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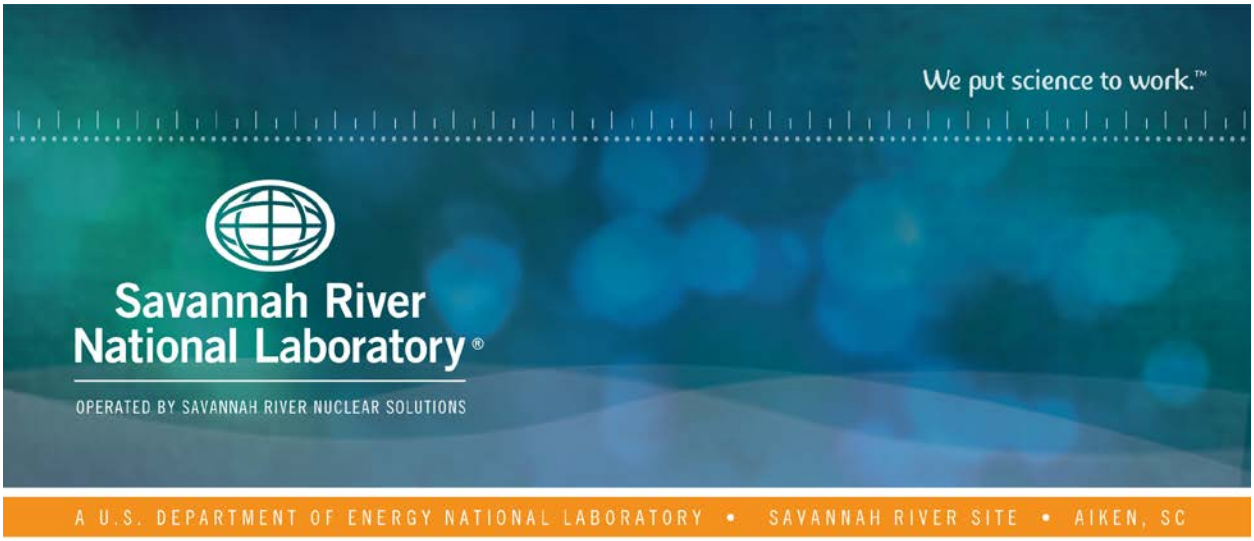

Product Consistency Test Results for the LXC-Series Glasses

M. C. Hsieh

K. M. Fox

June 2020

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EXECUTIVE SUMMARY

This report provides chemical analysis of a series of Product Consistency Test (PCT) leachates from simulated nuclear waste glasses. The resulting data will be used in the development of improved property/composition models.

For some of the glass leachates, minor scatter among the triplicate values of some analytes was observed. For other leachates, there were more significant differences among the triplicate values. A review of the PCT data noted that there was little difference between the normalized values on the basis of targeted or measured glass composition. Several of the canister centerline cooled study glasses have NC_i values that are greater than the Hanford Tank Waste Treatment and Immobilization Plant immobilized low-activity waste constraint of 4 g/L for B and Na. The results of these glasses will help ensure the ability of advanced glass performance models to appropriately predict acceptable compositions. For many of the study glasses, heat treatment had only a marginal impact on the NC_i values. The samples of the Environmental Assessment (EA) reference glass included with each PCT set had generally consistent NC_i values. The release rates for boron and sodium, and for sodium and silicon were highly correlated for the study glasses, while for the other analytes, less correlation was observed.

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LIST OF ABBREVIATIONS

BDL	Below Detection Limit
CCC	Canister Centerline Cooled
DOE	U.S. Department of Energy
EA	Environmental Assessment
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectroscopy
LAW	Low-Activity Waste
NC_i	Normalized Concentration of element "*i*"
ORP	Office of River Protection
PCT	Product Consistency Test
PNNL	Pacific Northwest National Laboratory
%RSD	Percent Relative Standard Deviation
SRNL	Savannah River National Laboratory
TTQAP	Task Technical and Quality Assurance Plan
wt %	Weight Percent
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1.0 Introduction

The U.S. Department of Energy (DOE) is building the Hanford Tank Waste Treatment and Immobilization Plant (WTP) at the Hanford Site in Washington to remediate 55 million gallons of radioactive waste that is temporarily stored in 177 underground tanks. The Office of River Protection (ORP) has requested that the Savannah River National Laboratory (SRNL) contribute in areas of recognized capabilities and expertise for glass waste form development to support successful startup of the WTP.

Successful efforts have allowed for demonstration of greatly enhanced treatment efficiencies of those projected from the minimum requirements set forth in the WTP Contract. Additional flexibility and expansion of the qualified glass forming region are the current focus. SRNL support of this work is defined in the Task Technical and Quality Assurance Plan (TTQAP).[1]

In this report, SRNL provides chemical analysis of a series of Product Consistency Test leachates from simulated nuclear waste glasses fabricated at the Pacific Northwest National Laboratory (PNNL). The glasses were selected as part of a broader study of the influence of glass composition on chemical durability, sulfur retention, and other properties.[2,3] The glasses were designated the LXC-series glasses. The resulting data will be used in the development of improved property/composition models for nuclear waste glasses.

2.0 Experimental Procedure

2.1 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in Savannah River Site Manual E7, Procedure 2.60. SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2. Laboratory data for this study were recorded in the SRNL Electronic Laboratory Notebook system, experiment C3489-00079-33. The glasses provided by PNNL were identified for testing based on a Task Plan[4].

2.2 Glasses Selected for Study

The baseline (quenched) glass compositions in this study were selected and fabricated by PNNL. PNNL performed canister centerline cooled (CCC) heat treatments on a subsample of each of the glasses. The ASTM Product Consistency Test (PCT) Method B was performed on quenched and CCC versions of each of the study glasses. The test durations were 6 days and 21 days. Solution IDs containing the identifier “21 d” indicate a test duration of 21 days. Solution IDs without this identifier had a test duration of 6 days. The resulting leachates were sent to SRNL for chemical analysis. Identifiers for the glass leachates received at SRNL are listed in Table 2-1.

In the sections that follow, the methods used for measuring the chemical compositions of the PCT leachates are described, the concentrations of the leachate constituents are normalized to the targeted and measured glass compositions, and reviews of the resulting data are provided. Detailed data from these analyses are included in the appendices.

Table 2-1. Identifiers for the PCT Leachates

PNNL Solution ID	PNNL Solution ID
NEW-IL-166731-LXC-A-PCT-1	LAWPH3-14-LXC-CCC-PCT-1
NEW-IL-166731-LXC-A-PCT-2	LAWPH3-14-LXC-CCC-PCT-2
NEW-IL-166731-LXC-A-PCT-3	LAWPH3-14-LXC-CCC-PCT-3
LAWPH3-14-LXC-Q-PCT-1	LAWPH3-17-LXC-CCC-PCT-1
LAWPH3-14-LXC-Q-PCT-2	LAWPH3-17-LXC-CCC-PCT-2
LAWPH3-14-LXC-Q-PCT-3	LAWPH3-17-LXC-CCC-PCT-3
DWPF-EA-1	LAWPH3-20-LXC-CCC-PCT-1
DWPF-EA-2	LAWPH3-20-LXC-CCC-PCT-2
DWPF-EA-3	LAWPH3-20-LXC-CCC-PCT-3
DI water-1	DWPF-EA-LXC-PCT-1 (2)
DI water-2	DWPF-EA-LXC-PCT-2 (2)
NEW-OL-62909MOD-LXC-Q-PCT-1	DWPF-EA-LXC-PCT-3 (2)
NEW-OL-62909MOD-LXC-Q-PCT-2	BLANK-1 (2)
NEW-OL-62909MOD-LXC-Q-PCT-3	BLANK-2 (2)
LAWPH3-06-LXC-Q-PCT-1	NEW-IL-166731-LXC-CCC-PCT-1-21d
LAWPH3-06-LXC-Q-PCT-2	NEW-IL-166731-LXC-CCC-PCT-2-21d
LAWPH3-06-LXC-Q-PCT-3	NEW-IL-166731-LXC-CCC-PCT-3-21d
LAWPH3-17-LXC-Q-PCT-1	NEW-IL-87749-LXC-CCC-PCT-1-21d
LAWPH3-17-LXC-Q-PCT-2	NEW-IL-87749-LXC-CCC-PCT-2-21d
LAWPH3-17-LXC-Q-PCT-3	NEW-IL-87749-LXC-CCC-PCT-3-21d
LAWPH3-20-LXC-Q-PCT-1	NEW-OL-62909MOD-LXC-CCC-PCT-1-21d
LAWPH3-20-LXC-Q-PCT-2	NEW-OL-62909MOD-LXC-CCC-PCT-2-21d
LAWPH3-20-LXC-Q-PCT-3	NEW-OL-62909MOD-LXC-CCC-PCT-3-21d
NEW-IL-87749-LXC-Q-PCT-1	LAWPH3-06-LXC-CCC-PCT-1-21d
NEW-IL-87749-LXC-Q-PCT-2	LAWPH3-06-LXC-CCC-PCT-2-21d
NEW-IL-87749-LXC-Q-PCT-3	LAWPH3-06-LXC-CCC-PCT-3-21d
LAWPH3-10-LXC-Q-PCT-1	LAWPH3-10-LXC-CCC-PCT-1-21d
LAWPH3-10-LXC-Q-PCT-2	LAWPH3-10-LXC-CCC-PCT-2-21d
LAWPH3-10-LXC-Q-PCT-3	LAWPH3-10-LXC-CCC-PCT-3-21d
NEW-IL-166731-LXC-CCC-PCT-1	LAWPH3-14-LXC-CCC-PCT-1-21d
NEW-IL-166731-LXC-CCC-PCT-2	LAWPH3-14-LXC-CCC-PCT-2-21d
NEW-IL-166731-LXC-CCC-PCT-3	LAWPH3-14-LXC-CCC-PCT-3-21d
NEW-IL-87749-LXC-CCC-PCT-1	LAWPH3-17-LXC-CCC-PCT-1-21d
NEW-IL-87749-LXC-CCC-PCT-2	LAWPH3-17-LXC-CCC-PCT-2-21d
NEW-IL-87749-LXC-CCC-PCT-3	LAWPH3-17-LXC-CCC-PCT-3-21d
NEW-OL-62909MOD-LXC-CCC-PCT-1	LAWPH3-20-LXC-CCC-PCT-1-21d
NEW-OL-62909MOD-LXC-CCC-PCT-2	LAWPH3-20-LXC-CCC-PCT-2-21d
NEW-OL-62909MOD-LXC-CCC-PCT-3	LAWPH3-20-LXC-CCC-PCT-3-21d
LAWPH3-06-LXC-CCC-PCT-1	DWPF-EA-1 (2)-21d
LAWPH3-06-LXC-CCC-PCT-2	DWPF-EA-2 (2)-21d
LAWPH3-06-LXC-CCC-PCT-3	DWPF-EA-3 (2)-21d
LAWPH3-10-LXC-CCC-PCT-1	BLANK 1-21d
LAWPH3-10-LXC-CCC-PCT-2	BLANK 2-21d
LAWPH3-10-LXC-CCC-PCT-3	18.2 mH Fresh Water Blank

2.3 PCT Leachate Analyses

The PCT leachate samples were analyzed by Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES) under the auspices of an analytical study plan[5]. Samples of a multi-element standard solution[a] were also included in the analytical plan as a check on the accuracy of the ICP-OES instrument used for these measurements. PNNL provided the dilution factors used in preparing the PCT leachates for analyses. The leachates received at SRNL were diluted by a factor of 6. The dilution factors were used in adjusting the leachate measurements as described further below. Normalized release values were calculated for each glass based on the targeted and measured[6-8] compositions.

3.0 Results and Discussion

Data for the PCT leachates received at SRNL are shown in Appendix A. These data are reviewed and discussed in the sections that follow. The normalized PCT results are presented in Appendix B. JMP Version 14.3.0 (SAS Institute, Inc.)[9] was used to support these analyses.

3.1 Measured Compositions of PCT Leachates

Table A-1 in Appendix A provides the elemental leachate concentration measurements for the PCT leachates and standard solutions. Values are shown both as received from the analytical laboratory and after correction for the dilutions performed at PNNL. Note that the measured concentrations of the analytes in the blank samples were below detection limits.

Table A-2 in Appendix A provides a review of the measurements of the solution standard samples that were included in the analytical blocks for the PCT leachate analyses. For each analytical block, the mean, standard deviation, and percent relative standard deviation (%RSD) are determined for each element present in the standard. Following the guidance in ASTM C 1285[10], there were two primary evaluations conducted for these summary statistics: the mean value for each analytical block was found to be less than 10% from the reference value (i.e., a percent relative bias less than 10%) for the element in question, and the %RSD was less than 10% for the element in question. The results in Table A-2 satisfies these criteria, and thus, the results for the solution standard suggest no significant issues with the analytical outcomes for the measurements of the PCT leachates.

Exhibit A-1 in Appendix A provides plots of the dilution corrected leachate concentrations (mg/L) in analytical sequence by analytical block. Both linear and logarithmic plots are provided for each analyte. Plotting the data in this format provides an opportunity to identify gross trends in performance of the analytical instrument within and among calibration blocks. The following observations were made:

- Sample “S-11144” was noted to have a high value in the Al plots.
- Sample “S-11205” was noted to have high values in the Al, B, Na, and Si plots.

These samples are further discussed in the following paragraph. No other issues were observed in a review of these plots.

Exhibit A-2 in Appendix A provides plots of the triplicate dilution corrected leachate concentrations by the Glass ID. Both linear and logarithmic plots are provided for each analyte. Plotting the data in this format allows for the assessment of the repeatability of the measurements for each glass. For some of the glasses, minor scatter among the triplicate values of some analytes is observed. For three glasses, there were more significant differences among the triplicate values. Table 3-1 provides the PNNL dilution corrected values for these samples. After discussion with PNNL, it was decided that these samples would be excluded from normalization calculations.

[a] ICP multi-element custom solution, product number SM-744-013, High Purity Standards, Charleston, SC.

Table 3-1. Excluded PCT Samples

PNNL Solution ID	Lab ID	Al (mg/L)	B (mg/L)	Cr (mg/L)	Na (mg/L)	Si (mg/L)
DWPF-EA-2 (2)-21d	S-11205	26.5	3170	<6.00	9420	2810
LAWPH3-10-LXC-Q-PCT-3	S-11144	90.0	73.8	8.22	840	374
NEW-IL-87749-LXC-CCC-PCT-3	S-11150	8.16	15.2	<6.00	105	33.1

3.2 Normalization of PCT Data

The PCT leachate data were used to determine normalized concentrations for each element of interest using both the targeted and measured (quenched) compositions of the glasses following the expression given in ASTM C1285:

$$NC_i = \frac{c_i\left(sample\right)}{f_i}$$

where NC_i is the normalized concentration in units of $g_{waste\ form}/L_{leachant}$, c_i *(sample)* is the concentration of element "*i*" in the leachate in units of g_i/L (corrected for the dilutions performed at PNNL), and f_i is the mass fraction of element "*i*" in the unleached glass in units of g_i/g_{glass}.[a]

An equation was developed to allow for calculation of the NC_i values using the units of measurement provided with the analytical results for this study, and to accommodate the triplicate leachate measurements for each of the study glasses. Note that the symbols in this second equation were kept consistent with those used in ASTM C1285, but the units of measurement differ. The common logarithm of the normalized concentration for each element "*i*" (NC_i) for each of the study glasses was determined using the equation:

$$\log_{10}\left(NC_i\right) = \overline{\log_{10} c_i} - \left[1 + \log_{10} f_i\right]$$

where NC_i remains in units of $g_{waste\ form}/L_{leachant}$, $\overline{\log_{10} c_i}$ is the average of the common logarithms of the measured concentrations of element "*i*" in the triplicate leachates in units of mg/L (corrected for the dilutions performed at PNNL as discussed in Section 2.3), and $\log_{10} f_i$ is either the common logarithm of the targeted concentration of element "*i*" in the glass in units of wt %, or the common logarithm of the average measured concentration of element "*i*" in the glass in units of wt % (reported earlier[11]).

Table B-1 in Appendix B provides a listing of the normalized PCT responses in units of g/L.

Exhibit B-1 in Appendix B provides plots of the normalized PCT responses for the quenched (Q) and canister centerline cooled (CCC) for each of the study glasses as well as the responses for the Environmental Assessment (EA) reference glass[11] (labeled "DWPF EA" in the PNNL experiments). The results are grouped by compositional view. Note that an indicator is provided as part of these plots to show results involving below detection limit (BDL) values. The plots of Exhibit B-1 provide a graphical comparison between the PCT responses for the two heat treatments of each study glass.

[a] Note that the waste forms in this study were assumed to be of similar density. The PCT-A reference volume of leachant to sample mass ratio was used, and the 100 to 200 mesh reference particle size was used. Thus, no adjustment for the density of the glasses was made in normalizing the PCT results. Data provided in the appendices of this report allow for the calculation of normalized elemental mass loss (NL_i) if glass densities are measured at a later date.

A review of the PCT data resulted in the following observations:

- Little difference is seen when evaluating the normalized values on the basis of targeted or measured glass composition.
- Several of the CCC study glasses have NC_i values that are greater than the WTP immobilized LAW constraint[a] of 4 g/L for B and Na.[b]
    - In two cases, LAWPH3-10-LXC-CCC and LAWPH3-17-LXC-CCC, both the 6 day test duration and the 21 day test duration samples exceeded this constraint.
    - In two other cases, LAWPH3-06-LXC-CCC-21d and NEW-IL-166731-CCC-21d, only the 21 day test duration samples exceeded this constraint.
- For many of the study glasses, heat treatment had only a marginal impact on the NC_i values.
    - In two cases (i.e., glasses LAWPH3-10-LXC-Q, and LAWPH3-17-LXC-Q), the CCC heat treatment led to higher NC_i values.
- For most of the study glasses, test duration had marginal impact on the NC_i values.
    - In one case, NEW-IL-166731-LXC-CCC-21d, the duration led to significantly higher NC_i values.
- For most of the samples of the EA reference glass (labeled "DWPF-EA" in the study) included with each PCT set, the NC_i values were consistent.
- As discussed earlier, three samples were noted to have significantly different values from the other samples within the same triplicate. After discussion with PNNL, it was decided to exclude these samples from normalization calculations due to the potential errors of the initial dilutions.
    - Sample "DWPF-EA-2 (2)-21d" had values that were 4 times higher than the other samples in the triplicate. Sample "NEW-IL-87749-LXC-CCC-PCT-3" had values that were half of the other values of the other samples in the triplicate.
    - Sample "LAWPH3-10-LXC-Q-PCT-3" had values that were 2 to 4 times higher than the other samples of the same triplicate, depending on the analyte. The source of these differences was not determined.

Exhibit B-2 provides the results of an evaluation of congruent leaching among the analytes for the EA reference glass and the study glasses. The release rates for the analytes of the EA glass are highly correlated. The release rates for boron and sodium and for sodium and silicon are highly correlated for the study glasses. The release rates for boron and silicon are highly correlated in the quenched study glasses. For the other analytes, less correlation is seen among the release rates for the study glasses.

4.0 Summary

In this report, SRNL provides chemical analysis of a series of PCT leachates from simulated low-activity waste glasses fabricated at PNNL. The resulting data will be used in the development of improved property/composition models for nuclear waste glasses. The measured concentrations of the analytes in the blank samples were below detection limits. The results for the solution standard suggest no significant issues with the analytical methods used. For some of the glasses, minor scatter among the triplicate values of some analytes was observed. For other glasses, there were more significant differences among the triplicate values. A review of the PCT data noted that there was little difference between the normalized values on the basis of targeted or measured glass composition. Several of the CCC study glasses had NC_i values that are greater than the WTP immobilized LAW constraint of 4 g/L for B and Na. For many of the study glasses, heat treatment had only a marginal impact on the NC_i values. For many of the study glasses, test duration had only a marginal impact on the NC_i values. The samples of the EA reference glass included with each PCT set had consistent NC_i values. The release rates for boron and sodium and for sodium and

[a] Contract DE-AC27-01RV14136, as amended, U.S. Department of Energy, Richland, WA (2000)
[b] This constraint is based on a test duration of 7 days.

silicon were highly correlated for the study glasses, while for the other analytes, less correlation was observed.

