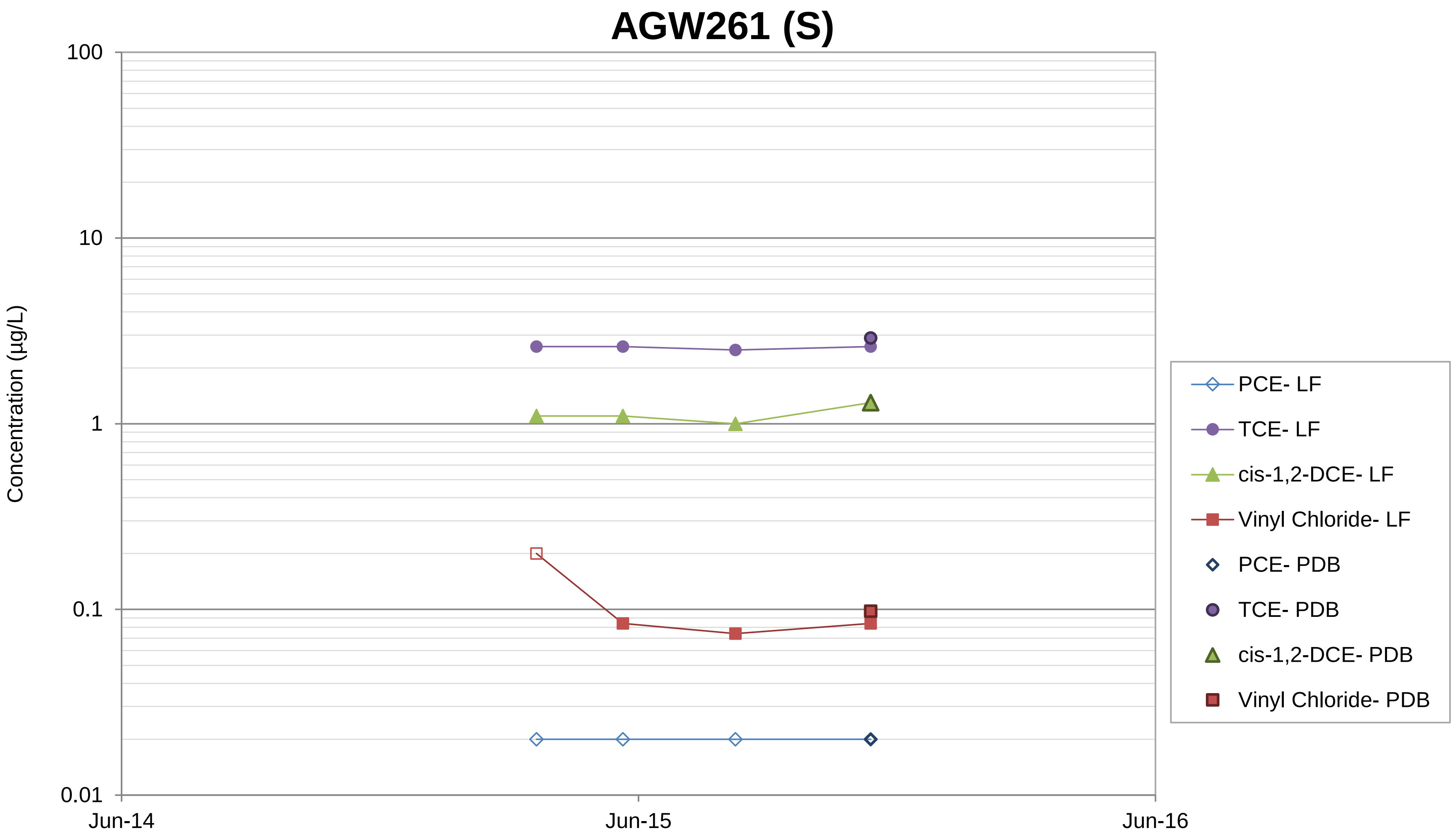


Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

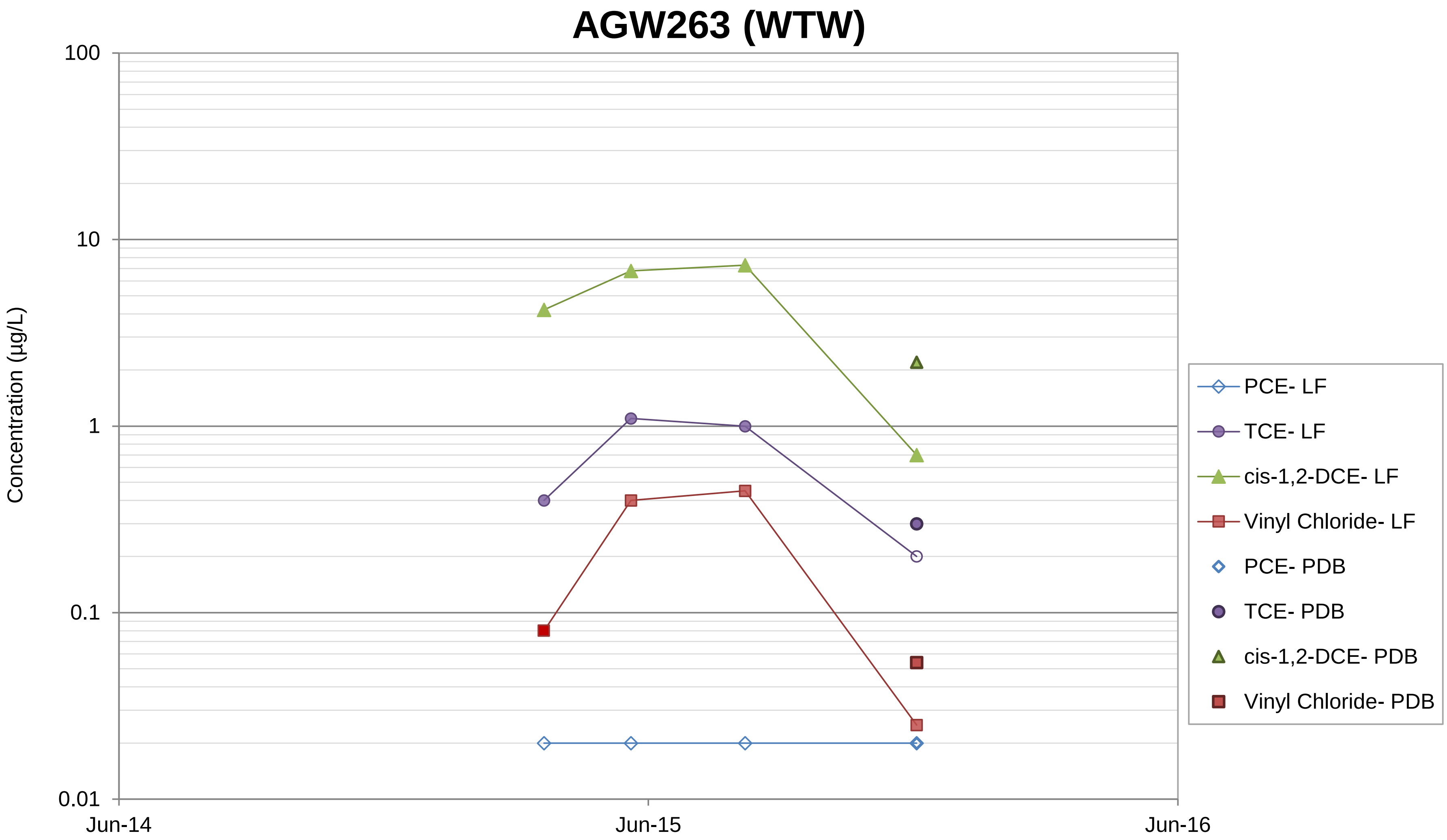
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES	Boeing Auburn Auburn, Washington	**AGW245 VOC Concentrations**	Figure B-21



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.
2) Open markers shown in the legend indicate the compound has never been detected at this location.
3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES	Boeing Auburn Auburn, Washington	**AGW261 VOC Concentrations**	Figure B-22



Notes: 1) Open markers on graphs denote non-detect values, values shown represent analytical reporting limit.

2) Open markers shown in the legend indicate the compound has never been detected at this location.

3) LF and PDB in legend indicate sampling method; LF = low-flow and PDB = passive diffusion bag.

LANDAU ASSOCIATES

Boeing Auburn
Auburn, Washington

AGW263 VOC Concentrations

Figure
B-23