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Appendix A Tables and Exhibits Supporting Analysis of the PCT Leachates

Table A-1. PCT Leachate Measurements in Analytical Sequence

PNNL Solution ID	Lab ID	Block	Seq	Al (ar)	B (ar)	Cr (ar)	Na (ar)	Si (ar)	Dil. Fac.	Al (mg/L)*	B (mg/L)*	Cr (mg/L)*	Na (mg /L)*	Si (mg/L)*
std-11	std-11	1	1	3.89	19.9	<1.00	78.4	47.2	1	3.89	19.90	<1.00	78.40	47.20
BLANK 2-21d	S-11208	1	3	<1.00	<1.00	<1.00	<1.00	<1.00	1	<1.00	<1.00	<1.00	<1.00	<1.00
NEW-OL-62909MOD-LXC-CCC-PCT-3-21d	S-11188	1	4	1.65	3.54	<1.00	12.2	3.38	6	9.90	21.24	<6.00	73.20	20.28
LAWPH3-14-LXC-CCC-PCT-1	S-11160	1	5	2.64	6.54	<1.00	70.1	20.0	6	15.84	39.24	<6.00	420.60	120.00
LAWPH3-14-LXC-CCC-PCT-2-21d	S-11196	1	6	3.02	8.19	<1.00	88.0	23.8	6	18.12	49.14	<6.00	528.00	142.80
DWPF-EA-1 (2)-21d	S-11204	1	7	<1.00	125	<1.00	396	159	6	<6.00	750.00	<6.00	2376.00	954.00
LAWPH3-20-LXC-Q-PCT-1	S-11136	1	8	1.44	4.89	<1.00	41.3	14.4	6	8.64	29.34	<6.00	247.80	86.40
NEW-IL-166731-LXC-CCC-PCT-1-21d	S-11180	1	9	1.10	90.9	<1.00	247	59.2	6	6.60	545.40	<6.00	1482.00	355.20
LAWPH3-06-LXC-CCC-PCT-3	S-11156	1	10	8.72	3.38	<1.00	84.6	15.5	6	52.32	20.28	<6.00	507.60	93.00
NEW-OL-62909MOD-LXC-CCC-PCT-2	S-11152	1	11	1.34	2.92	<1.00	9.67	2.81	6	8.04	17.52	<6.00	58.02	16.86
LAWPH3-14-LXC-Q-PCT-2	S-11120	1	12	2.10	7.44	<1.00	71.9	23.0	6	12.60	44.64	<6.00	431.40	138.00
NEW-OL-62909MOD-LXC-Q-PCT-2	S-11128	1	13	1.85	2.96	<1.00	14.4	3.96	6	11.10	17.76	<6.00	86.40	23.76
std-12	std-12	1	14	3.89	20.3	<1.00	76.6	48.9	1	3.89	20.30	<1.00	76.60	48.90
NEW-IL-166731-LXC-A-PCT-1	S-11116	1	15	3.62	5.38	<1.00	26.1	11.7	6	21.72	32.28	<6.00	156.60	70.20
LAWPH3-17-LXC-CCC-PCT-2	S-11164	1	16	8.54	17.3	1.45	222	26.3	6	51.24	103.80	8.70	1332.00	157.80
DWPF-EA-3	S-11124	1	17	<1.00	109	<1.00	313	133	6	<6.00	654.00	<6.00	1878.00	798.00
LAWPH3-10-LXC-Q-PCT-3	S-11144	1	18	15.0	12.3	1.37	140	62.4	6	90.00	73.80	8.22	840.00	374.40
LAWPH3-10-LXC-CCC-PCT-1-21d	S-11192	1	19	3.65	51.5	3.40	268	25.4	6	21.90	309.00	20.40	1608.00	152.40
BLANK-1 (2)	S-11172	1	20	<1.00	<1.00	<1.00	<1.00	<1.00	1	<1.00	<1.00	<1.00	<1.00	<1.00
NEW-IL-87749-LXC-Q-PCT-2	S-11140	1	21	2.91	1.83	<1.00	25.0	8.26	6	17.46	10.98	<6.00	150.00	49.56
LAWPH3-06-LXC-Q-PCT-3	S-11132	1	22	2.66	2.31	<1.00	45.5	9.71	6	15.96	13.86	<6.00	273.00	58.26
NEW-IL-87749-LXC-CCC-PCT-2-21d	S-11184	1	23	3.44	5.58	<1.00	43.5	14.3	6	20.64	33.48	<6.00	261.00	85.80
NEW-IL-87749-LXC-CCC-PCT-1	S-11148	1	24	2.54	4.76	<1.00	32.2	11.4	6	15.24	28.56	<6.00	193.20	68.40
LAWPH3-17-LXC-CCC-PCT-3-21d	S-11200	1	25	9.20	18.6	1.60	264	30.6	6	55.20	111.60	9.60	1584.00	183.60
LAWPH3-20-LXC-CCC-PCT-3	S-11168	1	26	1.41	5.03	<1.00	39.6	15.1	6	8.46	30.18	<6.00	237.60	90.60
std-13	std-13	1	27	4.02	20.9	<1.00	76.7	49.7	1	4.02	20.90	<1.00	76.70	49.70
std-21	std-21	2	1	3.94	20.2	<1.00	78.6	47.6	1	3.94	20.20	<1.00	78.60	47.60
LAWPH3-14-LXC-CCC-PCT-2	S-11161	2	2	2.67	6.67	<1.00	71.0	20.2	6	16.02	40.02	<6.00	426.00	121.20
NEW-IL-87749-LXC-CCC-PCT-2	S-11149	2	3	2.56	4.61	<1.00	34.2	11.0	6	15.36	27.66	<6.00	205.20	66.00
LAWPH3-20-LXC-CCC-PCT-1-21d	S-11201	2	4	1.49	6.19	<1.00	51.6	17.6	6	8.94	37.14	<6.00	309.60	105.60
DWPF-EA-LXC-PCT-1 (2)	S-11169	2	5	<1.00	105	<1.00	316	134	6	<6.00	630.00	<6.00	1896.00	804.00
NEW-IL-166731-LXC-CCC-PCT-2-21d	S-11181	2	6	1.15	78.5	<1.00	216	54.6	6	6.90	471.00	<6.00	1296.00	327.60
NEW-IL-87749-LXC-Q-PCT-3	S-11141	2	7	2.33	1.58	<1.00	22.1	6.39	6	13.98	9.48	<6.00	132.60	38.34
LAWPH3-10-LXC-CCC-PCT-1	S-11157	2	8	3.05	49.0	3.10	244	20.8	6	18.30	294.00	18.60	1464.00	124.80
NEW-IL-166731-LXC-A-PCT-2	S-11117	2	9	3.75	5.52	<1.00	27.5	11.6	6	22.50	33.12	<6.00	165.00	69.60
BLANK-2 (2)	S-11173	2	10	<1.00	<1.00	<1.00	<1.00	<1.00	1	<1.00	<1.00	<1.00	<1.00	<1.00
LAWPH3-06-LXC-CCC-PCT-1-21d	S-11189	2	11	14.1	6.04	1.33	192	26.3	6	84.60	36.24	7.98	1152.00	157.80
DI water-1	S-11125	2	12	<1.00	<1.00	<1.00	<1.00	<1.00	1	<1.00	<1.00	<1.00	<1.00	<1.00
LAWPH3-14-LXC-Q-PCT-3	S-11121	2	13	1.98	6.76	<1.00	68.0	20.6	6	11.88	40.56	<6.00	408.00	123.60
std-22	std-22	2	14	3.96	20.1	<1.00	77.9	47.5	1	3.96	20.10	<1.00	77.90	47.50

ar = as-received measurements prior to correction for dilution factor (Dil. Fac.)
* = dilution corrected values

Table A-1. PCT Leachate Measurements in Analytical Sequence (continued)

PNNL Solution ID	Lab ID	Block	Seq	Al (ar)	B (ar)	Cr (ar)	Na (ar)	Si (ar)	Dil. Fac.	Al (mg/L)*	B (mg/L)*	Cr (mg/L)*	Na (mg /L)*	Si (mg/L)*
LAWPH3-10-LXC-CCC-PCT-2-21d	S-11193	2	16	3.61	53.2	3.40	279	25.2	6	21.66	319.20	20.40	1674.00	151.20
NEW-IL-87749-LXC-CCC-PCT-3-21d	S-11185	2	17	3.26	5.53	<1.00	42.1	13.5	6	19.56	33.18	<6.00	252.60	81.00
NEW-IL-166731-LXC-CCC-PCT-1	S-11145	2	18	1.98	11.1	<1.00	35.7	16.1	6	11.88	66.60	<6.00	214.20	96.60
LAWPH3-20-LXC-Q-PCT-2	S-11137	2	19	1.51	5.18	<1.00	43.3	15.5	6	9.06	31.08	<6.00	259.80	93.00
LAWPH3-14-LXC-CCC-PCT-3-21d	S-11197	2	20	3.08	8.04	<1.00	84.1	23.2	6	18.48	48.24	<6.00	504.60	139.20
LAWPH3-17-LXC-Q-PCT-1	S-11133	2	21	2.73	5.48	<1.00	129	23.2	6	16.38	32.88	<6.00	774.00	139.20
LAWPH3-17-LXC-CCC-PCT-3	S-11165	2	22	8.72	17.4	1.38	226	25.9	6	52.32	104.40	8.28	1356.00	155.40
DWPF-EA-2 (2)-21d	S-11205	2	23	4.42	528	<1.00	1570	469	6	26.52	3168.00	<6.00	9420.00	2814.00
NEW-OL-62909MOD-LXC-Q-PCT-3	S-11129	2	24	1.88	3.42	<1.00	14.3	3.83	6	11.28	20.52	<6.00	85.80	22.98
NEW-OL-62909MOD-LXC-CCC-PCT-3	S-11153	2	25	1.33	3.36	<1.00	10.2	3.10	6	7.98	20.16	<6.00	61.20	18.60
std-23	std-23	2	26	3.96	20.1	<1.00	76.2	47.3	1	3.96	20.10	<1.00	76.20	47.30
std-31	std-31	3	1	3.88	20.0	<1.00	77.3	47.6	1	3.88	20.00	<1.00	77.30	47.60
LAWPH3-06-LXC-CCC-PCT-1	S-11154	3	2	8.89	3.40	<1.00	85.1	16.4	6	53.34	20.40	<6.00	510.60	98.40
LAWPH3-17-LXC-CCC-PCT-1-21d	S-11198	3	3	8.96	17.2	1.41	253	29.0	6	53.76	103.20	8.46	1518.00	174.00
LAWPH3-17-LXC-Q-PCT-2	S-11134	3	4	2.62	5.29	<1.00	108	22.7	6	15.72	31.74	<6.00	648.00	136.20
NEW-IL-166731-LXC-A-PCT-3	S-11118	3	5	3.62	5.48	<1.00	26.6	11.4	6	21.72	32.88	<6.00	159.60	68.40
LAWPH3-10-LXC-Q-PCT-1	S-11142	3	6	3.33	6.85	<1.00	83.4	17.2	6	19.98	41.10	<6.00	500.40	103.20
LAWPH3-10-LXC-CCC-PCT-3-21d	S-11194	3	7	3.47	53.0	3.42	280	25.3	6	20.82	318.00	20.52	1680.00	151.80
LAWPH3-06-LXC-Q-PCT-1	S-11130	3	8	2.70	2.45	<1.00	50.9	9.67	6	16.20	14.70	<6.00	305.40	58.02
NEW-IL-87749-LXC-CCC-PCT-3	S-11150	3	9	1.36	2.54	<1.00	17.5	5.51	6	8.16	15.24	<6.00	105.00	33.06
DWPF-EA-LXC-PCT-2 (2)	S-11170	3	10	<1.00	105	<1.00	308	133	6	<6.00	630.00	<6.00	1848.00	798.00
LAWPH3-14-LXC-CCC-PCT-3	S-11162	3	11	2.73	6.42	<1.00	67.3	19.3	6	16.38	38.52	<6.00	403.80	115.80
DWPF-EA-3 (2)-21d	S-11206	3	12	<1.00	126	<1.00	394	156	6	<6.00	756.00	<6.00	2364.00	936.00
DI water-2	S-11126	3	13	<1.00	<1.00	<1.00	<1.00	<1.00	1	<1.00	<1.00	<1.00	<1.00	<1.00
std-32	std-32	3	14	3.94	20.1	<1.00	78.3	47.9	1	3.94	20.10	<1.00	78.30	47.90
LAWPH3-10-LXC-CCC-PCT-2	S-11158	3	15	3.07	50.2	3.24	246	20.6	6	18.42	301.20	19.44	1476.00	123.60
LAWPH3-20-LXC-CCC-PCT-1	S-11166	3	17	1.41	4.95	<1.00	40.0	14.3	6	8.46	29.70	<6.00	240.00	85.80
LAWPH3-20-LXC-Q-PCT-3	S-11138	3	18	1.40	4.66	<1.00	39.7	13.8	6	8.40	27.96	<6.00	238.20	82.80
NEW-IL-166731-LXC-CCC-PCT-3-21d	S-11182	3	19	1.19	71.7	<1.00	207	51.6	6	7.14	430.20	<6.00	1242.00	309.60
DWPF-EA-1	S-11122	3	20	<1.00	106	<1.00	330	139	6	<6.00	636.00	<6.00	1980.00	834.00
LAWPH3-20-LXC-CCC-PCT-2-21d	S-11202	3	21	1.50	6.23	<1.00	51.2	16.9	6	9.00	37.38	<6.00	307.20	101.40
LAWPH3-06-LXC-CCC-PCT-2-21d	S-11190	3	22	12.0	4.71	1.06	135	22.0	6	72.00	28.26	6.36	810.00	132.00
NEW-IL-166731-LXC-CCC-PCT-2	S-11146	3	24	1.94	10.6	<1.00	34.4	15.4	6	11.64	63.60	<6.00	206.40	92.40
NEW-OL-62909MOD-LXC-CCC-PCT-1-21d	S-11186	3	25	1.68	3.64	<1.00	11.9	3.10	6	10.08	21.84	<6.00	71.40	18.60
std-33	std-33	3	26	3.88	19.8	<1.00	77.0	47.1	1	3.88	19.80	<1.00	77.00	47.10
std-41	std-41	4	1	3.96	20.3	<1.00	79.8	48.4	1	3.96	20.30	<1.00	79.80	48.40
NEW-OL-62909MOD-LXC-CCC-PCT-2-21d	S-11187	4	2	1.71	3.50	<1.00	11.8	2.93	6	10.26	21.00	<6.00	70.80	17.58
LAWPH3-06-LXC-CCC-PCT-2	S-11155	4	3	8.84	3.36	<1.00	86.4	15.4	6	53.04	20.16	<6.00	518.40	92.40
LAWPH3-06-LXC-Q-PCT-2	S-11131	4	4	2.74	2.39	<1.00	52.7	9.40	6	16.44	14.34	<6.00	316.20	56.40
DWPF-EA-LXC-PCT-3 (2)	S-11171	4	5	<1.00	105	<1.00	284	134	6	<6.00	630.00	<6.00	1704.00	804.00

ar = as-received measurements prior to correction for dilution factor (Dil. Fac.)

* = dilution corrected values

Table A-1. PCT Leachate Measurements in Analytical Sequence (continued)

PNNL Solution ID	Lab ID	Block	Seq	Al (ar)	B (ar)	Cr (ar)	Na (ar)	Si (ar)	Dil. Fac.	Al (mg/L)*	B (mg/L)*	Cr (mg/L)*	Na (mg /L)*	Si (mg/L)*
LAWPH3-17-LXC-CCC-PCT-2-21d	S-11199	4	7	9.31	17.7	1.48	233	29.5	6	55.86	106.20	8.88	1398.00	177.00
18.2 mH Fresh Water Blank	S-11209	4	9	<1.00	<1.00	<1.00	<1.00	<1.00	1	<1.00	<1.00	<1.00	<1.00	<1.00
LAWPH3-10-LXC-Q-PCT-2	S-11143	4	10	3.24	6.64	<1.00	84.3	16.6	6	19.44	39.84	<6.00	505.80	99.60
LAWPH3-06-LXC-CCC-PCT-3-21d	S-11191	4	11	11.8	4.65	1.05	132	21.8	6	70.80	27.90	6.30	792.00	130.80
LAWPH3-20-LXC-CCC-PCT-3-21d	S-11203	4	12	1.53	6.14	<1.00	53.4	17.2	6	9.18	36.84	<6.00	320.40	103.20
NEW-IL-87749-LXC-Q-PCT-1	S-11139	4	13	2.72	1.77	<1.00	26.6	7.29	6	16.32	10.62	<6.00	159.60	43.74
std-42	std-42	4	14	3.89	19.8	<1.00	81.7	47.9	1	3.89	19.80	<1.00	81.70	47.90
NEW-OL-62909MOD-LXC-Q-PCT-1	S-11127	4	15	1.84	3.00	<1.00	15.0	3.95	6	11.04	18.00	<6.00	90.00	23.70
NEW-OL-62909MOD-LXC-CCC-PCT-1	S-11151	4	16	1.27	3.29	<1.00	10.3	2.88	6	7.62	19.74	<6.00	61.80	17.28
BLANK 1-21d	S-11207	4	17	<1.00	<1.00	<1.00	<1.00	<1.00	1	<1.00	<1.00	<1.00	<1.00	<1.00
LAWPH3-20-LXC-CCC-PCT-2	S-11167	4	18	1.39	4.91	<1.00	43.2	14.5	6	8.34	29.46	<6.00	259.20	87.00
DWPF-EA-2	S-11123	4	19	<1.00	107	<1.00	291	135	6	<6.00	642.00	<6.00	1746.00	810.00
LAWPH3-14-LXC-Q-PCT-1	S-11119	4	20	2.13	7.73	<1.00	79.7	22.8	6	12.78	46.38	<6.00	478.20	136.80
LAWPH3-17-LXC-Q-PCT-3	S-11135	4	21	2.59	5.20	<1.00	109	22.1	6	15.54	31.20	<6.00	654.00	132.60
LAWPH3-10-LXC-CCC-PCT-3	S-11159	4	22	3.12	51.2	3.37	237	21.5	6	18.72	307.20	20.22	1422.00	129.00
NEW-IL-166731-LXC-CCC-PCT-3	S-11147	4	23	1.93	10.7	<1.00	36.1	15.6	6	11.58	64.20	<6.00	216.60	93.60
LAWPH3-17-LXC-CCC-PCT-1	S-11163	4	24	8.52	16.3	1.29	207	24.8	6	51.12	97.80	7.74	1242.00	148.80
LAWPH3-14-LXC-CCC-PCT-1-21d	S-11195	4	25	3.00	8.28	<1.00	89.4	23.7	6	18.00	49.68	<6.00	536.40	142.20
NEW-IL-87749-LXC-CCC-PCT-1-21d	S-11183	4	26	3.28	5.50	<1.00	45.1	13.5	6	19.68	33.00	<6.00	270.60	81.00
std-43	std-43	4	27	3.92	20.0	<1.00	80.1	48.0	1	3.92	20.00	<1.00	80.10	48.00

ar = as-received measurements prior to correction for dilution factor (Dil. Fac.)

* = dilution corrected values

Table A-2. Results from Samples of the Multi-Element Solution Standard Included with the PCT Leachates

Analytical Block	1	2	3	4	Reference Values (mg/L)
Mean (Al (mg/L))	3.93	3.95	3.90	3.92	4
Mean (B (mg/L))	20.37	20.13	19.97	20.03	20
Mean (Na (mg/L))	77.23	77.57	77.53	80.53	81
Mean (Si (mg/L))	48.60	47.47	47.53	48.10	50
% relative bias, A	-1.67	-1.17	-2.50	-1.92	<10% per ASTM C1285
% relative bias, B	1.83	0.67	-0.17	0.17	
% relative bias, Na	-4.65	-4.24	-4.28	-0.58	
% relative bias, Si	-2.80	-5.07	-4.93	-3.80	
Std Dev (Al (mg/L))	0.075	0.503	1.012	1.277	
Std Dev (B (mg/L))	0.012	0.058	1.234	0.153	
Std Dev (Na (mg/L))	0.035	0.153	0.681	0.404	
Std Dev (Si (mg/L))	0.035	0.252	1.021	0.265	
%RSD (Al (mg/L))	1.91	2.47	1.31	2.63	<10% per ASTM C1285
%RSD (B (mg/L))	0.29	0.29	1.59	0.32	
%RSD (Na (mg/L))	0.89	0.77	0.88	0.85	
%RSD (Si (mg/L))	0.90	1.26	1.27	0.55	

Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence

Analyte=Al (mg/L)
Variability Chart for Measured Conc (mg/L)

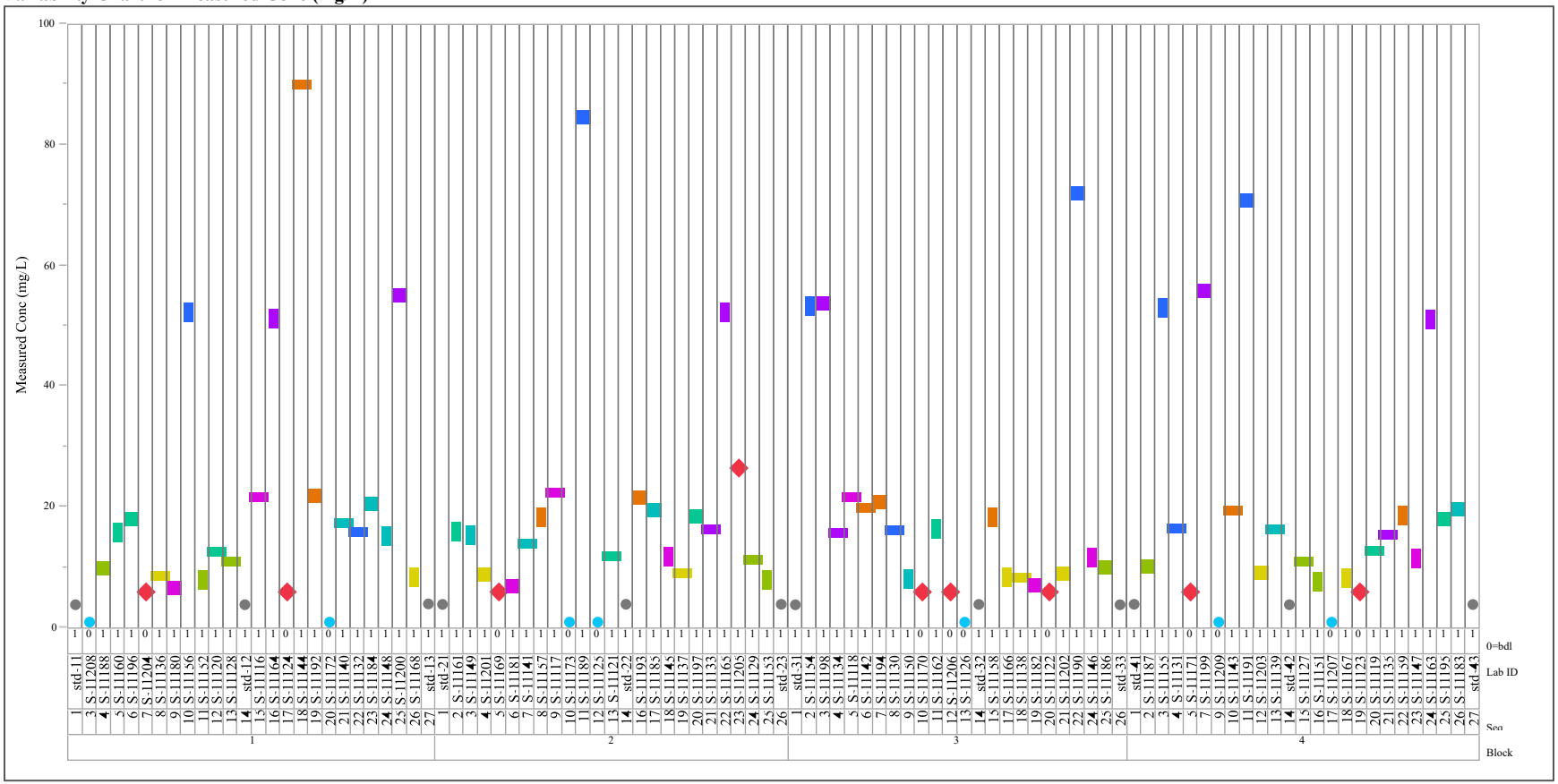


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Al (mg/L)
Variability Chart for log [Conc (mg/L)]

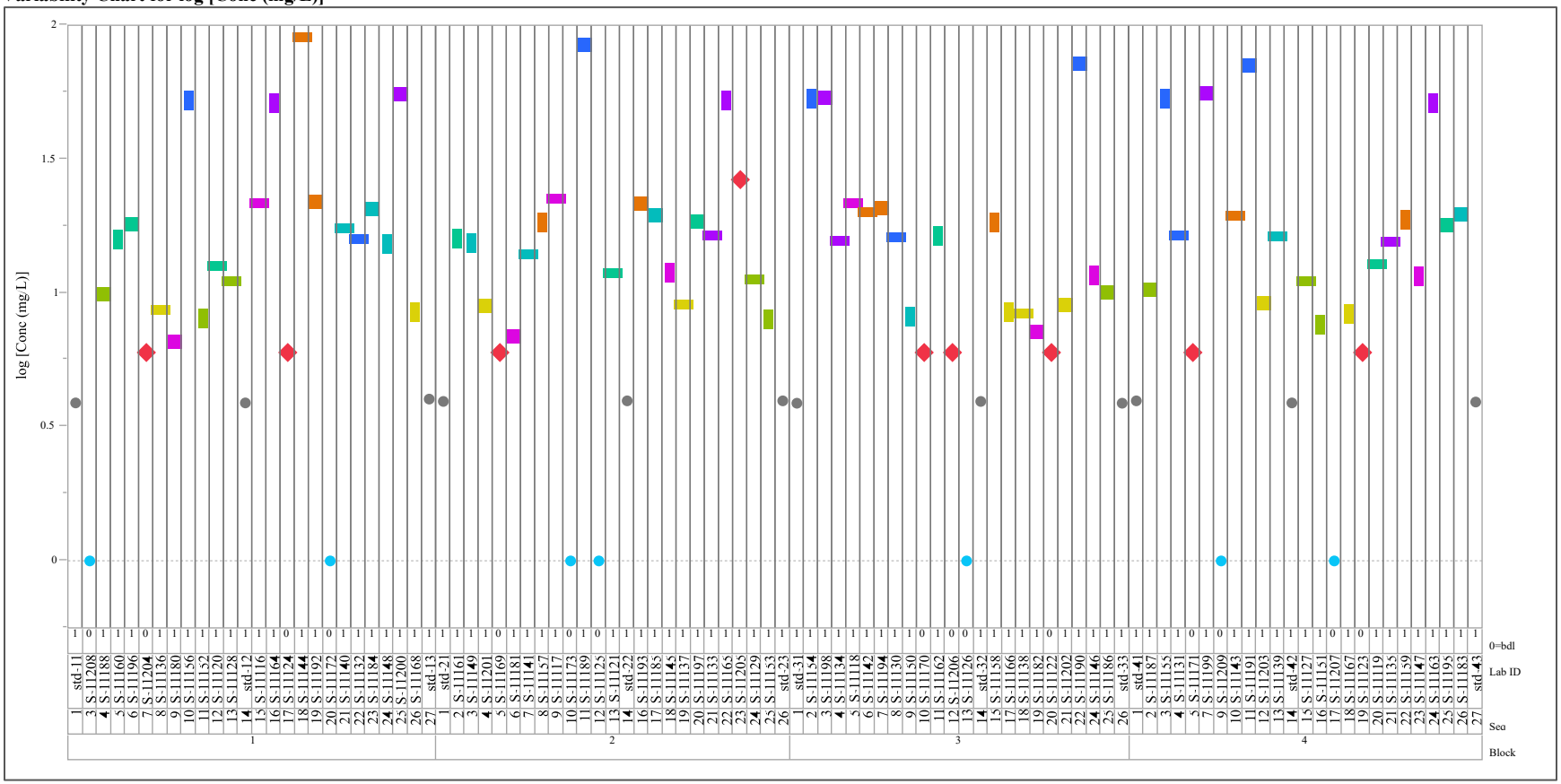


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=B (mg/L)
Variability Chart for Measured Conc (mg/L)

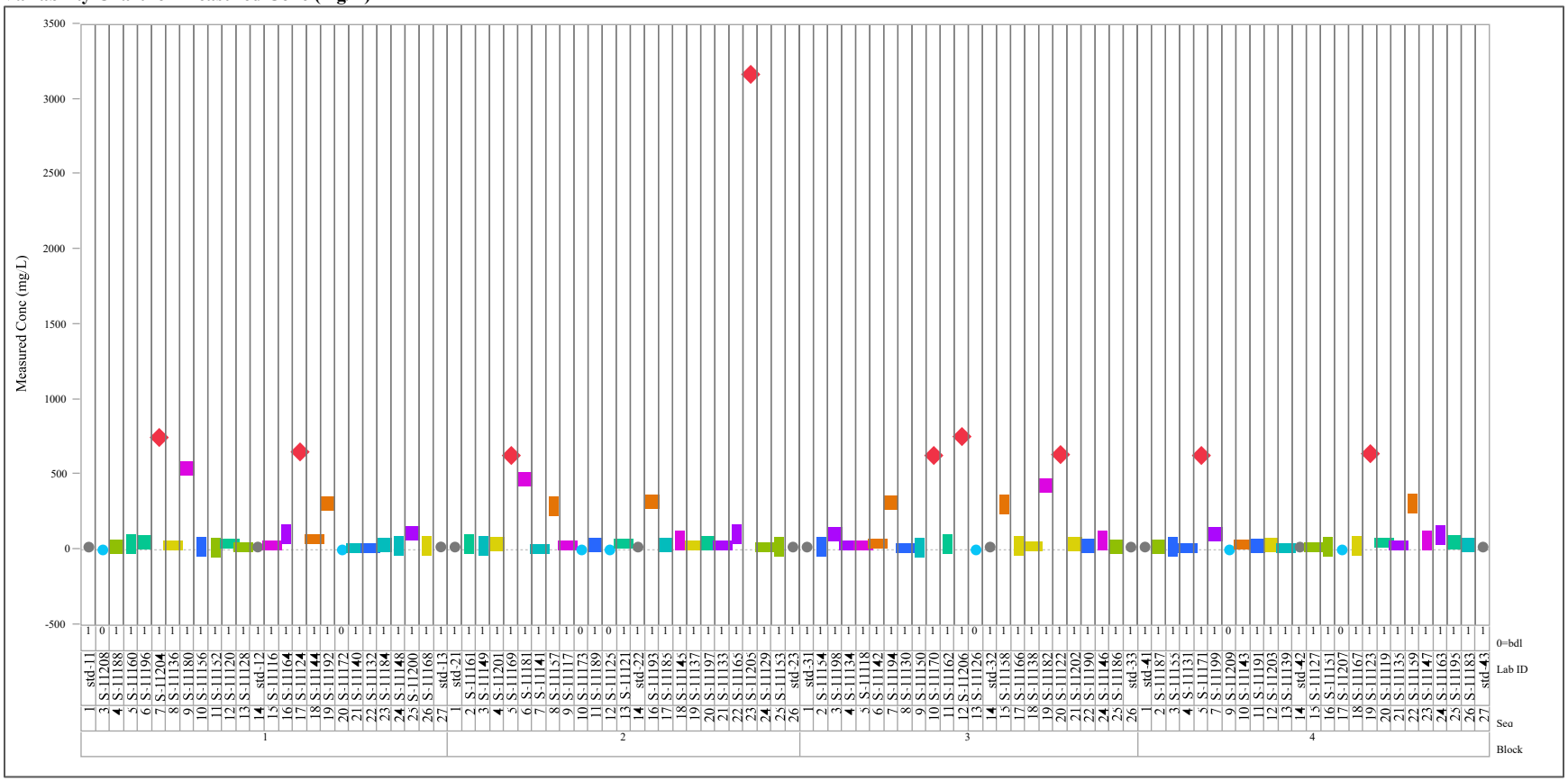


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=B (mg/L)
Variability Chart for log [Conc (mg/L)]

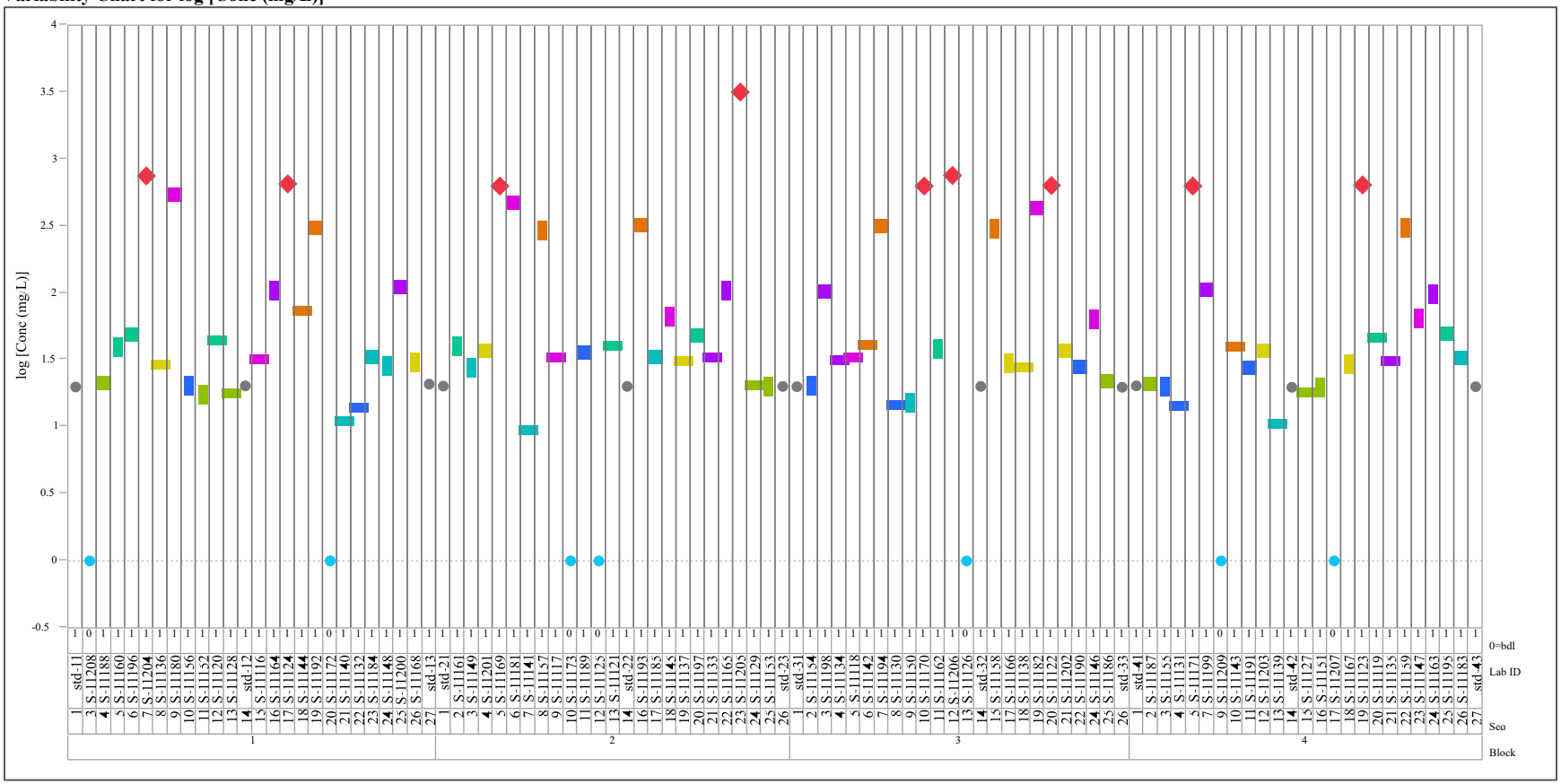


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Cr (mg/L)
Variability Chart for Measured Conc (mg/L)

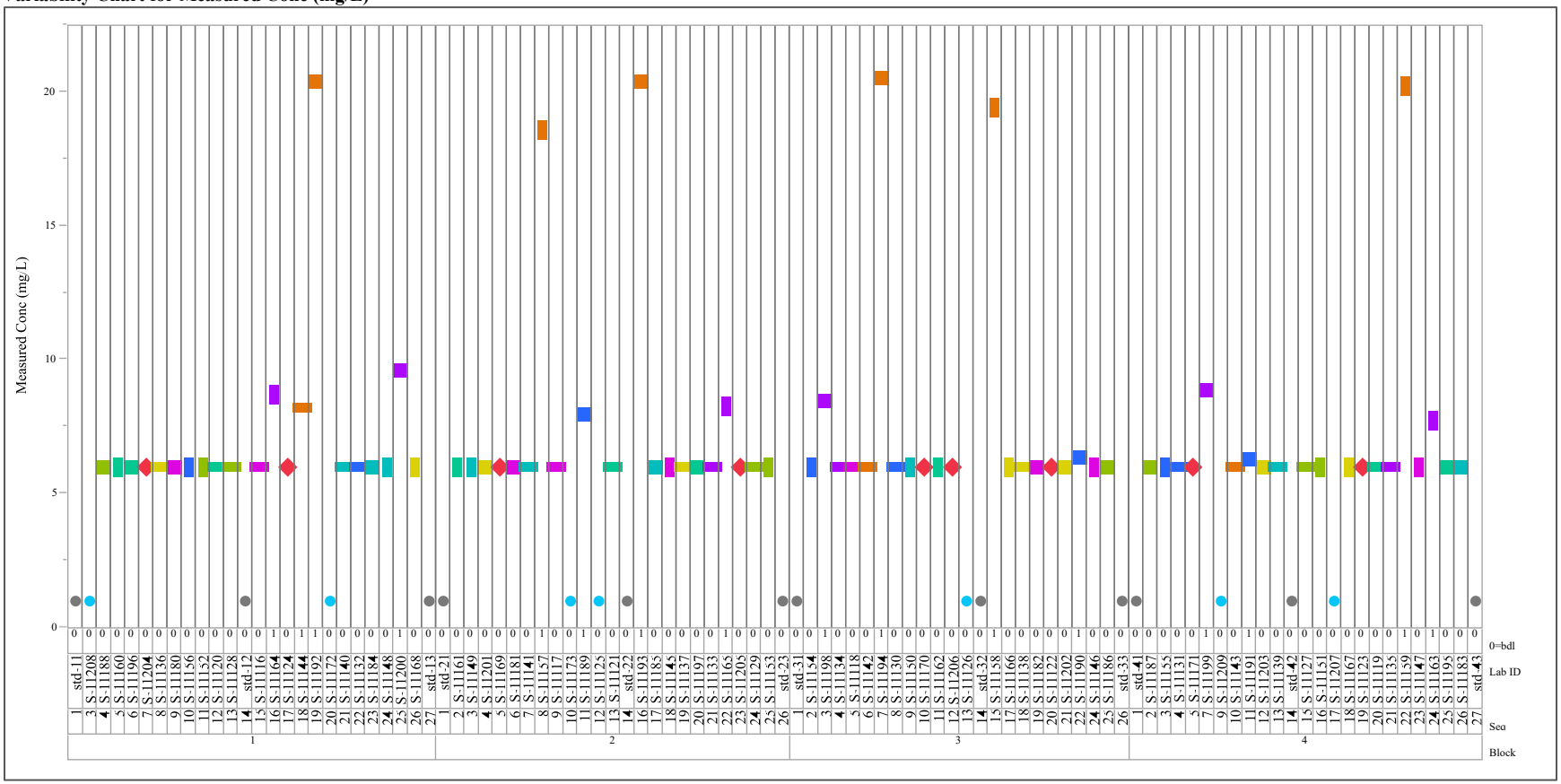


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Cr (mg/L)
Variability Chart for log [Conc (mg/L)]

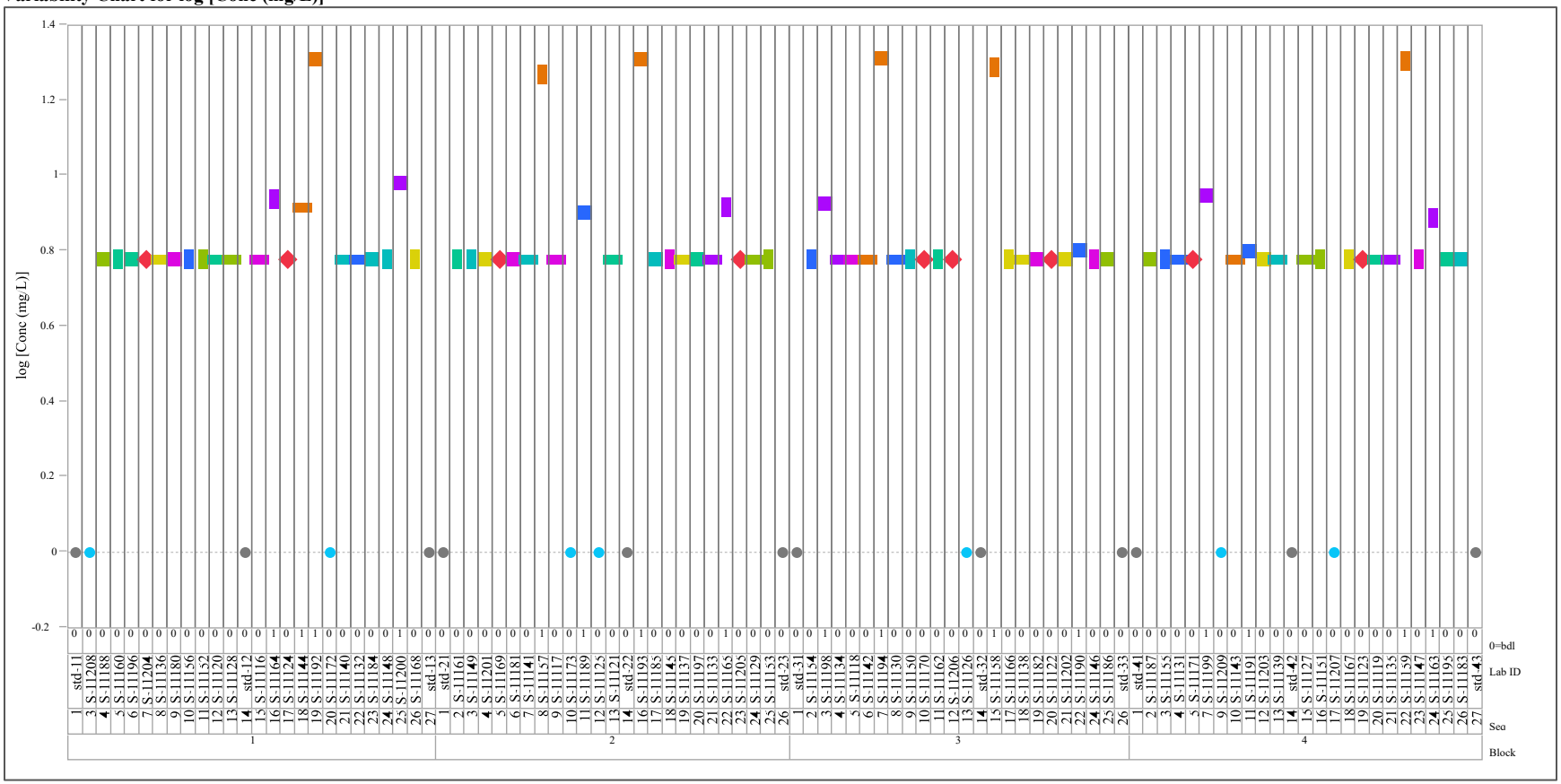


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Na (mg/L)
Variability Chart for Measured Conc (mg/L)

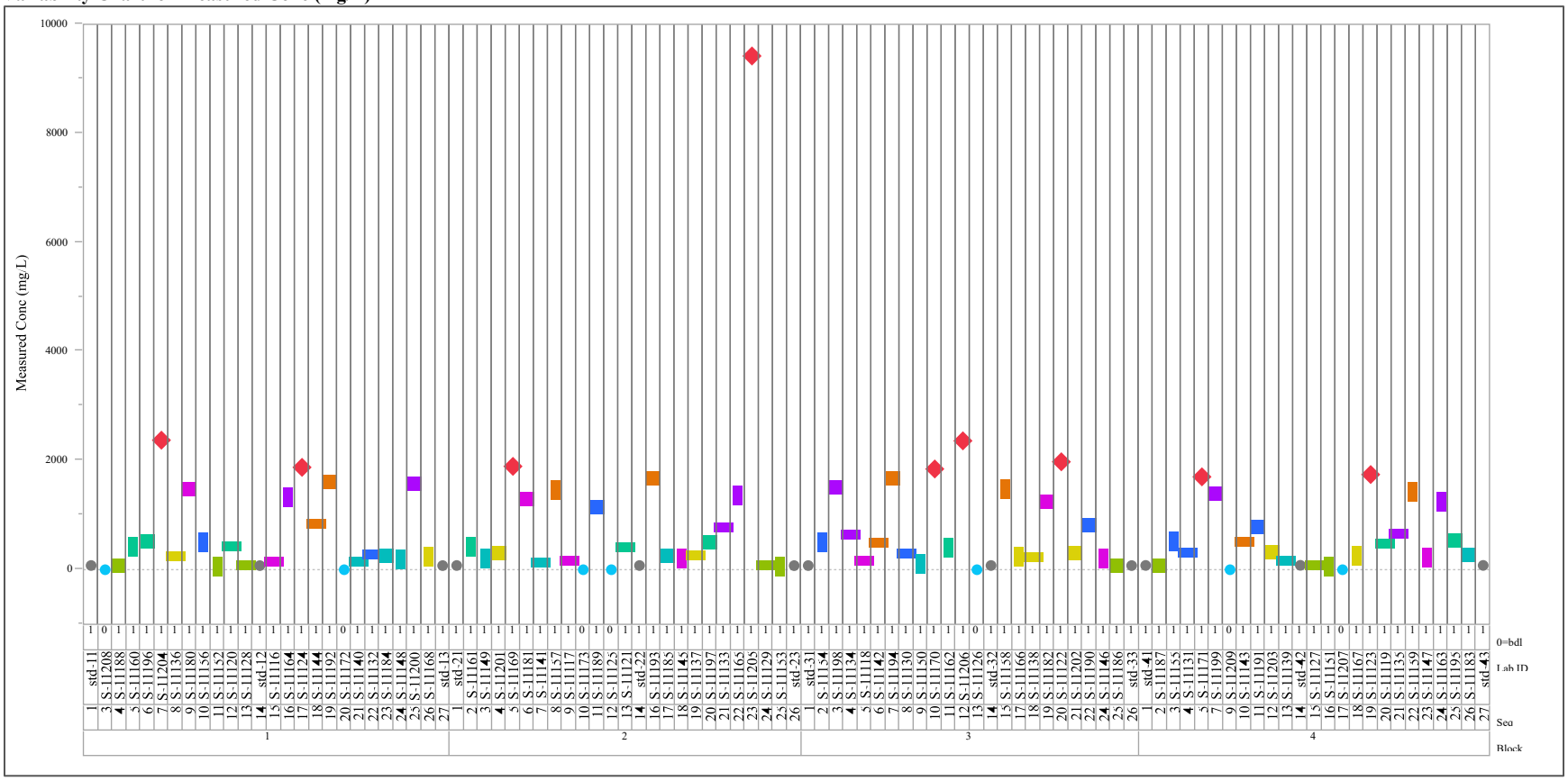


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Na (mg/L)
Variability Chart for log [Conc (mg/L)]

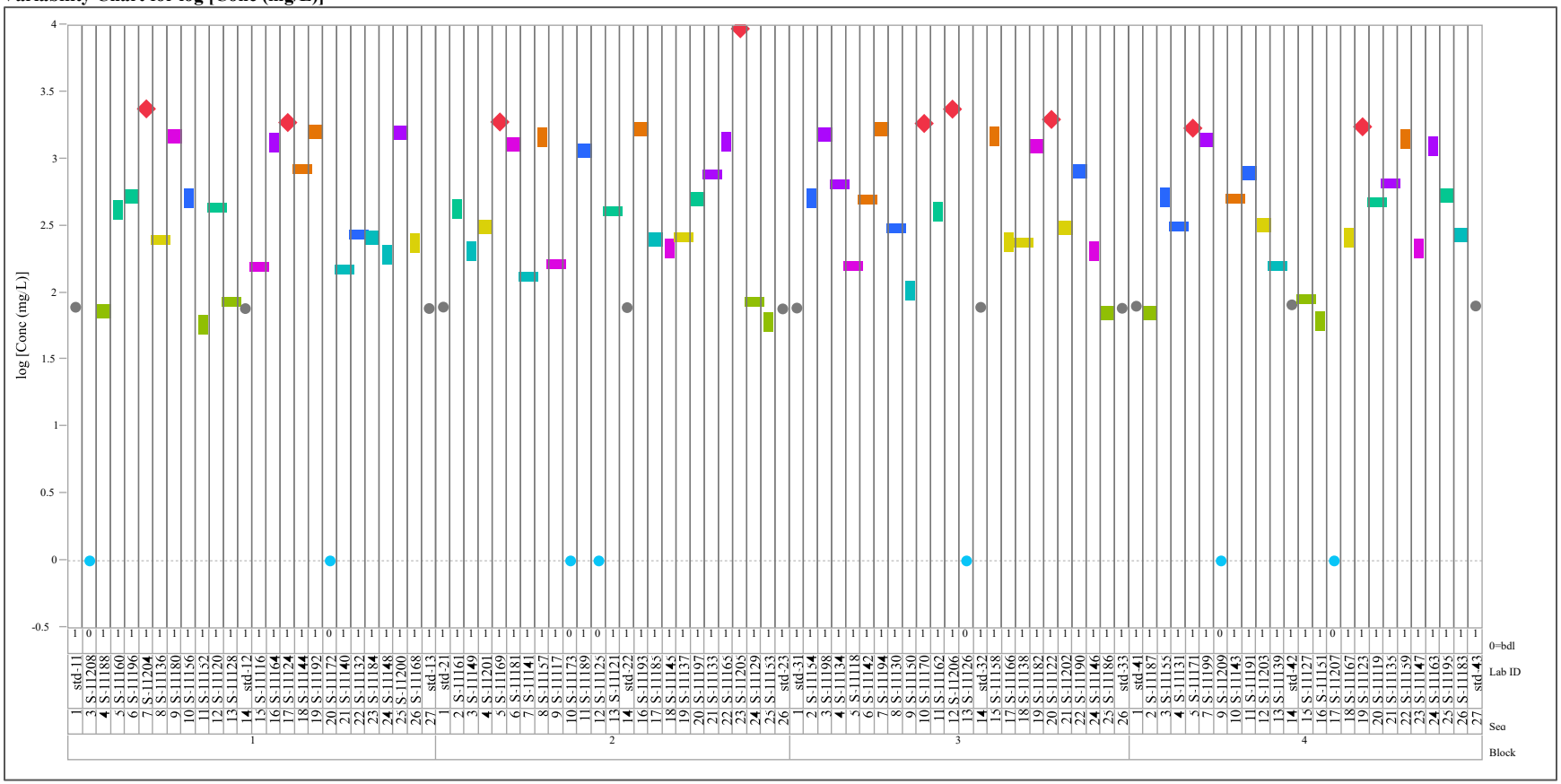


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Si (mg/L)
Variability Chart for Measured Conc (mg/L)

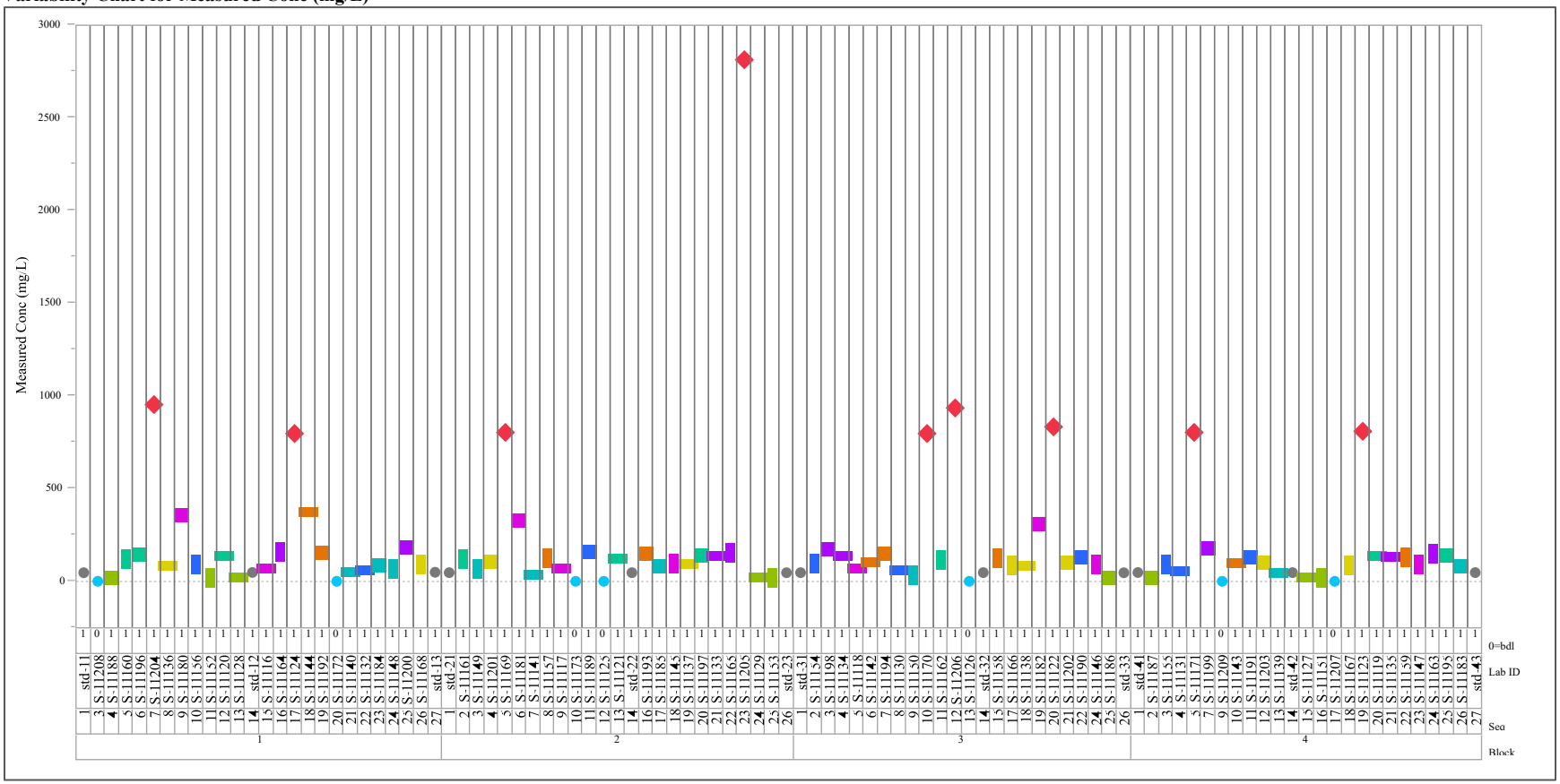


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Si (mg/L)
Variability Chart for log [Conc (mg/L)]

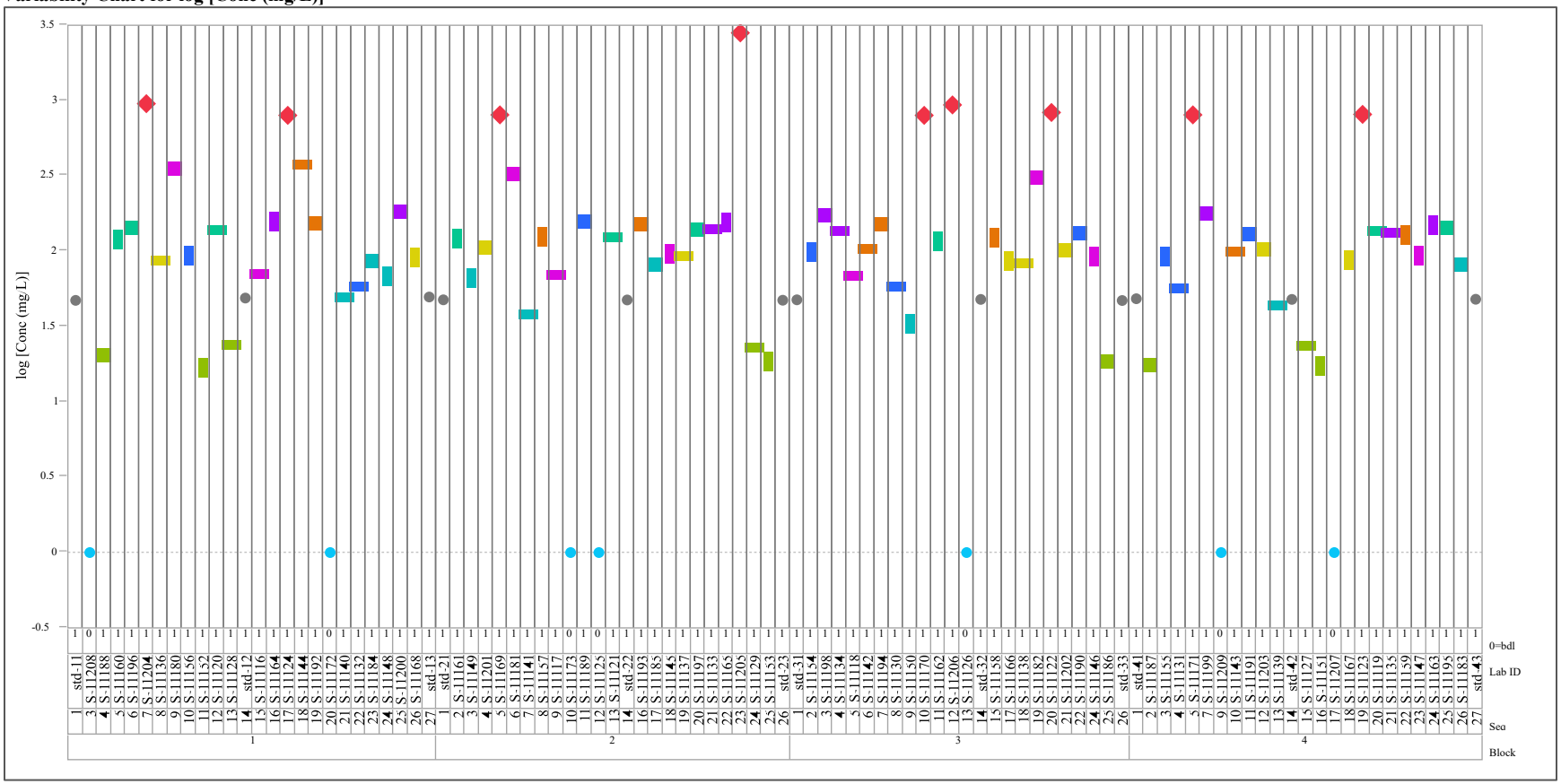


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID

Analyte=Al (mg/L)
Variability Chart for Measured Conc (mg/L)

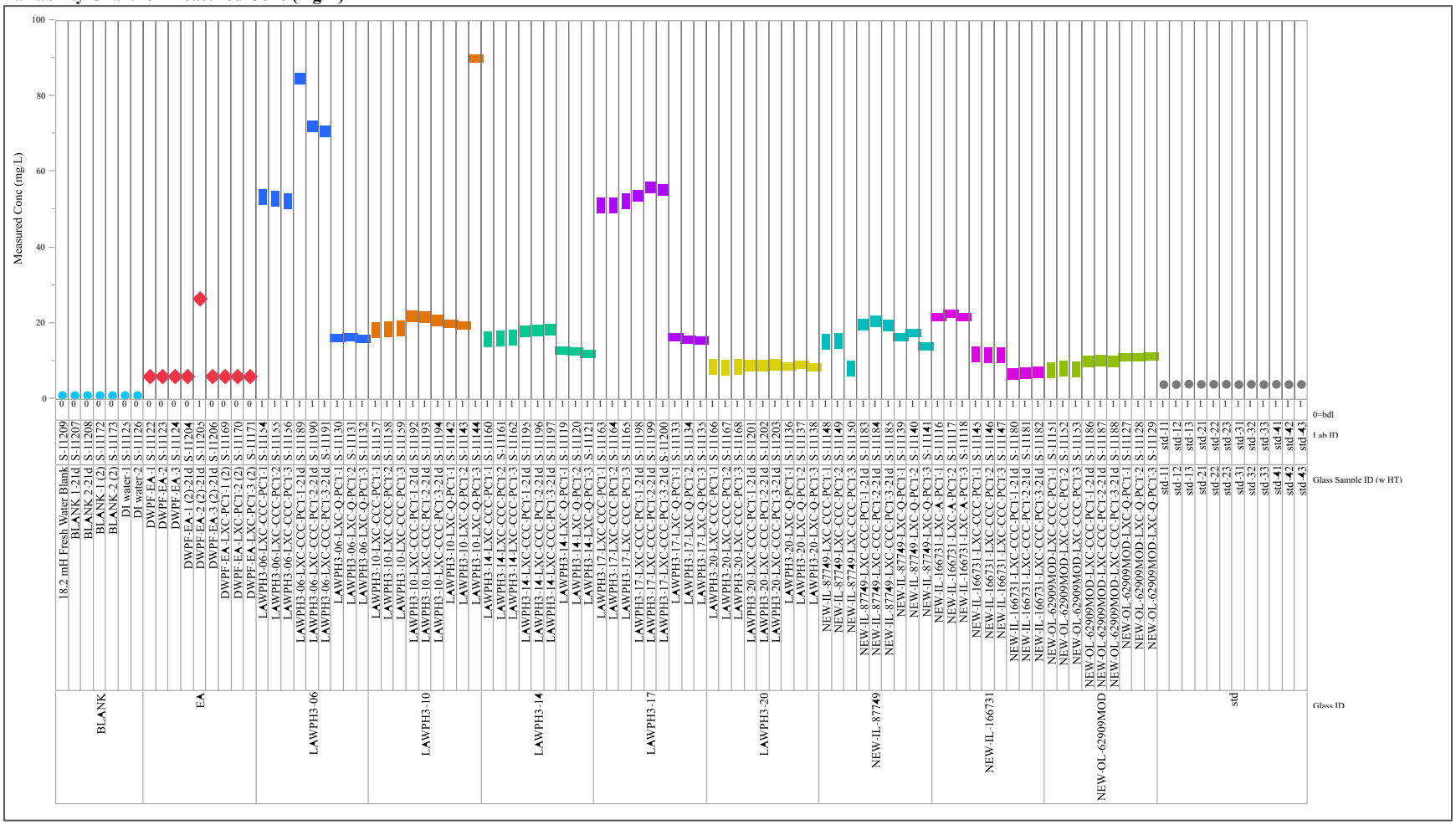


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=Al (mg/L)
Variability Chart for log [Conc (mg/L)]

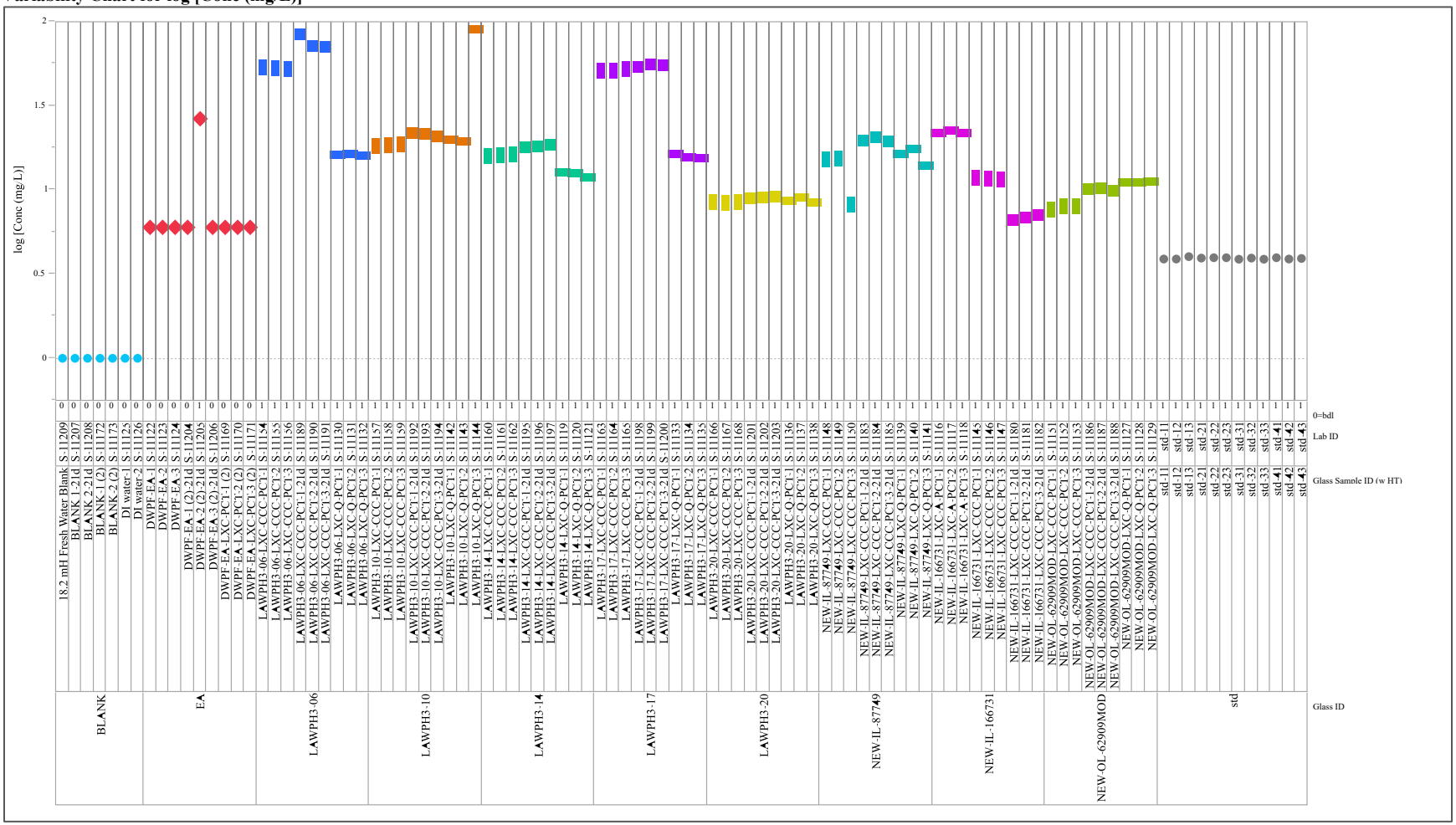


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=B (mg/L)
Variability Chart for Measured Conc (mg/L)

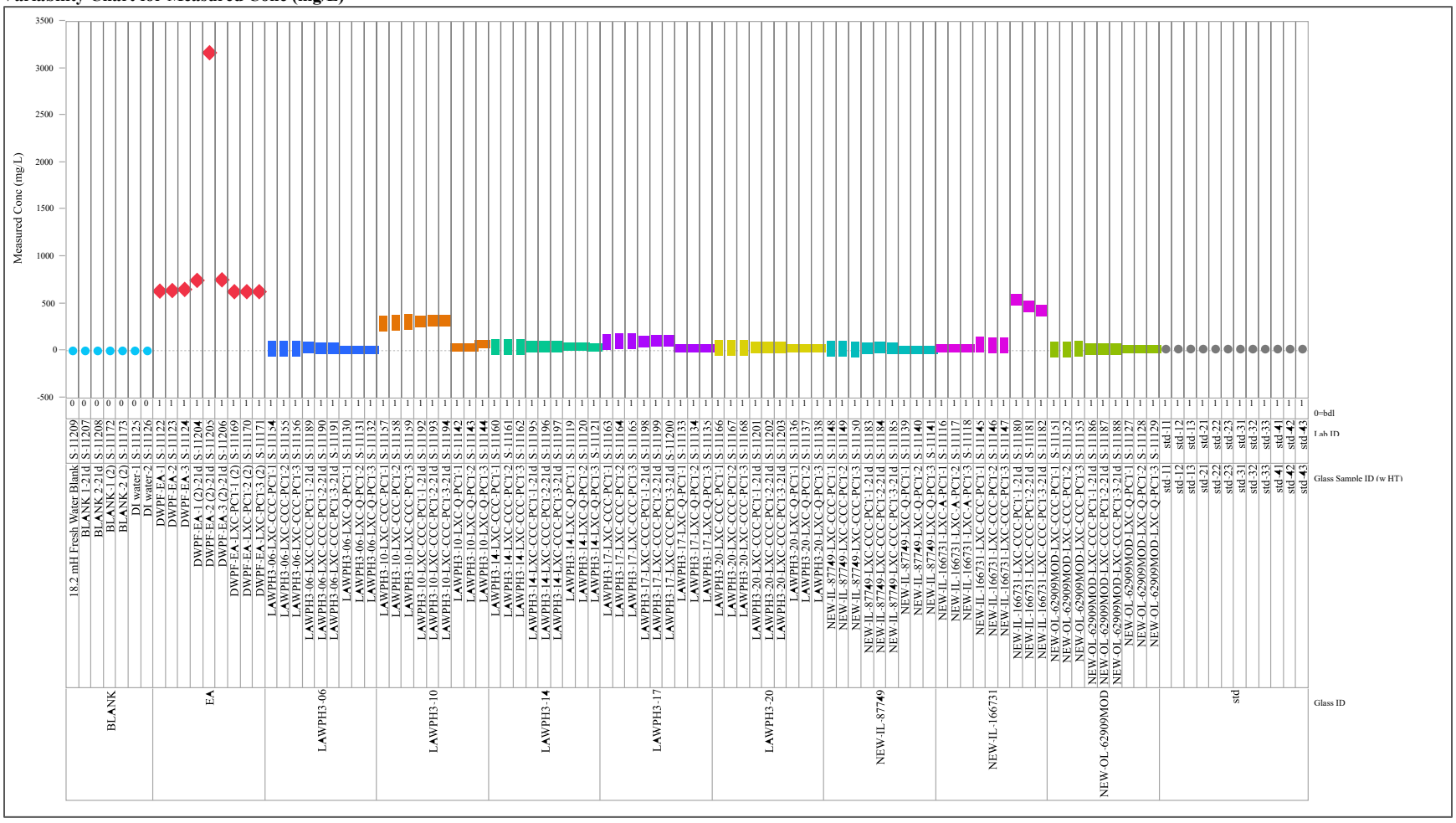


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=B (mg/L)
Variability Chart for log [Conc (mg/L)]

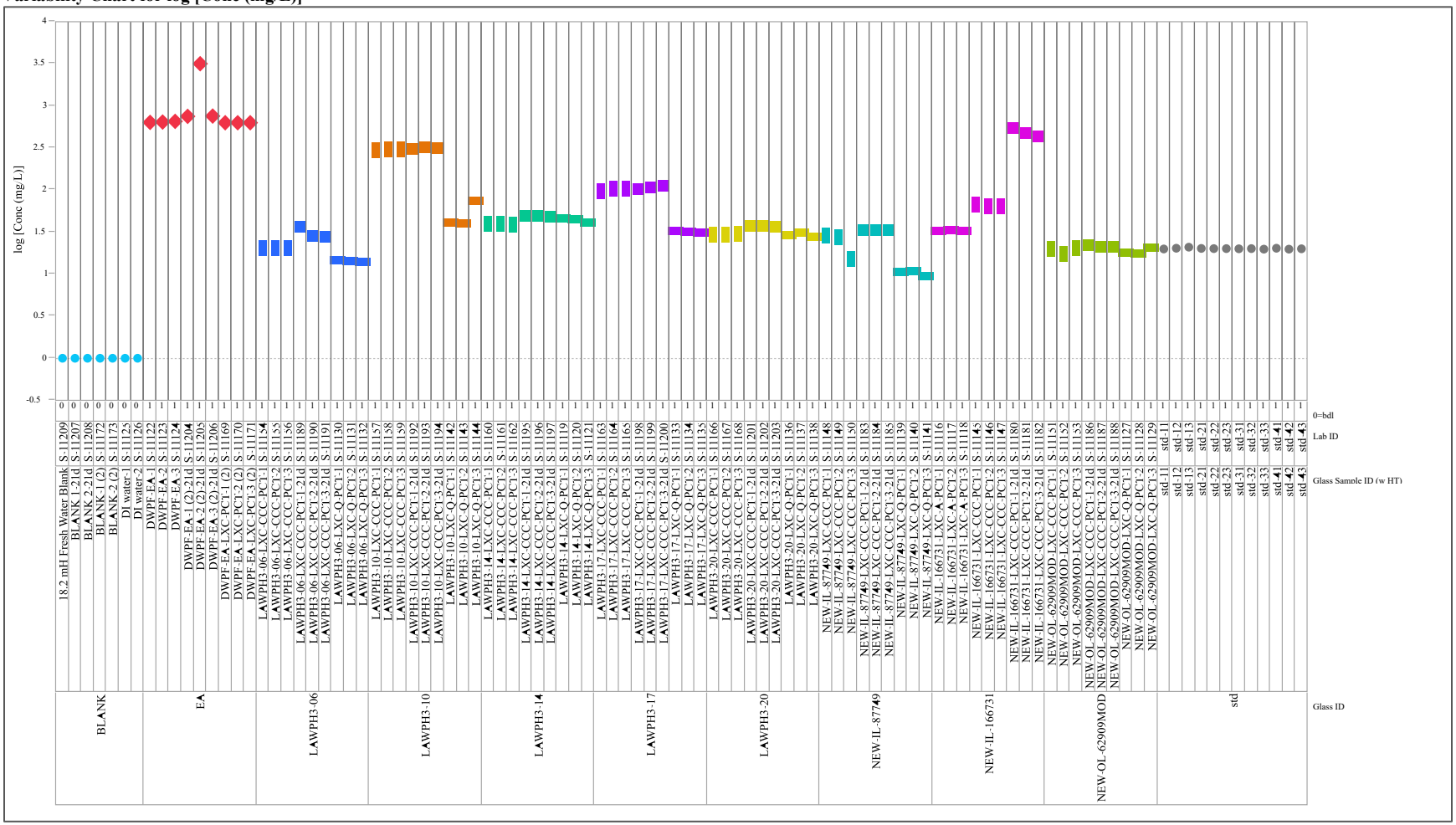


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=Cr (mg/L)
Variability Chart for Measured Conc (mg/L)

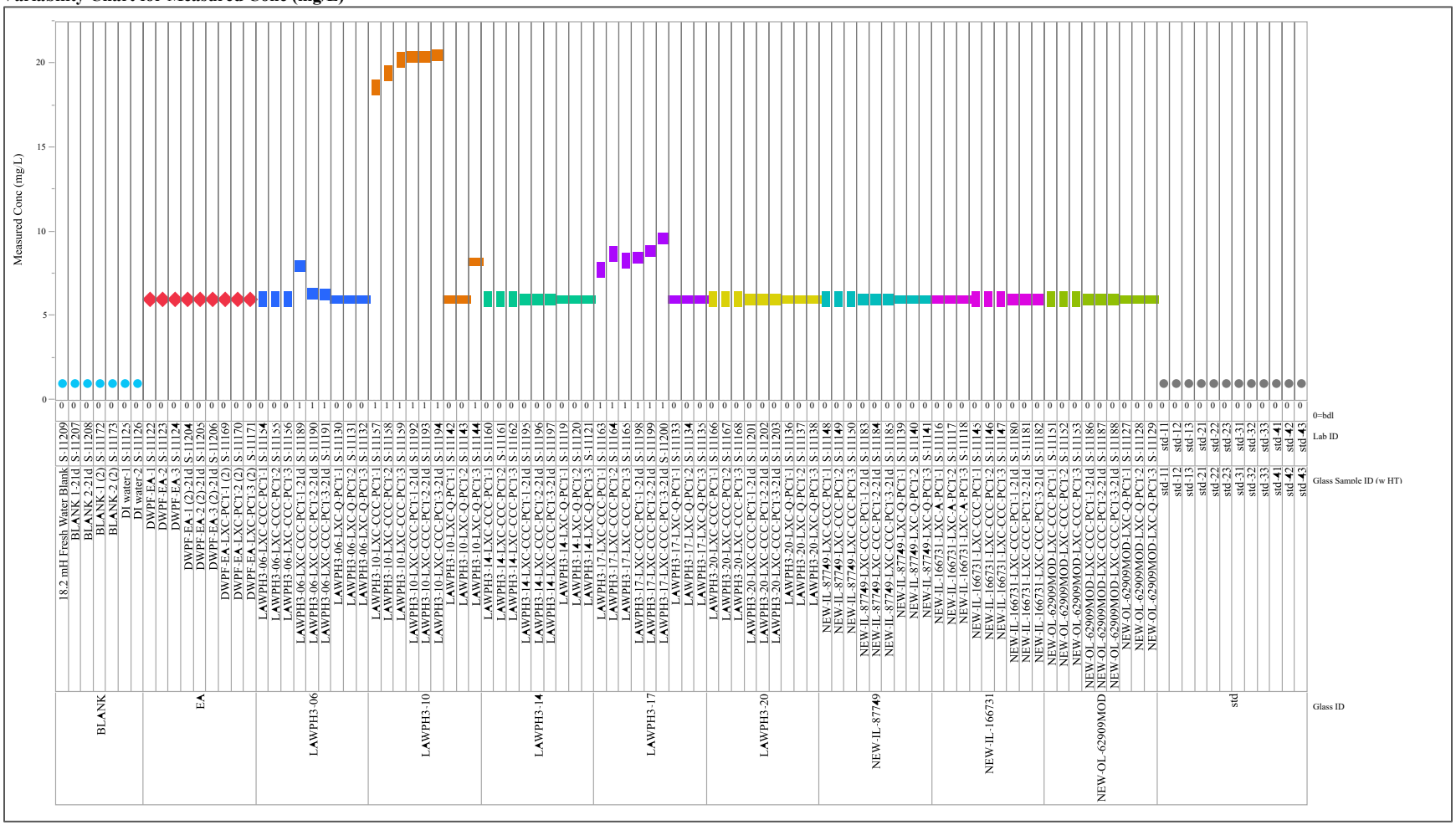


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=Cr (mg/L)
Variability Chart for log [Conc (mg/L)]

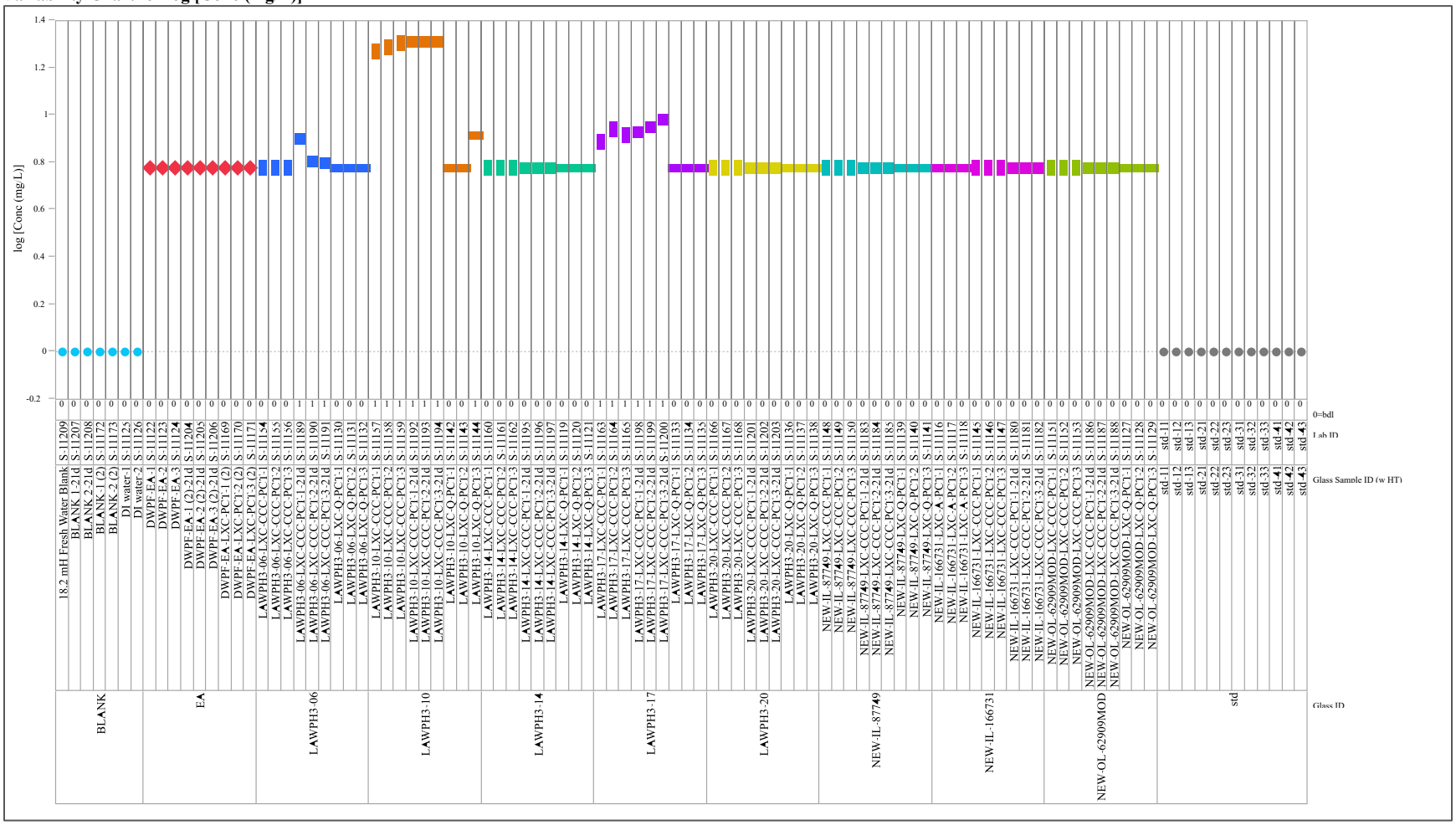


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=Na (mg/L)
Variability Chart for Measured Conc (mg/L)

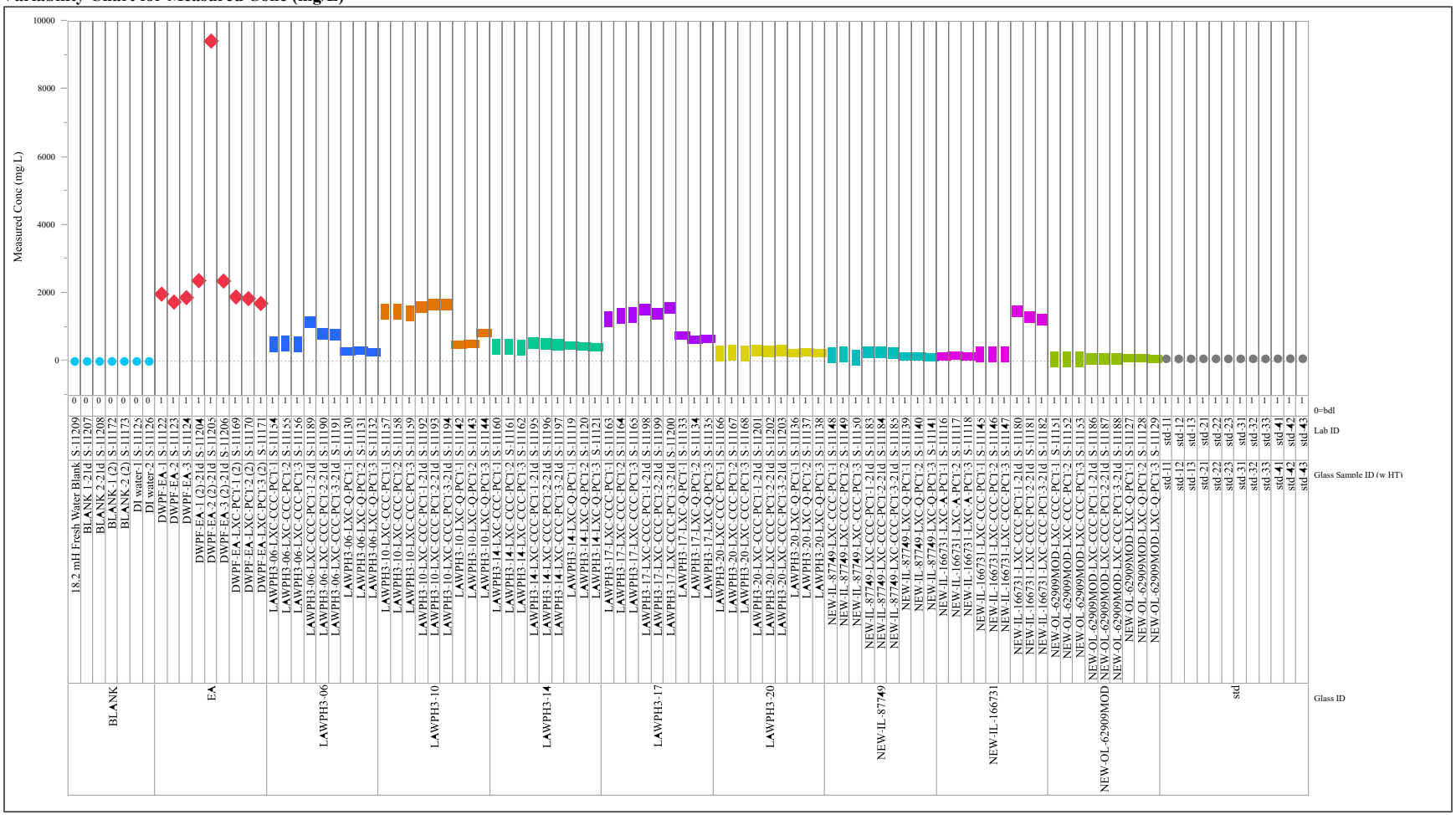


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=Na (mg/L)
Variability Chart for log [Conc (mg/L)]

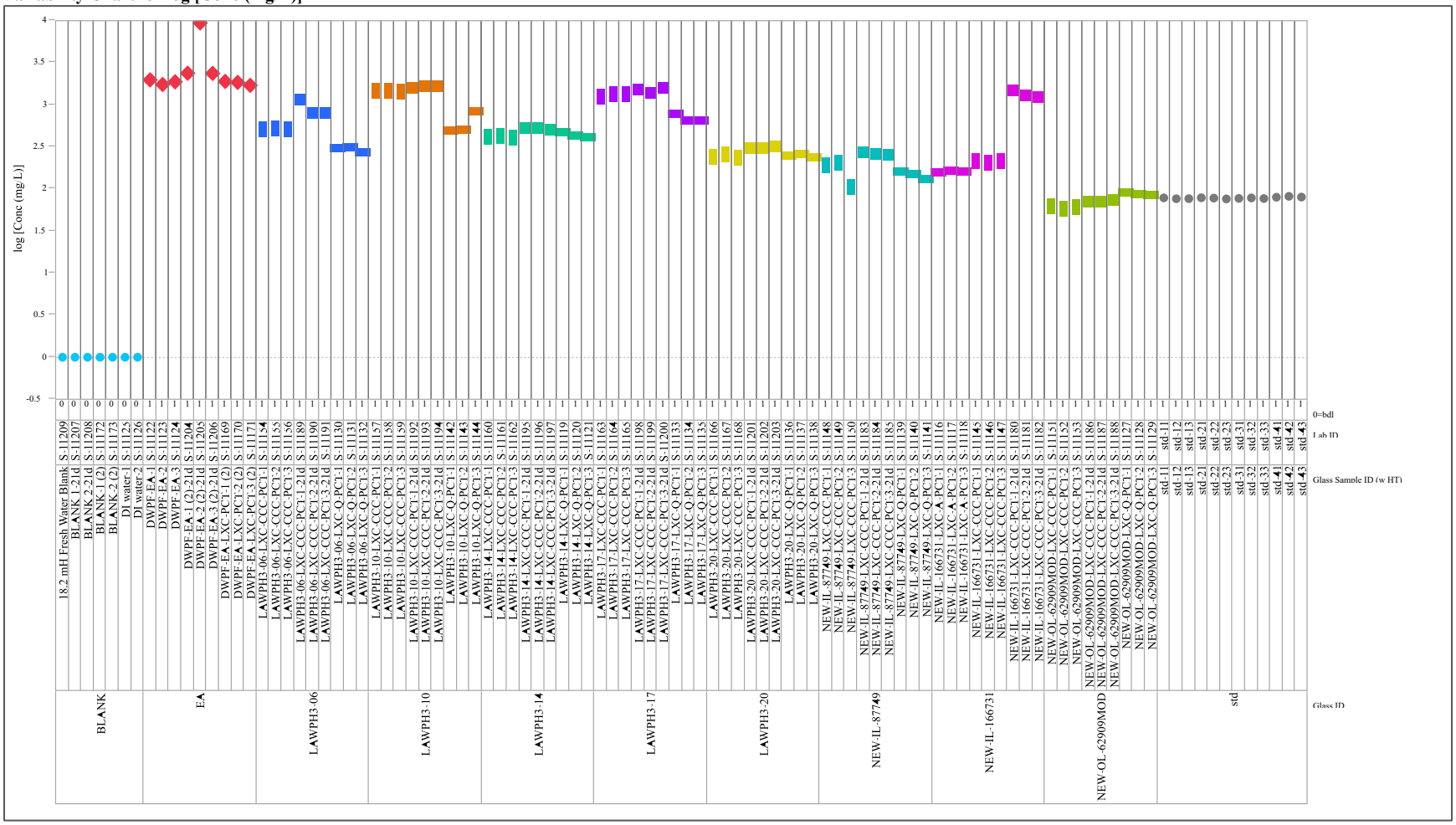


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=Si (mg/L)
Variability Chart for Measured Conc (mg/L)

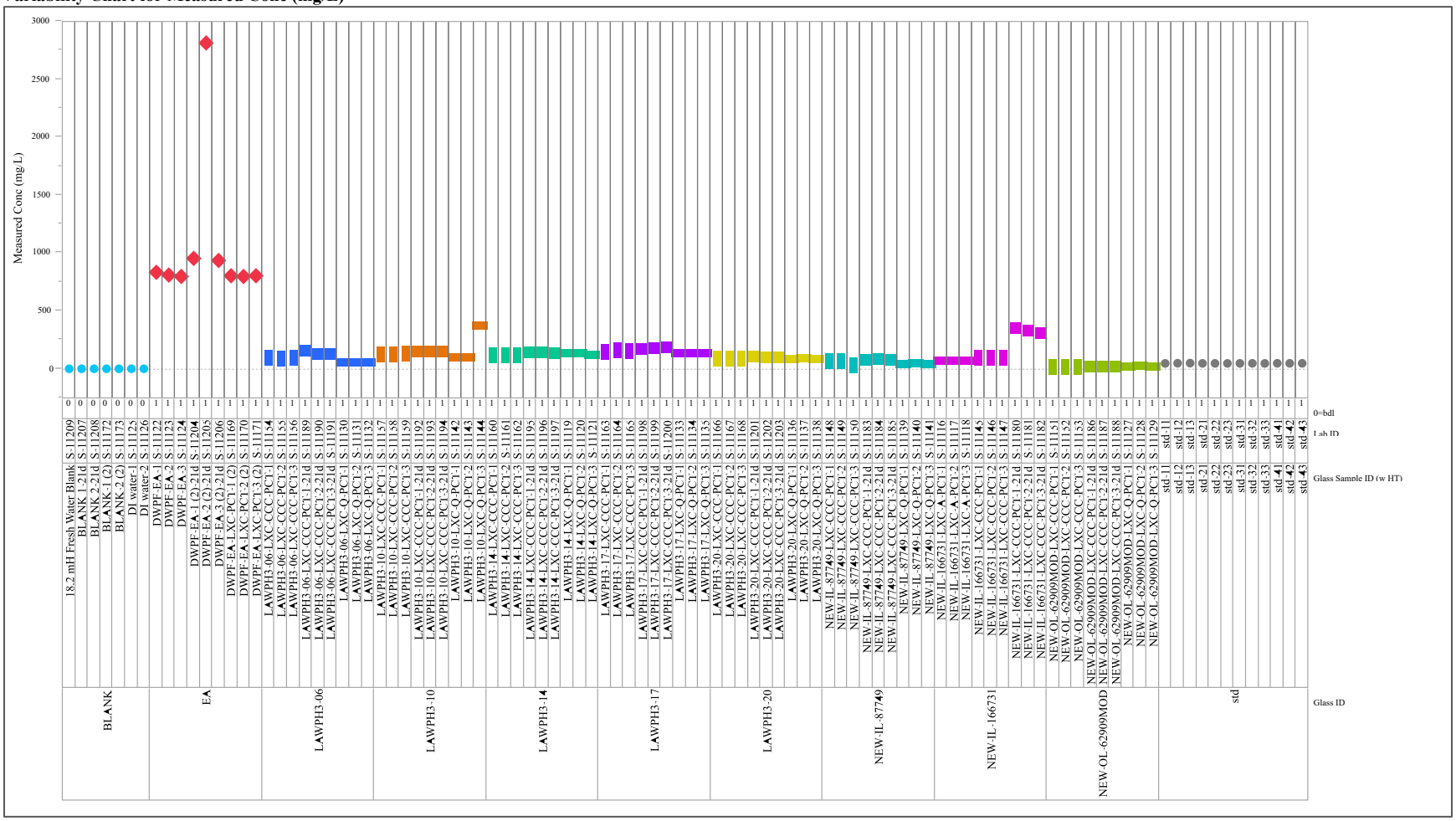
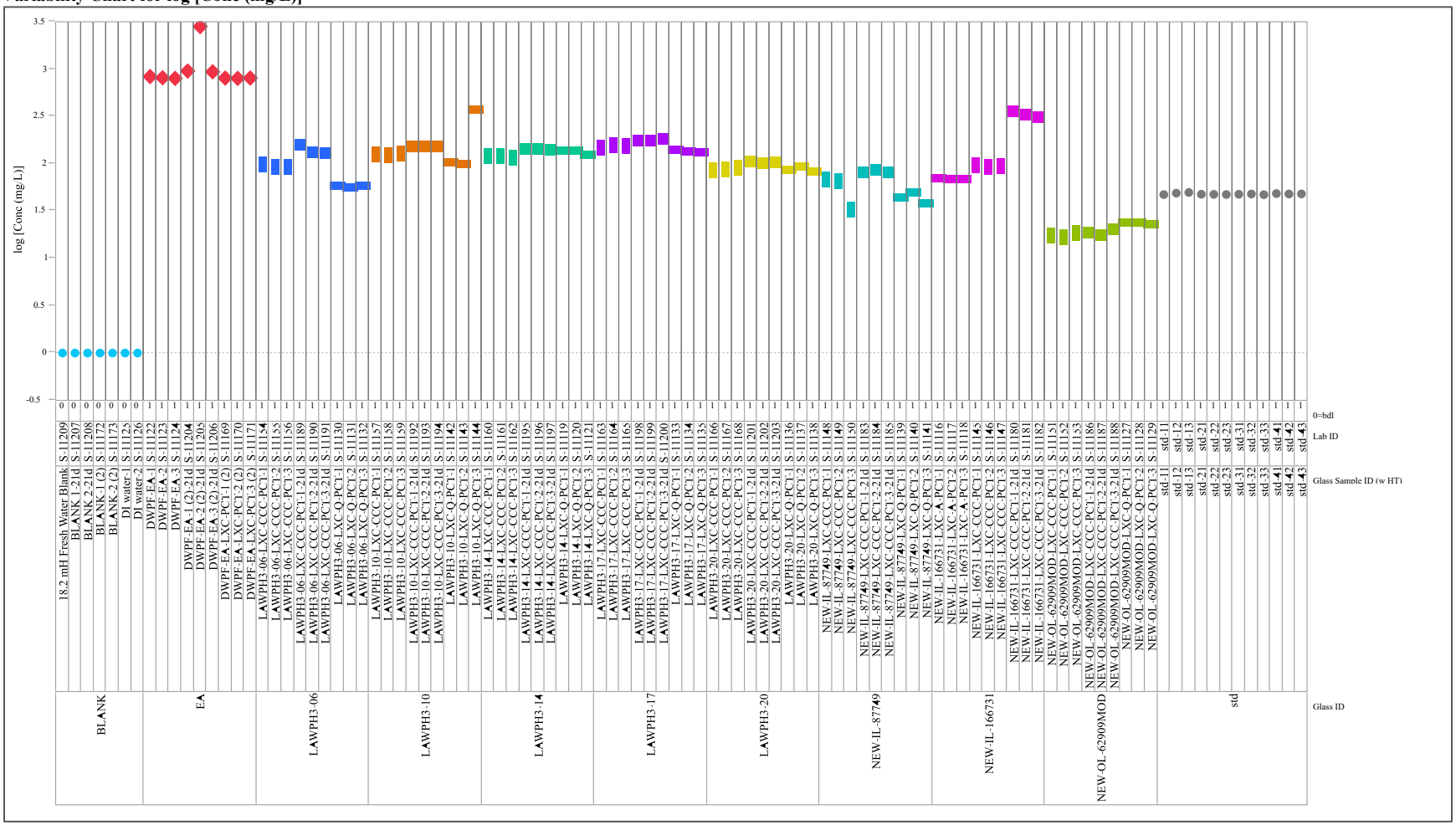


Exhibit A-2. Dilution Corrected PCT Leachate Measurements by Glass ID (continued)

Analyte=Si (mg/L) Gla
Variability Chart for log [Conc (mg/L)]



Appendix B Normalized PCT Results

Table B-1. Normalized PCT Results

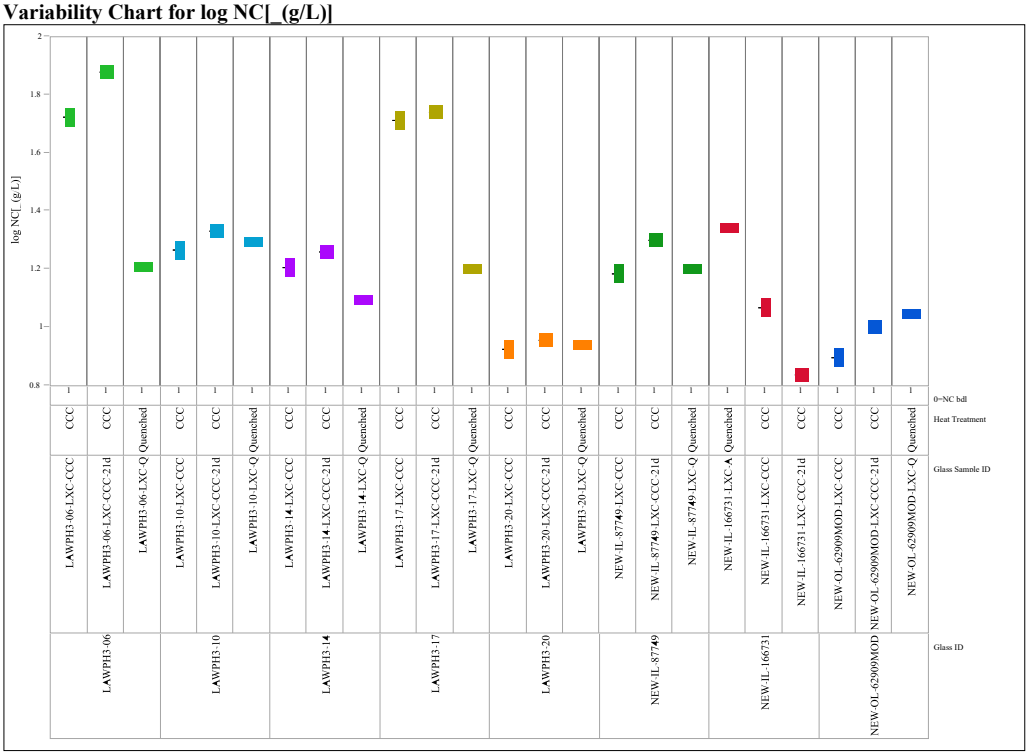
Glass ID	Comp. View	NC_{Al} (g/L)	NC_B (g/L)	NC_{Cr} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
DWPF-EA	Reference	< 0.306	18.349	NA	14.969	3.573
DWPF-EA-21d	Reference	< 0.306	21.456	NA	19.016	4.148
DWPF-EA-LXC	Reference	< 0.306	17.952	NA	14.556	3.521
LAWPH3-06-LXC-CCC	Measured	1.121	0.877	< 1.720	3.449	0.557
LAWPH3-06-LXC-CCC	Target	1.108	0.971	< 1.504	3.247	0.566
LAWPH3-06-LXC-CCC-21d	Measured	1.601	1.322	1.960	6.088	0.823
LAWPH3-06-LXC-CCC-21d	Target	1.583	1.464	1.715	5.731	0.835
LAWPH3-06-LXC-Q	Measured	0.343	0.618	< 1.720	2.004	0.339
LAWPH3-06-LXC-Q	Target	0.339	0.684	< 1.504	1.887	0.344
LAWPH3-10-LXC-CCC	Measured	0.430	14.798	8.729	8.838	0.729
LAWPH3-10-LXC-CCC	Target	0.423	15.219	7.856	8.304	0.758
LAWPH3-10-LXC-CCC-21d	Measured	0.499	15.517	9.192	10.053	0.880
LAWPH3-10-LXC-CCC-21d	Target	0.491	15.959	8.273	9.446	0.914
LAWPH3-10-LXC-Q	Measured	0.459	1.991	< 2.698	3.058	0.588
LAWPH3-10-LXC-Q	Target	0.451	2.048	< 2.429	2.874	0.611
LAWPH3-14-LXC-CCC	Measured	0.473	1.472	< 2.904	2.321	0.648
LAWPH3-14-LXC-CCC	Target	0.458	1.529	< 2.757	2.190	0.643
LAWPH3-14-LXC-CCC-21d	Measured	0.535	1.838	< 2.904	2.913	0.771
LAWPH3-14-LXC-CCC-21d	Target	0.518	1.909	< 2.757	2.747	0.764
LAWPH3-14-LXC-Q	Measured	0.365	1.642	< 2.904	2.441	0.723
LAWPH3-14-LXC-Q	Target	0.354	1.706	< 2.757	2.303	0.717
LAWPH3-17-LXC-CCC	Measured	1.609	4.943	3.497	7.470	0.837
LAWPH3-17-LXC-CCC	Target	1.580	5.359	3.068	6.955	0.865
LAWPH3-17-LXC-CCC-21d	Measured	1.714	5.185	3.810	8.548	0.968
LAWPH3-17-LXC-CCC-21d	Target	1.683	5.622	3.343	7.959	1.001
LAWPH3-17-LXC-Q	Measured	0.495	1.548	< 2.549	3.935	0.739
LAWPH3-17-LXC-Q	Target	0.486	1.679	< 2.237	3.664	0.764
LAWPH3-20-LXC-CCC	Measured	0.271	1.121	< 2.284	1.563	0.450
LAWPH3-20-LXC-CCC	Target	0.264	1.073	< 2.145	1.475	0.456
LAWPH3-20-LXC-CCC-21d	Measured	0.290	1.397	< 2.284	1.989	0.530
LAWPH3-20-LXC-CCC-21d	Target	0.283	1.338	< 2.145	1.877	0.537
LAWPH3-20-LXC-Q	Measured	0.279	1.108	< 2.284	1.582	0.447
LAWPH3-20-LXC-Q	Target	0.272	1.061	< 2.145	1.493	0.453
NEW-IL-166731-LXC-CCC	Measured	0.199	2.318	< 3.986	1.544	0.541
NEW-IL-166731-LXC-CCC	Target	0.192	2.235	< 4.164	1.584	0.547
NEW-IL-166731-LXC-CCC-21d	Measured	0.117	17.169	< 3.986	9.715	1.898
NEW-IL-166731-LXC-CCC-21d	Target	0.113	16.554	< 4.164	9.969	1.918

Table B-1. Normalized PCT Results (continued)

Glass ID	Comp. View	NC_{Al} (g/L)	NC_{B} (g/L)	NC_{Cr} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)
NEW-IL-166731-LXC-A (quenched)	Measured	0.373	1.172	< 3.986	1.166	0.399
NEW-IL-166731-LXC-A (quenched)	Target	0.360	1.130	< 4.164	1.196	0.403
NEW-IL-87749-LXC-CCC	Measured	0.259	1.166	< 5.846	1.517	0.385
NEW-IL-87749-LXC-CCC	Target	0.251	1.131	< 10.962	1.535	0.384
NEW-IL-87749-LXC-CCC-21d	Measured	0.338	1.378	< 5.846	1.991	0.473
NEW-IL-87749-LXC-CCC-21d	Target	0.328	1.337	< 10.962	2.014	0.472
NEW-IL-87749-LXC-Q	Measured	0.268	0.429	< 5.846	1.120	0.250
NEW-IL-87749-LXC-Q	Target	0.261	0.416	< 10.962	1.133	0.250
NEW-OL-62909MOD-LXC-CCC	Measured	0.122	0.683	< 2.923	0.604	0.109
NEW-OL-62909MOD-LXC-CCC	Target	0.120	0.691	< 2.827	0.625	0.112
NEW-OL-62909MOD-LXC-CCC-21d	Measured	0.156	0.763	< 2.923	0.718	0.117
NEW-OL-62909MOD-LXC-CCC-21d	Target	0.154	0.772	< 2.827	0.744	0.120
NEW-OL-62909MOD-LXC-Q	Measured	0.172	0.669	< 2.923	0.874	0.146
NEW-OL-62909MOD-LXC-Q	Target	0.170	0.677	< 2.827	0.906	0.150

Exhibit B-1. Normalized PCT Results by Compositional View by Heat Treatment for Each Glass

Analyte=Al, Comp View=Measured
Variability Chart for log NC[_(g/L)]



Analyte=Al, Comp View=Target
Variability Chart for log NC[_(g/L)]

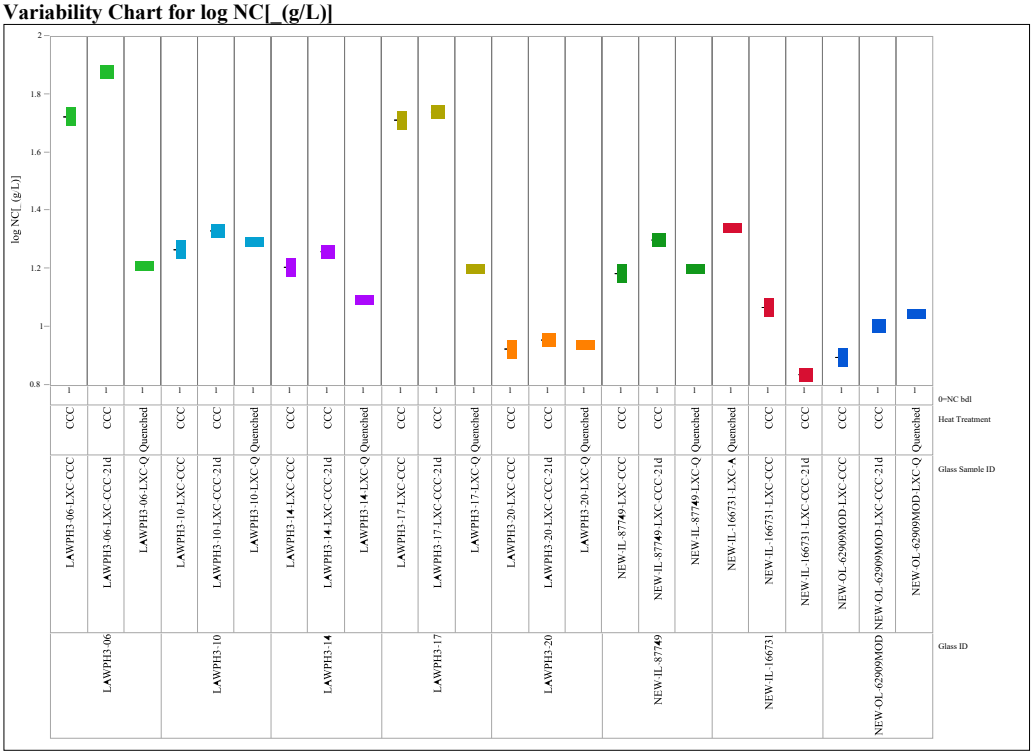
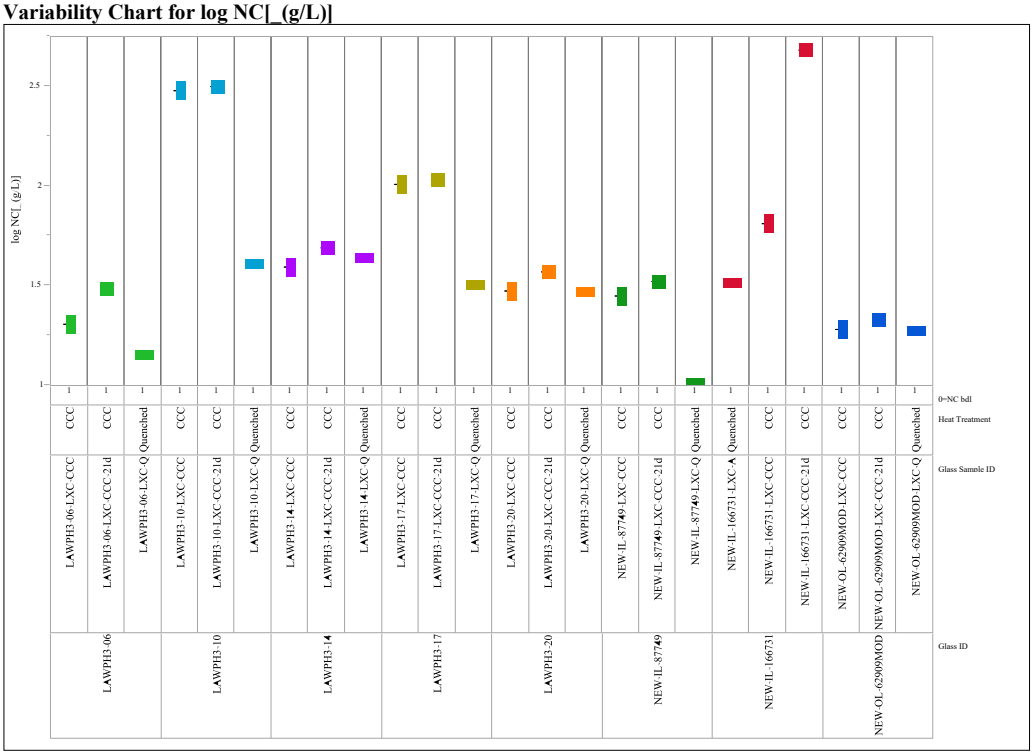


Exhibit B-1. Normalized PCT Results by Compositional View by Heat Treatment for Each Glass (continued)

Analyte=B, Comp View=Measured
Variability Chart for log NC[_(g/L)]



Analyte=B, Comp View=Target
Variability Chart for log NC[_(g/L)]

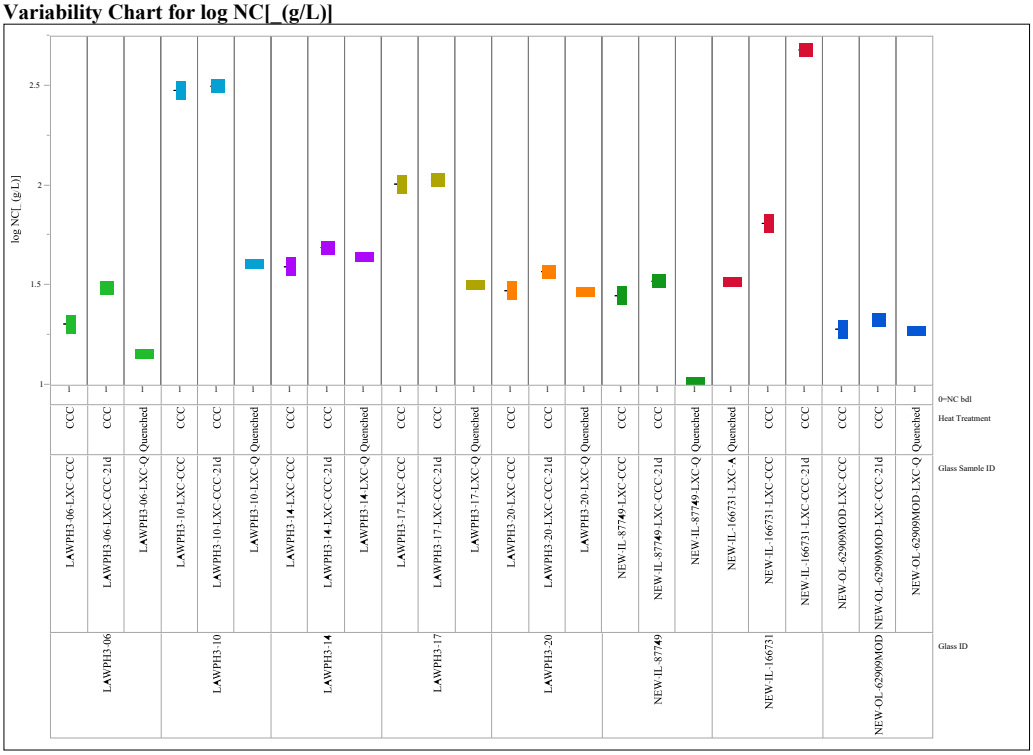
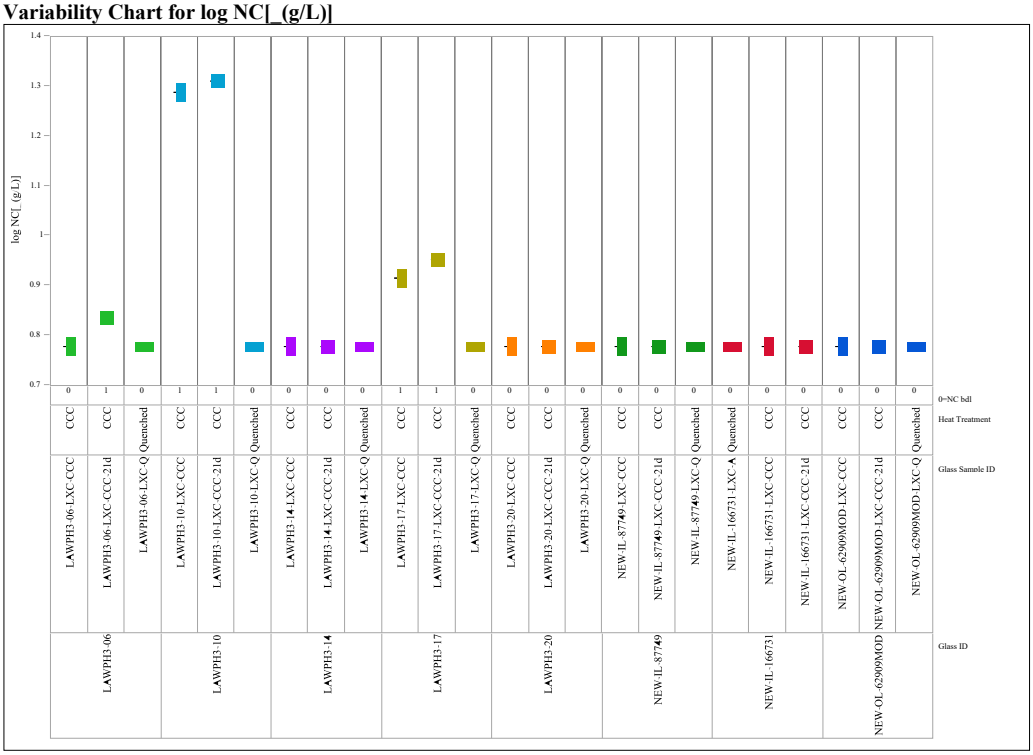


Exhibit B-1. Normalized PCT Results by Compositional View by Heat Treatment for Each Glass (continued)

Analyte=Cr, Comp View=Measured
Variability Chart for log NC[_(g/L)]



Analyte=Cr, Comp View=Target
Variability Chart for log NC[_(g/L)]

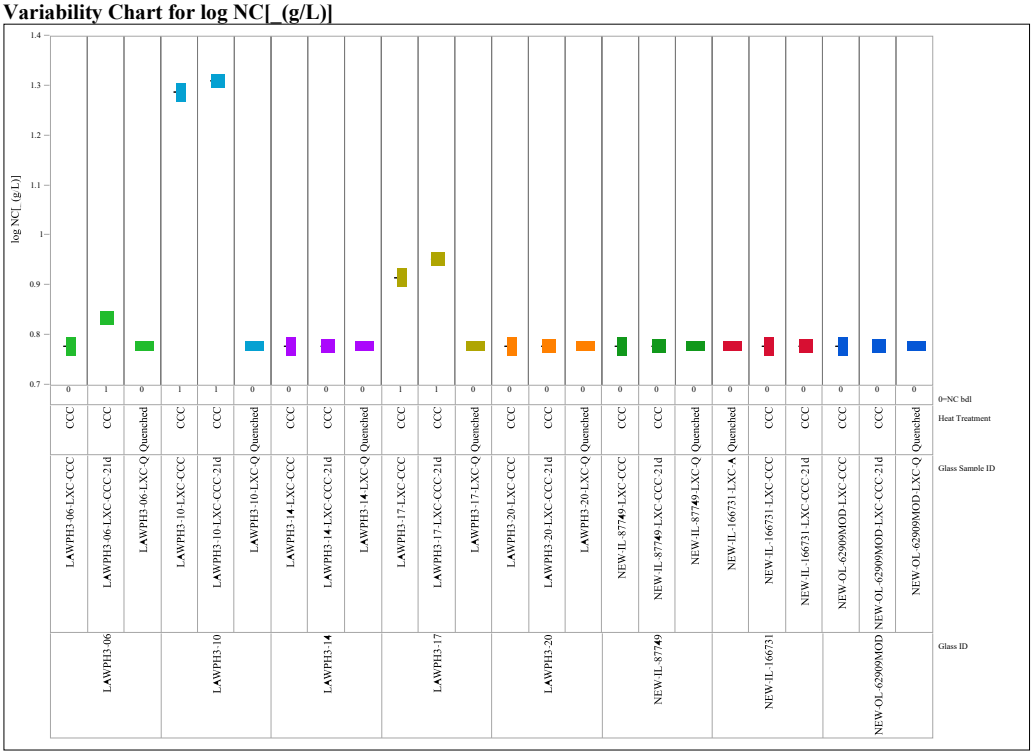
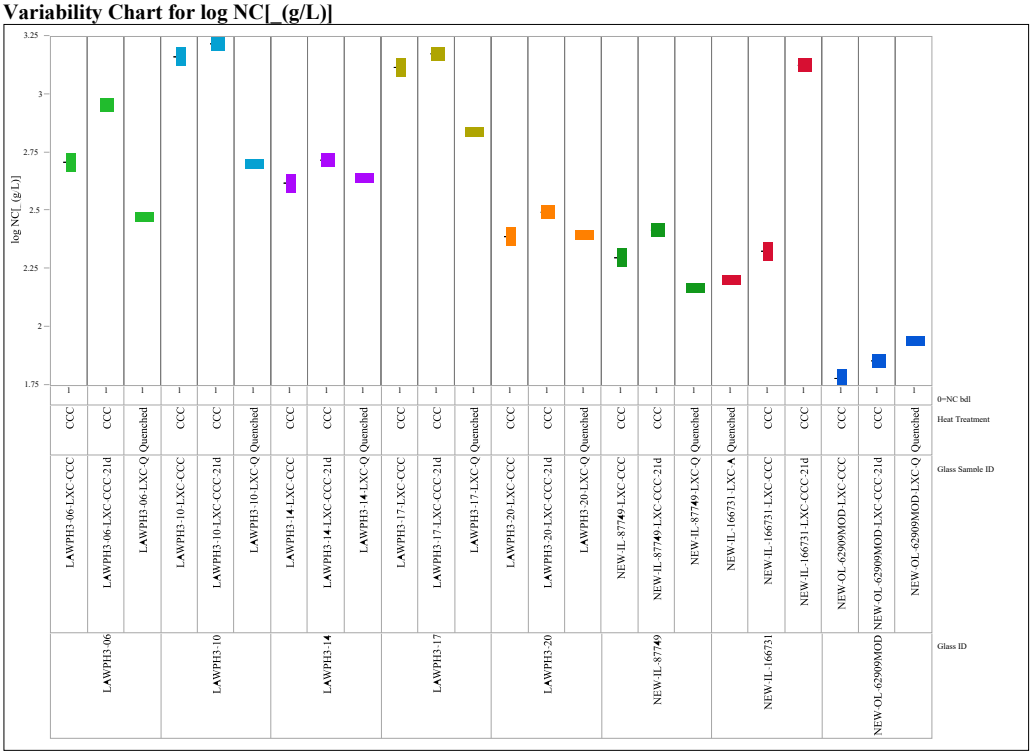


Exhibit B-1. Normalized PCT Results by Compositional View by Heat Treatment for Each Glass (continued)

Analyte=Na, Comp View=Measured
Variability Chart for log NC[_(g/L)]



Analyte=Na, Comp View=Target
Variability Chart for log NC[_(g/L)]

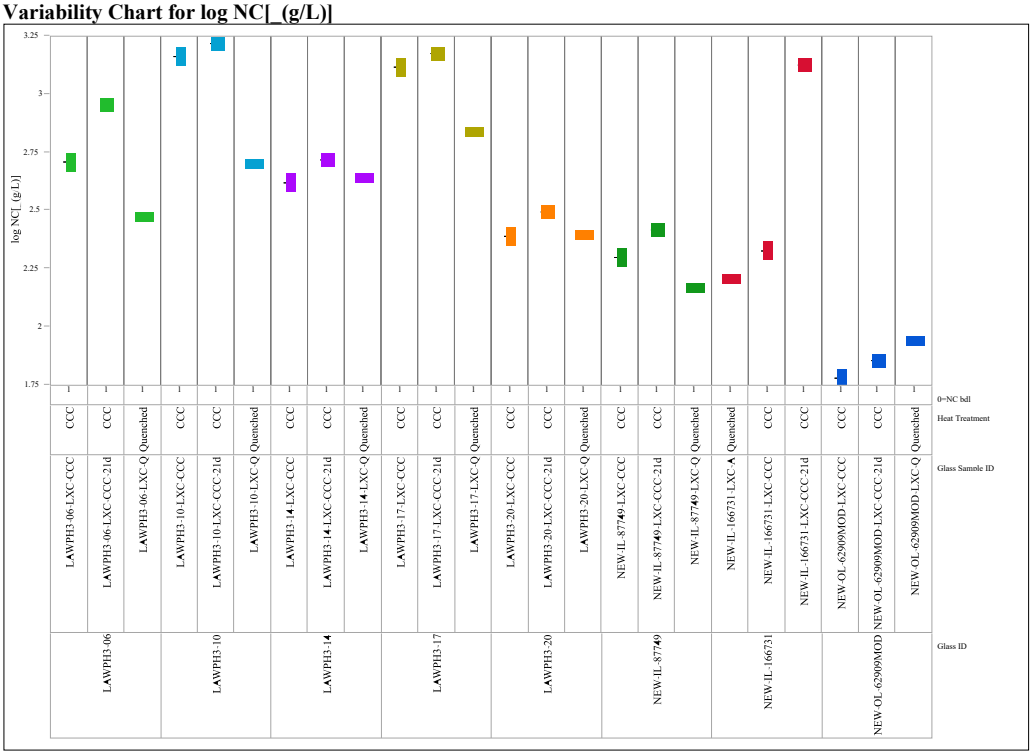
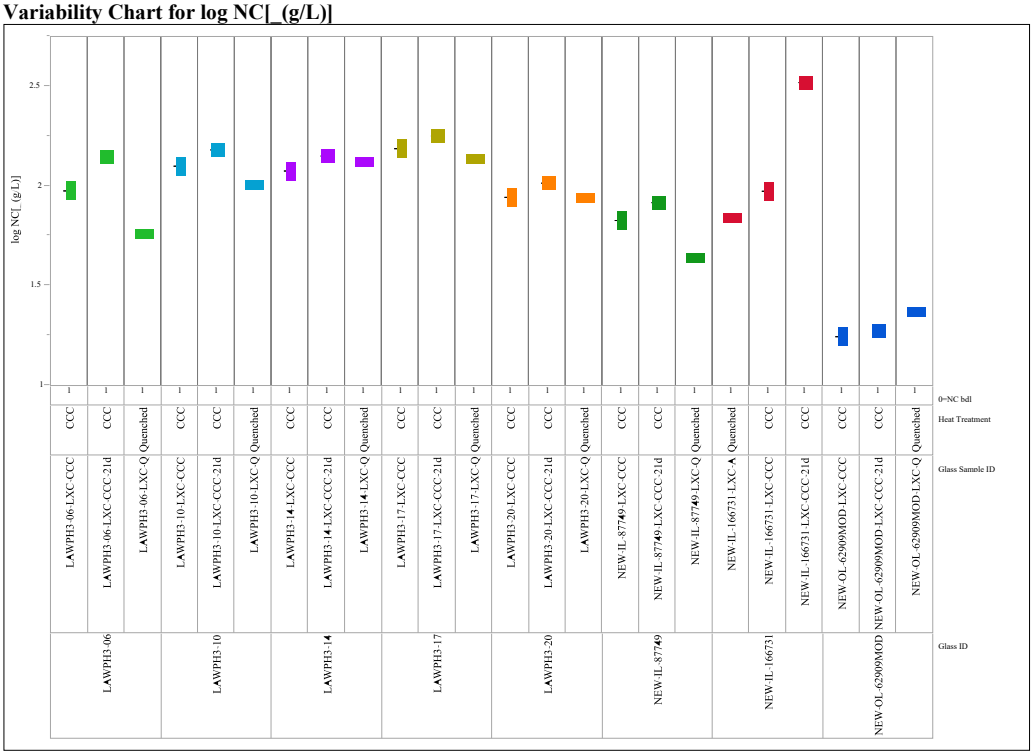


Exhibit B-1. Normalized PCT Results by Compositional View by Heat Treatment for Each Glass (continued)

Analyte=Si, Comp View=Measured
Variability Chart for log NC[_(g/L)]



Analyte=Si, Comp View=Target
Variability Chart for log NC[_(g/L)]

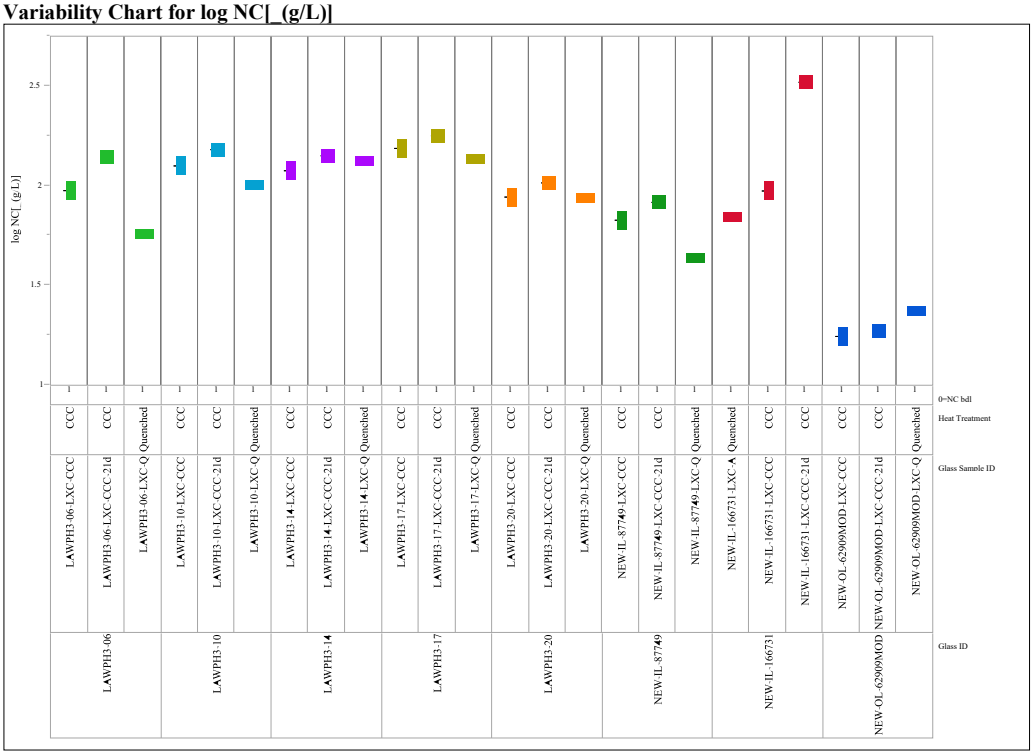
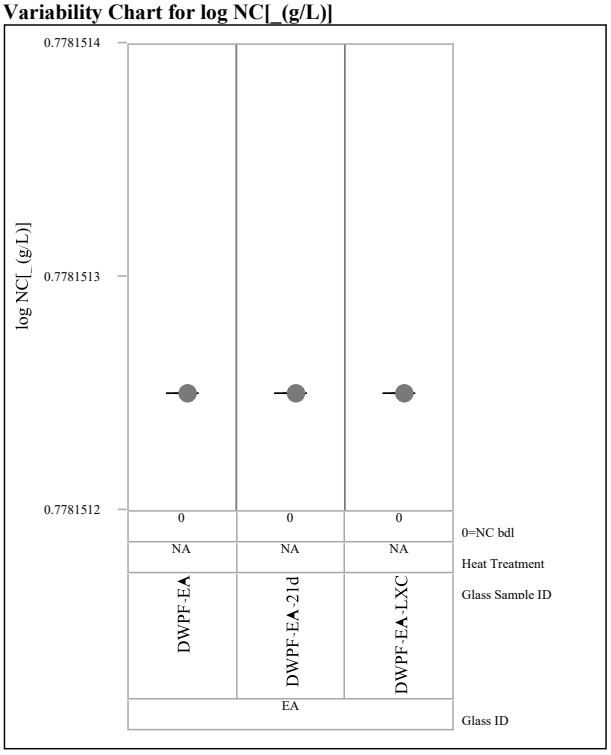


Exhibit B-1. Normalized PCT Results by Compositional View by Heat Treatment for Each Glass (continued)

Analyte=Al, Comp View=Reference
Variability Chart for log NC[_(g/L)]



Analyte=B, Comp View=Reference
Variability Chart for log NC[_(g/L)]

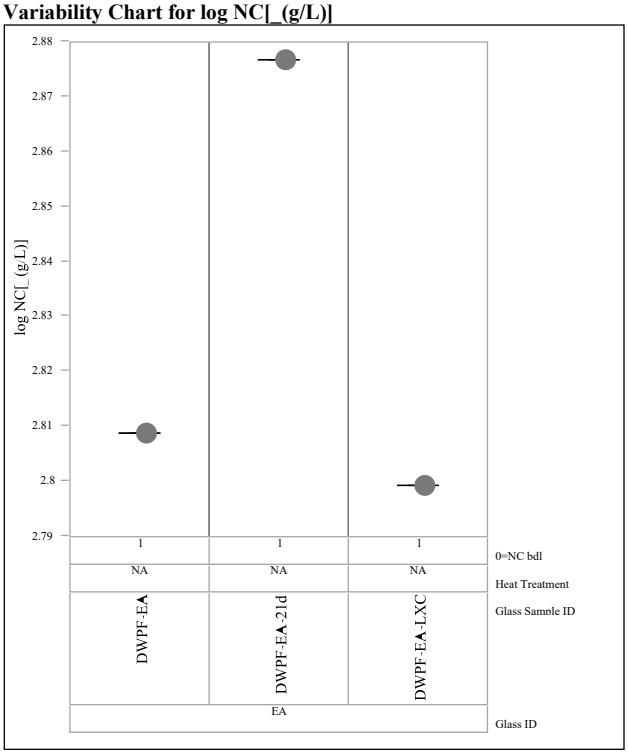
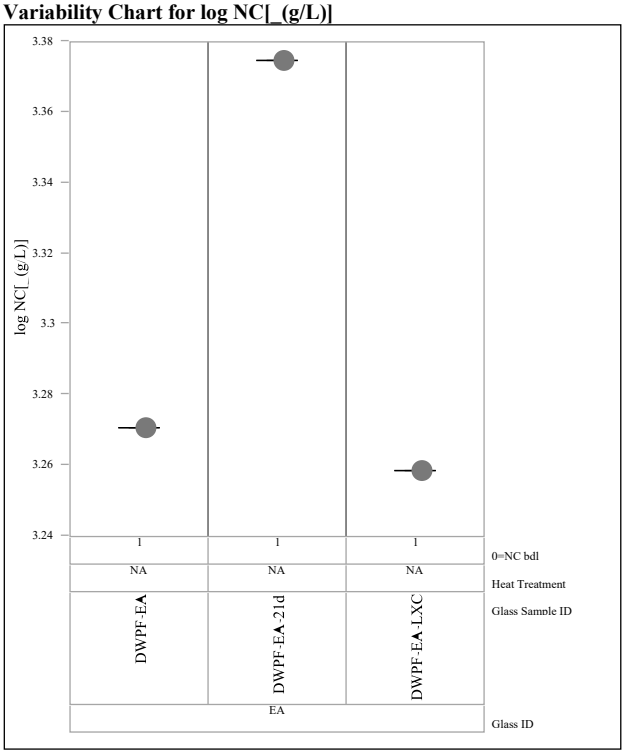


Exhibit B-1. Normalized PCT Results by Compositional View by Heat Treatment for Each Glass (continued)

Analyte=Na, Comp View=Reference
Variability Chart for log NC[_(g/L)]



Analyte=Si, Comp View=Reference
Variability Chart for log NC[_(g/L)]

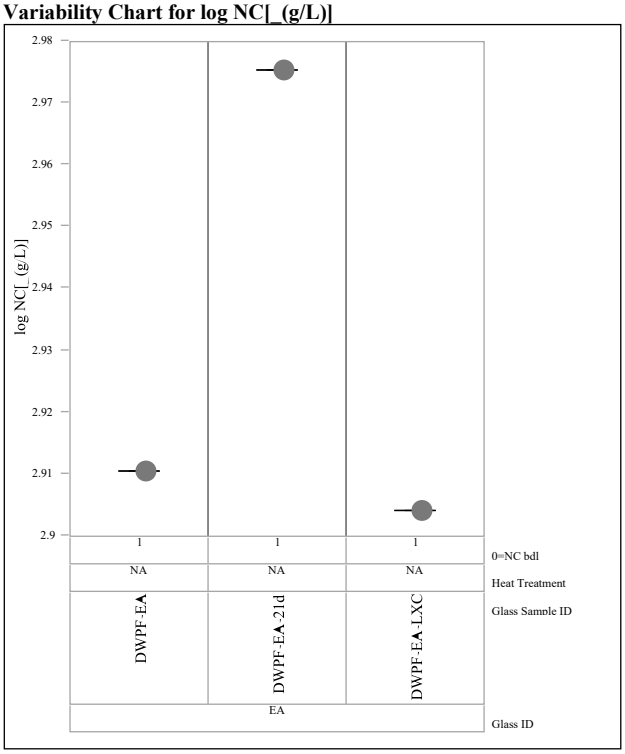


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results

Multivariate Correlations
Measured-CCC

	log NC[Al (g/L)]	log NC[B (g/L)]	log NC[Cr (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[Al (g/L)]	1.0000	0.1169	-0.1671	0.5846	0.4517
log NC[B (g/L)]	0.1169	1.0000	0.6542	0.8345	0.7116
log NC[Cr (g/L)]	-0.1671	0.6542	1.0000	0.3342	0.1856
log NC[Na (g/L)]	0.5846	0.8345	0.3342	1.0000	0.8790
log NC[Si (g/L)]	0.4517	0.7116	0.1856	0.8790	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix

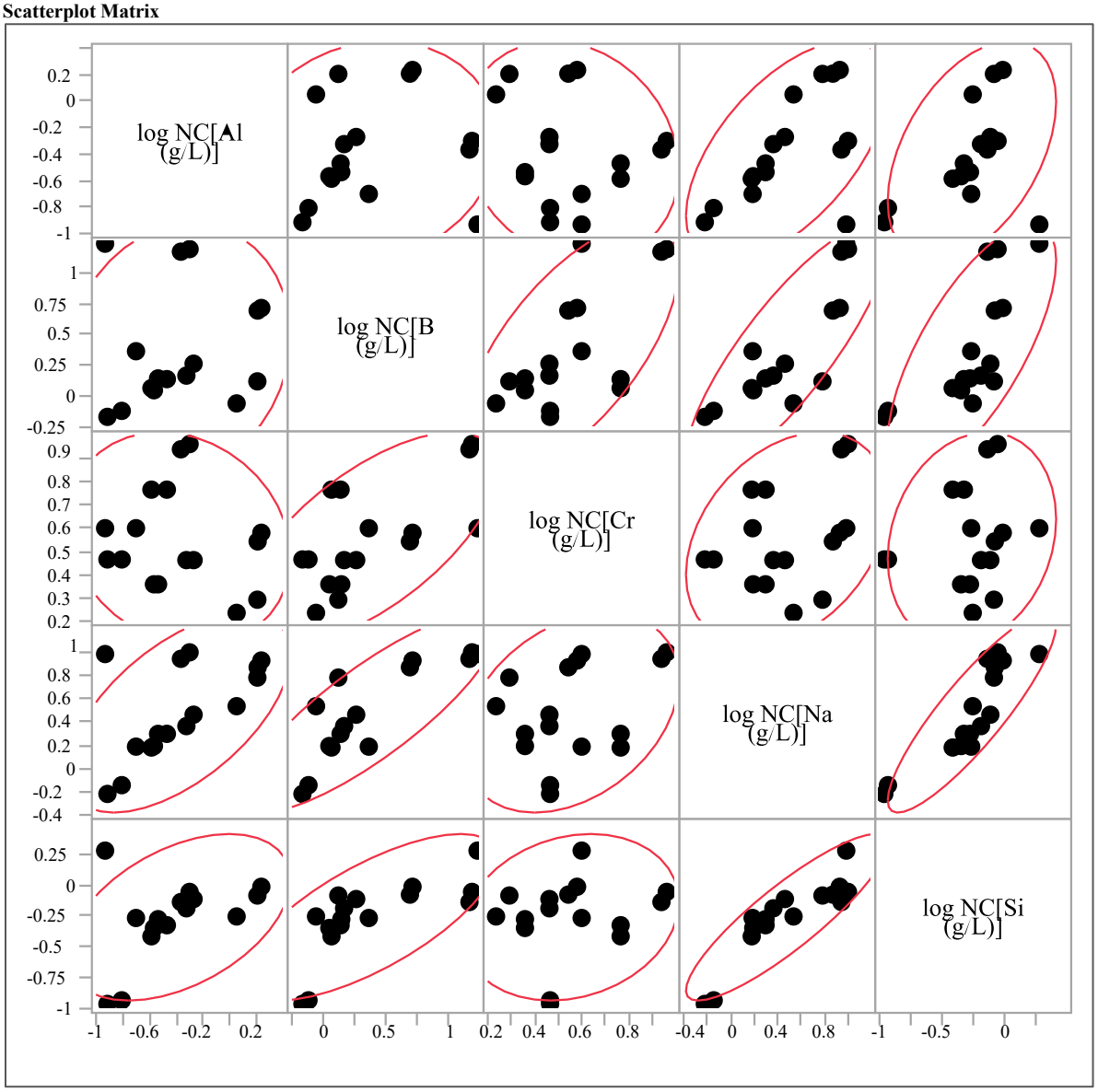


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results (continued)

Multivariate Correlations
Measured-Quenched

	log NC[Al (g/L)]	log NC[B (g/L)]	log NC[Cr (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[Al (g/L)]	1.0000	0.6848	-0.1929	0.8540	0.8901
log NC[B (g/L)]	0.6848	1.0000	-0.3057	0.7084	0.8180
log NC[Cr (g/L)]	-0.1929	-0.3057	1.0000	-0.4720	-0.2701
log NC[Na (g/L)]	0.8540	0.7084	-0.4720	1.0000	0.8716
log NC[Si (g/L)]	0.8901	0.8180	-0.2701	0.8716	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix

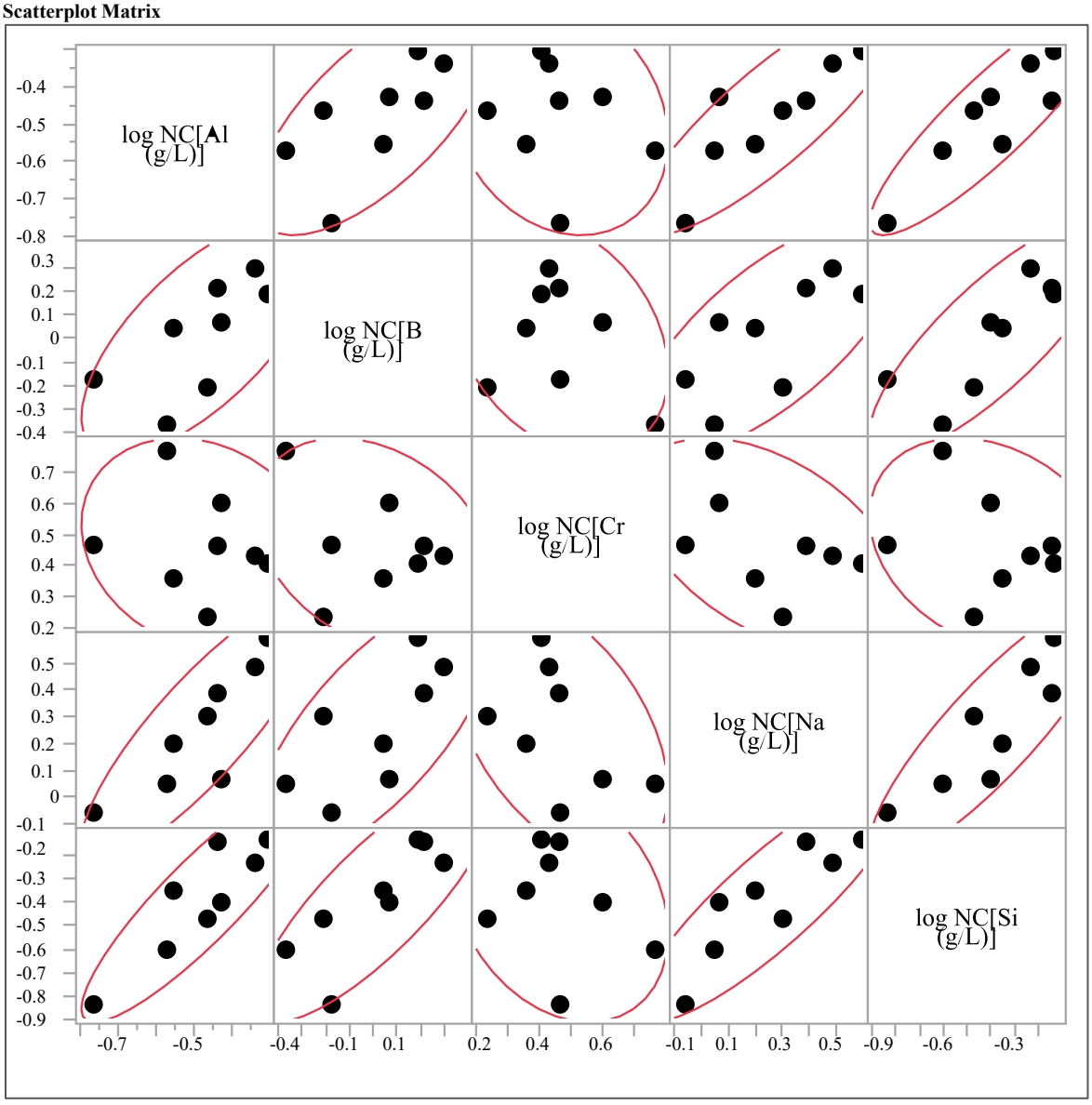


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results (continued)

Multivariate Correlations
Target-CCC

	log NC[Al (g/L)]	log NC[B (g/L)]	log NC[Cr (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[Al (g/L)]	1.0000	0.1541	-0.2649	0.5601	0.4506
log NC[B (g/L)]	0.1541	1.0000	0.4076	0.8636	0.7292
log NC[Cr (g/L)]	-0.2649	0.4076	1.0000	0.1558	0.0825
log NC[Na (g/L)]	0.5601	0.8636	0.1558	1.0000	0.8871
log NC[Si (g/L)]	0.4506	0.7292	0.0825	0.8871	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix

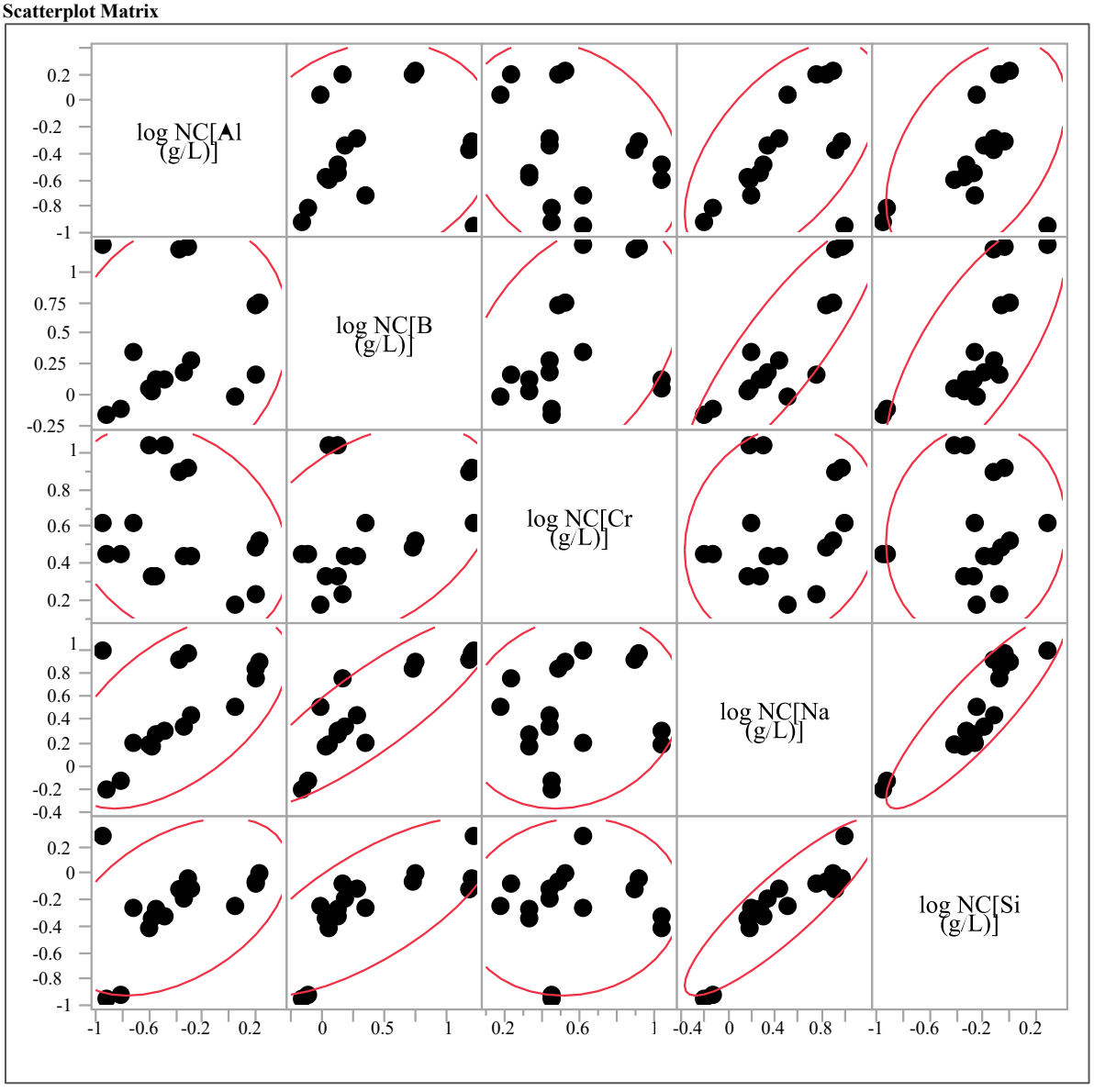


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results (continued)

Multivariate Correlations
Target-Quenched

	log NC[Al (g/L)]	log NC[B (g/L)]	log NC[Cr (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[Al (g/L)]	1.0000	0.7122	-0.2705	0.8714	0.8913
log NC[B (g/L)]	0.7122	1.0000	-0.5075	0.7632	0.8400
log NC[Cr (g/L)]	-0.2705	-0.5075	1.0000	-0.4850	-0.3502
log NC[Na (g/L)]	0.8714	0.7632	-0.4850	1.0000	0.8792
log NC[Si (g/L)]	0.8913	0.8400	-0.3502	0.8792	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix

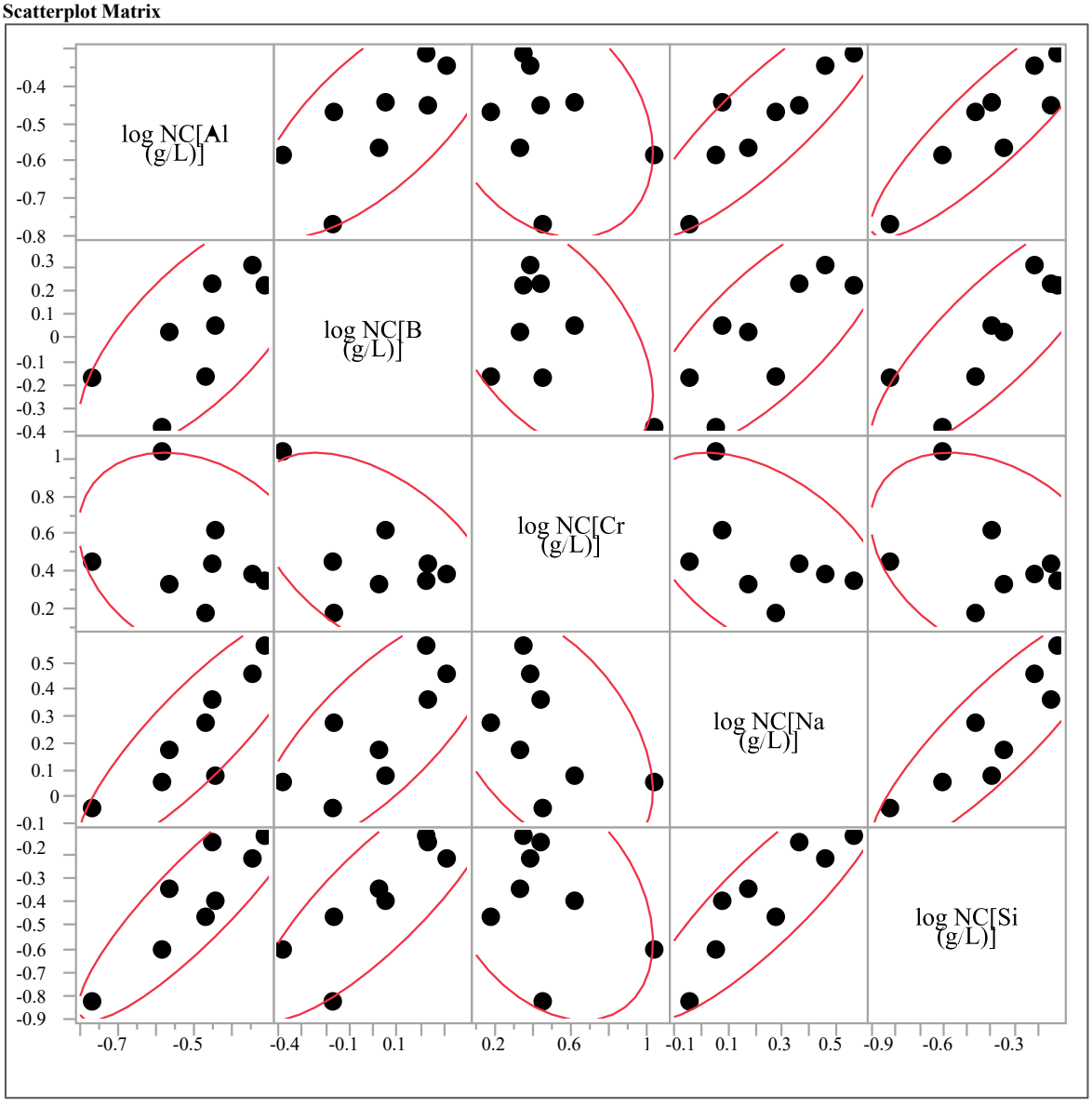


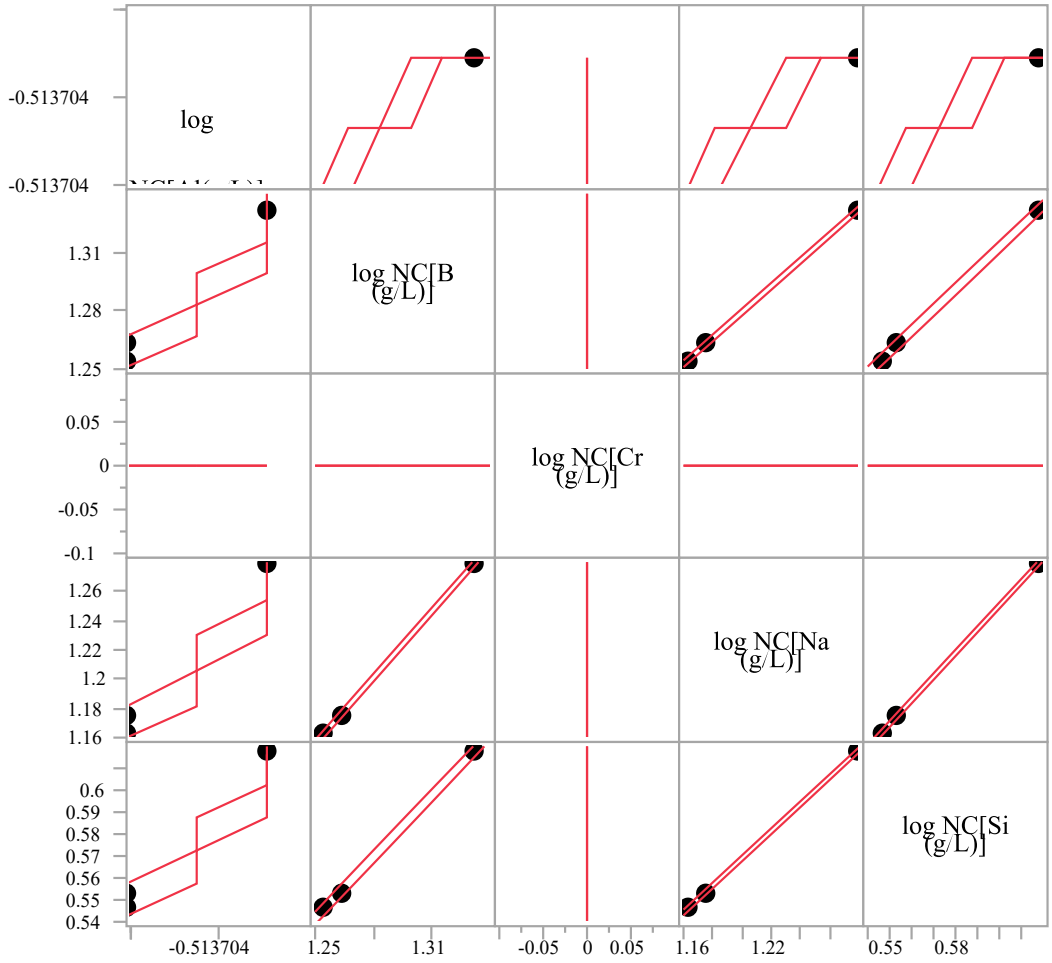
Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results (continued)

Multivariate Correlations
Reference-NA

	log NC[Al(g/L)]	log NC[B (g/L)]	log NC[Cr (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[Al(g/L)]	1.0000	0.9936	0.0000	0.9955	0.9967
log NC[B (g/L)]	0.9936	1.0000	0.0000	0.9998	0.9995
log NC[Cr (g/L)]	0.0000	0.0000	1.0000	0.0000	0.0000
log NC[Na (g/L)]	0.9955	0.9998	0.0000	1.0000	0.9999
log NC[Si (g/L)]	0.9967	0.9995	0.0000	0.9999	1.0000

There are 3 missing values. The correlations are estimated by Pairwise method.

Scatterplot Matrix



Distribution:

J. W. Amoroso, 999-W
A. D. Cozzi, 999-W
C. L. Crawford, 773-42A
W. C. Eaton, PNNL
T. B. Edwards, 999-W
A. P. Fellinger, 773-42A
S. D. Fink, 773-A
K. M. Fox, 999-W
B. L. Garcia-Diaz, 999-2W
V. Gervasio, PNNL
H. K. Hall, 999-1W
C. C. Herman, 773-A
A. M. Howe, 999-W
M. C. Hsieh, 999-W
T. Jin, PNNL
F. C. Johnson, 999-W
D. S. Kim, PNNL
A. A. Kruger, DOE-ORP
B. Lee, 999-W
C. E. Lonergan, PNNL
J. Manna, 999-W
D. J. McCabe, 773-42A
D. L. McClane, 773-41A
G. A. Morgan, 999-W
F. M. Pennebaker, 773-42A
W. T. Riley, 999-1W
R. L. Russell, PNNL
T. E. Skidmore, 730-A
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